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EDITORIAL

Longevity risk and capital markets: the 2023–2024 update

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This Special Issue of the *European Actuarial Journal* contains five contributions to the academic literature all dealing with longevity risk and capital markets. They were originally presented at *Longevity 18: The Eighteenth International Longevity Risk and Capital Markets Solutions Conference* that was held at Bayes Business School on 7–8 September 2023—and hosted by the Pensions Institute at City St George's, University of London.

Longevity risk and related capital market solutions have grown increasingly important in recent years, both in academic research and in the markets we refer to as the Life Market, i.e., the capital market that trades longevity- and mortality-linked assets and liabilities. Mortality improvements around the world are putting increasing pressure on governments, pension funds, life insurance companies and individuals to deal with the longevity risk they face. At the same time, capital markets can, in principle, provide vehicles to hedge longevity risk effectively and transfer the risk from those unwilling or unable to manage it to those willing to invest in this risk in exchange for appropriate risk-adjusted returns or to those who have a counterbalancing risk that longevity risk can hedge, e.g., life offices and reinsurers with mortality risk on their books. Many new investment products have been created both by the re/insurance industry and by the capital markets. Mortality catastrophe bonds are an early example of a successful insurance-linked security. Some new innovative capital market solutions for transferring longevity risk include longevity (or survivor) bonds, longevity (or survivor) swaps, mortality (or q-) forward contracts and reinsurance sidecars (also called strategic reinsurance vehicles). The aim of the *International Longevity Risk and Capital Markets Solutions Conferences* is to bring

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together academics and practitioners from all over the world to discuss and analyze these exciting new developments.

As with the previous conferences, *Longevity 18 (L18)* consisted of both academic papers and more practical and policy-oriented presentations. There were four plenary sessions ((1) Aging and health; (2) Longevity 2.0—Bringing the longevity risk market into its next phase; (3) Longevity issues; (4) Pension de-risking sets new records, while alternative capital finds its stride), each comprising a number of keynote presentations. A detailed summary of the sessions is provided as online supplementary material.

The academic papers that were selected for inclusion in this special issue went through a refereeing process subject to the usual high standards of the *European Actuarial Journal.* Below, we briefly discuss each of the five papers selected.

In 'Covid-19 mortality: The Proportionality Hypothesis', Cairns et al. [1] introduce and provide evidence to support the Proportionality Hypothesis—which states that Covid-19 infection fatality rates are approximately proportional to all-cause death rates by age and subgroup (e.g., socio-economic class). They also show that vaccination played a very significant role in preventing people infected with Covid-19 from needing to be hospitalized, since it reduced the average severity of an infection. Death rates involving Covid-19 were very significantly lower for people in the fully vaccinated group compared to the unvaccinated group. During the pandemic, death rates from other causes were in some cases reduced (e.g., flu and pneumonia), in some cases unchanged (e.g., lung cancer) and in some cases elevated (e.g., heart disease). The authors discuss the implications of their findings both for potential adjustments to extrapolative mortality models which allow for future pandemics in a way that is consistent with the Proportionality Hypothesis and for insurance companies in terms of both modelling extreme scenarios and the design of mortality catastrophe bonds.

In 'Decomposing changes in life annuities', Di Palo [2] proposes a novel approach for assessing changes in the expected present value of life annuities by adapting decomposition techniques traditionally applied in demographic research. Building upon Vaupel and Canudas-Romo's method, a closed-form relationship is derived within the continuous framework to express changes in the expected present value of life annuities. By employing commutation functions, the concept of financially adjusted life-table entropy is introduced to capture the interplay between mortality and interest rate changes, offering a new and comprehensive measure for evaluating annuity price sensitivity. The approach is illustrated through a numerical application using life tables from Italy and the United Kingdom.

In 'An iterative Least-Squares Monte Carlo approach for the simulation of cohort-based biometric indices', Bacinello et al. [3] tackle the problem of approximating the distribution of future biometric indices under a cohort-based perspective. Unlike period-based evaluations, cohort-based schemes require the computation of conditional expectations for which explicit solutions often do not exist. To overcome this issue, the authors suggest the application of a well-established methodology, i.e., the Least-Squares Monte Carlo approach. The idea is to approximate conditional expectations by combining simulations and regression techniques, thus avoiding a straightforward but computationally demanding

nested simulations method. To show the extreme flexibility and generality of the proposal, they provide extensive numerical results concerning two main longevity indices, life expectancy and lifespan disparity, obtained by adopting both single- and multi-population mortality models. Comparisons between period- and cohort-based results are made as well. Finally, the paper shows that the proposed methodology can be used to approximate other biometric indices at future dates for which cohort-based estimations are often replaced by period ones for computational simplicity.

In 'Individual health indices via register-based health records and machine learning', Hansen et al. [4] argue that quantifying individual latent health has potential value in healthcare policy. Their paper constructs an individual-level health index using detailed population-wide registers for individuals at advanced ages. In the methodology, the authors use traditional and machine learning techniques. They provide importance rankings of health variables and evaluate their ability to form an accurate stratification of health states. The high dimensionality of the data allows the authors to derive a small subset of health measures that enables similar analysis in settings where individual health registers may not be available. Finally, the authors use the indices to forecast individual-level mortality.

Finally, in 'Fast estimation of the Renshaw–Haberman model and its variants', Guo and Li [5] argue that in mortality modelling, cohort effects are often taken into consideration as they add insights about variations in mortality across different generations. Statistically speaking, models such as the Renshaw–Haberman model may provide a better fit to historical data compared to their counterparts that incorporate no cohort effects. However, when such models are estimated using an iterative maximum likelihood method in which parameters are updated one at a time, convergence is typically slow and may not even be reached within a reasonably established maximum number of iterations. Among others, the slow convergence problem hinders the study of parameter uncertainty through bootstrapping methods. The authors propose an intuitive estimation method that minimizes the sum of squared errors between actual and fitted log central death rates. The complications arising from the incorporation of cohort effects are overcome by formulating part of the optimization as a principal component analysis with missing values. Using mortality data from various populations, they demonstrate that their proposed method produces satisfactory estimation results and is significantly more efficient compared to the traditional likelihood-based approach.

Longevity 19 took place in Amsterdam on 16–17 September 2024; *Insurance: Mathematics & Economics* will publish a special issue. *Longevity 20* will take place in Singapore on 8–9 September 2025; the *Journal of Risk & Insurance* will publish a special issue. *Longevity 21* is planned for Rome in 2026.

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Longevity Risk and Capital Markets: The 2023-24 Update

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Abstract

We discuss the papers presented at *Longevity 18: The Eighteenth International Longevity Risk and Capital Markets Solutions Conference* that was held at Bayes Business School on 7-8 September 2023. We also discuss (1) the development of the longevity risk transfer market since it started in 2005-06 and (2) key factors that will affect the future of the market: peak cash flows; the volatility of life expectancy trends; population aging; the aging process and anti-aging treatments; preventative health care and later life wellness; artificial intelligence, machine learning, robotics, and quantum computing; the implications of global aging for financial markets and economic growth; and climate change and sustainable development.

Key words: longevity risk transfer, capital markets
JEL: G15, G22, G23, J11, O31, Q01, Q54

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Longevity risk and related capital market solutions have grown increasingly important in recent years, both in academic research and in the markets we refer to as the Life Market, i.e., the capital market that trades longevity-linked assets and liabilities.[1] Mortality improvements around the world are putting more and more pressure on governments, pension funds, life insurance companies, as well as individuals, to deal with the longevity risk they face. At the same time, capital markets can, in principle, provide vehicles to hedge longevity risk effectively and transfer the risk from those unwilling or unable to manage it to those willing to invest in this risk in exchange for appropriate risk-adjusted returns or to those who have a counterpoising risk that longevity risk can hedge, e.g., life offices and reinsurers with mortality risk on their books. Many new investment products have been created both by the insurance/reinsurance industry and by the capital markets. Mortality catastrophe bonds are an early example of a successful insurance-linked security. Some new innovative capital market solutions for transferring longevity risk include longevity (or survivor) bonds, longevity (or survivor) swaps, mortality (or *q*-) forward contracts and reinsurance sidecars (also called strategic reinsurance vehicles). The aim of the *International Longevity Risk and Capital Markets Solutions Conferences* is to bring together academics and practitioners from all over the world to discuss and analyze these exciting new developments.

2005: Longevity 1

The conferences have closely followed the developments in the market. The first conference (*L1*) was held at Bayes Business School[2] in London in February 2005. This conference was prompted by the announcement of the Swiss Re Vita mortality catastrophe bond in December 2003 and the European Investment Bank/BNP Paribas/PartnerRe longevity bond in November 2004.

2006: Longevity 2

The second conference (*L2*) was held in April 2006 in Chicago and hosted by the Katie School at Illinois State University.[3] Since *L1*, there have been further issues of mortality catastrophe bonds, as well as the release of the Credit Suisse Longevity Index. In the UK,

[1] Blake et al. (2013).
[2] Formerly Cass Business School.
[3] The conference proceedings for *L2* were published in the December 2006 issue of the *Journal of Risk and Insurance*.

new life companies backed by global investment banks and private equity firms were setting up for the express purpose of buying out the defined benefit (DB) pension liabilities of UK corporations.[4] Goldman Sachs announced it was setting up such a buy-out company itself (Rothesay Life) because the issue of pension liabilities was beginning to impede its mergers and acquisitions activities. It decided that the best way of dealing with pension liabilities was to remove them altogether from the balance sheets of takeover targets. So there was firm evidence that a new global market in longevity risk transference had been established. However, as with many other economic activities, not all progress follows a smooth path. The EIB/BNP/PartnerRe longevity bond did not attract sufficient investor interest and was withdrawn in late 2005. A great deal, however, was learned from this failed issue about the conditions and requirements needed to launch a successful capital market instrument.

2007: Longevity 3

The third conference (*L3*) was held in Taipei, Taiwan on 20-21 July 2007. It was hosted by National Chengchi University.[5] It was decided to hold *L3* in the Far East, not only to reflect the growing importance of Asia in the global economy, but also to recognize the fact that population aging and longevity risk are problems that affect all parts of the world and that what we need is a global approach to solving these problems.[6] Since the Chicago conference, there had been a number of new developments, including: the release of the LifeMetrics Indices covering England & Wales, the US, Holland and Germany in March 2007 by J.P. Morgan, the Pensions Institute and Towers Watson;[7] the world's first publicly announced longevity swap between Swiss Re and the UK life office Friends Provident in April 2007 (although this was structured as an insurance or indemnification contract rather than a capital market transaction).

Since the Taiwan conference, there were further developments in the capital markets. In December 2007, Goldman Sachs launched a monthly index suitable for trading life settlements.[8] The index, QxX.LS, was based on a pool of 46,290 anonymized US lives over the age of 65 from a database of life policy sellers assessed by the medical underwriter AVS. In 2008, Institutional Life Services (ILS) and Institutional Life Administration

[4] With a buy-out, an insurance company buys out the liabilities of a pension scheme which is paid for with the pension scheme assets and a loan if the scheme is in deficit at the time. Both the pension scheme assets and liabilities are removed from the corporate sponsor's balance sheet. Each member has a personal annuity from the insurer who takes over responsibility for paying the pensions. This contrasts with a buy-in, where the liabilities remain on the sponsor's balance sheet, but the scheme buys a bulk purchase annuity (BPA) from an insurance company and pays members' pensions from the annuity payments it receives from the insurer. The BPA is an asset of the scheme, not the members. A BPA is more commonly known as a group annuity in other countries, such as the US and Canada.

[5] The conference proceedings for *L3* were published in the Fall 2008 issue of the *Asia-Pacific Journal of Risk and Insurance*.

[6] In fact, Asia has the world's largest and fastest growing aging population (United Nations, 2007).

[7] www.lifemetrics.com

[8] Life settlements are traded life policies. In April 2007, the Institutional Life Markets Association started in New York, as the dedicated institutional trade body for the life settlements industry.

(ILA), a life settlements trading platform and clearing house, were launched by Goldman Sachs, Genworth Financial, and National Financial Partners. ILS and ILA were designed to modernize dealing in life settlements and meet the needs of consumers by ensuring permanent anonymity of the insured and of the capital markets by providing a central clearing house for onward distribution of life settlement assets, whether individually or in structured form.[9]

2008: Longevity 4

The fourth conference (*L4*) was held in Amsterdam on 25-26 September 2008. It was hosted by the Netspar Network for Studies on Pensions, Aging and Retirement and the Pensions Institute.[10]

Xpect Age and Cohort Indices were launched in March 2008 by Deutsche Börse. These indices cover, respectively, life expectancy at different ages and survival rates for given cohorts of lives in Germany and its regions, Holland and England & Wales.

The world's first capital market derivative transaction, a *q*-forward contract[11] between J. P. Morgan and the UK pension fund buy-out company Lucida, took place in January 2008. The world's first capital market longevity swap was executed in July 2008. Canada Life hedged £500m of its UK-based annuity book (purchased from the defunct UK life insurer Equitable Life). This was a 40-year swap customized to the insurer's longevity exposure to 125,000 annuitants. The longevity risk was fully transferred to investors, which included hedge funds and insurance-linked securities (ILS) funds. J. P. Morgan acted as the intermediary and assumed counter-party credit risk. In August 2011, ITV, the UK's largest commercial TV producer, completed a £1.7bn bespoke longevity swap with Credit Suisse for its £2.2bn pension plan: the cost of the swap is reported as £50m (3% of the swap value). The largest to date in the UK, covering £16bn of pension liabilities, was the longevity swap for the British Telecom Pension Scheme, arranged by the Prudential Insurance Co of America (PICA)[12] in July 2014. In February 2010, Mercer launched a pension buy-out index for the UK to track the cost charged by insurance companies to buy out corporate pension liabilities: at the time of launch, the cost was some 44% higher than the accounting value of the liabilities which highlighted the attraction of using cheaper alternatives, such as longevity swaps.[13]

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[9] In 2010, National Financial Partners became the sole owner of ILS/ILA.

[10] The conference proceedings for *L4* were published in the February 2010 issue of *Insurance: Mathematics and Economics*.

[11] Coughlan et al. (2007).

[12] We will use PICA to refer to the US-based insurer, which is a Prudential Financial Inc. company, as well as Prudential Retirement and Prudential Retirement Insurance and Annuity Company (PRIAC).

[13] The Index tracks the relationship between the accounting liability for retirees of a defined benefit pension plan and two cost measures: the estimated cost of transferring the pension liabilities to an insurance company (i.e., a buy-out) and the approximate total economic cost of retaining the pension obligations on the balance sheet.

Also in 2008, Credit Suisse initiated a longevity swap with Centurion Fund Managers, whereby Centurion acquired a portfolio of synthetic (i.e., simulated) life policies, based on a longevity index built by Credit Suisse.

2009: Longevity 5

The fifth conference (*L5*) was held in New York on 25-26 September 2009.[14]

In 2009, survivor swaps began to be offered to the market based on Deutsche Börse's Xpect Cohort Indices.

2010: Longevity 6

The sixth conference (*L6*) was held in Sydney on 9-10 September 2010.[15]

On 1 February 2010, the Life and Longevity Markets Association (LLMA) was established in London. Its members were Aviva, AXA, Deutsche Bank, J.P. Morgan, Morgan Stanley, Prudential (UK) PLC, and Swiss Re. LLMA was formed to promote the development of a liquid market in longevity- and mortality-related risks. This market is related to the ILS market and is also similar to other markets with trend risks, e.g., the market in inflation-linked securities and derivatives. LLMA aims to support the development of consistent standards, methodologies and benchmarks to help build a liquid trading market needed to support the future demand for longevity protection by insurers and pension funds. In April 2011, the LifeMetrics indices were transferred to LLMA with the aim of establishing a global benchmark for trading longevity and mortality risk.

In December 2010, building on its successful mortality catastrophe bonds and taking into account the lessons learned from the EIB bond, Swiss Re launched a series of eight-year longevity-based ILS notes valued at $50m. To do this, it used a special purpose vehicle, Kortis Capital, based in the Cayman Islands. As with the mortality bonds, the longevity notes are designed to hedge Swiss Re's own exposure to mortality and longevity risk. In particular, holders of the notes were exposed to an increase in the spread between mortality improvements in 75-85-year-old English & Welsh males and 55-65-year-old US males, indicating that Swiss Re has life insurance (mortality risk) exposure in the US and pension (longevity risk) exposure in the UK.

[14] The conference proceedings for *L5* were published in the *North American Actuarial Journal* (Volume 15, Number 2, 2011).

[15] The conference proceedings for *L6* were published in the October 2011 issue of *Geneva Papers on Risk and Insurance - Issues and Practice.*

2011: Longevity 7

The seventh conference (*L7*) was held at the House of Finance, Goethe University, Frankfurt, Germany on 8-9 September 2011.[16]

In January 2011, the Irish government announced that it would issue bonds that allow the creation of sovereign annuities.[17] This followed a request from the Irish Association of Pension Funds and the Society of Actuaries in Ireland. If the bonds are purchased by Irish pension funds, this will have a beneficial effect on the way in which the Irish funding standard values pension liabilities. On account of a statutory deadline to submit a deficit repair plan, 2013 was a record year for bulk annuity transactions in Ireland with sovereign annuities being used in a significant number of transactions.

The world's first longevity swap for non-pensioners (i.e., for active and deferred members of a pension plan) took place in January 2011, when J. P. Morgan executed a £70m 10-year *q*-forward contract with the Pall (UK) pension fund. This was a value swap designed to hedge the longevity risk in the value of Pall's pension liabilities, rather than the longevity risk in its pension payments as in the case of cash flow swaps which have been the majority of the swaps that had so far taken place. Longevity risk prior to retirement is all valuation risk: there is no cash flow risk and most of the risk lies in the forecasts of mortality improvements. Further, the longevity exposure of deferreds is not well defined as a result of the options that plan members have, e.g., lump sum commutation options, early retirement options, and the options to increase spouses' benefits at the expense of members' benefits.

In April 2011, the International Society of Life Settlement Professionals (ISLSP)[18] formed a life settlement and derivatives committee and announced that it was developing a life settlement index. The purpose of the index was to benchmark net asset values in life settlements trading. Investors need a reliable benchmark to measure performance and the index will help turn US life insurance policies into a tradable asset class according to ISLSP. The calculation agent for the index was AA Partners.

The first pension risk transfers deals outside the UK took place in 2009-11. The first buy-in deal outside the UK took place in 2009 in Canada; it was arranged by Sun Life Financial and valued at C$50m. The first buy-in deal in Europe took place in December 2010 between the Dutch food manufacturer Hero and the Dutch insurer Aegon (€44m). The first

[16] The conference proceedings for *L7* were published in the September 2013 issue of the *Journal of Risk and Insurance*.

[17] A sovereign annuity, introduced by the 2011 Social Welfare and Pensions Act, is an annuity contract issued by insurance companies where the annual income payment is linked directly to payments under bonds issued by Ireland or any other EU member state (known as reference bonds). The payments can be reduced if there is an event of non-performance in relation to the bonds to which the annuity is referenced. This contrasts with a standard annuity where the insurer guarantees to make the agreed payments for the lifetime of the annuitant.

[18] www.islsp.org

buy-in deal in the US took place in May 2011 between Hickory Springs Manufacturing Company and PICA ($75m). The first buy-out deal outside the UK was announced in May 2011 and involved the C$2.5bn Nortel pension plan in Canada. In September 2011, CAMRADATA Analytical Services launched a new pension risk transfer (PRT) database for US pension plans. The database provides insurance company organizational information, pension buy-in and buy-out product fact sheets and screening tools, pricing data, up-to-date information on each PRT provider's financial strength and relevant industry research. Users can request pension buy-in and buy-out quotes directly from providers, including American General Life Companies, MetLife, Pacific Life, Principal Financial Group, PICA, Transamerica and United of Omaha.

The first international longevity reinsurance[19] transaction took place in June 2011 between Rothesay Life (UK) and PICA and was valued at £100m. The first life book reinsurance swap since the 2007-08 Global Financial Crisis took place in June 2011 between Atlanticlux and institutional investors and was valued at €60m.

2012: Longevity 8

The eighth conference (*L8*) was held at the University of Waterloo, Ontario, Canada on 7-8 September 2012.[20]

In February 2012, Deutsche Bank executed a massive €12bn index-based longevity swap for Aegon in the Netherlands. This solution was based on Dutch population data and enabled Aegon to hedge the liabilities associated with a portion of its annuity book. Because the swap[21] was out of the money, the notional amount of longevity risk transferred (€300mn) was far less than that suggested by the headline €12bn figure. Nonetheless, the key driver for this transaction from Aegon's point of view was the reduction in economic capital it hoped to achieve. Most of the longevity risk was passed on to capital markets investors in the form of private bonds and swaps. The duration of the hedge was 10 years.

In June 2012, General Motors Co. (GM) in the US announced a huge deal to transfer up to $26bn of pension obligations to PICA. This is by far the largest ever longevity risk transfer deal globally. The transaction is effectively a partial pension buy-out involving the purchase of a group annuity contract for GM's salaried retirees who retired before 1 December 2011 and refused a lump sum offer in 2012. To the extent retirees accepted a lump sum payment in lieu of future pension payments, the longevity risk was transferred directly to the retiree.[22] The deal was classified as a partial buy-out rather than a buy-in because it involved the settlement of the obligation. In other words, the portion of the liabilities associated with the annuity contract will no longer be GM's obligation.

[19] The insurance industry's name for a longevity swap.
[20] The conference proceedings for *L8* were published in the *North American Actuarial Journal* (Volume 18(1), 2014).
[21] It is structured as a bull call option spread – see Michaelson and Mullholland (2014).
[22] In fact, the lump sum was only being offered to limited cohorts of plan members.

Moreover, in contrast to a buy-in, the annuity contract will not be an asset of the pension plan, but instead an asset of the retirees. In October 2012, GM did a $3.6bn buy-out of the pension obligations of its white-collar retirees. Also in October 2012, Verizon Communications executed a $7.5bn bulk annuity buy-in with PICA. The buy-out deals in the US in 2012 amounted to $36bn.

2013: Longevity 9

The ninth conference (*L9*) was held in Beijing, China on 6-7 September 2013.[23]

The first £1bn+ PRT in the UK took place in July 2013, when Citigroup executed a £1.5bn buy-out for its EMI Group Pension Fund with Pension Insurance Corporation (PIC), a specialist UK buy-out insurer, covering all 20,000 members.[24]

In February 2013, the first medically underwritten bulk annuity (MUBA) transaction was executed in the UK by the UK insurer Partnership.[25] This involved each member filling in a medical questionnaire in order to get a more accurate assessment of their life expectancy based on their medical history or lifestyle. This was particularly useful in the case of 'top slicing', where scheme trustees insure the pensioners (who will typically be the company directors) with the largest liabilities and who therefore represent a disproportionate risk concentration for the scheme. In December 2014, Partnership executed a £206m medically underwritten bulk annuity transaction with a 'top slicing' arrangement for the £2bn Taylor Wimpey pension scheme. UK insurer Legal & General (L&G) transacted a £230m medically-underwritten buy-in in December 2015. The process of collecting medical information has been streamlined in recent years using third-party medical data collectors, such as MorganAsh, Age Partnership and Aon's AHEAD platform. It is expected that the share of medically underwritten de-risking deals will increase significantly over the next few years in the UK, with new business more than doubling from £540m in 2014 to £1,200m in 2015.[26]

In April 2013, L&G reported its first non-UK deal, the buy-out of a €136m annuity book from New Ireland Life. In June 2013, the Canadian Wheat Board executed a C$150m pension buy-in from Sun Life of Canada, involving inflation-linked annuities, while in March 2014, an unnamed Canadian company purchased C$500m of annuities from an insurer (reported to be Industrial Alliance), making it the largest ever Canadian pension risk transfer deal to date.

[23] The conference proceedings for *L9* were published in July 2015 in *Insurance: Mathematics and Economics* 63(C): 1-203.
[24] https://www.professionalpensions.com/news/2280322/emi-scheme-agrees-recordbreaking-gbp15bn-buyout
[25] Harrison and Blake (2013).
[26] Hunt and Blake (2016).

In August 2013, Numerix, a risk management and derivatives valuation company, introduced a new asset class called 'life' on its risk modeling platform (in addition to equities, bonds and commodities). In November 2013, SPX Corp. of Charlotte, NC, purchased a buy-out contract with Massachusetts Mutual Life Insurance Co. (MassMutual) as part of a deal that moved $800m in pension obligations off SPX's balance sheet.

In September 2013, UK consultant Barnett Waddingham launched an insurer financial strength review service which provides information on an insurer's structure, solvency position, credit rating, and key risks in their business model. This service was introduced in response to concerns about the financial strength of some buy-out insurers.

In November 2013, Deutsche Bank introduced the Longevity Experience Option (LEO). It is structured as an out-of-the-money call option spread on 10-year forward survival rates and has a 10-year maturity. The survival rates will be based on males and females in five-year age cohorts (between 50 to 79) derived from the England & Wales and Netherlands LLMA longevity indices. LEOs will be traded over-the-counter under a standard ISDA[27] contract. They allow longevity risk to be transferred between pension funds, insurance companies and investors. They are intended to provide a cheaper and more liquid alternative to bespoke longevity swaps which are generally costly and time consuming to implement. Purchasers of the option spread, such as a pension fund, will gain if realized survival rates are higher than the forward rates, but the gains will be limited, thereby providing some comfort to the investors providing the longevity hedge. The 10-year maturity is the maximum that Deutsche Bank believes investors will tolerate in the current stage in the development of a market in longevity risk transfers. It was reported that Deutsche Bank executed its first LEO transaction with an ILS fund in January 2014.

In December 2013, Aegon executed a second risk transfer to capital markets investors and reinsurers, including SCOR. The €1.4bn index-based hedge involved Dutch longevity risk and US mortality risk, had a notional value of €200m and a duration of 20 years. Société Générale was the intermediary in the deal and Risk Management Solutions (RMS) was the modelling agent.

Also in December 2013, the Joint Forum reported on the results of its consultation on the longevity risk transfer market. It concluded that this market is not yet big enough to raise systemic concerns, but 'their massive potential size and growing interest from investment banks to mobilize this risk make it important to ensure that these markets are safe, both on a prudential and systemic level' (Joint Forum (2013, p.2)).

[27] International Swaps and Derivatives Association; https://www.isda.org/

2014: Longevity 10

The tenth conference (*L10*) was held at Universidad Diego Portales in Santiago, Chile on 3-4 September 2014.[28]

In February 2014, the Mercer Global Pension Buy-out Index was introduced. It shows the benchmark prices of 18 independent third-party insurers in the four countries with the greatest interest in buying out DB liabilities: UK, US, Canada and Ireland. Costs were highest in the UK where the cost of insuring £100m of pension liabilities was 123% of the accounting value of the liabilities – equivalent to £32 per £1 p.a. of pension.[29] The comparable costs in Ireland, the U.S. and Canada were 117%, 108.5% and 105%, respectively. The higher cost in the UK is in part due to the greater degree of inflation uprating in the UK compared with the other countries. The difference between the US and Canada is explained by the use of different mortality tables. Rising interest rates and equity markets will lower funding deficits and hence lead to lower buy-out costs in future, especially in the US.

In March 2014, L&G announced the biggest single buy-out in the UK to date when it took on £3bn of assets and liabilities from ICI's pension fund, a subsidiary of AkzoNobel. In December 2014, L&G announced the largest ever UK buy-in valued at £2.5bn with US manufacturer TRW. Around £13bn of bulk annuity deals were executed in the UK in 2014, the largest volume of business since the de-risking market began in 2006 and beating the previous best year of 2008, just before the Global Financial Crisis, when £7.9bn of deals were completed. The total volume of de-risking deals in the UK in 2014 (covering buy-outs, buy-ins and longevity swaps) was £35bn, a significant proportion of which is accounted for by the £16bn BT longevity swap.

In July 2014, Mercer and Zurich launched Streamlined Longevity Solution, a longevity swap hedge for smaller pension schemes with liabilities above £50m. This is part of a new Mercer SmartDB service which provides bespoke longevity de-risking solutions and involves a panel of reinsurers led by Zurich. It reduces the costs by having standardized processes for quantifying the longevity risk in each pension scheme. The first deal, valued at £90m, was transacted with an unnamed UK pension scheme in December 2015.

In August 2014, the Dutch insurer Delta Lloyd executed a six-year index-based longevity hedge with Reinsurance Group of America (RGA Re) with a notional value of €300m and providing partial cover on €12bn of liabilities.[30]

[28] The conference proceedings for L10 were published in the *Journal of Risk and Insurance*, Volume 84, Number S1, April 2017, 273-532.
[29] Towers Watson (2015) *Corporate Briefing*, April.
[30] https://www.bloomberg.com/news/articles/2014-08-22/delta-lloyd-completes-16-billion-longevity-swap-with-rga

In November 2014, the Longevity Basis Risk Working Group (2014) of the Institute and Faculty of Actuaries (IFoA) and LLMA published 'Longevity Basis Risk: A Methodology for Assessing Basis Risk'. This study develops a new framework for insurers and pension schemes to assess longevity basis risk.[31] This, in turn, will enable simpler, more standardized and easier to execute index-based longevity swaps to be implemented. Index-based longevity swaps allow insurers and pension schemes to offset the systematic risk of increased liabilities resulting from members living longer than expected. It had hitherto been difficult to assess how effectively an index-based longevity swap could reduce the longevity risk in a particular insurance book or pension scheme. The methodology developed in the report is applicable to both large schemes (which are able to use their own data in their models) and smaller schemes (by capturing demographic differences such as socio-economic class and deprivation).

In December 2014, Towers Watson launched Longevity Direct, an off-shore longevity swap hedging service that gives medium-sized pension schemes with liabilities between £1-3bn direct access to the reinsurance market, via its own cell (or captive) insurance company. This allows schemes to bypass insurers and investment banks, the traditional de-risking intermediaries, and significantly reduces transactions costs and completion times, while still getting the best possible reinsurance pricing. The first reported transaction on the Longevity Direct platform was the £1.5bn longevity swap executed by the Merchant Navy Officers Pension Fund (MNOPF) in January 2015 which was insured by MNOPF IC, a newly established cell insurance company based in the Channel Island of Guernsey, and then reinsured with Pacific Life Re. In February 2015, PwC launched a similar off-shore longevity swap service for pension schemes as small as £250m. It used a Guernsey-based incorporated cell company called Iccaria, established by Artex Risk Solutions, to pass longevity risk directly on to reinsurers. The arrangement is fully collateralized and each scheme owns a cell within Iccaria which again avoids the costs of dealing with insurer and investment bank intermediaries.

There is increasing demand from reinsurance companies for exposure to large books of pension annuity business to offset the risk in their books of life insurance.[32] For example, in 2014, Warren Buffett's Berkshire Hathaway agreed to a £780m quota-reinsurance deal

[31] According to the Institute and Faculty of Actuaries: 'Longevity basis risk arises because different populations, or subpopulations, will inevitably experience different longevity outcomes. This is a significant issue for those wishing to hedge longevity risk using a published mortality index – whether they be pension schemes, insurers, reinsurers, or banks'. The IFoA and Life and Longevity Markets Association have developed a readily-applicable methodology for quantifying the basis risk arising from the use of population-based mortality indices for managing longevity risk; https://www.actuaries.org.uk/learn-and-develop/research-and-knowledge/actuarial-research-centre-arc/recent-research/longevity-basis-risk

[32] The key risk in life books, mortality risk (the risk that life policy holders die sooner than expected, so payouts are made before sufficient premiums have been collected), can be offset (at least partially) by assuming the longevity risk in annuity books (the risk that annuitants live longer than expected). If there is an unanticipated reduction in life expectancy, the increased payouts on the life book are offset by the reduced payouts on the annuity book, and vice versa. This is known as a 'natural hedge'.

with PIC.[33] Similarly, in August 2014, AXA France executed a €750m longevity swap with Hannover Re.

2015: Longevity 11

The eleventh conference (*L11*) was hosted by Université Lyon 1, Lyon, France on 7-8 September 2015.[34]

In March 2015, the UK government announced that it would introduce a new competitive corporate tax structure to allow ILS to be domiciled in the UK and the associated Risk Transformation Regulations 2017, creating a new regulated activity of insurance risk transformation, came into effect in December 2017. In May 2015, Rothesay Life, the insurance company owned by Goldman Sachs, bought out the liabilities of Lehman Brothers' UK pension scheme for £675m, thereby securing the pensions of former employees of the company associated with the beginning of the Global Financial Crisis. In April 2016, Rothesay bought two-thirds of Aegon's UK annuity book – representing 187,000 policy holders – for £6bn, bringing total assets under management to £20bn and total lives assured to over 400,000. This was the first substantial annuity transfer since the introduction of Solvency II[35] in January 2016. This new solvency regime for EU-based insurers increased capital requirements and has reduced the attractiveness of annuities as a business line for certain insurers and raised buy-out prices by 5-7%.[36]

In 2015, L&G entered both the US and European pension risk transfer markets. It executed a $450m transaction with the US subsidiary of Royal Philips covering 7,000 scheme members in October and a €200m deal with ASR Nederland NV, a Dutch insurer in December. The pension obligations were transferred to L&G Re in cooperation with Hannover Re. L&G said: 'The pension risk transfer market has become a global business…The potential market for pension risk transfer in the US, UK and Europe is huge, and will play out over many decades'. Two US insurers were also involved in the Royal Philips deal: PICA also acquired $450m of scheme liabilities covering another 7,000 members, while American United Life Insurance Company issued annuity contracts to 3,000 deferred scheme members, valued at $200m.

In January 2015, the Bell Canada Pension Plan executed a C$5bn longevity swap with Sun Life Financial,[37] SCOR, and RGA Re; it was SCOR's first transaction in North America. In the process, Canada became the first country apart from the UK to have all three pension risk transfer solutions actively in use. In the same year, it completed its first inflation-linked

[33] Reported in *Financial News*, 14 July 2014.
[34] The conference proceedings for *L11* were published in *Insurance: Mathematics and Economics*, 78 (2018), 157–380.
[35] https://www.eiopa.europa.eu/browse/solvency-2_en and https://en.wikipedia.org/wiki/Solvency_II
[36] *Financial News*, 28 March–3 April 2016.
[37] Sun Life Financial uses the RMS Longevity Risk Model, which RMS describes as a 'structural meta-model of geroscience advancement'.

buy-in annuity transaction, while in 2017, it completed its first buy-in annuity covering active future benefits.[38] In June 2015, Delta Lloyd did a second €12bn longevity swap with RGA Re: the swap was also index-based, with an 8-year duration and had a notional value of €350m.[39] In July 2015, Aegon executed one valued at €6bn with Canada Life Re, a new entrant to the de-risking market in 2015. Another new entrant was Scottish Widows.

In June 2015, the Mercer Pension Risk Exchange was launched. It gives clients in the US, UK and Canada up-to-date buy-in and buy-out pricing based on their plan's data. It collects prices provided monthly by insurers in the bulk market, based on plan benefit structures and member data. Mercer said: 'Many companies have the appetite to transfer pension risk off their balance sheet, but they face barriers: lack of clear information about the true cost of a buy-in or buy-out, limited transparency, the fluctuation of market rates and plan economics to name but a few. [The exchange will enable] sponsoring employers and trustees to be more strategic and sophisticated in their approach and to know that they are executing a buy-in or a buy-out at the best time for them and at a competitive price'.

2016: Longevity 12

The twelfth conference (*L12*) was held in Chicago on 29-30 September 2016 and hosted by the Society of Actuaries and the Pensions Institute.[40]

In April 2016, Willis Towers Watson (WTW[41]) released PulseModel which uses medical science and the opinions of medical experts to improve longevity predictions. For example, the model predicts that 16% of 50-year-old men in the UK will develop type-2 diabetes in the next 20 years, but this rises to 50% for those who are both obese and heavy smokers. Overall, the model predicts that longevity improvements in the future will be lower than currently predicted, at around 1% p.a. rather than 1.5%. If this turned out to be correct, then the current price of longevity of risk transfer products would be overestimated.

The largest buy-in in 2016 (in December) was Phoenix Life's £1.2bn buy-in for the 4,400 pensioners in the PGL Pension Scheme, which is sponsored by the Phoenix Group, Phoenix Life's parent company. This replaced a longevity swap that it had set up for the plan in 2014. This is the first example of a transaction which transforms a longevity swap into a bulk annuity. Phoenix Life saw this as an opportunity to bring £1.2bn of liquid assets (mostly UK government bonds) onto its balance sheet, which could then be swapped into a higher yielding, matching portfolio, structured to maximize the capital benefit under Solvency II. This, in turn, meant that Phoenix Life would be assuming the market risks associated with the PGL scheme pension liabilities in addition to the longevity risks – and already does this on its existing book of individual annuities which are backed by £12bn

[38] Eckler Consultants (2017) *Pension Risk Transfer Report*, November.
[39] http://www.artemis.bm/blog/2015/06/26/delta-lloyd-rga-in-second-e12-billion-longevity-swap-deal/
[40] The conference proceedings for *L12* were published in volume 25(S1) of the *North American Actuarial Journal* in 2021.
[41] The Willis Group and Towers Watson merged in 2016 to form WTW.

of assets. The timing was also critical. Phoenix wanted to ensure that its internal model under Solvency II had bedded down well and that the capital and balance sheet impacts of the transaction were well understood, and that Phoenix had elicited the full support of the UK Prudential Regulation Authority (PRA)[42] for the transaction, thereby ensuring execution certainty. Phoenix also provided comfort to the plan's trustees by giving them 'all-risks' cover from point of buy-in ('all-risks' cover is not usually provided until buy-out) and strong collateral protection.[43]

2016 saw the beginning of a trend towards consolidation amongst insurance companies involved in the longevity risk transfer business in the UK. In April 2016, the two largest UK medical underwriters, Partnership and Just Retirement merged to form the Just Group valued at £16bn. Aegon sold its £9bn UK annuity portfolio to Rothesay Life and L&G between April and May, as part of a strategy to free up capital from non-core businesses. Part of the reason for this is the additional capital requirements under Solvency II. In September, Deutsche Bank sold its Abbey Life subsidiary to Phoenix Life – a consolidator of closed insurance books – for £935m, as part of a planned program of disposals aimed at restoring its capital base. There is an estimated £100bn of UK individual annuities in back books and further consolidation of these back books is anticipated. In December 2017, L&G sold its £33bn closed book of traditional insurance-based pensions, savings and investment policies to the ReAssure division of Swiss Re for £650m.

Solvency II has also been blamed for some companies pulling out of the bulk annuities market altogether, a key example being Prudential (UK) in January 2016. Prudential (UK) announced it would be selling a portion of its £45bn UK annuity and pension liability businesses due to an inadequate return on capital and to transfer that capital to its growing businesses in the Far East.[44] Reinsurance deals have also increased in response to Solvency II, involving non-EU reinsurers. For example, PIC executed a £1.6bn longevity reinsurance agreement with PICA in June 2016.

2016 also witnessed the increasing streamlining and standardization of contracts. This is particularly beneficial to small plans below £100m. Previously, smaller plans have been less attractive to insurers due to the higher costs of arranging such deals relative to the profit earned. To circumvent this, consultants have begun offering services that allow smaller plans to access improved pricing and better commercial terms using a standardized off-the-shelf process incorporating pre-negotiated legal contracts. Pricing is more competitive because the insurer's costs are kept low. An example is WTW's Streamlined Bulk Annuity Service. The increasing maturity of the market has meant that some larger plans have also been prepared to use pre-negotiated contracts.

[42] This is the regulatory authority for insurance companies in the UK.
[43] Stephanie Baxter (2017) How PGL's longevity swap was converted into a buy-in, *Professional Pensions*, 10 April.
[44] https://www.ftadviser.com/pensions/2016/12/05/prudential-seeks-buyers-for-45bn-annuity-business/

2016 was also the tenth anniversary of the longevity transfer market. Since its beginning in the UK in 2006, £40bn of buy-outs and £31bn of buy-ins have taken place in the UK, covering one million people.[45] Yet this equates to just 5% of the £1.5trn of UK DB pension assets and 3% of the £2.7trn of DB pension liabilities on a buy-out basis in 2016. In addition, forty eight longevity swaps are known to have been completed in the United Kingdom between 2007 and 2016, valued at £75bn and covering 13 insurance companies' annuity and buy-out books, 22 private sector pension funds, and one local authority pension fund (some of which executed more than one swap).[46]

2017: Longevity 13

The thirteenth conference (*L13*) was held in Taipei, Taiwan on 21-22 September 2017. It was hosted by the Department of Risk Management and Insurance and the Risk and Insurance Research Center at National Chengchi University, and by the Pensions Institute.[47]

At the beginning of 2017, there were eight UK-domiciled insurers actively participating in the pension risk transfer market in the UK. The largest players were PIC and L&G, with market shares of 37% and 30%, respectively. The others were Rothesay Life, Canada Life, Zurich, Scottish Widows, Standard Life, and new entrant Phoenix (since August). Occasionally, the insurers co-operate in a transaction. To illustrate, in August 2017, L&G executed a longevity swap in respect of £800m of the pension liabilities of Scottish and Southern Energy (SSE), while PIC completed a £350m buy-in for the company. Consultant LCP estimated that £12bn buy-ins and buy-outs took place in 2017 and £19bn took place in 2018, with total insurer capacity at £25bn: 'There remains significant capacity and competition – even if a large back-book comes to market – providing attractive opportunities for pension plans to transfer longevity risk through a buy-in or buy-out'.[48]

One of the largest deals in 2017 (in September) involved a £3.4bn longevity swap between the Marsh & McLennan Companies (MMC) UK Pension Fund and both Canada Life Re and PICA, using Guernsey-based incorporated cell companies, Fission Alpha IC Limited and Fission Beta IC Limited. MMC subsidiary Mercer led the transaction as adviser to the pension fund trustee and the deal was the first to be completed using the Mercer Marsh longevity captive solution, with no upfront premium. The two reinsurers shared the risk equally and the use of the captive ICC vehicle meant that no insurer intermediary was

[45] LCP, *Professional Pensions* (15 December 2016 and 26 January 2017). Since 2007, some 92 buy-ins have been completed.
[46] www.artemis.bm/library/longevity_swaps_risk_transfers.html.
[47] The conference proceedings for *L13* were published in volume 25(S1) of the *North American Actuarial Journal* in 2021.
[48] https://www.lcp.uk.com/media-centre/press-releases/2017/08/buy-in-and-buy-out-volumes-nearly-double; LCP (2018) *Pension De-risking 2018*.

required, making the deal more cost-effective for the pension fund.[49] Also in September, the British Airways' Airways Pension Scheme used a similar Guernsey-based captive insurer to set up a £1.7bn longevity swap. The longevity risk was then reinsured with Partner Re and Canada Life Re. The scheme had previously hedged £2.6bn of liabilities through two longevity swap transactions executed by Rothesay Life in 2010 and 2011.[50] In November 2017, PIC executed a £900m longevity swap with PICA, while in December 2017, L&G executed a £600m longevity swap with PICA.[51]

In December 2017, NN Life, part of the Nationale-Nederlanden Group, the largest Dutch insurance company, executed an index-based longevity hedge with reinsurer Hannover Re, in a deal covering the insurer against the longevity trend risk in €3bn of its liabilities (the notional value was €100m). The intermediary was Longitude Solutions, run by Avery Michaelson and David Schrager. The hedge structure is similar to the 2013 Aegon tail-risk deal arranged by Société Générale and builds on subsequent work including Michaelson and Mulholland (2014) and Cairns and El Boukfaoui (2021). While the term of the transaction is 20 years, NN Life is protected over a longer time period via a commutation function[52] that applies at maturity. If longevity improvements have been much stronger than expected, this will be assumed to continue until the liabilities run-off and NN will receive a payment under the hedge. The transaction helped to reduce the solvency capital requirement of NN's Netherlands life business by €35m. The index attachment point for the hedge is close to NN's best estimate, which helps maintain the SCR (Solvency Capital Requirement)[53] relief and effective risk transfer over time.[54, 55]

In order to reduce the costs of de-risking, pension plans are encouraged to perform some liability reduction exercises, the key ones being:[56]

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[49]http://www.artemis.bm/blog/2017/09/14/mmc-pension-offloads-huge-3-4bn-of-longevity-risk-to-reinsurers. The counter to this cost-effectiveness is that the hedger takes on additional counterparty risk. If a reinsurer fails then there is no insurer to protect MMC's pension scheme.

[50] Nick Reeve (2017) BA scheme uses 'captive insurer' in £1.6bn longevity risk hedge, *IPE*, 13 September.

[51] https://www.pensioncorporation.com/media/press-releases/Prudential, PIC Reach $1.2 Billion Longevity Reinsurance Agreement; L&G reinsures £600m of longevity risk through Prudential, *Professional Pensions*, 21 December 2017.

[52] The role of the 'commutation function' is to 'compress' the risk period. As explained in Michaelson and Mulholland (2014, pp.32-33): 'This is accomplished by basing the final index calculations on the combination of two elements: (1) the actual mortality experience, as published by the national statistical reporting agency, applied to the exposure defined for the risk period; and (2) the present value of the remaining exposure at the end of the risk period calculated using a 're-parameterized' longevity model that takes into account the realized mortality experience over the life of the transaction'.

[53] The SCR is the amount of funds that insurance and reinsurance companies are required to hold under Solvency II in order to have a 99.5% confidence they could survive the most extreme expected losses over the course of a year. The SCR incorporates market, credit, operational and counterparty risks, and must be recalculated at least once per year; https://www.risk.net/definition/solvency-capital-requirement

[54] http://www.artemis.bm/blog/2017/12/01/nn-life-gets-index-based-longevity-hedge-from-hannover-re/

[55] https://www.nn-group.com/Investors/Capital-Markets-Day-2017.htm

[56] *Professional Pensions* (2016) Risk reduction and the extent of trust in pension scheme advisers and providers, June, p.26.

- Enhanced transfer values (ETVs) – allow deferred members to transfer an uplifted value of their benefits to an alternative arrangement. In August 2017, a 64-year old entitled to an annual index-linked pension starting at £10,000 from age 65 would be offered a transfer value of £237,000, according to the Xafinity Transfer Value Index.[57] In October 2019, the transfer value was £244,200. In 2019, around 50,000 members transferred out of their DB scheme, around 1% of eligible members.[58]
- Flexible retirement options (FROs) – allow deferred members aged 55 and over to retire early, or to take a transfer value and secure benefits in a different format from their plan benefits, or to use funds for drawdown purposes.
- Pension increase exchanges (PIEs) – allow pensioners to exchange non-statutory increases for a higher immediate pension with lower or even zero future increases (e.g., a £10,000 annual pension with inflation uplifting is replaced by a £12,000 annual pension with no further increases).
- Trivial commutations (TCs) – allow members with low value benefits to cash these in.

The most common exercises currently in the UK are PIEs and TCs – and these can be conducted either before or at the same time as a bulk purchase annuity broking exercise. Hymans Robertson has estimated that the use of these liability reduction exercises could reduce the buy-out cost for UK DB schemes by around £100bn or 6% of total liabilities.[59]

Innovation is a continuing feature of this market. Some examples include (see, e.g., Legal & General and Engaged Investor, 2016):[60]

- Buy-ins and buy-outs with deferred premium payments – to spread costs, schemes that cannot afford the upfront premium of a de-risking solution pay for it in instalments over a number of years.
- Buy-outs combined with a longevity hedge.[61]
- Phased buy-ins, where the largest risks or the lowest cost risks are insured first.
- Phased de-risking using a sequence of partial buy-ins with an 'umbrella' structure to avoid more than one set of contract negotiations – to spread costs.
- Accelerated buy-ins – the insurer provides a loan to the plan equal to the deficit (sometimes called a winding up lump sum (WULS)), so that a partial buy-in can take place immediately, with this converting to a full buy-in when the loan has been repaid, or with the option of a full buy-out at a later date.

[57] Hannah Godfrey (2017) DB transfer values back on the rise in August, *Professional Adviser*, 7 September.
[58] Sophie Smith (2019) DB transfer values in record fall – XPS, *Pensions Age*, 7 November.
[59] https://www.ipe.com/news/uk-roundup-clear-member-options-could-reduce-buyout-db-costs-by-100bn/10060598.article
[60] Legal & General and Engaged Investor (2016) *De-risking Journeys of Mid-sized Pension Schemes*, June.
[61] An example of this was the Philips Pension Fund which in 2015 completed a full buy-out valued at £2.4bn with PIC. The longevity risk was simultaneously reinsured with Hannover Re. Another interesting feature of this deal was that it covered both retired and deferred members.

- Forward start buy-ins – a standard buy-in with the start date delayed to reflect the level of funding available, with additional options, such as paying deferred members as and when they retire if this is prior to the start date, or the ability to bring forward the start date for an additional fee.
- Self-managed buy-ins – which allows pension schemes to run their own asset management strategy at lower cost and with a lighter regulatory burden than if an insurer was involved (introduced in 2018 by the UK asset manager Insight Investment). The strategy uses swaps to hedge interest, inflation and longevity risks and is estimated to be 10-15% cheaper than the equivalent insurance product.[62]
- Automated bulk plan transfers – to reduce risks (introduced in November 2017 by Scottish Widows and Standard Life).[63]
- Top-slice buy-ins – to target the highest value liabilities.
- Named-life longevity swap – if the named member lives longer than expected, the insurer pays out the difference (examples being the £400m Bentley plan and an unnamed plan with 90 named pensioners valued at £50m).
- Tranching by age – to reduce costs; according to consultant Punter Southall, a buy-in for pensioners up to age 70 will make a subsequent buy-out within the following 10 years cheaper than a buy-in for the over 70s.[64]
- Longevity swaps for small pension plans with liabilities of £50-100m – previously only available for medium (£100-500m) and large plans (above £500m).
- Novation – the ability to transfer a longevity hedge from one provider to another, thereby introducing some liquidity into what had previously been a completely illiquid market. An example would be the reinsurance of a small bulk annuity transaction. Contract simplicity is a desirable feature of such arrangements.
- Longevity swap to buy-in conversions – as pioneered by Phoenix Life in December 2016 for its parent company's pension plan. Solvency II incentivizes buy-in providers to hold longevity insurance, otherwise they pay an additional risk margin. This encourages buy-in providers to seek out plans which already have a longevity hedge and encourage them to do a buy-in. Another driver is longevity swap providers that are not currently active in the market – such as J.P. Morgan and Credit Suisse – but are still responsible for running off their existing swaps. They might have an incentive to encourage the associated pension plan to novate the swap to a buy-in provider and hence extinguish their liability.[65]
- Insuring away the extreme tail of liabilities in a closed plan after a specified term, such as 5 or 10 years – to reduce costs.

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[62] Angus Peters (2018) Insurers compete with fund managers for lucrative pension pots, FTfm, 15 January. The article points out that 'insurers and asset managers are engaged in a turf war for the £1.6tn sitting in the UK's defined benefit schemes'.

[63] Michael Klimes (2017) How the first automated bulk scheme transfers happened, *Professional Pensions*, 10 November.

[64] James Phillips (2017) DB schemes insuring wrong tranche of members in buy-ins, *Professional Pensions*, 14 August.

[65] Stephanie Baxter (2017) Converting longevity swaps into bulk annuities: The next de-risking innovation?, *Professional Pensions*, 13 April.

- Increasing optionality in contracts to improve flexibility – for example, the option to switch the indexation measure for pensions in payment from the Retail Price Index to the Consumer Price Index if government legislation changes; or the option to secure discretionary benefits, such as actual inflation above a 5% cap; or surrender options.
- Insuring the tail of the liabilities – whereby a closed scheme that cannot afford a full buy-out insures only the liabilities after a certain point in time, say, 10 years' ahead.
- Combining liability management solutions (such as interest rate and inflation swaps, and ETV, FRO and PIE exercises) and bulk annuities in a buy-out – so instead of completing liability management before considering a buy-out, plans do this in a single exercise.
- 'Buy-out aware' investment portfolios – used to reduce buy-out price volatility and close the funding shortfall, with the buy-out price locked to the value of the buy-out aware funds once a target shortfall has been reached and whilst the contract documentation for a buy-out is being completed.
- Improved arrangements for handling data errors that arise after a deal has been executed – to reduce pre-deal negotiation requirements and post-deal transaction uncertainty. Common data errors include member gender, date of birth, and benefit amounts for both member and partner. A simplified data error process could deal with these issues in the following way: locking down benefits, removing the need for re-pricing; mechanistically adjusting demographic errors; and using due diligence to check for systematic errors with the data.[66]
- Residual risk insurance, covering, e.g., benefit specification errors, data errors, and unidentified beneficiary cover.
- Arrangements to handle deferred members – to improve insurer appetite to assume the additional risk and cost involved. Deferred lives make up almost half (45%) of the membership of UK DB plans in the UK.[67] They are much more expensive to hedge for a number of reasons. First, there can be problems with their existence and identification. Second, they enjoy a large number of options which need to be priced.[68] Third, their longevity risk is greater, because the longevity improvement assumption used for pricing has greater reliance on the assumed long-run trend.[69] Fourth, as a direct consequence of the previous points, more capital is needed and

[66] Andrew Murphy (2017) Developments in longevity swaps, Pacific Life Re, 23 November, IFoA Life Conference. Provided due diligence has been carried out at the outset, subsequent data errors tend to be unbiased in terms of their impact and so average out close to zero.
[67] That is 4.9m members (The Pension Regulator and the Pension Protection Fund, *Purple Book 2015*).
[68] For example, lump sum commutation, trivial commutation, early/late retirement, increasing a partner's benefits at the expense of the member's benefits, and pension increase exchanges.
[69] Valuation and risk assessment of a deferred annuity can be broken down into five overlapping components: survival to retirement; the socio-economic group of the pensioner at the date of retirement; the base mortality table at the time of retirement for that socio-economic group; general mortality improvements (e.g., age 65+) up to the date of retirement; and the mortality improvement rate after retirement. Uncertainty in the probability of survival to retirement will typically be quite small in relation to the other risks.

> this, in turn, increases the demand for reinsurance. These issues can be at least partially mitigated as follows: a robust existence checking procedure is needed involving electronic tracing, assuming a fixed percentage of the pension is exchanged for tax-free cash, setting the assumed retirement date to the plan's normal retirement date, assuming no pension is exchanged for additional partner pension, restricting the age profile to older deferred members, and restricting the proportion of deferred members in the transaction.[70]

These are all innovations in the space linking pension plans and insurance companies designed to ease the transfer of pension liabilities (or at least the longevity risk in them) from pension plans to insurance companies.

The innovations have helped to encourage more business, but this, in turn, has exposed potential longer term capacity constraints within insurance companies. As one consultant said: 'Given the market has historically completed only 150-200 deals in any one year, there is a real risk of capacity constraints in the market, not just from an insurer capital perspective, but also from a resource and expertise perspective'.[71]

A total of £12.4bn in buy-ins and buy-outs and £.6.4bn in longevity swaps took place in the UK in 2017.

In April 2015, the UK government introduced 'Freedom and Choice' pension reforms which gave more flexibility to how individuals could draw down their defined contribution (DC) pension pots.[72] In particular, there was no longer a requirement to purchase an annuity.[73] This immediately led to a fall in annuity sales by around 75% (Cannon et al (2016)). The situation was not helped by the fall in gilt (UK government bond) yields (which led to a corresponding fall in annuity rates) arising from the government's quantitative easing program introduced after the Global Financial Crisis. In August 2017, a 65-year old with a £100,000 pension pot, could get a level income for life of £4,894: two years before, the amount would have been £5,292.[74] By 2017, the following insurers had pulled out of the open market for annuities: Aegon, LV=, Partnership (before it merged with Just Retirement to form Just Group), Prudential (UK), Standard Life, Friends Life

[70] Andrew Murphy (2017) Developments in longevity swaps, Pacific Life Re, 23 November, IFoA Life Conference.

[71] Martyn Phillips, Mercer (quoted in *Professional Pensions* (2016) Risk Reduction and the Extent of Trust in Pension Scheme Advisers and Providers, June, p.28). Hannover Re had previously warned about this: 'The number of risk-takers is limited and there is no unlimited capacity in the market for taking on longevity risk. The increasing worldwide demand for longevity cover will challenge the capacity for securing longevity risk' (quoted in Punter Southall (2015) *De-risking Bulletin*, March). At the time, there were significant human resource bottlenecks in some parts of the transaction chain, in particular, a shortage of qualified lawyers.

[72] The proposal was announced by the UK finance minister (George Osborne) in his Budget Speech on 19 April 2014.

[73]https://www.pensionsadvisoryservice.org.uk/about-pensions/pension-reform/freedom-and-choice

[74] Josephine Cumbo (2017), Pensioners hit as annuity rates drop 10% in two years, *Financial Times*, 1 September.

(merged with Aviva), Reliance Mutual, B&CE, and Retirement Advantage. This left just six providers in what was once the world's largest annuity market: Aviva (offering standard and enhanced (i.e., medically underwritten) annuities), Canada Life (standard and enhanced), Hodge Lifetime (standard only), Just Group (enhanced only), L&G (standard and enhanced) and Scottish Widows (standard and enhanced).[75]

In place of annuities, individuals took their pension pot either as a lump sum or they purchased an income drawdown product. In both cases, they bear their own longevity risk. Evidence shows that people systematically underestimate their life expectancy which implies that there is a significant probability that many people will spend their pension pot before they die. A study by Just Group found that UK men aged 40-54 expect to live until 78.9 years on average, whereas the official estimate of their life expectancy is 87.5; the figures for women are 80.5 and 90.1.[76]

A number of UK insurers providing bulk annuities for buy-ins are also involved in the UK equity release mortgage (ERM, or reverse mortgage or lifetime mortgage) market which allows home owners to borrow against the equity in their homes. The modern form of the market began when the Equity Release Council (ERC) representing providers was established in 1991 with a voluntary code of conduct that offered a number of guarantees. Before this, users of the product could lose their homes when the value of the loan plus interest exceeded the value of the property. Since 1991, there is a guaranteed right to remain living in the property, either for life or until entry into long-term care. In addition, there is a 'no negative equity guarantee' (NNEG)[77] which means that the value of the loan plus interest can never exceed the value of the property, and so no debt can be passed on to the estate of the equity release borrower. The providers in the new market therefore face longevity risk in a way that those in the old market did not. In 2017, a total of £3bn in equity release loans were made with an average size loan of £102,000. In 2018, the UK Prudential Regulation Authority (2018) raised concerns that providers were not properly reflecting the cost of the NNEG in their capital reserving. Instead of valuing the NNEG using the Black (1976) model as a series of put options on the forward house price (which is lower than the current price to reflect the loss of rental income due to deferred possession) weighted by the probability of mortality, morbidity and pre-payment, it pointed out that most providers were using the expected future house price which required assumptions about property growth.

There were also important developments outside the UK in 2017, although many of these involve innovations adopted from the UK market. Apart from the US, Canada, and the Netherlands, new markets include Germany, Switzerland and Ireland. Examples of

[75] *Source: Hargreaves Lansdown, August 2017. Scottish Widows introduced a standard annuity in September 2019.*
[76] Chris Seekings (2018) Millions of Brits underestimating their life expectancy by a decade, *The Actuary*, 3 May. There were similar findings in a study by the Institute for Fiscal Studies, see James Phillips (2018) New retirees overly pessimistic about life expectancy, *Professional Pensions*, 17 April.
[77] See Dowd et al. (2019).

innovations in the US include: plan-specific mortality data – with $250m as the minimum transaction size; asset-in-kind premium funding – where bonds are used to fund the transaction. Insurer capacity has also increased, with 14 insurers engaged in pension buy-outs. Three new insurers joined: Athene,[78] Mutual of America, and CUNA Mutual. Athene wrote more than $2bn of business in 2017. A total of $24.7bn pension risk transfers were conducted in the US in 2017. In Canada, group annuity sales amounted to C$3.7bn, and a new group annuity provider, Brookfield Annuity, joined the market. In Germany, many schemes were considering using lump sum settlement payments to pensioners to transfer longevity risk. In Switzerland, insurers are now willing to consider transfers involving active members. In Ireland, Danske Bank transferred €335m of its Irish DB pension liabilities to Irish Life.[79]

In April 2017, the International Monetary Fund (IMF) released a new edition of its *Global Financial Stability Report*. Chapter 2 ('Low Growth, Low Interest Rates, and Financial Intermediation') suggests that DB pension funds across the globe might have to cut benefits 'significantly' in the long term because of ultra-low interest rates. Attempts to increase returns by changing asset allocations 'appears feasible only by taking potentially unacceptable levels of risk'. In the face of such low rates, the IMF argues that 'life insurers and pension funds would face a long-lasting transitional challenge to profitability and solvency, which is likely to require additional capital' or would require a 'very high' level of volatility risk to meet their funding goals. However, a combination of risk aversion and regulatory constraints was likely to deter the vast majority from taking this second path. The IMF instead believes that the current situation might work to the benefit of insurers backing buy-ins and buy-outs. With investors increasingly monitoring the size of DB liabilities and the effects on company share prices, profits, and dividends, the IMF said offloading these liabilities to insurers 'is an attractive option' and 'may represent a market-efficient arrangement' and that 'regulation could play an important role in this area by facilitating such transactions'.

2018: Longevity 14

The fourteenth conference (*L14*) was held in Amsterdam on 20-21 September 2018. It was hosted by the Pensions Institute and the Netspar Network for Studies on Pensions, Aging and Retirement.[80]

2018 saw the start of a trend towards consolidation amongst pension schemes in the UK. This was led by a group of private equity investors. One example is the Pension Superfund which was launched in March with £500m in seed capital provided by Edi Truell's Disruptive Capital and Warburg Pincus. Another example is Clara-Pensions which has £500m in seed capital from TPG Sixth Street Partners. Both have set up as occupational

[78] Athene is majority owned by private equity company Apollo Global Management, LLC.
[79] Navigating you through your de-risking journey: Overseas, *Aon Risk Settlement Market Review 2018*.
[80] The conference proceedings for *L14* were published in volume 14(2) of the *Annals of Actuarial Science* in 2020.

pension scheme master trusts. Antony Barker of the Pension Superfund predicted that if the UK follows the experience of the Dutch and the Australian markets, consolidation could lead to the 5,500 UK DB schemes being reduced to 1,500 by the end of the decade. He argued that, while many will go into insurance buy-outs and another 50-100 insolvent schemes could end up in the Pension Protection Fund (PPF),[81] this leaves potentially 2,000 that could end up with a superfund. That could represent £800bn in assets out of a total of £1.8trn in UK DB pension assets.[82]

The business models of the two consolidators are different, however. Clara-Pensions takes over the obligations and risks from pension scheme sponsors, but then becomes a 'bridge to a buy-out'. Its shareholders do not see a return on capital until every member has their full benefits secured in the insured market. In the meantime, it will need to hedge these risks, including longevity risk. By contrast, the Pension Superfund operates as a long-term run-off scheme. But instead of being supported by an operating company covenant, as in a standard occupational pension scheme trust, it is supported by a financial covenant in the form of a partnership holding material financial commitments from the former sponsor and new external capital providers, that should ensure members get at least 99% certainty of receiving their promised benefits in full. Any surplus of assets above 115% of liabilities 'on a prudent actuarial basis' will be shared one-third to members and two-thirds to the investors. The liabilities would be hedged and the investment strategy would be 'fairly low risk'. The Pension Superfund planned to use reinsurance through a captive model in due course. It would be initially targeting schemes with assets between £200m-£1bn with a strong sponsor covenant.[83]

Insurers have expressed concerns that, since such pension consolidation vehicles come under the Pensions Regulator (TPR) (i.e., are classified as pension schemes), they do not have to satisfy the much stricter solvency requirements of insurers which are regulated by the Prudential Regulation Authority, which is part of the Bank of England.[84] Both the Pension Superfund and Clara-Pensions aim to undercut insurance buy-out pricing by up to 10-15%.[85] The two consolidators justify themselves as filling a gap between a full insurance buy-out and schemes entering into the PPF following the insolvency of their

[81] The Pension Protection Fund is a statutory fund in the UK which takes on the assets and liabilities of the defined benefit schemes of UK companies that have become insolvent. Any member who is over their normal retirement age or who retired early due to ill health will receive 100% of their current pension. Other members will receive 90% of their pension entitlement at the time of insolvency up to a cap. The sponsors of all eligible schemes must pay a levy to the PPF. See https://www.ppf.co.uk/

[82] Quoted in Mona Dohle (2020) Superfunds - New entrants to the DB consolidation market, *Portfolio Institutional*, 17 August.

[83] Adam Saron, Chief Executive Officer, Clara-Pensions, and Antony Barker, Managing Director, The Pension Superfund, interviewed in *Longevity Trends 2020*, published by Longevity Leaders, January 2020. See also Willis Towers Watson *De-risking Report 2020*, January (p.24).

[84] James Phillips (2018) The Pension Superfund to split surplus with members and capital providers, *Professional Pensions*, 12 July.

[85] *Superfunds: New solutions for DB pension plans?*, KPMG, August 2018; https://assets.kpmg/content/dam/kpmg/uk/pdf/2018/08/kpmg-superfunds-solutions-for-db-pension-plans.PDF

sponsor. Each year, around 2% of the UK's 5,500 schemes either buy-out or enter the PPF. The consolidators offer a solution to solvent companies that cannot afford a full buy-out. Insurers have responded to the challenge from the consolidators by offering these companies access to an investment and hedging strategy that moves them closer to the goal of a full buy-out or buy-in. The Pension Superfund agreed two deals in 2019, but these have been delayed due to an absence of regulatory approval and the government was at the time still considering an authorization, supervision and solvency regime.[86] An interim regime for superfunds was introduced in June 2020. In November 2021, Clara-Pensions became the first superfund to complete TPR's assessment process and meet its 'tough new standards' of governance and administration. It appointed Kempen Capital Management as fiduciary manager and Hymans Robertson as scheme administrator.[87]

The General Data Protection Regulation (GDPR) was introduced in all EU member states in May 2018 and will affect longevity risk transfers since they involve the exchange of personal data. There are fines for data protection breaches. The GDPR distinguishes between data controllers – people who determine how and why data should be used – and data processors – who process data on behalf of data controllers. Pension scheme trustees will be data controllers, as will insurers if they have received personal data in connection with a potential buy-out transaction (e.g., if they are conducting a data cleansing or medical underwriting exercise). In other cases, insurers might be classified as data processors. International data transfers, e.g., in the case where an insurer wants to transfer data to a reinsurer located outside the European Economic Area, can only take place if adequate data protections are in place. Care needs to be taken even if anonymized data is transferred, since it might still be possible to identify the individuals to whom the data relates, e.g., company directors might be identified from information about the size of their pension benefits and date of birth.

For 2018, the key highlights in the UK longevity risk transfer market were:[88]

- PIC reinsured all its pensioner liabilities (73% of its total exposure) with Partner Re in January. It also helped to fund University Partnerships Programme acquisitions of student accommodation with index-linked bonds in February.
- Scottish Widows executed a £1.3bn longevity swap with PICA in February.[89] It was the last UK insurer to hedge at least some of its longevity risk. It did this to reduce its Solvency II capital requirements.

[86] Nick Reeve (2019) Pension Super Fund signs up second client in £300m deal, *IPE*, 30 July; James Phillips (2019) Clara: 'Shadow market' is huge for DB consolidation, *Professional Pensions*, 22 October. The government passed a Pension Schemes Act in February 2021, but it did not contain legislation for a DB consolidator regime.

[87] https://www.pensionsage.com/pa/BREAKING-Clara-Pensions-becomes-first-TPR-assessed-DB-superfund.php

[88] There were £24.2bn of transfers (buy-outs and buy-ins) in the UK in 2018 plus another £7bn in longevity swaps. The biggest insurers in the market were L&G, PIC, Zurich, Scottish Widows, Aviva, Canada Life, Just, Phoenix Life, and Rothesay Life (*LCP De-risking Report 2020*).

[89] Since 2011, PICA has completed more than £32bn in international reinsurance deals, including the £16bn deal with the BT Pension Scheme in 2014.

- Standard Life Aberdeen sold £2.93bn of its annuity back-book to Phoenix in February, with the rest of Standard Life Assurance sold to Phoenix in September.
- Prudential (UK) sold £12bn of its annuity back-book covering 400,000 policies to Rothesay Life in March, making Rothesay the UK's largest specialist annuity insurer with more than £37bn of assets and 750,000 lives insured.[90]
- In March, the Marks & Spencer Pension Scheme executed two buy-ins totalling £1.4bn with Aviva and Phoenix covering 15% of its pension liabilities. It was Aviva's largest buy-in to date (at £925m) and Phoenix's first external buy-in (at £475m).
- In March, PIC and PICA introduced a 'flow reinsurance' system which automates the longevity reinsurance element of buy-outs and buy-ins for schemes with liabilities below £200m. The system allows PIC to secure a commitment from PICA to assume the longevity risk early on in a transaction.
- In March, employee benefits consultant, JLT, launched a 'buy-out comparison service' and monitoring tool which allows schemes to upload their own data and receive regular bulk annuity quotations from eight insurers currently active in the market.
- In April, JLT became the first consultant to implement Club Vita's longevity analytics capabilities which have been incorporated into RiskFirst's PFaroe modelling system for DB plans. This will allow JLT clients to set best-estimate longevity assumptions.[91] Club Vita data shows that pension schemes can have a very different demographic composition compared with the national population, with liabilities that could be up to 10% higher or lower as a result of different mortality experience.
- PIC executed a £900m longevity swap with PICA in May, covering 7,500 pensioners.[92]
- In June, Canada Life sold its £2.7bn back book of 155,000 UK life and pension savings policies to Scottish Friendly. The company said it wanted to concentrate on

[90] In August 2019, the High Court in London blocked the Prudential-Rothesay transfer on the grounds that Rothesay was a 'relatively new entrant without an established reputation in the business' and although it had solvency ratios at least equal to Prudential's, 'it does not have the same capital management policies or the backing of a large group with the resources and a reputational imperative to support a company that carries its business name if the need were to arise over the lifetime of the annuity policies' (Susanna Rust (2019) High Court blocks £12bn Prudential-Rothesay annuities transfer, *IPE*, 19 August). In September 2019, Prudential and Rothesay announced that they would appeal against the decision on the basis that the judgement 'contains material errors of law' and should be reconsidered. On 2 December 2020, the Appeal Court granted an appeal against the High Court decision to block the Prudential to Rothesay Life transfer, on the grounds that the High Court had not given adequate weight to analysis by industry bodies and conclusions by the Prudential Regulation Authority and the Financial Conduct Authority, neither of which objected to the transfer. The issue of whether to sanction the scheme would be passed to the High Court for a second hearing. In November 2021, the High Court approved the transfer of the £12bn portfolio of annuities from Prudential (now a subsidiary of M&G) to Rothesay Life.

[91] Club Vita is a longevity data analytics company which pools data from over 220 UK DB schemes covering 2.8m pensioners, approximately one quarter of the total. RiskFirst is a fintech company which launched the PFaroe software in 2009 to enable pension funds to manage their asset and liability risks.

[92] This brought the total value of all the deals between the two companies to £4.4bn.

developing new retirement products following its acquisition of Retirement Advantage, an annuity and retirement income specialist, in January.

- Siemans completed a £1.3bn buy-in of its UK pension liabilities covering 6,000 members with PIC in July.
- Aviva executed a £1bn longevity swap with PICA in August.
- National Grid Electricity Group completed a £2bn longevity swap with Zurich[93] for the Electricity Supply Pension Scheme also in August.
- In August, L&G entered the small scheme longevity insurance market after completing a £300m longevity swap with an unnamed pension fund. The deal had a 'streamlined structure' with simplified data requirements which helped to keep fixed costs down. The swap was later reinsured with SCOR. According to L&G, 'the transaction demonstrates that longevity reinsurance is a realistic option for most pension schemes, including for trustees whose schemes are not quite at the point they can enter into buy-in or buy-out, but want to manage their longevity risk'.
- In September, the British Airways' Airways Pension Scheme entered into the UK's largest buy-in agreement to date (at £4.4bn) with L&G, covering 60% of pensioner liabilities; taking account of the £1.7bn longevity swap agreed in 2017, the scheme has now hedged 90% of its longevity risk.
- The Automobile Association Pension Scheme completed a £351m buy-in with Canada Life also in September.
- In October, the UK pension scheme of Nortel, the Canadian telecoms company which became insolvent in 2009, agreed a £2.4bn buy-out deal with L&G, covering 15,000 pensioners and 7,200 deferred members, thereby avoiding entering the Pension Protection Fund.
- In December, PIC executed another longevity swap, this time with SCOR, covering 8,000 pensioners and valued at £1.2bn.[94]

In April 2018, the PRA said it was concerned that too much longevity risk was being transferred offshore through reinsurance arrangements, preferring that more of it be retained in the UK. It said it would consider amending Solvency II risk charges to encourage greater retention. While it said it understood the need for risk transfer, it said that it was concerned that pension assets were being transferred overseas, taking them outside of its regulation, so that if an offshore reinsurance firm failed, UK pensioners might not get their pensions.[95]

The first ever longevity swap in the US was executed by RGA in 2018. In Canada, the Life Insurance Capital Adequacy Test (LICAT) regulations came into effect at the start of 2018.

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[93] Zurich reinsured a significant proportion of the longevity risk with Canada Life Re. It has executed £3.5bn longevity risk transfer deals since it entered the market in 2016.

[94] This brought the total value of the deals between the two companies to £2.2bn.

[95] Steve Evans (2018) Bank of England wants more longevity risk retained, less reinsured, *Reinsurance News*, 27 April; https://www.reinsurancene.ws/bank-of-england-wants-more-longevity-risk-retained-less-reinsured/

RGA redesigned a longevity transaction structure to create two LICAT-compliant cash flow swaps which transferred longevity risk but not investment risk, and improved capital efficiency for both parties[96]

2019: Longevity 15

The fifteenth conference (*L15*) was held in Washington DC on 12-13 September 2019. It was hosted by the Pensions Institute.[97]

A total of £43.8bn longevity risk transfer deals were announced for the UK in 2019.[98] XPS reported that for a buy-out for a medium-sized scheme, pensioner member transfers used a 'gilts + 0.3% p.a.' discount rate to value the liabilities (i.e., technical provisions), while for

[96] https://www.rgare.com/docs/default-source/investor-relations/rga_ar18.pdf
[97] The conference proceedings for *L15* were published in 2021 in *Insurance: Mathematics and Economics*, 99(C): 130-508.
[98] *LCP De-risking Report 2020*. This compares with £1bn when the market started in 2006. The eight insurance companies involved were: Rothesay Life (37% market share), L&G (24%), PIC (16%), Aviva (9%), Phoenix Life (9%), Scottish Widows (5%), Just (3%), and Canada Life (1%). Their total assets and asset allocations are given below. In terms of transaction volumes, 65% of deals were over £1bn, 29% of deals were between £100m and £1bn, and 6% of deals were below £100m.

Total assets and asset allocations of the main UK PRT providers 2019

	L&G	Rothesay Life	Aviva	PIC	Scottish Widows	Just	Canada Life	Phoenix Life
Total assets (£bn)	75.9	53.7	46	40.9	22	21.6	18.7	11.7
Government bonds & cash (%)	72	47	14	44	30	57	61	28
Corporate bonds (%)		14	29	53	30			44
Equity release/lifetime mortgages (%)	6	5	16	3	40 (alternative credit investments)	37	6	23
Commercial mortgages and healthcare (%)	-	-	16	-		-	8	-
Secured Lending and residential mortgages (%)	-	25	-	-		-	-	-
Infrastructure (%)	-	9	17	-	-	4	-	-
Private placement and structured finance	-	-	4	-	-	2	-	5
Direct investments (%)	22	-	-	-	-	-	-	-
Real estate (%)	-	-	-	-	-	-	5	-
Other (%)	-	-	4	-	-	-	-	-

Source: LCP *De-Risking Report 2020*

deferred members the discount rate was 'gilts – 0.5% p.a.'.[99] Willis Towers Watson reported an average buy-in price at 0.15% p.a. above gilts.[100]

Highlights included:

- In January, PIC invested £125m in Exeter University accommodation in order to generate index-linked cash flows to pay its pensioners.
- In the same month, PIC completed a £425m buy-in with the Co-operative Group's Somerfield Pension Scheme.
- L&G executed buy-ins with the Pearson Pension Plan (£500m in February), Howden Group Pension Plan (£230m in March) and 3i Group (£95m in April).
- Rothesay completed a buy-in (amount undisclosed) with the Teachers Assurance Group Pension Scheme in February, and a £110m buy-out with the Laird Pension Scheme in April.
- Also in April, PIC completed a £1.2bn buy-in with Commerzbank in respect of the Dresdner Kleinwort Pension Plan of its UK subsidiary. This involved three transactions. The first was a £900m buy-in of the DB section. The second and third involved the DC section and gave members of the hybrid scheme the option of transferring their DC pension out or convert it into a DB equivalent for transfer to PIC.
- In May 2019, the British American Tobacco UK Pension Fund completed a £3.4bn buy-in with PIC, the second-largest buy-in to date.
- Also in May, PIC and Phoenix insured £900m and £460m, respectively, of the liabilities of Marks & Spencer's UK pension scheme.
- In June, Rolls Royce executed the biggest buy-out to date – at £4.6bn – with L&G, covering the benefits of 33,000 pensioners. As part of the deal, a longevity swap originally with Deutsche Bank was transferred to L&G – the first time a swap has been novated between counterparties.
- In July, Scottish Widows completed buy-ins totalling £830m with Peugeot and QinetiQ
- In August, PIC executed a £3.4bn de-risking deal with the British American Tobacco UK Pension Fund covering both 8,300 pensioners and 2,300 deferred members. It is the biggest deal to date covering both retired and non-retired members.
- In August, PICA completed a £7bn longevity swap with banking group HSBC's UK pension scheme – making it the second largest swap in the UK after the £16bn swap for the British Telecom Pension Scheme in 2014, also arranged by PICA. The transaction – which covers half of the scheme's pensioner liabilities – was structured as an insurance contract with a Bermuda-based, HSBC-owned captive insurer, which reinsured the longevity risk with PICA. It was the first captive longevity reinsurance transaction for a pension scheme associated with a major

[99] *XPS Risk Transfer News*, 10/19.
[100] Figure 2 in Willis Towers Watson *De-risking Report 2020*, January.

bank. Amy Kessler, PICA's head of longevity risk transfer, said: 'The captive approach has become the strategy of choice for large pension schemes seeking to hedge longevity risk'.[101]

- In August, Phoenix Life completed a £1.1bn buy-in of its own DB pension scheme, the PGL Pension Scheme. In the same month, it executed a longevity reinsurance arrangement with PICA.[102]
- In August, Rothesay Life executed a £520m buy-in with the Cadbury Mondelēz Pension Fund, covering 1,900 pensioner members.
- In August, L&G announced it had completed a buy-in transaction for the UK hybrid pension scheme of data and technology company Hitachi Vantara. The deal was described as 'innovative' since it also took into account the DC elements of the scheme. Each member's retirement benefit is based on the higher of the DB and DC pension over their career with Hitachi Vantara. The buy-in was structured to maintain this arrangement, allowing deferred members to 'consider their options' prior to a full buy-out.[103]
- In September, L&G arranged a £930m buy-in with the Tate & Lyle Pension Scheme, covering 4,800 members.
- In September, Rothesay Life executed an even larger buy-in than the Rolls Royce deal in June – at £4.7bn – with the GEC 1972 Plan, covering 39,000 members split 70-30 between pensioners and deferreds. There is an option for a buy-out at a later date. Hence this is known as a 'buy-in to buy-out deal'. The parent company of GEC is Telent.
- Also in September, Rothesay Life insured £3.8bn of members' benefits for the Allied Domecq Pension Fund in another buy-in covering around 27,000 pensioners and deferred members, spilt 63-37. The parent company of Allied Domecq is the Pernod Ricard Group.
- In October, Rothesay completed a £2.8bn buy-in with the National Grid Pension Scheme (Section A). The following month, L&G completed a £1.6bn buy-in with the National Grid Pension Scheme (Section B), covering 6,000 pensioner members.
- In October, Rothesay executed a full buy-in with retailer ASDA (owned by Walmart) for £3.8bn, covering 4,800 pensioners and 7,500 deferred members. This converted to a full buy-out in 2020-21 at an additional cost of £800m.
- In October, Aviva Life and Pensions UK completed a £1.7bn buy-in for the Aviva Staff Pension Scheme, covering 1,500 pensioners and 4,300 deferred members.
- In November, Phoenix completed a £144m buy-in with the Aegon UK Staff Retirement and Death Benefit Scheme.
- In December, Zurich and Hannover Re completed a £800m longevity swap with an unnamed FTSE100 company.

Other UK developments in 2019 included:

[101] Susanna Rust (2019) HSBC pension scheme strikes £7bn longevity risk transfer, *IPE*, 6 August.
[102] https://www.artemis.bm/news/prudential-in-longevity-reinsurance-deal-for-pension-insurer-phoenix/
[103] Nick Reeve (2019) L&G backs 'innovative' buy-in for Hitachi UK pension scheme, *IPE*, 14 August.

- In February, L&G launched Track My Apps, a tracking service provided by fintech company Origo, to enable advisers to track their clients pension transfers online.
- £936m of equity release deals in the first quarter with 20,000 households, taking out an average of £50,000 in housing wealth.
- In May, L&G announced the creation of a UK retirement housing business called Guild Living which plans to deliver 3,000 new homes over the next five years with a gross development value of £2bn.[104] The business will contribute the income it needs to pay the benefits on its longevity risk transfer business. In August, L&G announced it had acquired a site in Walton-on-Thames suitable for building 300 homes.
- In June, L&G launched the first pension risk transfer execution platform to be driven by blockchain technology. Known as 'Estua-Re', the technology provides a 'single ecosystem capable of driving every stage of the PRT reinsurance value chain', including pricing, claims handling, financial reporting, and collateral. It allows multiple parties to transact with each other without the need for an intermediary and there will be greater transparency since all parties will have access to the latest version of the ledger database.[105]
- In August, PICA and the Phoenix Group launched a reinsurance counterparty to provide longevity reinsurance for insurers in the UK pension risk transfer market, covering both their buy-out and buy-in transactions. Phoenix head of bulk annuities Justin Grainger said: 'Phoenix views longevity reinsurance as a key risk management tool. This transaction brings further depth to our reinsurer relationships and enhances our ability to offer competitive terms to pension schemes as we continue to develop our de-risking proposition'. Prudential Financial head of international transactions for longevity risk transfer Rohit Mathur said: '[PICA] has consistently focused on supporting the entire UK pension de-risking market. The addition of Phoenix is a culmination of our efforts over the past several years to do just that. We have invested in our pricing and transaction teams and …and we are happy to be in a position to support the robust pipeline of pension buy-ins and buy-outs seeking to be completed while market conditions hold'. PICA was advised in this deal by Willkie Farr & Gallagher, while Phoenix was advised by CMS and Eversheds Sutherland.[106]
- In September, Rothesay announced it would raise an additional £500m in shareholder capital to support its longevity risk transfer business – which in 2019 alone executed around £10bn in new deals.
- In November, L&G agreed to provide annuities to Prudential (UK) customers with guaranteed rates. As part of the deal, all guaranteed benefits will be honoured by Prudential (UK) and fulfilled by L&G. As mentioned above, Prudential (UK), while

[104] https://www.legalandgeneralgroup.com/media-centre/press-releases/legal-general-launches-guild-living-bringing-retirement-communities-to-uk-city-centres/
[105] https://www.professionalpensions.com/news/3077264/-deploys-blockchain-technology-streamline-pension-reinsurance
[106] Holly Roach (2019) PICA launches reinsurance counterparty to back UK bulk annuities, *Professional Pensions*, 5 August.

remaining a UK-registered company, is closing down its UK operations in order to grow its businesses in the Far East.

- In November, PIC converted a £800m longevity swap – originally executed in 2017 with L&G – for a £750m buy-in for Scottish & Southern Energy (SSE) on the back of improved funding for the pension scheme. This is the first example of a transfer of obligations between counterparties where the first counterparty (L&G) could have offered the buy-in itself. In novating the swap between counterparties, it is another important milestone in bringing an early form of liquidity to the longevity swaps market. The first conversion of a longevity swap to buy-in took place in 2016 (by Phoenix Life) and the SSE conversion is the fifth one to date. PIC said that a longevity swap provides a useful first step towards a buy-in.[107]
- In November, Scottish Friendly bought the back book of Canada Life's 127,000 life and pensions policies, with assets under management increasing by £2.4bn as a result.
- There was a modest recovery in annuity sales following the big fall in sales after the 'Freedom and Choice' reforms of 2015. There were 74,000 (internal and open market) annuity purchases in 2018/19. Annuity rates for 65-year olds were 4%, which although low by historical standards, exceeded the 3% that a lower-risk fund recommended as a sustainable withdrawal rate.[108]

There were a number of reasons explaining the strength of the UK longevity risk transfer market in 2018 and 2019. First, funding levels had improved as a result of deficit reduction contributions and strong equity returns, which increased asset values, and lower liability values due to a combination of higher interest rates and lower mortality improvements since 2011;[109] UK funds exhibited the first surplus in aggregate since 2011.[110] Second, there was an increase in capital and competition from insurers which had recruited heavily and so had more staff to model pension scheme mortality, provide price quotations and implement transactions. Third, was an associated increase in reinsurance capacity, which is important since most of the longevity risk assumed by insurers is reinsured with global reinsurers. Fourth, there had been increasing standardization of the frameworks used to execute transfers, with three dominant examples: intermediated, pass through, and captive. Fifth, insurers had been increasing their investment in high yielding illiquid matching assets, such as infrastructure, housing and urban regeneration, and equity release, and had

[107] Susanna Rust (2019) Energy scheme completes rare longevity swap to buy-in conversion, *IPE*, 13 November.
[108] Greg Nielson (2019) Glimmers of an annuity market renaissance, *Retirement Planner*, 7 November.
[109] This is discussed later.
[110] At the end of November 2018, aggregate pension assets were £1.58trn, while aggregate pension liabilities were £1.57trn on a section 179 basis, according to the Pension Protection Fund's *Purple Book*. Some 3,008 schemes had a combined deficit of £137.6bn, while 2,442 schemes had a combined surplus of £151.9bn. During the previous 10 years, FTE100 companies had paid £82bn into their DB schemes in order to reduce their deficits (which equals one-eighth of the £636bn they paid out in dividends). If companies doubled their annual pension contributions to £16.6bn, 30% of schemes could buy-out their pension liabilities in 5 years, and 70% in 10 years (Kim Keveh (2019) Half of FTSE100 DB schemes could buy-out within 10 years, finds Barnett Waddingham*, Professional Pensions*, 1 July).

passed on the additional yield (including illiquidity premium) to schemes in the form of lower prices. Sixth, greater certainty over how Solvency II reserving requirements operate had helped to reduce margins for prudence. Finally, once a scheme closes to new entrants, its maturity increases rapidly: the proportion of the scheme's liabilities due to pensioners increases and the average age of non-pensioners also increases. Mature schemes tend to attract more favourable pricing because: scheme data for pensioners tend to be more reliable than for other types of member, there is less uncertainty over the timing and size of future cash flows, and the risk of the actual mortality experience deviating from that which was assumed is lower. All this helped to reduce the capital an insurer is required to hold.[111] Mercer has estimated that by 2030 more than £600bn of longevity risk transfers will have taken place in the UK, which represents around one-third of UK pension fund assets.[112]

Outside the UK, some significant developments took place in 2019, including:

- A longevity swap by RGA Life Reinsurance Company of Canada, covering 45,000 Manulife Canadian annuitants (February).
- A longevity swap by PartnerRe, covering 25,000 Manulife annuitants (March and May).
- A €5.5bn longevity swap by Canada Life Re, covering 150,000 in-payment and deferred pensioners liabilities of Dutch firm VIVAT (March).
- A €12bn longevity swap by Canada Life Re, for Dutch insurer Aegon, covering 200,000 in-payment and deferred pensioners (December).[113]
- There were also some significant buy-outs and buy-ins, e.g., PICA's $1.8bn buy-out of the Lockheed Martin pension scheme and a C$200m buy-in with an unnamed Canadian scheme executed by Brookfield Annuity Company and reinsured by L&G; this was L&G's first transaction in Canada.
- LifeXcel, a trading platform for mortality-linked contracts (MLCs), such as life settlements, was established in the US for institutions and hedge funds only. LifeXcel is an alternative assets administration company, specializing in structuring, distributing, and managing portfolios of MLCs. In 2021, the platform opened to 'accredited investors' in the US.

The introduction of third-party capital

We had mentioned earlier the problem of capacity constraints in the insurance and reinsurance industries. Our conference series is explicitly about capital markets solutions to the problem of transferring longevity risk. When the modern form of the longevity risk transfer market started in 2006, investment banks, such as J.P.Morgan, with their links to capital market investors, became active in the market along with insurers. However, the

[111] Attractive pricing opportunities for buy-in/buy-out, XPS Pensions, *Briefing Note No. 2*, June 2018.
[112] Mark Cobley (2019) Pension insurance deals to top £600bn by 2030, says Mercer, *Financial News*, 16 December.
[113] https://www.artemis.bm/news/aegon-gets-e12bn-longevity-reinsurance-cover-from-canada-life-re/

Global Financial Crisis in 2007-08 and the 2010 US Dodd-Frank (Restoring American Financial Stability) Act which followed led to the majority of investment banks withdrawing from the market. A few banks with insurance subsidiaries – such as Goldman Sachs, owner of Rothesay Life, and Deutsche Bank, owner of Abbey Life – remained for a while before they too sold their life businesses. So for the past few years, the market has been dominated by insurers and reinsurers. However, they are beginning to see that the current growth rates in the market are not sustainable without new sources of external (or third-party) capital.

One new solution to this problem that has emerged recently is the reinsurance sidecar – which is a way to share risks with new investors when the latter are concerned about the ceding reinsurer having an informational advantage. Formally, a reinsurance sidecar is a financial structure established to allow external investors to take on the risk and benefit from the return of specific books of insurance or reinsurance business. It is typically set up by existing (re)insurers that are looking to either partner with another source of capital or set up an entity to enable them to accept capital from third-party investors (Bugler et al. (2021)).

It is established as a special purpose vehicle (SPV), with a maturity of 2-3 years. It is capitalized by specialist insurance funds, usually by preference shares, though sometimes in the form of debt instruments. It reinsures a defined pre-agreed book of business or category of risk. Liability is limited to the assets of the SPV and the vehicle is unrated. The benefit to insurers is that sidecars can provide protection against exposure to peak longevity risks,[114] help with capital management by providing additional capacity without the need for permanent capital, and can provide an additional source of income by leveraging underwriting expertise. The benefit to investors is that they enjoy targeted non-correlated returns relating to specific short-horizon risks and have an agreed procedure for exiting; investors can also take advantage of temporary price hikes, but without facing legacy issues that could affect an investment in a typical insurer.

There are a number of challenges to the use of sidecars in the longevity risk transfer market. There is the tension between the long-term nature of longevity risk and investor preference for a short-term investment horizon. There are also regulatory requirements on cedants, affecting their ability to generate a return. These include: the posting of prudent collateral, the underlying assets in the SPV must generate matching cash flows, the risk transfer must be genuine, and the custodian/trustee must be financially strong. There is also a risk to cedants of losing capital relief if regulatory requirements are not met or they change.

Three reinsurance sidecars were established at the end of 2017 and the beginning of 2018, with investment capital provided by private equity investors and hedge funds, in addition to insurers and pension funds.

[114] That is, specific individual cashflows that give rise to the greatest uncertainty in value terms.

In December 2017, Athene entered into a reinsurance agreement with Voya Financial, covering $19bn of fixed, indexed and variable annuity liabilities. The matching assets will be managed by Athene Asset Management. By using an 'enhanced asset management' strategy and positioning itself for 'incremental value creation in a more favorable credit spread environment', the company hopes to generate 'mid-teens returns'. The capital is supplied mainly by private equity investors, including Apollo, Athene's parent company, Crestview Partners and Reverence Capital Partners.[115]

In January 2018, RGA Re and RenaissanceRe, announced a new start-up named Langhorne Re, which will target in-force life and annuity business. The new company has secured $780m of equity capital from RGA, RenaissanceRe and third-party sidecar investors, including pension funds and other life companies.[116]

In February 2018, the $400m Leo Re Ltd 2018-1 collateralized reinsurance sidecar was established between Dutch pension fund manager PGGM and Munich Re as a private ILS deal. The agreement allows PGGM, which manages the pension assets of the Dutch healthcare workers' scheme, PFZW, to gain access to a share of Munich Re's portfolio. PGGM will enter into direct ILS trades with counterparties, via quota share arrangements with a reinsurer, for a proportion of the counterparties' underwriting book, thereby sharing in the cedents' risks and underwriting returns.[117]

By 2021, more than $20bn in third-party capital from sidecar investors had been deployed to support around $400bn worth of life and annuity book transfers. There are three categories of transactions. The first is standard spread business, like pension risk transfer, fixed annuities, and fixed indexed annuities. The second focus on mortality risk for inclusion in the same sidecar as annuity risk, thereby offsetting longevity and mortality risks in a capital-efficient way.[118] The third is variable annuities which is a more specialist category. The first category is the most common, while the third is the least. Sidecar platforms which cover all three categories include: Atlas Merchant Capital, Berkshire Hathaway, J. C. Flowers & Co, and Varge Agam. Sidecar investors include pension funds (e.g., APG, Canada Pension Plan, Ontario Teachers Pension Plan, PGGM), asset managers (e.g., Blackstone, Invesco, PIMCO), sovereign wealth funds (e.g., Abu Dhabi Investment Authority, NZ Super Fund), private equity and hedge funds (e.g., D. E. Shaw & Co, KKR), ILS funds (e.g., Leadenhall Capital Partners, Securis Investment Partners), endowments and family offices.[119]

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[115] Athene & Apollo get long-term capital in $19bn annuity reinsurance deal, by Artemis on December 21, 2017; http://www.artemis.bm/blog/2017/12/21/athene-apollo-get-long-term-capital-in-19bn-annuity-reinsurance-deal/

[116] Steve Evans (2018) Langhorne Re launched by RGA and RenRe as in-force life and annuity reinsurer, *Reinsurance News*, 11 January,

[117] PGGM's $400m Leo Re is a private sidecar deal with Munich Re, by Artemis on February 5, 2018; http://www.artemis.bm/blog/2018/01/02/pggm-secures-140m-leo-re-sidecar-tranche-takes-2018-issue-to-400m/

[118] That is, exploiting the natural hedge in the insurer's balance sheet.

[119] Kessler (2021, Table 14).

In July, the Channel Island of Guernsey announced it would develop a simplified structure for the ILS market via an all-in-one legal entity that would combine insurance/reinsurance and investment activity in one vehicle – described as a 'Fund of One'. This would create a more transparent vehicle for investors which would promote 'true convergence' in ILS. Investors would establish both an unregulated investment fund and a reinsurance transformer cell. This would remove the need for multiple vehicles and allow a sidecar to have both the risks and the assets held in a single vehicle. This would help to reduce the challenges often associated with multiple vehicles, such as doing business in various jurisdictions, regulation, time zones, account rules, audit, and multiple layers of administration expenses.[120]

Another example of introducing new third-party capital is an initial public offer (IPO). This was the route Swiss Re considered in June 2019 when it proposed listing the shares of ReAssure – its UK closed book life consolidator business – on the London Stock Exchange. The idea was to provide working capital to put into new transactions and grow the UK life insurance book under the SwissRe brand. However, the idea was shelved due to weak demand and, in December 2019, ReAssure was sold to Phoenix for £3.2bn. In the process, Phoenix – which was valued at the time at £5.3bn – became Europe's biggest consolidator of life and pension businesses and justified the acquisition on the grounds that 'there are too many insurance companies in a market which is consolidating..[and the acquisition will] give us the opportunity to capture significant cost and capital synergies'.[121]

In September 2019, the European Life Settlement Association launched the ELSA Master Agreement for Tertiary Transactions (MATT). The aim was to develop an industry standard purchase and sale agreement to make tertiary transactions more cost and time efficient – in a similar manner as the ISDA Master Agreement.[122]

2020

Longevity risk transfers

2020 was a near record year for the longevity risk transfer market in the UK at £55.8bn. LCP and Mercer reported that £31.7bn of buy-ins and buy-outs and £24.1bn of longevity swaps were completed during the year. L&G had a 24% market share, followed by Rothesay with 22%, Aviva and PIC both on 19%.[123]

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[120] Guernsey targets "true convergence" via all in one ILS structure, by Artemis on July 24, 2018; http://www.artemis.bm/blog/2018/07/24/guernsey-targets-true-convergence-via-all-in-one-ils-structure/

[121] Matt Sheehan (2019) Swiss Re confirms ReAssure IPO is set for July, *Reinsurance News*, 14 June; https://www.reinsurancene.ws/swiss-re-confirms-reassure-ipo-is-set-for-july/. Louis Ashworth and Michael O'Dwyer (2019) Phoenix boss bows out with £3.2bn takeover of insurance rival ReAssure, *Daily Telegraph*, 7 December.

[122] https://www.derivsdocu.com/services/consultancy/What-is-an-ISDA-Master-Agreement/

[123] UK. Pension longevity risk transfers reach record-breaking £55.8bn in 2020,*Pension Policy International*, 19 March 2021.

One explanation was that bulk annuity pricing in 2020 fell slightly compared with 2019. Pensioner pricing was based on a 'gilts + 0.2% p.a.' discount rate to value liabilities (instead of 'gilts + 0.3% p.a.'), while the pricing of deferred pensioner liabilities was based on a 'gilts – 0.35% p.a.' liability (instead of 'gilts – 0.5% p.a.'). This implied that a buy-out for pensioners was cheaper than using gilts for pensioners in payment (equivalent to valuing liabilities on a gilts-flat basis).[124]

Highlights for 2020 in the UK included:

- In January, Securis Investment Partners announced that they had completed a capital market derisking deal – a longevity swaption – with a 'large well-known life risk carrier': 'we have taken structured longevity risk on a specific block of business. The transaction was structured as an indemnity derisking tool, i.e., without the use of any longevity indices, as a way to optimize the impact for our counterparty even further.. [It involved] a direct risk transfer to a Securis fund with no intermediary involved,…and was a first in terms of regulatory approval'.[125]
- In January, PIC said it would raise £750m in additional capital from existing investors to continue expanding its buy-out business. At the time, it managed £40.9bn on behalf of 225,000 pension scheme members.[126]
- Also in January, Pacific Life Re executed a £10bn longevity swap with three Lloyds Banking Group pension schemes – the second largest on record. The deal covers pensioner liabilities in the Lloyds Bank Pension Schemes No.1 and No.2 and the HBOS Final Salary Pension Scheme. The deal was structured as an insurance contract with Scottish Widows as the insurer and Pacific Life Re as the reinsurer.[127]
- In February, PIC agreed a £1.6bn buy-in with the Merchant Navy Officers' Pension Fund covering 14,000 members, in the process taking over a longevity swap that the fund initially executed with Pacific Life Re in 2014, using a Guernsey captive cell insurance company arrangement offered by Willis Towers Watson. This is another example of the novation of a swap to an annuity.[128]
- In February, Aviva and PIC each completed a £1bn buy-in with the Co-operative Pension Scheme. The deal was completed using a pre-agreed 'umbrella contract' designed to support a quick and efficient continuous process, each one covering

[124] Nick Reeve (2020), Longevity and risk transfer: A booming market, *IPE*, February; *XPS Risk Transfer News,* 8/20.
[125] Email announcement from Luca Tres, 8 January 2020. See also Paul Fulcher and Luca Tres (2019) A capital management toolkit for life re/insurers, *InsuranceERM*, 14 March; https://www.insuranceerm.com/analysis/a-capital-management-toolkit-for-life-reinsurers.html
[126] Emily Horton (2020) Pension Insurance Corporation to raise £750m from backers, *Financial News*, 28 January.
[127] James Phillips (2020) Lloyds schemes agree £10bn longevity swap with Pacific Life Re, *Professional Pensions*, 29 January; Lloyds Banking Group pension schemes strike £10bn longevity swap, *IPE*, 29 January 2020.
[128] Susanna Rust (2020) Merchant navy fund converts longevity swap to £1.bn buy-in, *IPE*, 19 February.

7,000 members. In May, Aviva completed a £350m buy-in transaction with the Co-operative Scheme covering an additional 2,300 members.[129]

- In February, PICA executed a $6bn reinsurance transaction with Rothesay Life.[130]
- In February, the AIB Group UK Pension Scheme completed a £1.1bn de-risking transaction with L&G, comprising a £850m buy-in combined with a £250m assured payment policy (APP).[131] The APP hedges the scheme's investment risk by protecting against changes in asset yields, interest rates and inflation, giving the scheme increased surety of being able to reach a full buy-out over a planned timeframe.[132]
- In March, the Xylem UK Pension Plan completed a £255m bulk annuity transaction with Rothesay Life, covering around 2,500 final salary section members.[133]

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[129] Susanna Rust (2020) Co-op pension scheme insures more liabilities as PIC deal disclosed, *IPE*, 19 February. Aviva in £350m bulk annuity deal with Co-operative Pension Scheme, *Reinsurance News*, 14 May 2020.

[130] Ditto.

[131] An assured payment policy is an insurance policy that provides the pension scheme with protection against investment-related risks, such as changes in asset returns, interest rates and inflation It was developed by L&G. APPs:

- Provide a pre-agreed series of future payments, which may be fixed or inflation-linked.
- Similar in nature to a buy-in, with the crucial difference being that APPs do not vary with longevity risk or other demographic experience. Compared with bulk annuities, they will be cheaper by around 15-20% for deferred pensioner members, but will be more expensive for pensioner members.
- Held as a pension scheme asset.
- Can apply to any sub-set of a pension scheme's liabilities.
- Can be used in combination with other de-risking solutions, such as pensioner buy-ins.

APPs can best be thought of as:

- Partial insurance: an APP locks down investment risk now, with a clear structure for adding the remaining pension-related risks in the future to 'complete the bulk annuity'; or
- An investment: an APP allows a pension scheme to 'build its own bond', with tailored inflation coverage and no exposure to market and reinvestment risk, while achieving a yield in excess of gilts.

APPs work as follows:

- An APP's fixed or inflation-linked pre-agreed payments are designed to match all or some of a pension scheme's liabilities.
- The trustees pay an upfront premium, as per a bulk annuity. In exchange, a payment schedule is agreed at outset, and payments are made by the provider to the trustees of the pension scheme as per that schedule.
- APPs can be structured to allow for conversion to buy-in or buy-out, including through a series of partial conversions over time. This flexibility, and the effective and transparent conversion mechanics, create a more certain de-risking journey.

Source: https://www.legalandgeneral.com/institutional/pension-risk-transfer/what-we-offer/app/

[132] AIB UK scheme completes £1.1bn de-risking deal, *IPE*, 13 February 2020. In May 2021, £61m of the AIB Group's APP was converted into a buy-in policy, which L&G said shows 'how APPs facilitate the de-risking journey'.

[133] Xylem UK Pension Plan secures £255m bulk annuity deal, *Pensions Age,* 2 March 2020.

- In March, L&G announced that it executed eight PRT deals worth £261m, ranging in size between £2.2m and £80m.[134]
- In March, the General Healthcare Group (GHG) Pension & Life Assurance Plan secured a £150m buy-in contract with Aviva to cover all 700 of its defined benefit members.
- In May, L&G completed a £650m buy-in with the *3i* Group Pension Plan.[135]
- Also in May, L&G completed a £70m buy-in for the ICI Pension Fund, the fund's 17th de-risking deal.[136]
- In June, the pension scheme of the Willis Group, now part of Willis Towers Watson, entered into a longevity swap with Munich Re. The swap covered £1bn pensioner liabilities of around 3,500 members. The longevity risk was transferred to the reinsurer via a Guernsey-based captive insurance company fully owned by the trustee of the scheme. It was established under Willis Towers Watson Guernsey ICC Limited, which is part of Willis Towers Watson's Longevity Direct solution allowing pension schemes to use a 'ready-made' incorporated cell company to access the reinsurance market.[137]
- In June, PIC executed a £280m longevity reinsurance deal with MetLife.[138]
- In July, the UBS (UK) Pension and Life Assurance Scheme executed a £1.4bn longevity swap with Zurich Assurance, covering around half the longevity risk in its £3bn DB scheme. Mercer, which acted as the adviser to the trustees, said the deal was structured as an 'innovative "pass through"' insurance contract, with 100% of the longevity risk reinsured by Canada Life Re.[139]
- In July, UBS executed a £1.4bn longevity swap with Zurich.[140]
- In July, the LV= Employee Pension Scheme converted a longevity swap held with ReAssure into a £800m buy-in with Phoenix Life. The buy-in covered the 4,100 pensioners and 200 deferred members who had been covered by the longevity swap, which had been agreed in 2012 and reinsured by Swiss Re. Swiss Re will continue to cover the longevity risk by providing reinsurance to Phoenix Life.[141]
- In July, the DB pension fund of Premaberg Holdings Limited, a UK manufacturer, completed a £5m bulk annuity transaction covering 50 members, of which around 80% are pensioners in payment. The buy-in was executed with Just Group and completed using Mercer's streamlined quotation service, which monitors buy-in pricing, demonstrating that 'smaller schemes can and do achieve successful bulk annuity transactions, despite continued high demand from much larger schemes'.[142]

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[134] L&G completes £261m of pension risk transfer deals in March, *Pension Policy International*, 3 April 2020.
[135] L&G agrees £650m buy-in with 3i scheme, *Professional Pensions*, 27 May 2020.
[136] ICI fund teams up with Legal & General for 17th buy-in, *IPE*, 13 August 2020.
[137] Willis pension scheme strikes £1bn longevity hedge with Munich Re, *IPE*, 30 June 2020.
[138] https://www.artemis.bm/news/metlife-enters-uk-longevity-reinsurance-market-with-pic-transaction/
[139] UBS UK pension scheme enters into £1.4bn longevity hedge, *IPE*, 7 July 2020.
[140] *Aon's Risk Settlement Market Review 2020.*
[141] https://www.pensionsage.com/pa/LV-converts-longevity-swap-into-800m-Phoenix-Life-buy-in.php
[142] £5m deal shows small schemes' ability to access bulk annuity market, *IPE*, 22 July 2020.

- In July, the superannuation scheme for a farmers' cooperative secured the benefits of all its 120 members via a £13m buy-out with L&G.
- In July, the Countrywide Farmers Retirement Benefits Scheme agreed a £100m bulk annuity deal with L&G covering the benefits of 360 deferred members and 712 retirees. The scheme had entered the PPF assessment[143] in March 2018 following the insolvency of its sponsor, a rural retailer, livestock feed and energy supplier. However, it was overfunded on a PPF measure, and was therefore able to complete a so-called 'PPF+' transaction with L&G, which provided enhanced benefits compared with those available from the PPF, but less than those available from a full buy-out.[144]
- In August, the Littlewoods Pensions Scheme insured all its pension liabilities with a £930m buy-in covering deferred members with Rothesay Life, following a £880m buy-in covering pensioners with Scottish Widows in 2018.[145]
- Also in August, Hitachi UK agreed a £275m buy-in transaction for the remaining deferred and pensioner members of its DB pension scheme with L&G. Hitachi's first buy-in was with Scottish Widows in 2018.[146]
- In October, the Old British Steel Pension Scheme agreed a £2bn buy-in covering 30,000 members with PIC, with a buy-out expected at a later date.[147]
- In October, Rothesay executed a $320m longevity reinsurance deal with MetLife.[148]
- In November, the Marks & Spencer Pension Scheme completed a third set of buy-ins with Aviva (for £390m) and Phoenix (for £360m), with 80% of the scheme's £3.7bn pensioner liabilities now insured. Both of the new transactions were carried out under 'umbrella contracts' entered into in 2018.[149]
- In November, the Prudential (UK) Staff Pension Scheme agreed a £3.7bn longevity swap covering 20,000 pensioners. The deal involved a Guernsey-based captive insurance company owned by the scheme trustees, which provided access to the reinsurance market. Artex Risk Solutions established the captive entity, with Pacific Life Re as the reinsurer.[150]
- In November, the £2.9bn Pearl Group Staff Pension Scheme, one of Phoenix Group's pension schemes, completed a £731m buy-in with the group's life assurance company, Phoenix Life.
- Also in November, the £1.4bn Baker Hughes UK pension plan completed a £100m buy-in with Just Group.

[143] That is, being considered for inclusion in the PPF due to sponsor insolvency.
[144] Pension scheme of collapsed rural retailer agrees £100m bulk annuity, *IPE*, 30 July 2020.
[145] Littlewoods scheme completes de-risking with £930m buy-in, *IPE*, 12 August 2020.
[146] Louron Pratt (2020) Hitachi UK completes £275 million pensions buy-in transaction, *Employee Benefits*, 26 August; https://employeebenefits.co.uk/hitachi-pensions-buy-in-transaction/
[147] Pension Insurance Corporation buys British Steel pension fund in £2bn deal, *Financial News,* 22 October 2020.
[148] https://www.artemis.bm/news/metlife-reinsures-320m-of-pension-longevity-risk-for-rothesay-life/
[149] M&S tops up de-risked pensioner liabilities with £750m set of buy-ins, *IPE*, 4 November 2020.
[150] Prudential Staff Pension Scheme agrees £3.7bn longevity swap, *IPE*, 11 November 2020.

- Smiths Group completed a £290m buy-in with Aon as consultant in the August-December period.[151]
- In December, the Barclays Bank UK Retirement Fund completed a £5bn longevity swap transaction with RGA. Aon advised on all aspects of the transaction, including risk analytics, design and structuring, reinsurance selection and operational establishment. Tom Scott, principal consultant in Aon's risk settlement team, said: 'This transaction…demonstrates the capacity and appetite of the global reinsurance market to take on pension fund longevity risk, even in these challenging times'.[152]
- In December, the BBC Pension Scheme completed a longevity swap that covers more than £3bn of pensioner liabilities, Zurich Life was the insurer, while reinsurance was provided by Canada Life Re. The swap covers around one-third of the scheme's pensioner and dependant members.[153]
- In December, L&G executed a $2bn longevity reinsurance deal with MetLife.[154] It also completed a £400m APP with the L&G Group UK Senior Pension Scheme, covering 200 deferred members and 385 pensioner members.
- In December, the National Grid UK Pension Scheme completed an £800m buy-in with Rothesay.[155]
- In December, Maersk agreed £1.1bn buy-in with L&G.
- Also in December, the Aon Retirement Plan completed a £510m pensioner buy-in with Scottish Widows.[156]
- Finally, Willis Towers Watson completed a £3.3bn buy-in with an unnamed company, the market's largest bulk annuity to date.[157]

A number of other key developments took place in the UK in 2020.

In June, Prudential Retirement, a subsidiary of PICA, introduced 'funded reinsurance' to the UK PRT market, with a deal involving UK insurer Aviva. Funded reinsurance allows an insurer to transfer both the asset risk and longevity risk associated with pension and annuity liabilities.[158] It therefore protects the insurer not only from the financial risk of an

[151] *Aon's Risk Settlement Market Review 2020.*
[152] Barclays Bank UK scheme agrees £5bn longevity swap transaction, *IPE*, 14 December 2020.
[153] https://www.artemis.bm/news/bbc-pension-gets-3bn-longevity-swap-from-zurich-canada-life-re/
[154] https://www.artemis.bm/news/metlife-reinsured-2bn-of-longevity-risk-for-lg-in-2020/
[155] National Grid completes £800m buy-in with Rothesay, *Professional Pensions*, 9 December 2020.
[156] BBC scheme strikes £3bn longevity swap, Aon plan in £510m buy-in, *IPE*, 15 December 2020.
[157] Willis Towers Watson, *De-risking Report 2021: Keep calm and carry on de-risking*; https://www.willistowerswatson.com/en-GB/Insights/2021/01/keep-calm-and-carry-on-de-risking-de-risking-report-2021
[158] It is also known as 'asset-intensive' reinsurance. It has been described as 'akin to a bulk annuity insurer doing its own buy-in behind the scenes. The insurer takes a portion of the buy-in/buy-out premium received from the pension scheme and passes it on to a reinsurer, often but not necessarily overseas. The reinsurer is then on the hook for providing monthly benefit payments to the insurer, and the insurer passes these payments on to the pension scheme or (following buy-out) the pensioners directly.' (Michael Abramson and Lara Desay (2023) The Insurance Regulator Takes a Look at Funded Reinsurance, *Life Risk News*, 2(8),10

unexpected increase in life expectancy, but also from unexpected losses in the invested assets. In return for a single premium, the reinsurer pays monthly benefits to the insurer for as long as the insured members live.[159] Before this, Prudential Retirement only reinsured the longevity risk of other insurers. As a consequence of the huge growth in the UK PRT market, insurers have been looking for reinsurance partners to bring in additional capital and asset management expertise in order to help manage the asset and longevity risk they have assumed. Amy Kessler, then head of international reinsurance at PICA, said: 'Our entry into the funded reinsurance business is a natural place for us to expand. The presence of reinsurers like us, with both longevity capacity and asset management capabilities, will allow the UK market to continue to grow in new ways in the years to come. …At least five reinsurers… closed funded reinsurance transactions, resulting in meaningful volume and capacity to support the growth in the UK'.[160]

In June, PIC announced that it had invested £75m in debt issued by a UK housing association, Trident Housing Association. PIC said the maturity profile of the debt has been tailored to match PIC's pension liabilities in years where it is difficult to source low-risk, long-term, secure cashflows in the public bond markets. It will also meet Trident's borrowing needs to develop more social housing stock. The debt is secured on a pool of housing assets owned by the association.[161] In November, PIC invested £65m in Welsh housing association Pobl in order to create 10,000 new homes over the next 10 years, with the debt secured on social housing assets. PIC said: 'This investment complements our portfolio providing low risk, long-term, secure cashflows that match our pension liabilities for decades into the future'.[162]

In July, a report by L&G – *The Power of Pensions: How pension savings can help to build the UK's infrastructure and drive growth in all regions* – suggested that pension risk transfer providers, such as insurers, were willing to invest up to £190bn of pension assets in UK infrastructure over the next decade. According to the report, this would provide 20% of the investment needed to 'to support our society's needs', since investment in infrastructure was the 'key' to maintaining the long-term competitiveness of the UK economy and was 'vital' to delivering the government's 'industrial strategy' and would bring the economic stimulation and employment opportunities needed following the Covid-19 pandemic. Long-term infrastructure investments are 'very attractive' to insurers because of their security and ability to generate steady cash flows for paying pensions as they fall due.[163]

August, https://liferisk.news/the-insurance-regulator-takes-a-look-at-funded-reinsurance/?utm_campaign=life-risk-news-volume-2-issue-8-august-2023).

[159] https://www.pacificlife.com/content/dam/plre/GFS-deal-signing-press-release-Final.pdf

[160] Prudential Retirement enters funded reinsurance business, 30 October 2020; https://news.prudential.com/prudential-retirement-enters-funded-reinsurance-business.htm#.X5wS1QIIOSE.linkedin; Kessler (2021).

[161] UK housing association Trident secures £75m funding from PIC, *IPE*, 19 June 2020.

[162] PIC invest a further £65m in Welsh housing association Pobl, *IPE*, 26 November 2020.

[163] PRTs could help plug UK infrastructure 'mega-gap' – L&G, *Pension Policy International*, 9 July 2020.

However, pension funds face barriers to infrastructure investing. There is a shortage of supply of suitable assets and those that are available face stiff competition from commercial fund managers and sovereign wealth funds which have significant amounts of capital to deploy and are often prepared to accept lower returns. Also while bigger schemes can acquire assets directly, smaller schemes have to invest via infrastructure funds which involve higher fees. Morten Nilsson, chief executive of the British Telecom Pension Scheme, argues that the government could help stimulate supply through the UK Infrastructure Bank which was set up in June 2021 to support infrastructure that drives local economic growth or helps tackle climate change through loans, credit enhancement and equity investments. It has a £22bn budget, split between £12bn of equity and debt capital, and the ability to issue £10bn of government guarantees.[164]

The most significant pension event of 2020 was the introduction in June by TPR of an interim regulatory regime for the superfund pension consolidation market.[165] This is the market where pension schemes are consolidated into a larger fund, while remaining legally classified as pension schemes.[166] Consolidators must be able to demonstrate that they are well-governed, run by fit and proper people, and are backed by adequate capital, thereby reducing the chance that they later become insolvent and fall back on the PPF which bails out the pension schemes of insolvent sponsors.

Transferring to a consolidator might be a preferred option for a sponsoring company that wants to remove its pension liabilities, but cannot afford a full buy-out. The interim regime also explains how consolidators will be assessed and regulated. Capital adequacy is a key aspect of TPR's interim regime, since there will no longer be an employer covenant. TPR will require superfunds to hold sufficient assets to meet the promises to savers with a high degree of certainty. This will include the requirement for the scheme's liabilities (or technical provisions) to be calculated using specific assumptions set out in TPR's guidance and for additional assets to be held in a capital buffer. The interim regime sets a 1-in-100 risk of failure to pay benefits promised to scheme members in full, which is less stringent than the Solvency II regime for insurers which sets a 1-in-200 risk of failure. Superfunds must not extract any surplus from a scheme or its capital buffer until such time as either the pension liabilities are bought out with an insurer or final payments have been made. The interim regime will eventually be replaced by a legislative authorization and supervision framework.

[164] Val Cipriani (2021) Pension funds 'outcompeted' on UK green infrastructure investments, *Pensions Expert*, 29November 29; https://www.pensions-expert.com/Investment/Pension-funds-outcompeted-on-UK-green-infrastructure-investments

[165] https://www.thepensionsregulator.gov.uk/en/media-hub/press-releases/2020-press-releases/tpr-launches-tough-new-interim-regime-for-emerging-superfund-pension-market

[166] This contrasts with buy-outs where the liability for paying pensions is transferred to an insurance company.

Trustees need to be certain that a transfer to a superfund is in their members' interests. In October, TPR issued further guidance to trustees, setting out, three 'gateway principles' that transactions with superfunds must meet:

- A transfer to a superfund should only be considered if the scheme cannot afford to buy out now;
- A transfer to a superfund should only be considered if a scheme has no realistic prospect of buy-out in the foreseeable future, given potential employer cash contributions and the insolvency risk of the employer; and
- A transfer to the chosen superfund must improve the likelihood of members receiving full benefits.

TPR said: 'We expect ceding employers to apply for clearance in relation to a transfer from their scheme to a superfund, and for trustees to demonstrate they have done their due diligence in respect of the transfer'. Marc Hommel, senior pensions adviser at EY, said the guidance 'further signals that the government and pensions regulator are backing employers to access superfunds as more affordable solutions to discharge their pension obligations and, in distressed situations, for trustees to have better options for their members relative to the Pension Protection Fund. In the near term, superfund transactions are likely to take place only where the employer is distressed or insolvent'.[167]

The introduction of the interim regime renewed the debate between the consolidators and insurers about which model of PRT was safer. Insurers complain that because superfunds operate as pension funds, there is no legislation which sets standards on their capital requirements or investment strategy. Hetty Hughes, policy adviser at the Association of British Insurers (ABI), argued: 'By underwriting superfunds with the PPF, you are potentially privatizing the gains and socializing the losses'.

However, superfunds counter that they must also hold a capital buffer, and, unlike insurers, they cannot distribute profits to investors for three years. Antony Barker of the Pension Superfund even argues that superfund capital requirements are more onerous than those of the insurers: 'If you do the maths on their one-year test versus our five year test, they have to hold less capital than us. For the schemes in PPF assessment, insurers can cut members' benefits unilaterally in securing them, but superfunds cannot'.

Nevertheless, Hughes believes that the interim guidance is insufficient. Her concern is that superfunds are targeting well-funded schemes: 'That is where the risk of regulatory arbitrage becomes more acute. The regime doesn't need to be Solvency II compliant as it is trying to serve a market that can't afford a buy-out, but that doesn't mean the regime doesn't need to have similar features to Solvency II. For example, the life insurance industry has undergone stress tests recently, where they have to measure the impact if half their assets' credit rating were downgraded. This was found to be manageable, whereas TPR guidance simply says that superfunds can do their own homework and come up with

[167] UK regulator delivers superfund guidance for trustees, sponsors, *IPE*, 21 October 2020.

their own stress tests. The regulator imposing a three-year ban on passing profits to investors, is still insufficient. We might not see legislation for another five years and the guidance also says that the three-year rule is under review. What it doesn't say is that there are other ways of extracting value other than dividends. Performance fees and management fees are examples of the instructions private equity firms tend to put in place'. Andrew Bailey, the governor of the Bank of England, has also warned that the lack of firmer rules in TPR's interim guidance could pose a risk to financial stability.

It is certainly appears to be the case that superfunds have greater flexibility than insurers over investment strategy and can take on more investment risk. The Pension Superfund, for example, has a target allocation of 80% in a liability-driven investment (LDI) strategy,[168] with the rest in return-seeking assets. Barker accepts that, unlike insurers, superfunds have more freedom to adjust this target portfolio to the allocation that schemes already have in place: 'Our actual strategy will be driven to some extent by the schemes we inherit. One of our unique features is that we novate the schemes' existing portfolios. That ensures that our transaction costs are lower. So, if people already have private equity, we don't need them to sell it to provide us with cash and government bonds. The return-seeking assets are going to be drawn from public and private markets, but will probably allow us to focus more on private markets and illiquid assets because we expect that our peak cash-flows are going to be in the late 2030s to early 2040s so that gives us a lot of time to invest in illiquids. We can look at infrastructure, private equity, insurance-linked securities, land, property and other real assets'.

Chris Clark, DB policy lead at TPR, says: 'We don't see superfunds as a replacement for insurance, they are not targeting an insurance level of guarantee, but there are many schemes out there that can't afford that level of guarantee. For trustees considering a transfer, it is vital that they are doing so because it is in the best interest of scheme members'. Yet, David Weeks, co-chair of the Association for Member Nominated Trustees, points out that currently superfunds do not allow for member nominated trustees with any say in scheme governance.[169]

In October, a third superfund consolidator, Stoneport, joined the market. It was established by actuarial consultant Punter Southall with the aim of targeting the 4,350 DB schemes with fewer than 1,000 members. Punter Southall's own small DB scheme has joined up. Stoneport has the following aims: 'To address the growing number of problems facing trustees and sponsoring employers of small schemes, Stoneport [aims] to target running cost, investment management and end-game efficiencies, as well as improving governance standards'. Small schemes have running costs of £1,000 per member per year, compared with less than £100 for the largest schemes, leading to potential long-term savings of

[168] Huw Jones and Sinead Cruise (2022) What is LDI? Liability-Driven Investment strategy explained, Reuters, 12 October 2022; https://www.reuters.com/markets/europe/what-is-ldi-liability-driven-investment-strategy-explained-2022-10-04/.
[169] Quoted in Mona Dohle (2020) Superfunds – New entrants to the DB consolidation market, *Portfolio Institutional*, 17 August.

£40bn, comprising savings in lifetime running costs of £10bn, reduced investment management costs, the dividend from good governance, and the saving from joining together for an eventual buy-out.[170] In December 2021, Stoneport appointed Mobius Life as its investment platform provider. The platform will host Stoneport's investment funds which small schemes will be able to access without having to do their own market research.[171]

Another innovation in 2020 was the introduction of 'third-party capital solutions' (TPCSs).[172] These involve investors who provide a 'helping hand' to pensions schemes in the form of an additional capital buffer to schemes planning for a buy-out (or even just to achieve self-sufficiency) at a future target date if pre-agreed funding thresholds are not met. The link between the sponsor, the scheme and the trustees is maintained, so this model is different from the superfund model. It is also different from a buy-in which involves the bulk purchase of an annuity from an insurer. The model is most similar to the reinsurance sidecar discussed earlier, although with differences.

With a TPCS, the investors have a bigger influence on the investment strategy of the scheme. Indeed, the scheme trustees need to agree an investment strategy with the investors which will incorporate a return on the capital provided. The investment strategy can target higher returns and possibly enable lower sponsor contributions, since the capital buffer gives greater downside risk protection. However, once the investment strategy has been agreed, it cannot be changed without the consent of the investors, and the downside protection is limited to the size of the capital buffer. On the target date, if the scheme is sufficiently well funded to achieve a full buy-out, both the scheme and capital structure are wound up, with investors getting back their capital in full; otherwise the scheme reverts to normal operations and the investors receive a partial return of capital. TPCS investors are looking at schemes with a strong sponsor covenant, with liabilities below £250m, which are at least 85% funded on a buy-out basis, and with a significant proportion of total liabilites in the form of deferred pensions.

International developments outside the UK in 2020 included:

- In May, NN Life, executed a €13.5bn longevity reinsurance and swap transaction covering a portfolio of annuity policies for over 200,000 pensioners and dependants. The deal was reinsured with Canada Life Re, Munich Re and Swiss Re, and NN Group said it would lower its required capital and strengthen its capital position, with a 25 percentage points increase to its Solvency II ratio, which at the end of April 2020 stood at 220%. There will be an immediate upfront capital benefit, as well as lower future operating capital generation of approximately €90m

[170] New DB consolidator targets UK's small schemes, *IPE*, 20 October 2020.
[171] https://www.ipe.com/news/uk-db-consolidator-appoints-mobius-life/10056678.article
[172] Willis Towers Watson, *De-risking Report 2021: Keep calm and carry on de-risking*; https://www.willistowerswatson.com/en-GB/Insights/2021/01/keep-calm-and-carry-on-de-risking-de-risking-report-2021

p.a., although the ongoing longevity reinsurance premiums will reduce the International Financial Reporting Standards (IFRS) operating result before tax by approximately €30m p.a.[173]

- In June, actuarial consultant Milliman released the results of its new Milliman Pension Buy-out Index (MPBI) for the US. The MPBI uses the FTSE Above Median AA Curve, along with annuity purchase composite interest rates from a number of insurers, to estimate the average cost of a PRT annuity de-risking strategy. During May, the estimated cost to transfer retiree pension risk to an insurer dropped from 105.5% to 103.9% of a scheme's pension liabilities, as measured by its accumulated benefit obligation (ABO). The explanation for the fall is that discount rates in May dropped 27 basis points compared to a 10 basis point drop for annuity purchase rates, resulting in the relative cost of annuities decreasing by 1.6 percentage points.[174]
- The launch in August by Australian annuity provider Challenger – Australia's largest provider of annuities[175]– of a guaranteed floating rate lifetime annuity, with payments linked to the Reserve Bank of Australia (RBA) cash rate, so that annuitants would gain from any increase in interest rates.[176]
- In September, Mercer's US pension buy-out index indicated that the buy-out cost was only 97.7% of a US DB plan's accounting obligations, making buy-outs increasingly attractive. This followed a number of amendments to the US index which was originally launched in 2013 in response to changing to market conditions, including:
    - competition – the number of insurers who compete for annuity and buy-out transactions has doubled since 2012;
    - investments – insurer pricing is generally driven by the ability of insurers to source higher yielding, less liquid assets, such as private credit and commercial mortgages, which provide a good match for illiquid annuity buy-out liabilities; and
    - mortality – insurers have evolved their mortality underwriting techniques to better assess mortality risk at the individual participant level. This may often lead to lower pricing especially for transactions with smaller benefits and/or where benefit accruals have been frozen for many years.

  By contrast, the estimated long-term costs of maintaining pension liabilities on sponsor balance sheets was 105.2%, which reflects costs not included in accounting liabilities (i.e., ABOs), such as Pension Benefit Guaranty Corporation (PBGC)[177]

[173] https://www.artemis.bm/news/nn-life-transfers-eur-13-5bn-of-pension-longevity-risk-to-reinsurers/; *Aon's Risk Settlement Market Review 2020.*

[174] Milliman analysis: Estimated cost of retiree pension risk transfer drops significantly, from 105.5% to 103.9% in May, *Pension Policy International*, 24 June 2020.

[175] https://www.challenger.com.au/about-us/challenger-group

[176] Australia. Challenger launches floating rate annuity, *Pension Policy International*, 24 August; https://pensionpolicyinternational.com/challenger-launches-floating-rate-annuity/

[177] The PBGC is a mandatory US federally-chartered insurance plan that pays pensions to members of private defined benefit pension plans when the sponsor has become insolvent; https://www.pbgc.gov/

premiums, investment management and administration fees, and the risk associated with fixed-income defaults and downgrades.[178]

- In November, Milliman's US Pension Buy-out Index was modified to reflect the impact of competitive pricing on estimated buy-out cost and two new insurers were added to the index: Massachusetts Mutual Life Insurance Co. and Banner Life Insurance Company (Legal & General America). During September, the average estimated cost to transfer retiree pension risk to an insurer decreased by 60 basis points, from 102.9% of a plan's total liabilities to 102.3% of those liabilities, measured on a retiree ABO basis. Annuity purchase costs were even lower at 100.2% (down from 101.0% in August).[179]
- L& G completed its first two cross-country PRT transactions in 2020. The first, in May, covered IHS Markit's UK and US pension plans. The UK deal was for £37.8m and covered 150 members in the IHS (Global) Ltd. Pension and Life Assurance Scheme. The US deal was for $97.2m and covered 1,200 members in the IHS Retirement Income Plan.[180] In December, US chemicals company Evonik agreed a £544m full buy-in with L&G for its four UK pension schemes. This built on a $93m 'lift-out' completed by L&G for the US Evonik Corporation Retirement Plan in September. In a lift-out, a subset of pension scheme members are lifted out and transferred to an insurance company.[181] The main reason for a lift-out are to reduce administrative costs and, especially, the PBGC fixed-rate premiums of around $83 per participant.[182]

For many PRT providers, 2020 was a record year with L&G, for example, completing more than 60 deals worth over £8bn across its US and UK businesses.[183] Actuarial consultant Hymans Robertson has pointed out that since the PRT market took off in 2007, UK buy-ins/buy-outs (£180bn) and longevity swaps (£110bn) have insured £300bn of risk from DB pension schemes and expects an additional £700bn by the end of 2031, resulting in £1trn of DB pension scheme risk – around 50% of the total – being insured by then.[184]

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[178] Revised Mercer U.S. Pension Buyout Index Methodology Shows That Costs of Annuity Buyouts Could Be Less Than Accounting Liability, *Pension Policy International,* 18 September 2020; https://pensionpolicyinternational.com/revised-mercer-u-s-pension-buyout-index-methodology-shows-that-costs-of-annuity-buyouts-could-be-less-than-accounting-liability/

[179] Milliman expands Pension Buyout Index to include competitive pricing rate, which drops to 100.2% in September, *Pension Policy International*, 4 November 2020; https://pensionpolicyinternational.com/milliman-expands-pension-buyout-index-to-include-competitive-pricing-rate-which-drops-to-100-2-in-september/

[180] https://www.ipe.com/news/uk-roundup-tpr-pipes-up-over-inter-dc-transfers-cross-country-prt-deal/10045567.article

[181] https://www.ipe.com/news/evonik-legal-and-general-add-544m-buy-in-to-us-de-risking-transaction/10050112.article

[182] https://www.pbgc.gov/prac/prem/premium-rates

[183] *Insurance Asset Management*, 3 February 2021.

[184] https://www.pensionpolicy.net/uk-roundup-1trn-of-db-pension-risk-to-be-insured-by-2031-says-hymans/

The Covid-19 pandemic

The most significant global event of 2020 was, of course, the Covid-19 pandemic.[185] There was no longevity conference in 2020 as a result. Here we discuss the implications of the pandemic for pension schemes and the PRT market.

A study in May 2020 by Cairns et al (2020) of the UK predicted that if total Covid-19 deaths were capped at around 80,000, then this would have little overall effect on pension liabilities. By June 2022, total UK Covid-19 deaths were 200,000.[186] Liabilities fell since some pensioners would die, especially those in care homes, and that would be offset by a small increase in the average life expectancy of survivors. The UK government announced that it would save around £600m in state pension payments in 2020 as a result of an increase in excess deaths among the elderly. Given state spending on pensions of £100bn, this amounts to a reduction of 0.6%.[187] Given that pension scheme members are typically from higher socio-economic groups than the average, we should expect the liabilities of pension schemes to fall by less than this.

LCP's 2020 *Longevity Report* predicted that the value of a typical UK defined benefit scheme's net liabilities might fall by less than 0.25% as a direct result of the deaths of pensioners arising from Covid-19 in 2020. Since, total UK DB liabilities are around £2.2trn, excess deaths in 2020 due to Covid-19 could reduce liabilities by less than £5bn. However, this is dwarfed by the increase in liability values of over £50bn in 2020 as a result of falling stock markets and ultra low interest rates. The report concluded: 'The ultimate impact of deaths due to the coronavirus on the funding of DB pensions will be driven more by the economic and social consequences of the pandemic following 2020, in particular, a severe recession.' The report also found that longevity insurers and reinsurers are making very little – if any – allowance for Covid-19 in their longevity assumptions at the moment: 'Any impact on the affordability of longevity hedging has therefore been dwarfed by the impact of changes to the financial markets due to the pandemic'.[188] XPS Pensions estimated a larger fall in UK pension liabilities of between 1.5% and 3.5%, equivalent to £25bn-£60bn.[189]

Willis Towers Watson found that the UK bulk annuities and longevity swaps markets remained active all throughout the lockdown, implying that insurers' operating

[185] XPS COVID-19 Tracker for UK: https://www.xpsgroup.com/what-we-do/technology-and-trackers/xps-covid-19-tracker/
[186] https://ourworldindata.org/explorers/coronavirus-data-explorer?facet=none&Metric=Confirmed+deaths&Interval=7-day+rolling+average&Relative+to+Population=true&Color+by+test+positivity=false&country=~GBR (29 June 2022).
[187] *Daily Telegraph*, 25 November 2020; https://www.statista.com/statistics/283917/uk-state-pension-costs/
[188] UK roundup: LCP on COVID-19's direct, indirect liabilities hit, *IPE*, 23 June 2020, https://www.ipe.com/news/uk-roundup-lcp-on-covid-19s-direct-indirect-liabilities-hit/10046384.article
[189] https://www.professionaladviser.com/news/4028930/covid-19-leaves-schemes-overestimating-pension-liabilities-research

and financial models were robust enough to withstand the instability. Indeed, the widening of credit spreads created some exceptional pricing opportunities, which were taken advantage of by schemes already in the process of de-risking as well as schemes that had previously transacted and hence were in a position to execute a 'repeat deal' relatively quickly. WTW said it was involved in 20 buy-ins for 19 schemes, covering £8.6bn of liabilities, with most of these taking place during lockdown. It was also involved in five longevity swaps covering £14.7bn of liabilities. It noted: 'There is a significant appetite for reinsurers to take on new longevity swaps and this is producing very attractive pricing, and in several cases, schemes have been able to hedge at little or no cost, relative to their technical provisions'.[190]

WTW's *Emerging Trends in DB Pensions Survey 2020*[191] found that Covid-19 and the consequences for the wider economy are placing sponsors and schemes under strain, weakening the sponsor covenant: 1 in 3 say the sponsor's ability to support the scheme has weakened in the short term; 1 in 6 say it has in the long term. There is a trade-off between scheme security and business recovery: trustees aim to shorten the time to meet schemes' long term funding targets, while corporates expect to extend it. In the next 3 years, 4 in 10 schemes are looking to complete a bulk annuity transaction or longevity swap.

The economic impact of the Covid-19 pandemic following the lockdowns that most countries introduced to stop the virus spreading has affected the ability of workers and employers to contribute to private-sector pension schemes, according to the OECD's *Pensions Outlook 2020.*[192] It also points out that the liabilities of DB schemes are likely to grow. Although government wage support schemes meant that workers did not lose their entitlement to a state pension while they were furloughed, the huge cost of those schemes will inevitably impact the ability of governments to fund state pensions in the future.

Conducting an international comparison of mortality rates during 2020-21, Club Vita found that Canada's excess mortality rates versus the underlying trend were 6.3% and 2.9% in 2020 and 2021, while the US's were 14.3% and 14.4% and the UK's were 13.5% and 8.6%. Club Vita said 'Whether these levels of increased deaths continue and for how long will be vitally important for pension plans and insurers trying to understand future longevity trends in the UK, US and Canada'.[193] The World Health Organization Global Health Observatory estimated that global healthy life expectancy (HALE) at age 60 fell by 1.1 years between

[190] Willis Towers Watson, *De-risking Report 2021: Keep calm and carry on de-risking*; https://www.willistowerswatson.com/en-GB/Insights/2021/01/keep-calm-and-carry-on-de-risking-de-risking-report-2021

[191] https://www.willistowerswatson.com/en-GB/Insights/2020/10/emerging-trends-in-db-pensions-survey-2020; October 26, 2020.

[192] Published 7 December 2020; https://www.oecd-ilibrary.org/finance-and-investment/oecd-pensions-outlook-2020_67ede41b-en

[193] https://www.clubvita.us/news-and-insights/top-charts-22-03-2021-excess-deaths

2019 and 2021 due to the Covid-19 pandemic; it fell by 1.4 years (from 16.61 to 15.21 years) over the same period in the Region of the Americas.[194]

In February 2024, the UK Office of National Statistics, on the basis of a new estimation methodology, revised down the number of excess deaths during the first pandemic year (2020), from 84,064 to 76,412. The highest number of excess deaths over the nine years prior to the pandemic was 30,858 in 2015, while the 2023 figure was 10,994. The new methodology allows for trends in mortality and the lags arising as a result of weekend deaths not being registered until the following week.[195] Richards (2024) proposed a method for removing the bias and distortion to the forecasts caused by the Covid-19 mortality shock; this also provided a robust starting point for making projections.

Evidence has begun to emerge about the long-term impact of the Covid-19 lockdowns that governments imposed. These affected people of all ages. Lockdown babies have been slower to reach milestones such as talking, pointing and waving goodbye, due to smaller social circles. The academic attainment of primary school pupils is significantly below pre-pandemic levels and their social and emotional development has been retarded. Lockdowns appear to have caused the premature ageing of teenagers' brains. The University of Washington found that the average acceleration in the development of the male adolescent brain was 1.4 years, while for females it was 4.2 years, possibly as a result of their heavier reliance on social relationships. A 2022 study by KCL found that disruption to education and prolonged social isolation 'exposed young people to many known risk factors for mental illness, raising serious concerns about their wellbeing'. The effect as endured: a 2023 study by University College London and the Sutton Trust found a third of 17 and 18-year-olds reported the legacy of Covid was still harming their education and mental health.

There has been an increase in UK university drop-outs that have been linked to school-leaving examinations during 2020-21 being graded on the basis of teacher assessments. The grades were sometimes higher than would have been awarded on the basis of exams and some students could not subsequently cope with university-level courses. The main reason given for dropping out was mental health, according to a 2023 study by KCL. Students who graduated missed out on the social interactions of university life, while those entering the job market while working from home were unable to learn from more experienced colleagues. In 2024, a UK study by the NHS Confederation and Boston Consulting Group found that thousands of new graduates were moving straight from university into long-term sickness, mainly with mental health conditions: 63,400 16-to-24 year olds in 2021-22, compared with 37,000 in 2019-20.

While young people's drug use decreased during Covid, alcohol use increased, mainly due to boredom. Research from NHS England and the University of Sheffield suggests that

[194] https://www.pensionpolicyinternational.com/impact-of-covid-19-on-healthy-life-expectancy-of-older-adults-in-the-region-of-the-americas/
[195] https://www.telegraph.co.uk/news/2024/02/20/excess-deaths-last-year-were-two-thirds-lower-than-expected/

excess drinking could lead to thousands of extra deaths over the next 20 years. The research also found that young adults aged 25 to 34 who were already heavier drinkers than their peers pre-pandemic were more likely to have increased alcohol consumption during and following lockdown. A similar pattern holds for the middle aged (in their late 30s, 40s and 50s) who were already drinking more than young adults before the pandemic. The acute anxiety, stress and boredom of lockdown, combined with the fact that many in this group were furloughed or laid off, led large numbers in this group to open a bottle of wine or can of beer much earlier in the evening than usual. As a consequence, the number of alcohol-related deaths recorded in the UK in 2022 at 10,046 was 4.2% and 32.8% higher than in 2021 and 2019, respectively. University of Essex research in 2022 showed that the switch to homeschooling resulted in mothers of school-age children experiencing stresses equivalent to getting divorce. Finally, research by the University of Exeter and KCL found that retirees in their late 60s and 70s experienced a decline in cognitive function during the pandemic, as a result of increased loneliness, depression and drinking and reduced exercise.[196]

2021: Longevity 16

The sixteenth conference (*L16*) was held in Helsingør near Copenhagen on 13-14 August 2021. It was hosted by PerCent at Copenhagen Business School and the Pensions Institute.[197]

In 2021, UK DB schemes completed £44.8bn worth of PRT transactions covering buy-ins, buy-outs, longevity swaps and assured payment policies. Excluding APPS (which do not hedge longevity risk), bulk annuity transactions were £27.7bn. Five longevity swaps were executed worth £17.1bn.[198] There were four bulk annuity deals of £1bn or more, compared with seven such jumbo deals in 2020, reflecting fewer multi-billion pound opportunities. However, buy-ins/outs between £100m and £1bn have trebled since 2015 and comprised one-third of all deals in 2021, while the number of deals below £100m fell by a third over the same period. The market was dominated by five insurers: Aviva (£6.2bn in deals, 22% market share), Standard Life (part of Phoenix Group, £5.5bn, 20%), L&G (£5.3bn, 19%), PIC (£4.7bn, 17%) and Rothesay Life (£3.0bn, 11%). Helped by rising yields on corporate bonds (a key investment vehicle in de-risking strategies), competition between insurers was intense and this was reflected in keen pricing.[199]

[196] Rosa Silverman (2024) How Covid destroyed our lives, from newborns to pensioners, *Daily Telegraph*, 21 September; https://www.telegraph.co.uk//global-health/science-and-disease/how-covid-damaged-every-generation-from-babies-to-pensioner

[197] The conference proceedings for *L16* were published in September 2023 in the *Journal of Demographic Economics*, 89 (Special Issue 3: International Longevity Risk and Capital Markets Solutions): 299-312; https://doi.org/10.1017/dem.2023.2

[198] https://www.artemis.bm/longevity-swaps-and-longevity-risk-transfers/

[199] https://www.ipe.com/news/2021-uk-pension-risk-transfer-volumes-hit-439bn-with-record-core/10058708.article, https://www.pensions-expert.com/Investment/Derisking-activity-ramps-up-in-Q3

In March 2020, the UK Institute and Faculty of Actuaries' Continuous Mortality Investigation (CMI) released the CMI_2020 Mortality Projections Model.[200] This is used by most DB schemes in the UK and it requires schemes to choose what allowance to make for the pandemic. By 2021, there was enough information for schemes to form a best estimate. For most schemes, an appropriate pandemic allowance was a reduction of 1.5% to 3.5% in liabilities. For a scheme that is 90% funded, this could mean a 25% reduction in the deficit.[201]

The Longevity Index for England (LIFE Index) was introduced in 2021 (together with a LIFE App). It was developed by Andrew Cairns of Herriot Watt University and uses data science methods (e.g., the random forest algorithm which helps identify non-linearities in the data) and machine learning to analyze life expectancy at the neighbourhood level, based on ONS data, such as the Index of Multiple Deprivation. The LIFE Index indentifies distinct socio-economic and urban-rural differences in mortality levels. Income and employment deprivation are responsible for 80-90% of the variation in life expectancies, while urban-rural differences account for 10%.[202]

Highlights for 2021 in the UK included:

- In February, L&G agreed a £570m pensioner buy-in deal with Deutsche Bank's UK pension scheme; it was the £4.5bn scheme's first de-risking strategy.[203]
- In March, the AXA (UK) Pension Scheme executed a £3bn longevity swap with Hannover Re, covering a significant number of deferred members who comprise around 95% of the 16,000 members. This was helpful for the scheme's investment strategy as it provided increased cashflow certainty.[204] This transaction helped to open up the longevity market for pension schemes to reinsure non-pensioners.
- Also in March, an unnamed UK pension scheme executed a £6bn longevity swap with PICA and Zurich Assurance acting as an intermediary on a pass-through basis. The pass-through deal was the first used by PICA with a UK-based insurer, having previously used Guernsey- and Bermuda-based captive solutions. Rohit Mathur, the new head of international reinsurance at PICA, said 'We see the use of a third-party onshore UK-regulated insurer as a limited recourse intermediary as the logical next step in the de-risking solutions we can offer for clients in our evolving business model'.[205]

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[200] https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-investigations/mortality-projections

[201] Updating life expectancy assumptions for the new CMI_2020 model, *XPS Express for Employers*, March 2021.

[202] https://liferisk.news/using-local-knowledge-to-fine-tune-life-expectancy-analysis/

[203] https://www.pensionpolicy.net/deutsche-bank-inks-buy-in-deal-for-u-k-pension-fund-with-lg/

[204] https://www.ipe.com/news/axa-uk-scheme-signs-3bn-longevity-swap-for-mostly-deferred-liabilities/10051692.article

[205] https://www.professionalpensions.com/news/4030529/pica-reinsures-gbp6bn-longevity-risk-unnamed-scheme

- In April, PIC made a £37.5m debt investment in Welsh housing association Wales and West Housing which will fund the building of 2,500 new homes over the next five years. PIC said: 'Sourcing long-dated, secure cash flows is important to PIC. The investment backs our long-term pension liabilities, while having the beneficial outcome of putting PIC's capital to use in parts of the economy where funds are vitally needed'.[206]
- In May, the AIB Group UK Pension Scheme agreed a £61m transaction with L&G to convert a tranche of its existing APP into a buy-in policy. Covering both deferred members and new retirees, the transaction is the first example of a APP being partially converted into a new buy-in policy. The conversion builds on the original £250m APP transaction with the AIB Group scheme, and follows a £400m APP transaction with the L&G Group UK Senior Pension Scheme.
- In May, the Wyeth Group Pension and Life Assurance Scheme, a Pfizer Group subsidiary, completed a £190m bulk purchase annuity buy-in, covering 2,000 members.[207]
- Also in May, the ICL Group Pension Plan (whose sponsor is Fujitsu) completed a £3.7bn longevity swap with Swiss Re.[208]
- In June, the Tui Group UK Pension Trust agreed two buy-ins for £794m with L&G.[209]
- In June, PIC announced it was investing £200m in the development and operation of 10 new retirement living communities comprising around 2,000 older residents, via a partnership with Octopus Real Estate. PIC's aim is again to generate index-linked cash flows.[210] In the same month, it invested £175m in the senior secured debt funding of 18 Spanish solar parks owned by Q-Energy which in turn receives payments from the Spanish electricity system and so can guarantee an agreed level of return and predictable cashflows for PIC.[211]
- In July, L&G completed its third APP, another deal (valued at £925m) with its own DB pension scheme, covering 2,000 retired and 2,800 deferred members.[212]
- In July, the Pearl Group Staff Pension Scheme completed a second £998m buy-in with Phoenix Life.[213]

[206] https://realassets.ipe.com/news/pension-insurance-corporation-lends-to-welsh-housing-association/10052418.article
[207] https://www.ipe.com/news/251m-in-de-risking-deals-as-aib-converts-app-wyeth-seals-buy-in/10053116.article
[208] https://www.ipe.com/news/icl-group-scheme-strikes-37bn-longevity-hedge/10052771.article
[209] https://www.ipe.com/news/uk-roundup-tui-trust-strikes-800m-buy-in-pair-lothian-names-new-ceo/10053151.article
[210] https://realassets.ipe.com/news/pic-to-invest-up-to-200m-in-uk-retirement-communities-via-octopus-jv/10060819.article
[211] https://realassets.ipe.com/news/pic-increases-investment-in-renewable-energy/10053393.article
[212] https://www.ipe.com/news/legal-and-general-completes-925m-assured-payment-policy-transaction/10054195.article
[213] https://www.pensions-expert.com/DB-Derisking/Pearl-Group-pension-fund-completes-further-buy-in

- In July, the Kingfisher Pension Scheme completed a £900m bulk purchase annuity transaction with Aviva, covering 8,000 of the £3.7bn scheme's members.[214]
- In September, Aviva completed a £320m bulk purchase annuity transaction with the John Laing Pension Fund, covering 1,850 pensioners.[215]
- In September, Just Group introduced medical underwriting for its equity release mortgage range, by taking account of the client's medical conditions and lifestyle factors in determining the borrowing rate and limit.[216]
- In September, Standard Life entered the equity release market with a range of lifetime mortgage products launched in partnership with Key Group, under the brand Standard Life Home Finance. Earlier in the month, Phoenix Group bought a portfolio of equity release mortgages worth £300m from Just Retirement. In 2020, the equity release market totalled £3.89bn, while £1.17bn of property wealth was unlocked by over-55 homeowners in the second quarter of this year, according to the Equity Release Council.[217]
- In October, the Metal Box Pension Scheme agreed a £2.2bn buy-in, covering 10,300 pensioners and 2,200 non-pensioner members, with PIC as a step towards a full buy-out in November.[218]
- In October, the Sanofi Pension Scheme has signed a £760m buy-in policy with L&G, covering 2,900 retirees.[219]
- In December, the Imperial Tobacco Pension Fund completed a £1.8bn bulk purchase annuity transaction, covering 6,600 pensioner members, with Standard Life.[220]
- In December, the Gallaher Pension Scheme completed a £1.7bn bulk purchase annuity (BPA),[221] covering 7,600 members, with Standard Life. Standard Life said the assets underlying the deal will be used to continue its investment into UK infrastructure and socially responsible projects that are vital to the UK's post-pandemic recovery.[222]

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[214] https://www.ipe.com/news/kingfisher-pension-scheme-inks-900m-bulk-annuity-with-aviva/10054147.article

[215] https://www.pensionpolicyinternational.com/aviva-announces-320m-bulk-annuity-deal-with-the-john-laing-pension-fund/

[216] https://www.professionaladviser.com/news/4037321/group-launches-medical-underwriting-equity-release

[217] https://www.professionaladviser.com/news/4037061/standard-life-launches-lifetime-mortgage-range-key-group

[218] https://www.ipe.com/news/metal-box-scheme-in-wind-up-mode-after-striking-22bn-buyout/10055419.article

[219] https://www.ipe.com/news/sanofi-uk-pension-scheme-agrees-760m-buy-in-with-landg/10055597.article

[220] https://www.ipe.com/news/uk-roundup-tobacco-scheme-strikes-18bn-buy-in-deal/10057343.article

[221] Alternative name for a buy-in.

[222] https://www.ipe.com/news/de-risking-roundup-gallaher-pensions-17bn-buy-in-deal-with-standard-life/10057512.article

- In December, an unnamed pension scheme executed a £2.6bn longevity swap with Zurich and Metlife. It was MetLife's first pension scheme longevity swap transaction.[223]
- In December, the Phoenix Group completed a £1.8bn longevity swap covering its UK pension liabilities with Metlife.
- In December, the pension scheme of biochemical and food company CSM Limited completed a £86m buy-in with Just Group. The scheme received pricing from multiple insurers in three weeks using the PwC Insure service.[224]
- In December, Just Group also completed £345m buy-in transaction with the UK pension scheme of an unnamed global distribution company. The deal covered 1,000 deferred members and 900 pensioner members.[225]
- Also in December, the benefits in the pension plan of metal flow engineering company Vesuvius were fully insured with PIC following a seventh buy-in. The first buy-in with PIC was in 2012. With the latest deal, valued at £305m, over £600m of liabilities were insured with PIC.[226]

International developments outside the UK in 2021 included:

- Athora Netherlands executed two longevity swaps: the first was valued at €4.7bn with Canada Life Re in March and the second was valued at €3.3bn with RGA in September.
- Aegon executed a €7bn longevity swap with RGA in December. It had now reinsured 40% of the longevity risk of its Dutch pension insurance book. The deal improved the solvency ratio of Aegon's life business by 15 percentage points, releasing capital for new business growth.[227]
- NN Life executed a €4bn longevity swap with RGA also in December.[228]
- These transactions all involved Dutch insurers, but the larger Dutch pension plans have also been considering buy-outs as funding ratios have improved as a result of strong equity markets and higher interest rates. With funding ratios above 120%, accrued pension benefits can be transferred to an insurer with guaranteed indexation. In 2021, 44 plans out of a total of 129 reached this threshold (e.g., ING and ABN AMRO Bank) compared with 15 in 2020. Competition from insurers has also increased, with NN Group, previously the only provider, joined by Aegon, Zwitserleven and Lifetri. It is however possible, under new Dutch legislation, for accrued DB benefits to be transferred to a DC plan and the Dutch regulator expected up to 70% of plans to do this.[229]

[223] https://www.ipe.com/news/metlife-zurich-complete-35bn-longevity-swap/10057535.article
[224] https://www.ipe.com/news/csm-limited-scheme-completes-86m-deferred-heavy-buy-in/10058660.article
[225] https://www.ipe.com/news/metlife-zurich-complete-35bn-longevity-swap/10057535.article
[226] https://www.ipe.com/news/vesuvius-seals-seventh-final-buy-in-with-pic/10057145.article
[227] https://www.ipe.com/news/aegon-reinsures-dutch-longevity-risk/10057149.article
[228] https://www.artemis.bm/longevity-swaps-and-longevity-risk-transfers/
[229] https://www.ipe.com/news/higher-funding-ratios-and-dc-transition-fuel-dutch-demand-for-buyouts/10056974.article

- In December, the Amsterdam School of Economics and Nationale-Nederlanden opened the Research Centre for Longevity Risk.[230] The research centre 'will study developments in survival rates and life expectancy and how these developments are affected by a variety of factors. This includes studying demographic trends and medical developments, as well as the impact of local socioeconomic conditions and the quality of our living environment. The research findings pertaining to expected developments in life expectancy will also provide a foundation for studying the financial and social impact of these trends'.
- US corporate pension plan buy-out sales totaled $38bn in 2021, beating the previous record of $36bn set in 2012.[231] There were a number of large PRTs. For example, in August, Lockheed Martin Corp purchased group annuity contracts from Athene Holding to transfer $4.9bn pension plan liabilities, covering 18,000 retirees and beneficiaries.[232] In September, HP Inc agreed to purchase a group annuity contract from PICA to transfer $5.2bn in liabilities, covering 41,000 retirees and beneficiaries in the HP Pension Plan.[233]
- In November, State Street Global Advisors launched a deferred lifetime income annuity within the University of California's retirement plan. The deferred annuities are linked to target-date asset-allocation funds, which invest a portion of the plan member's assets in annuity contracts as the member approaches retirement age.[234]
- Canada introduced longevity funds which are mutual funds with mortality credits as a middle ground between pension funds and annuities. Purpose Investments launched the Longevity Pension Fund in 2021, while Guardian Capital launched GuardPath Longevity Solutions in 2022.[235]

2022: Longevity 17

The seventeenth conference (*L17*) was held online on 12-13 September 2022. It was hosted by the Pensions Institute.[236]

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[230] https://rclr.nl

[231] https://www.pensionpolicyinternational.com/us-pension-risk-transfer-market-posts-record-breaking-2021/

[232] https://www.pionline.com/pension-risk-transfer/lockheed-martin-offloads-another-43-billion-pension-liabilities-insurer

[233] https://www.pensionpolicyinternational.com/hp-ships-off-5-2-billion-in-pension-liabilities/

[234] https://www.pensionpolicyinternational.com/us-new-lifetime-annuities-in-401k-plans-could-cut-advisors-out-of-the-picture/

[235] https://www.pensionpolicyinternational.com/canada-are-longevity-fund-solutions-going-to-change-the-retirement-income-game/

[236] The conference proceedings for *L17* were published in April 2024 in *The Geneva Papers on Risk and Insurance - Issues and Practice*, 49(2): 229–233, Special Issue on Longevity Risks; https://doi.org/10.1057/s41288-024-00314-3; Supplementary materials, https://static-content.springer.com/esm/art%3A10.1057%2Fs41288-024-00314-3/MediaObjects/41288_2024_314_MOESM1_ESM.pdf

The effects of long Covid began to be observed in the UK in 2022. According to a study by the Institute for Fiscal Studies, there were 2m people with long Covid who have taken some time out of work, with 110,000 unable to work at any one time. Sufferers typically report long Covid for up to six months after they are first infected. Given that total unemployment and total vacancies both equal 1.3m, this implies 110,000 people had a 'meaningful effect' on the jobs market and the wider economy. The Office for National Statistics estimated that 8.75m people of working age were 'economically inactive', implying they were not in work or looking for work. This has risen by around 400,000 since the pandemic began. Of these, 2.3m were long-term sick (absent for more than four weeks), up by more than 200,000 since February 2020. Not only was this damaging for the economy, it also badly affected the finances of long Covid sufferers who experienced a reduction of income of around £1,100 per month on average.[237]

Douglas Anderson, Founder of Club Vita, reported that UK mortality rates for 2022 were below pre-Covid-19 levels. As social distancing measures were gradually relaxed at the start of 2022, Covid-19 cases increased, but the strain was less dangerous than at the beginning of the pandemic: 'Statistics show that there are many people in hospital *with Covid*, but *not because of Covid*. What we are seeing is the Covid has completed its journey …to now being a largely manageable endemic. When Covid first struck, the disease was materially more dangerous (a death rate of something like 10x flu). With vaccinations,[238] changes to the way we live our lives, better treatments and the emergence of less deadly dominant variants, the risk of death has thankfully reduced. …The patterns in North America are following a similar trajectory to the UK. But the picture in China is very different with Shanghai in lockdown [in May 2022]. It's a good reminder that despite the improvement, we have not reached "herd immunity", and some experts argue that we probably never will'.

Looking to the long-term and the implications for projecting pension liabilities, Anderson identified four trends for the UK:

[237] https://www.telegraph.co.uk/business/2022/07/27/long-covid-shrinks-workforce-110000/

[238] The World Health Organization estimated that Covid-19 vaccinations saved more than 1.4 million lives across Europe between December 2020, when the vaccine rollouts began, and March 2023; https://www.medrxiv.org/content/10.1101/2024.01.12.24301206v1. Further, undervaccination (receiving fewer than the recommended number of SARS-CoV-2 vaccine doses) could be associated with increased risk of severe COVID-19 outcomes (i.e., COVID-19 hospitalisation or death) compared with full vaccination (receiving the recommended number of SARS-CoV-2 vaccine doses), according to a meta-analysis of UK data published in *The Lancet*; https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(23)02467-4/fulltext

1. Waiting times for health treatments have lengthened: Since 2018 the number of people in England on a waiting list has risen from 4m to 6m, and the average wait time has almost doubled from 7 weeks to 13 weeks.[239]

2. More public money going into the UK National Health Service (NHS): To deal with this waiting list, in 2022, the government introduced a health and social care levy which will raise £12bn a year. Given that the NHS budget is around £150bn, 'that's useful money at the margin, but could be quickly used up by the continued aging of the population'.

3. Labour shortages are encouraging employers to prioritize employee wellbeing: 'Covid continues to cause a big shake out in working practices. Trade unions highlight the loss of 200,000 older workers, reversing a previously healthy trend in employment levels in older people. Further, workers show little appetite to return to a daily commute to the office, after showing that the job can be done perfectly well from home: "hybrid working" – part office-based, part home-based looks like it will be the "new normal" for those whose jobs are suitable. Employers are increasingly appreciating that they will need to invest more in health and wellbeing to attract and retain older employees. This emphasis on prevention in middle aged workers is very welcome. By focussing on slowing down aging by improving lifestyle, it is possible to soften the demands of the aging population on future treatment in the NHS system'.

4. More private money going into genetic research: 'Covid showcased the first mass benefit of the genetics research industry (mRNA[240] vaccines), leading to sharp share price gains for the visionary investors. This stunning success is encouraging other investors to back the biotechnology sector. The increase in research capacity bodes well for the volume of future advances. Take a look at the Deep Knowledge Group to see the growing coalition of researchers and investors'.

Anderson concludes: 'My personal sample of emerging themes offers three positive, but slow, improvements from three different stakeholder groups: government, employers and investors. Collectively, these may turn out to be more significant for pensioner longevity – when the inevitable peaks and troughs from year to year are smoothed out – than today's spike in waiting lists for treatments'.[241]

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[239] In the UK at the height of the pandemic in 2020, most cancer deaths occurred at home as hospitals prioritized Covid patients; https://www.telegraph.co.uk/news/2021/05/07/majority-cancer-deaths-occurred-home-last-year-hospitals-prioritised

[240] Messenger RNA (mRNA) is a type of single-stranded RNA involved in protein synthesis; https://www.genome.gov/genetics-glossary/messenger-rna

[241] Douglas Anderson (2022) UK deaths now below pre COVID levels: what's the long-term COVID legacy for pensioner longevity?, Club Vita, 11 May; https://www.clubvita.co.uk/news-and-insights/uk-deaths-now-below-pre-covid-levels-whats-the-long-term-covid-legacy-for-pensioner-longevity

In 2022, for the first time, all eight insurers in the UK market were in a position to offer full-scheme buy-outs with member-facing administration services, 'a reaction to the increasing maturity of final salary schemes and a growing conviction over targeting buy-out'.[242]

The funding position of UK defined benefit schemes increased by 20% during 2022 to 104% of liabilities (with assets of £1,456bn and liabilities of £1,394bn). This was largely explained by gilt yields rising by 3 percentage points and a corresponding 35% reduction in the value of liabilities, moving many UK schemes into a surplus position for the first time for many years.[243]

WTW reported that 2022 was the biggest on record for pension scheme de-risking in the UK, with £60bn of bulk annuity and longevity swap transactions completed, comprising £40bn in buy-ins and buy-outs and £20bn in longevity swaps. A key reason was higher gilt yields and widening corporate bond spreads which increased pension scheme funding levels and lowered buy-out prices significantly. Around 30% of pension schemes anticipate de-risking their liabilities in the next three years.[244]

There was increasing automation of the pricing process which removed manual input and made use of interpretable machine learning, ensuring greater accuracy. This has improved workflows by making them more consistent, cost effective and reliable, which, in turn, has increased pricing agility and speed to market.

Despite this, some insurers were struggling to keep up with the current levels of demand, according to a report by Aon, especially the teams responsible for pricing transactions. This has made it harder for smaller schemes to attract the attention of insurance companies. Although transactions under £100m have increased in recent years due to insurer innovation, small schemes were now 'having to compete harder for insurer engagement and potentially show flexibility over their auction timing and form'.[245]

Legal & General Investment Management's (LGIM's) DB Health Tracker found that a typical DB scheme could meet 98.8% of accrued pension benefits as of 30 June 2022: 'The increase in both nominal and real interest rates benefited a typical scheme due to underhedged liabilities. This was largely offset by poor performance of growth assets relative to expectations. Overall, however, our Expected Proportion of Benefits Met

[242] https://www.ipe.com/news/2021-uk-pension-risk-transfer-volumes-hit-439bn-with-record-core/10058708.article
[243] https://www.professionaladviser.com/news/4062207/defined-benefit-pensions-gbp400bn-funding-improvement-2022
[244] Willis Towers Watson (2023) Shifting up a Gear – De-risking Report 2023; https://www.ipe.com/news/bulk-annuity-longevity-hedging-deals-set-to-reach-60bn-says-wtw/10064524.article
[245] https://www.ipe.com/news/insurers-stretched-as-uk-pension-de-risking-demand-rises/10061581.article

(EPBM) measure managed to …reach a new high'.[246] A PwC survey of UK DB pension plans in July 2022 found that 80% expected to reach their long-term funding target (of ensuring pensions are paid in full) within the next nine years: 85% of both the smallest plans with assets of less than £300m and the largest plans with assets above £5bn said they could achieve this, whereas only 75% of medium-size plans felt they could. Asset returns were a key component of the strategy, with 92% of plans saying that they would rely in whole or in part on assets returns and 41% relying solely on asset returns; 8% had hedged their investment risk and were relying on sponsor contributions to reach their long-term funding target. PwC said that pension funding levels had improved dramatically over the last couple of years, with many schemes moving into a surplus position.[247] This will clearly increase the demand for buy-outs in the UK over the next decade.

In order to ensure they could meet their targets for buying out, pension funds were also increasing the inflation sensitivity of their portfolio in response to the increase in inflation following governments' pandemic quantitative easing programs and the increase in commodity prices following the Russian invasion of Ukraine on 24 February 2022. A poll of global pension funds by investment consultancy bfinance indicated that the funds were planning to increase their exposure to infrastructure (48%), private debt (39%) and real estate (36%). Alternatives were more popular as an inflation hedge than equities (18%), inflation-linked bonds (12%) and commodities (8%).[248]

In the light of the UK's departure from the EU, the UK government announced revisions to Solvency II on 17 November 2022. According to Pelkiewicz et al. (2019), the reason for this was as follows: 'Following the implementation of Solvency II, the risk margin[249] came under considerable criticism for being too large and too sensitive to interest rate movements. These criticisms are particularly valid for annuity business in the United Kingdom. …A further criticism is that mitigation of the impact of the risk margin has led to an increase of reinsurance of longevity risks, particularly to overseas reinsurers'.

The new regime for UK insurers is known as 'Solvency UK' and involves:

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[246] https://www.ipe.com/news/uk-roundup-db-schemes-health-reaches-new-high/10061802.article? By 31 August 2022, the average UK pension fund was 100.2% funded on a long-term target basis for the first time since aggregated records began, according to XPS Pensions Group's DB: UK funding tracker; https://www.ipe.com/news/uk-roundup-pension-funds-achieve-100-funding-on-long-term-targets/10061950.article?

[247] https://www.ipe.com/news/uk-db-schemes-expected-to-reach-long-term-funding-target/10061323.article

[248] https://www.ipe.com/news/pension-funds-turn-to-alternatives-for-inflation-protection/10059146.article

[249] The risk margin represents the potential costs of transferring insurance obligations to a third party should an insurer fail. It is the difference between the technical provisions (the transfer value) and the Best Estimate Liabilities (BELs). It is calculated in Solvency II using the 'cost-of-capital method' as an insurer's baseline solvency capital requirement (SCR) for unhedgeable risks multiplied by the cost of capital at 6% and discounted at current interest rates. Unhedgeable risks are risks that cannot be hedged or easily transferred to a third party, due to the absence of a deep and liquid market. A current example is longevity risk. The risk margin does not include credit and market risks as compensation for uncertainty arising from those risks is considered to be already adequately reflected in the BELs; https://www.risk.net/definition/risk-margin

- a reduction in the 'risk margin', including a cut of 65% for long-term life insurers;[250]
- more sensitive treatment of credit risk in the 'matching adjustment',[251] such as allowing insurers to invest in assets with 'highly predictable' (rather than strictly 'fixed') cashflows and assets with prepayment risk, such as callable bonds (up to 10% of the total matching adjustment);
- a significant increase in flexibility allowing insurers to invest in long-term assets such as infrastructure and other assets with a construction phase;
- a meaningful reduction in the current reporting and administrative burden on firms; and
- a new regime for start-up insurers, with adjusted entry requirements such as a lower capital floor, lower expectations for key personnel and governance structures, and exemptions from some reporting requirements, which is also aimed at developing the UK insurtech sector.[252]

The combined effect of these reforms is expected to release 10-15% of the capital currently held by life insurers.[253] They have been welcomed by UK insurers and are likely to lead to greater insurer capacity for schemes looking to de-risk through buy-ins and buy-outs. John Baines, partner at Aon and head of its bulk purchase annuity team, said the reforms struck a good balance between capital relief and policyholder protection, with the PRA likely to be reassured that the level of capital requirement would still be a 'gold standard approach to ensuring insurers had a high chance of meeting pension benefit obligations.[254] Chris Anderson, head of BPA consulting at EY, said: 'Risk margin rules at the moment drive insurers to transact a huge amount of longevity reinsurance when they complete a PRT deal. Two potential consequences of the proposed changes are that first, it may encourage insurance companies to carry out slightly less reinsurance, which could be beneficial on price for pension schemes, and secondly the risk margin on what remains will be lower, which also should be beneficial on price'. A key problem which slows down the pace of transactions is a shortage of qualified staff. According to Anderson: 'Everyone is trying to find people. Insurance companies need people to run the quotation process and to onboard

[250] 30% for non-life insurers.
[251] The matching adjustment give insurers capital relief for holding specific long-term assets which match the cash flows of a designated portfolio of life or annuity insurance and reinsurance obligations. It permits insurers to discount their liability cash flows at a higher rate than the risk-free rate, resulting in a lower liability value and hence lower regulatory capital. The higher rate is intended to reflect the illiquidity premium in the return on the long-term assets held and is calculated as the difference between the spread on these assets above the risk-free rate and the 'fundamental spread' or credit risk premium (i.e., the expected cost of default and downgrade of these assets); https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/publication/2022/solvency-ii-review-matching-adjustment-and-reforms-to-the-fundamental-spread
[252] https://www.skadden.com/insights/publications/2022/11/from-solvency-ii-to-solvency-uk
[253] https://ukfinancialservicesinsights.deloitte.com/post/102hnw5/the-uk-governments-consultation-on-solvency-ii-part-1-risk-margin-and-matchin
[254] https://www.ipe.com/news/analysis-uk-solvency-ii-reforms-and-the-pensions-buyout-market/10058506.article

schemes. Employee benefit consultants also need additional staff – everyone is resource constrained'.[255]

A report from PIC entitled *Investment Unleashed*[256] argued that appropriate reform to Solvency II could unlock 'tens of billions of pounds' to invest in infrastructure and social assets in the UK, including renewable energy and social housing. PIC estimated its planned investment of £30bn in productive finance by 2030 could increase to £50bn. According to the report, the ideal reform of Solvency II would:

- preserve insurer balance sheet resilience throughout the cycle – protecting policyholder pensions – whilst discouraging investment in relatively riskier assets in overvalued markets;
- encourage investment into productive finance throughout the cycle;
- ensure a competitive UK insurance industry – especially when compared to insurers operating under the EU Solvency II regime.[257]

However, Michael Luo, associate director at fiduciary manager Cardano, pointed out that in 2022 life insurers were facing geopolitical risks and a macroeconomic climate that had not been experienced in over 40 years, with the prospect that they could see the quality of their investments deteriorate through increased credit downgrades and defaults. In addition, any insurers looking to raise hybrid debt capital in the near-future may experience higher borrowing costs than in recent years, whilst any increase in volatility in interest rates and credit markets could create pressure on liquidity management. This implies that trustees and sponsors will need to put more focus on understanding insurers' financial strength, risk management and capital resilience when undergoing an insurer-led risk transfer exercise, to ensure the most appropriate insurer is selected to deliver benefits to their scheme members.[258]

In response to this, some pension plan trustees had become concerned about post-transaction protection. According to Alan Pickering, President of BESTrustees: 'If the trustees do not realize until the eleventh hour that once the scheme has no money, they will be depending on insurance or internal indemnities to guarantee that they will sleep at night for the rest of their lives, because ambulance chasing lawyers will not come after them claiming the benefit payments are wrong. You do not want to double bank external

[255] Quoted in Greg Winterton (2022) Solvency II Reform Proposals Could Drive Increased Pension Risk Transfer Activity, *Life Risk News*, Volume 1, Issue 8, December; https://liferisk.news/solvency-ii-reform-proposals-could-drive-increased-pension-risk-transfer-activity/
[256] https://www.pensioncorporation.com/media/200562/investment-unleashed-2021-211223v1.pdf
[257] https://www.ipe.com/news/solvency-ii-reform-could-free-up-tens-of-billions-of-pounds-for-uk-infra-says-pic/10057177.article
[258] https://www.pensionsage.com/pa/Trustees-urged-to-consider-insurers-financial-strength-as-PRT-market-approaches-unique-juncture.php

insurance and internal indemnities, but it is important to send trustees into retirement with peace of mind'.[259]

One of the most significant events of the year was the impact on UK pension funds' liability-driven investment (LDI) strategies – used by 73% of DB schemes according to Mercer[260] – following UK government's 'mini-Budget' of 23 September. The financial markets responded unfavourably to the unfunded tax cuts announced, predicting that the UK's national debt would increase substantially. The prices of gilts fell sharply and pension funds faced huge increases in collateral requirements as their hedging contracts for protecting against lower interest rates (principally in the form of interest rate swaps and gilt repurchase agreements[261]) moved out of the money. Pension funds were forced to sell gilts in an illiquid market to meet cash margin calls and this reduced gilt prices even further. The Bank of England was forced to step in and stabilize the market by agreeing to purchase gilts directly from pension funds. Although pension funds faced a severe liquidity crisis at the time, their solvency position actually improved, since the rise in gilt yields helped to reduce the value of their liabilities.[262]

This experience is expected to provide a further boost to buy-outs and buy-ins. It was also expected to be disappointing news for pension scheme consolidator companies that rely on LDI strategies to hedge their risks.[263] A survey by Russell Investments found that the volatility following the UK government's 'mini-Budget' had influenced asset allocation decisions, with moves away from developed markets (32% of respondents) and emerging markets equities (12%), as well as property (17%) exposure. Instead, investment grade credit (25%) and high yield credit (13%) were the key beneficiaries of this trend, as was infrastructure (16%) and private credit (12%), 'reflecting the perceived attractiveness of the risk/return opportunities available in these asset classes'.[264]

Another issue was currency movements. Sterling fell significantly against the US dollar during 2022 from $1.35 to $1.21. This reduced the costs for both US sponsors of UK pension plans and US insurers offering PRT solutions to UK plans.

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[259] Quoted in Mark Dunne (2022, Editor) Endgame investing - pi roundtable, July; https://www.portfolio-institutional.co.uk/roundtables/endgame-investing/

[260] *Portfolio Institutional*, October 2022 (p.44).

[261] See, e.g., *An Introduction to Liability Driven Investment*, Insight Investment, November 2021.

[262] Sarah Breeden (2022) Risks from leverage: how did a small corner of the pensions industry threaten financial stability? Bank of England, 7 November; https://www.bankofengland.co.uk/-/media/boe/files/speech/2022/november/sarah-breeden-speech-at-isda-aima.pdf.

[263] https://www.pensionpolicyinternational.com/uk-ldi-fallout-will-spur-pension-funds-to-seek-life-sector-arrangements/

[264] https://www.ipe.com/news/uk-mini-budget-accelerates-db-schemes-de-risking-says-russell-investments/10063686.article

A total of £44.7bn in buy-outs, buy-ins and longevity swaps were executed in 2022, of which £28.7bn were buy-ins and £15.7bn were in five longevity swaps.[265] The largest providers were Legal & General, Standard Life, Aviva, PIC and Rothesay, with Just Group having a record year with £2.6bn in transactions. Around 30% of buy-in and buy-out transactions were run on an exclusive basis in 2022 and did not go through an auction process.[266]

Highlights for 2022 in the UK included:

- In February, the Lloyds Banking Group Pensions Scheme executed a second longevity swap, covering £5.5bn of liabilities. It was structured as an insurance contract with Scottish Widows as the insurer and SCOR as the reinsurer, taking over the longevity risk.[267]
- In February, L&G agreed a £370m buy-in with London Heathrow's BAA Pension Scheme, securing the benefits of more than 1,400 retirees.[268]
- In February, L&G announced it would invest £2.5bn of DB pension assets in UK build-to-rent (BTR) projects over the next five years, creating more than 7,000 new homes.[269] This was followed up in April with an announcement that it would invest a further £2bn in affordable UK homes over the next five years, creating 10,000 new homes.[270] In August, it invested £500m in 'later living' residential homes in a joint venture with the NatWest Bank pension fund.[271]
- In March, the Air Canada (UK) Pension Trust Fund completed a £380m buy-in deal with PIC, covering 1,400 members.[272]
- In March, the Royal Mencap Society completed a £61m bulk annuity transaction for its pension scheme, covering 710 members. Following a one-round appointment process, the scheme was able to benefit from Canada Life and Aon's streamlined internal legal process. These efficiencies secured competitive pricing for the scheme.[273]

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[265] https://www.ipe.com/news/bulk-annuity-volumes-reach-278bn-according-to-aon/10065718.article?; https://www.artemis.bm/longevity-swaps-and-longevity-risk-transfers/

[266] Estimates from Hymans Robertson; *Insurance Asset Management*, 6 October 2023.

[267] https://www.professionalpensions.com/news/4044972/lloyds-scheme-completes-gbp-5bn-longevity-swap

[268] https://group.legalandgeneral.com/en/newsroom/press-releases/legal-general-agrees-c-370m-buy-in-with-heathrow-s-baa-pension-scheme

[269] https://realassets.ipe.com/news/landg-to-inject-25bn-of-pension-money-into-uk-build-to-rent-projects/10058092.article

[270] https://realassets.ipe.com/news/landg-to-invest-2bn-of-pension-money-into-affordable-uk-homes/10059125.article

[271] https://realassets.ipe.com/news/landg-and-natwest-pension-fund-to-invest-500m-in-uk-later-living-villages/10054341.article

[272] https://www.ipe.com/news/uk-pension-schemes-sign-buy-in-deals-with-pic-just-group/10058758.article

[273] https://www.ipe.com/news/uk-roundup-charity-completes-61m-bulk-annuity-transaction/10058643.article

- In March, the Newell Rubbermaid UK Pension Scheme has agreed to a £225m buy-in with L&G, covering 800 retirees and 900 deferred members.[274]
- In May, the £10.3bn British Steel Pension Scheme II agreed a second buy-in with L&G, insuring around 25% of its liabilities. The first buy-in was completed at the end of 2021 and covered 5% of the liabilities.[275] In December, the scheme completed a further £2bn buy-in with L&G. This covered 30% of its liabilities, and brought the total liabilities insured to 60%.[276]
- In May, PIC made a £130m debt investment in UK social housing provider Raven Housing Trust to help fund the development of 630 homes by 2026.[277] In September, PIC invested £105m to forward fund a new 'net-zero in-operation office' in Manchester to be let to the Government Property Agency for 25 years. In October, it invested £55m in Northern Ireland-based Clanmil Housing Association which will be used to build 1,400 new homes by 2026[278] and provided £102m of debt financing to Corelink Rail Infrastructure, a UK rolling-stock lessor.[279] Also in October, it invested £40m in the secured debt of UK social housing provider, Mhs, to fund the development of 600 new properties.[280] In November, it financed the construction of a £200m residential skyscraper in the West Midlands region of England.[281] Also in November, it created Senior Living Investment Partners with Octopus Real Estate which made its first £115m investment in a retirement community in St Albans.[282] In December, it invested £40m of debt in Housing Solutions, a housing association which owns and manages around 7,500 properties in the south-east of England.[283] In each case, the aim was to secure long-dated index-linked cashflows for the purpose of paying the 'pensions of our current and future policyholders over coming decades'.[284]

[274] https://www.ipe.com/news/uk-roundup-rubbermaid-scheme-completes-buy-in-with-legal-and-general/10058607.article
[275] https://www.pensionsage.com/pa/BSPS-II-secures-two-buy-ins-with-L-G.php
[276] https://www.ipe.com/news/british-steel-pension-scheme-completes-2bn-buy-in-with-legal-and-general/10064456.article
[277] https://realassets.ipe.com/news/uk-social-housing-provider-raven-secures-130m-funding-from-pic/10059795.article
[278] https://realassets.ipe.com/news/pic-invests-55m-in-clanmil-housing-association/10062602.article
[279] https://realassets.ipe.com/news/uk-rolling-stock-lessor-corelink-gets-102m-pic-loan/10062627.article
[280][280] https://realassets.ipe.com/news/pic-invests-in-secured-debt-issued-by-uk-housing-association-mhs/10062935.article
[281] https://realassets.ipe.com/news/pic-funds-200m-residential-skyscraper-project-in-birmingham/10063144.article
[282] https://realassets.ipe.com/news/pic-and-octopus-real-estates-uk-retirement-living-venture-makes-first-investment/10063332
[283] https://realassets.ipe.com/news/pic-provides-40m-of-debt-for-uk-social-housing-provider/10063997.article
[284] https://realassets.ipe.com/news/pic-invests-105m-to-forward-fund-gpa-hub-office-project/10062435.article

- In June, the House of Fraser's Beatties & Jenners Pension Scheme insured £600m of liabilities via a buy-out with PIC, covering 3,850 deferred members and 5,050 pensioners.[285]
- In June, the Phoenix Group provided £90m of long-term funding to regulated social housing provider, Alliance Homes, with the aim of generating index-linked cash flows.
- In July, the UBS (UK) Pension and Life Assurance Scheme extended its July 2020 longevity hedge by £500m to include 50% of its deferred members, those over 60. The combined hedge covered two-thirds of its DB liabilities. The deal involved Zurich Assurance as the insurer and Canada Life Re acting as the reinsurer.[286]
- In July, the Whitbread Group executed a £680m bulk purchase annuity covering approximately 8,000 members of its pension fund with Standard Life. Standard Life said: 'we receive a one-off premium from the scheme and then guarantee that member benefits will be paid into the future. This premium is invested across a broad range of assets to ensure we are able to meet the future liabilities. Given that member benefits will be paid out over decades we can afford to take a long-term view in the way we invest and make allocations to illiquid investments. We aim to invest 60% of our illiquid assets in sustainable investments including in areas like renewable energy, infrastructure, affordable housing and healthcare and education, …supporting some of society's most vulnerable people as well as …projects with a positive environmental impact, such as the provision of renewable electricity'.[287]
- In August, the Equity Release Council reported that 47,000 new and returning customers withdrew £3.13bn from their properties during the first half of 2022, an increase of 37% on the same period in 2021. The majority (54%) of the withdrawals were in the form of lump sum lifetime mortgages rather than drawdown lifetime mortgages. The Council believes that this is 'influenced by customers' continuing desire to gift money to younger family members and share their property wealth across generations'. Stephen Lowe, group communications director at Just Group, said the 'demand for equity release has recovered strongly from the pandemic wobbles. …Homeowners may be using equity release to generate lump sums, extra income or for estate-planning'.[288]
- In August, Phoenix Group announced it would acquire Sun Life Assurance Company of Canada (UK), a closed book UK life insurance company, from Sun Life Financial for £248m. The deal was expected to deliver £470m of incremental long-term cash generation, inclusive of cost and capital synergies. The insurer had about 480,000 in-force policies and £10bn of assets under administration, of which £2.5bn were annuities that would remain reinsured with Sun Life Financial.[289]

[285] https://www.ipe.com/news/uk-roundup-house-of-fraser-plan-strikes-600m-buyout/10060379.article
[286] https://www.ipe.com/news/ubs-uk-scheme-extends-longevity-hedge-by-500m/10060899.article
[287] https://www.ipe.com/whitbread-group-pension-fund-completes-680m-buy-in-with-standard-life/10061094.article
[288] https://www.professionaladviser.com/news/4054181/equity-release-activity-26?
[289] https://www.professionaladviser.com/news/4054283/phoenix-group-acquire-sun-life-uk-gbp248m

- In August, Standard Life completed a £1bn buy-in of the WH Smith Pension Trust, covering around 13,000 members. As with other insurers, the assets underlying the contract will be used to continue Standard Life's program of investing into UK infrastructure and socially responsible projects, such as renewable energy, infrastructure, and affordable homes.[290]
- In August, L&G agreed a £50m full scheme buy-in with the Boots Supplementary Pension Plan, covering the benefits of more than 110 members. Lisa Varley, a senior consultant in Aon's risk settlement group, which advised the trustees, said: 'The successful outcome illustrates that there are excellent opportunities for sub-£100m schemes, as long as insurers can see a clear line of sight to a successful transaction'.[291]
- In August, Railpen, the UK railways pension scheme, purchased a life-science business park in Oxford for £29m with plans to attract leading companies in scientific research as tenants and generate 'enhanced returns' for scheme members.[292] In October, Railpen agreed to fund the redevelopment of a mental health facility in Northern England in exchange for a 30-year lease on the site which will deliver inflation-linked returns for the scheme.[293]
- In September, the Barloworld UK Pension Scheme completed a £484m full scheme buy-in with Just Group, insuring the benefits of around 3,000 pensioners and 1,800 deferred members.[294]
- In September, the Yell Pension Plan executed a full scheme buy-in with PIC, covering the remaining £370m of liabilities, having completed a £200m buy-in also with PIC in 2014. All 1,800 plan members became PIC policyholders.[295]
- In October, the Cobham Pension Plan has concluded a £530m buy-in with Standard Life, covering around 3,000 members.[296]
- In November, the Balfour Beatty Pension Fund completed a £1.7bn longevity reinsurance transaction (i.e., swap) covering 15,000 members with Zurich UK as the insurer and SCOR taking on 100% of the longevity risk using a 'pass-through' structure.[297]

[290] https://www.ipe.com/news/standard-life-completes-1bn-buy-in-of-the-wh-smith-pension-trust/10061476.article
[291] https://www.ipe.com/news/boots-supplementary-agrees-50m-pension-buy-in-with-landg/10061569.article
[292] https://realassets.ipe.com/news/railpen-buys-29m-life-science-business-park-from-aew/10061697.article
[293] https://realassets.ipe.com/news/railpen-to-fund-monkwearmouth-hospital-redevelopment/10062796.article
[294] https://www.ipe.com/news/barloworld-uk-scheme-completes-484m-buy-in-deal-with-just-group/10061961.article?
[295] https://www.ipe.com/news/uk-roundup-yell-pension-plan-completes-370m-buy-in-deal-with-pic/10062218.article?
[296] https://www.ipe.com/news/uk-roundup-cobham-scheme-completes-530m-buy-in/10062986.article
[297] https://www.ipe.com/news/uk-roundup-balfour-beatty-in-17bn-longevity-transaction/10063743.article

- In November, an unnamed UK pension scheme sponsored by a Fortune 500 company completed a £1bn longevity swap with Zurich as insurer and PartnerRe as reinsurer. The deal covered both pensioner and non-pensioner members.[298]
- In November, the TT Group scheme executed a £400m buy-in deal with L&G, covering 5,000 members.[299]
- In December, the Barclays Bank UK Retirement Fund executed a £7bn reinsurance transaction, with reinsurance provided by PICA.[300]
- In December, the Amey pension fund executed a £400m buy-in deal with PIC, covering 3,473 members, including 1,938 deferred members.[301]
- In December, The Interserve Pension Scheme completed a £400m buy-in with Aviva, covering around 7,000 members.[302]
- In December, the Tioxide Pension Fund agreed a £430m buy-in with L&G, securing the benefits of around 2,700 retirees and deferred members.[303]
- In December, the Co-operative Pension Scheme's £2.1bn Bank Section completed a full £1.2bn buy-in with Rothesay Life, covering all the liabilities of 2,474 pensioners and dependants and a further 6,531 deferred members.[304]
- Also in December, Rothesay Life executed a £762m buy-in for the Morrisons Retirement Saver Plan, covering 2,650 pensioners and dependants and 5,500 deferred members.[305]

There were a number of significant international developments outside the UK in 2022.

The US PRT market had its most successful year to date, with 568 transactions valued at $51.8bn, of which $48.3bn was accounted for by 562 single premium buy-outs, while the remainder were buy-ins.[306] This was largely due to improved funding ratios rising from 87.9% in 2020 to 95.8% in 2021 and to 100.7% in 2022, on the back of strong equity market performance and higher interest rates. With rising levels of inflation, a potential recession, and geopolitical uncertainty, plan sponsors wanted to protect themselves from

[298] https://www.professionalpensions.com/news/4060514/fortune-500-sponsored-scheme-completes-gbp1bn-longevity-swap
[299] https://www.ipe.com/news/partnerre-in-1bn-longevity-swap-deal-with-uk-fortune-500-scheme/10063540.article
[300] https://www.professionalpensions.com/news/4061710/barclays-uk-retirement-fund-seals-gbp7bn-longevity-deal
[301] https://www.ipe.com/news/british-steel-pension-scheme-completes-2bn-buy-in-with-legal-and-general/10064456.article
[302] https://www.pensionsage.com/pa/Interserve-Pension-Scheme-completes-400m-buy-in-with-Aviva.php
[303] https://www.ipe.com/news/uk-roundup-tioxide-pension-fund-in-430m-buy-in-deal-with-landg/10064566.article
[304] https://www.pensions-expert.com/DB-Derisking/Co-operative-Pension-Scheme-completes-1.2bn-full-section-buy-in
[305] https://www.pensionsage.com/pa/Morrisons-agrees-762-m-buy-in-with-Rothesay.php
[306] https://www.pensionpolicyinternational.com/us-pension-risk-transfer-market-keeps-setting-records/; https://www.pensionpolicyinternational.com/u-s-pension-plan-buyouts-reach-record-volume-in-2022/; https://www.pensionpolicyinternational.com/us-pension-risk-transfers-spiked-in-2022-due-to-higher-interest-rates-report-shows/

market downturns. Some of the PRTs were lift-outs, with plans transferring some of their pension risk to an insurance company, but most followed plan terminations – and a consequential increase in annuity purchases – by plans that were over 100% funded. The market was also very competitive with 21 active insurers, including newcomers Global Atlantic, RGA and American National, compared with 10 in 2012.[307] As a result of this competition, the Milliman Pension Buyout Index was 98.9% of plans' retiree ABO, while the average annuity purchase cost across all insurers was 103.7%. This meant that the competitive bidding process was estimated to save plan sponsors on average around 4.8% of PRT costs (as of February 28). By September 30, the cost savings had fallen to 3.0% of PRT costs due to 'insurers having less appetite for interest rate risk, or less assets available for transactions'.[308] The average premium per transaction was $90m in 2022, up from $55m in 2018.[309] Another development is the entry of reinsurers into the market, providing additional balance sheet capacity to insurers, but without being direct writers in the market. There is beginning to be some interest in buy-ins in the US market, but longevity-only transactions, such as longevity swaps, are still rare, because they will not reduce PBGC premiums.[310] A prediction for 2023 will be artificial intelligence enhanced modelling of mortality and longevity risks which could lead to more longevity risk-transfer deals.[311]

One of the largest disclosed US transactions of the year was completed in June by Lockheed Martin Corp. which purchased group annuity contracts for 13,600 retirees from Athene Holding valued at $4.3bn.[312] An even bigger one was completed in September, when PICA and MetLife each agreed to reinsure 50% of the pension benefit payments of 100,000 IBM (International Business Machines) plan members. The total value of the PRT transaction was $16bn, making it the second-largest deal in the US market.[313] In December, Western & Southern Financial Group executed a $1.7bn longevity swap with RGA.[314]

In the Netherlands, there has been a movement away from longevity derivatives towards longevity swaps (or longevity reinsurance). According to Andre de Vries, vice president business development at RGA, longevity derivatives, which dominated the Dutch market between 2012 and 2017, 'are based on the mortality risk of the general Dutch population, as opposed to a specified portfolio of insured beneficiaries. In addition, these longevity

[307] https://www.institutionalinvestor.com/article/b1xzjngjkysg4t/Companies-Race-to-Offload-Pension-Risk-as-Market-Volatility-Rises
[308] https://www.pensionpolicyinternational.com/milliman-analysis-competitive-pension-risk-transfer-buyout-rate-rises-320-basis-points-to-100-1-during-september/
[309] https://www.pensionpolicyinternational.com/global-pension-risk-transfer-monitor-record-h1-transaction-volumes-in-uk-and-us/
[310] https://liferisk.news/still-plenty-of-capacity-for-growth-in-robust-us-prt-market/
[311] https://www.ipe.com/north-america/us-sponsors-back-pension-buyouts/10064707.article?
[312] https://www.pensionpolicyinternational.com/us-milliman-analysis-competitive-pension-risk-transfer-buyout-rate-hits-all-time-low-in-february-at-98-9/; https://www.pionline.com/pension-risk-transfer/us-corporate-pension-plan-buyouts-hit-record-123-billion-q2-limra-survey
[313] https://www.pensionpolicyinternational.com/prudential-and-metlife-entrusted-to-fulfill-16b-in-pension-obligations-for-100000-ibm-retirement-plan-participants-and-beneficiaries/
[314] https://www.artemis.bm/longevity-swaps-and-longevity-risk-transfers/

derivatives are structured to transfer more remote (out-of-the-money) longevity risk over a limited term and the benefit (claim) under these longevity derivatives is capped at a pre-defined amount. Compared to longevity reinsurance, longevity derivatives require only a limited set of data to be shared with the risk takers and impose less due diligence requirements on the ceding company compared to a reinsurance transaction. On the other hand, it is more challenging to determine the reduction in Solvency Capital Requirement under Solvency II (SII) resulting from these derivatives because there is no perfect fit between the longevity risk transferred and the longevity risk of the insurance company'.

In 2018, the Dutch market switched to longevity reinsurance because if the introduction of SII in the EU in January 2016: 'As longevity swaps transfer all the longevity risk of a specified portfolio of pension obligations over their full remaining term (which can easily be more than a few decades), these transactions are more expensive than longevity derivatives. On the other hand, because these reinsurance transactions exactly match the underlying liabilities of the insurance companies, these instruments allow insurance companies to fully release the SCR for the corresponding longevity risk. …SII has an explicit SCR for longevity risk which resulted in clear capital relief from longevity risk transfer transactions. This was not the case under the prior regulatory regime'.

Dutch longevity swaps have introduced a number of new features:

- Recouponing (or rebalancing) longevity swaps. The objective of recouponing is to provide additional protection to the party that is facing a positive value of the longevity swap at a future moment during the term of the transaction. Under this mechanism, the fixed leg (the premiums) of the longevity swap is adjusted in case its present value has become materially different (either higher or lower) compared to the prevailing present value of the floating leg (the claims).
- Accommodating a bail-in. This is one of the resolution tools included in the 2019 Recovery and Resolution Act for insurers which might allow pension obligations to be reduced so that an insurer can continue in business.
- Extending longevity reinsurance with asset performance risk or 'asset-intensive' (AI) life reinsurance.[315] This is a longevity swap whereby the present value of the fixed leg is paid at inception. To mitigate the counterparty credit exposure of the insurer on the reinsurer resulting from this initial settlement, a collateral arrangement forms part of AI reinsurance. Under this collateral arrangement, the reinsurer is responsible for maintaining a portfolio of assets within pre-agreed investment guidelines and restrictions. As asset performance risk is very capital intensive, Dutch insurers that are actively managing their capital position, are considering to also reinsure (some of the) asset performance risk resulting from these pension buy-outs. Such an approach might give them the opportunity to also

[315] In asset-intensive life reinsurance, the reinsurer takes on both the liabilities (which carry longevity risk) and the assets of the corporate pension plan.

offer very large pension buy-outs that they might otherwise not be comfortable executing because of the substantial capital implications.[316]

In July, AXA Germany announced the transfer of a portfolio of around 900,000 conventional life and annuity insurance contracts worth €19bn in assets under administration to Athora Germany for a purchase price of €610m. It will take five years to transfer the contracts, beginning in 2023.[317]

The Australian Prudential Regulation Authority (APRA) introduced a retirement income covenant in July 2022.[318] Regulated superannuation funds (or other registrable superannuation entities (RSEs)) are required to formulate a retirement income strategy (the strategy) for their members' decumulation phase which will improve their retirement outcomes and be in their best financial interests. Although not stated explicitly, the aim is to encourage greater use of lifetime annuities where that is appropriate for members. The A$220bn Australian Retirement Trust (ART) – formed from the merger of QSuper and Sunsuper in February 2022[319] – has introduced a lifetime pension product which is like an annuity. It offers a market-based income for life in a set-and-forget product in which the super funds are pooled with other investment funds to cover fees and costs and only a proportion of the assets are used to provide the pension. Other providers include *Challenger* Life and Generation Life which in May 2022 introduced an investment-linked lifetime annuity.[320] Previously, most retirees switched to an account-based pension which keeps their pension pot invested in the same pool of assets as in accumulation. Income from the account is tax free, but there is a minimum drawdown of 5% every year which increases as members get older.[321]

In March, the first longevity deal in Asia was completed, when Swiss Re agreed with Singapore-based composite insurer, NTUC Income, to co-insure the longevity risk on the latter's annuity book, by sharing any future payments to annuitants who live beyond their life expectancy. This enabled NTUC Income to improve its own capital efficiency and strengthen its solvency position.[322]

In May, the Bermuda Monetary Authority proposed amending the Insurance Act 1978 to introduce a new innovative class for long-term insurers (Class IILT). The BMA said it

[316] Andre de Vries (2022) Update on Longevity Risk Transfer in the Netherlands, *de actuaris*, December, 18-20; https://www.ag-ai.nl/view/51882-DA-30-2-art-deVries.pdf
[317] https://www.ipe.com/news/axa-germany-transfers-19bn-insurance-portfolio-to-athora/10061129.article
[318] https://www.apra.gov.au/implementation-of-retirement-income-covenant
[319] https://www.top1000funds.com/2022/03/super-and-sunsuper-merge-to-form-new-institutional-giant/. ART is the second largest super fund after the A$260bn AustralianSuper.
[320] https://frsltd.com/latest-news/generation-life-launches-australias-first-investment-linked-lifetime-annuity-solution-on-investpro-from-frs/
[321] https://www.ipe.com/asia-pacific/letter-from-australia-superfunds-focus-on-retirement-income/10057677.article
[322] https://www.swissre.com/media/press-release/nr-20220308-swiss-re-partners-with-ntuc-income-longevity-arrangement-shield-against-future-variation-incomes-annuity-book.html

believed that market developments in the next decade will lead to a conflux of insurance, capital markets, artificial intelligence, and distributed ledger technology: 'The Class IILT is intended for, but not limited to, innovative business models, such as those insurers that utilize digital assets for their operations… [which] would enhance liquidity and risk transfer efficiency'.[323]

One of the most significant events of 2022 was the opening of the Longitude Exchange – as the first digital marketplace for trading longevity risk in index-based format – in Bermuda which is regulated by the Bermuda Monetary Authority (BMA), Bermuda's financial regulator.[324] It describes itself as the Longevity Risk Marketplace for connecting hedgers and investors on a platform optimized for trading longevity risk. Its mission is to build an efficient and deep market for trading longevity risk, helping ensure the stability of individuals retirement income and the global financial system by: helping pension funds and insurers manage liabilities at a lower cost; providing investors better access to an uncorrelated asset class; enhancing the efficiency of trading longevity risk; and improving the security of the financial system.

The Longitude Exchange platform handles documentation, trade set-up, primary issuance, valuations, and secondary trading. Its tools streamline the process of hedging and investing in longevity risk. For hedgers, there are tools for: hedge construction – construct trades optimized for risk and capital objectives; hedge analysis – measure hedges' impact on risk and capital positions; hedge placement – conduct auctions, negotiate terms and execute deals; hedge reporting – receive reporting, payment and collateral instructions; and hedge management – increase or decrease hedges through secondary trading. For investors, there are tools for: longevity modeling – models and datasets to generate longevity scenarios; investment analysis – price transactions using longevity scenarios; investment execution – place bids and negotiate terms with counterparties; on-going valuations – live quotes and historical trades to mark positions; and secondary trading – list positions, request bids, and buy listed transactions.[325]

In May, the Longitude Exchange linked up with Dedomainia to advance the techniques and processes for monitoring, administering, and valuing index-based longevity risk hedges. In December 2016, Dedomainia had launched a web-based platform designed for longevity swap calculations called LISA (Longevity Insurance Servicing and Administration).[326] In September, the Longitude Exchange announced it had raised seed funding from the Deep Knowledge Group, a consortium of commercial and non-profit organizations active in several technological domains including Longevity, AI, FinTech, and InvestTech.

[323] https://www.reinsurancene.ws/bma-introduces-new-innovative-class-for-long-term-insurers-class-iilt/
[324] https://www.longitude.exchange/
[325] https://www.bayes.city.ac.uk/data/assets/pdf_file/0012/701013/MICHAELSON-Avery.pdf
[326] https://www.artemis.bm/news/efficient-management-of-longevity-transactions-key-for-counterparts/

Dr Erik Pickett, Chief Content Officer at Club Vita, argues that the key to developing a successful life market is the:

> *commoditization of longevity risk, i.e., the development of fungible, tradable financial instruments linked to longevity risk that increase the efficiency of each step of the risk transfer chain and ultimately the creation of a deep liquid market for longevity risk. Commoditization should attract more, much needed, capacity in longevity risk takers. This is expected largely to come from capital markets investors entering the market, attracted by returns diversified against key financial risks, with some extra capacity also released from existing players due to standardization and automation.*
>
> *It is often not economical for small pension funds to enter into complicated indemnity contracts to remove longevity risk. Streamlining of contracts such as those implemented by Mercer and Zurich have opened up this market to smaller players to a certain extent, but complete commoditization would open it up further. By simplifying the process and increasing the supply of risk takers, commoditization should create competitive pricing for longevity risk transfers. The clearing price will of course be affected by any increase in demand, but price loadings due to market frictions should be reduced; a commoditized market could allow risks that have not traditionally attracted insurers or reinsurers, such as deferred annuity longevity risk contracts. A standardized risk classification system and index-based instruments will enable more efficient risk management solutions, in particular allowing more efficient balancing of longevity and mortality risk and reducing capital demands.*
>
> *...For a commoditized market to develop, there needs to be a standardization of terms for the writing of financial instruments. Central to that will be the development of a set of widely accepted and accessible reference indices that would mimic the movements on the risk cedants' balance sheets. Index-linked instruments would be highly tradable and could protect cedants from extreme outcomes; they would also allow risk traders to act on their sentiment to future longevity risk. Innovative approaches to structuring financial instruments need to be developed that are attractive to both risk cedants and risk takers, in particular, instruments that reduce the time horizon of traditional indemnity swaps (such as those using commutation mechanisms) are needed to attract capital market investors. Shrinking the margins of dealers in a commoditized market could help to increase returns. Articulating the potential capital benefits of pairing longevity and mortality risk, or the diversification effect of longevity with key financial risks could help engage investors with the potential returns.*
>
> *... Despite some previous false starts for the commoditized longevity market, it feels like the stars may finally be aligning. Over the last few years there has been real concern in the reinsurance community about a capacity crunch if the projected*

annual market demand materializes. Pension fund consolidators and the success of streamlined longevity swap contracts are bringing smaller pension funds into the de-risking market and new ideas about structuring financial instruments to address the key obstacle of shorter term contracts have now been developed. Players in the market such as Longitude Exchange and Club Vita are working to standardize models and index data to get everyone talking the same language.

For a market to develop, timing of many factors need to align. Maybe that is what's happening right now.[327]

An additional factor is the aligned understanding of longevity risk, especially in the UK. As Song et al (2023) point out: 'The UK actuarial community has relatively easy access to credible mortality data and mortality improvement studies (e.g., the UK CMI model). Accessibility to quality population mortality data is crucial to balancing the information asymmetry between insurers (who have relatively smaller, more volatile portfolios) and global reinsurers (who have the capability to perform credible longevity studies with their large data repository and carry significant volumes of offsetting mortality risk from group life, catastrophe and other business). This free flow of information has created an unprecedented level of alignment of views on longevity risk among all UK PRT market participants, which in turn has helped the industry in setting an effective "market price" for that risk via longevity swaps'.[328]

Hedge funds (with assets of $4.13trn[329] in June 2022) and private equity (with assets of $7.97trn) could be attracted to this sector since the financial instruments being developed look like alternative fixed-income products with which they are already familiar. However, for them to commit capital, there needs to be much greater liquidity – which is where a trading platform like Longitude Exchange comes in.

Avery Michaelson, CEO of Longitude Exchange, argues that:[330]

In order for hedge funds and other institutional investors to get involved in the longevity market, they need a marketplace. Currently, transactions are brokered in an over-the-counter process using transaction formats that aren't well suited to the investment criteria of these players. These investors benefit from a certain level of commoditization of transactions, something which can be addressed with index-based transaction formats. By basing transaction pay outs on general-population

[327] Erik Pickett (2022) If Longevity Risk is an Asset Class, How Do We Make It More Tradeable?, *Life Risk News*, 13 July; https://liferisk.news/if-longevity-risk-is-an-asset-class-how-do-we-make-it-more-tradeable/
[328] Paul Song, Patricia Nguyen, Rey Malile and Mark Spong (2023) Managing Longevity Risk: A Solution to Consider, *Reinsurance News*; https://www.soa.org/sections/reinsurance/reinsurance-newsletter/2023/february/rsn-2023-02-spong/
[329] According to data and analytics provider Preqin.
[330] Quoted in Greg Winterton (2023) Is a Digital Exchange the Solution to the Investor Participation in Longevity Risk Transfer Conundrum?, *Life Risk News*, Volume 2, Issue 2, February; https://liferisk.news/is-a-digital-exchange-the-solution-to-the-investor-participation-in-longevity-risk-transfer-conundrum/

mortality data, information asymmetries can be removed along with much of the analytical complexity involved in pricing and risk analysis.

Rising interest rates have further accelerated pension de-risking, fuelling greater than ever demand for capital. Fortunately, there are already a number of ILS Funds with experienced life risk teams prepared to commit capital to this space. They will be joined by a much broader range of institutional investors as deal flow and liquidity materialize.

There are around $100trn of longevity linked liabilities, globally. And every year of unanticipated life expectancy adds around 5% to liabilities. So, if estimates are off by three years, longevity risk could cause $15trn of unfunded liabilities. The enormous quantum of this risk points to the need for capital markets participation. It's only a matter of time before longevity risk is recognized as its own asset class.

2023

The year opened well for the financial strength of the UK's remaining 5,000 pension schemes with the PwC Buyout Index showing a surplus of £245bn and the Low Reliance Index showing a surplus of £380bn.[331,332] This indicated another bumper year for the PRT market, with a record-breaking £21.2bn of buy-ins and buy-outs completed in the first half of 2023, £50bn for the whole year, and a total of 226 transactions completed during the year.[333] The largest providers were Rothesay (26% of the market), L&G (24%), and PIC (14%).[334] In addition, £10.3bn in longevity swaps were executed during the year: the BT Pension Scheme (£5bn), Marsh McLennan Companies (MMC) UK Pension Fund (£2bn), the Yorkshire and Clydesdale Bank Pension Scheme (£1.6bn) and the Nationwide Pension Fund (£1.7bn). Pension schemes were also beginning to consider using longevity swaps to

[331] November data. The Low Reliance Index assumes schemes invest in low-risk, income-generating assets like bonds, implying a low risk of calling on the sponsor for further funding. The resilience of pension schemes to short term market shocks is something the Pensions Regulator has highlighted in its draft Code of Practice on scheme funding. As a minimum, TPR expects trustees to model and 'stress test' the impact of the kind of event that might occur once every six years on their scheme's assets and liabilities. In contrast, insurance companies need to demonstrate that they can withstand at least a one-in-200 year stress scenario; https://www.pensionpolicyinternational.com/pension-scheme-consolidation-expected-to-continue-into-2024/

[332] The net buyout surplus to scheme sponsors increased by around £25bn as a result of a change to the surplus refund tax announced the UK Chancellor of the Exchequer in his Autumn Statement in November 2022; https://www.pensionpolicyinternational.com/pension-scheme-consolidation-expected-to-continue-into-2024/

[333] https://www.ipe.com/analysis/uk-pension-schemes-concerned-over-insurer-capacity-as-they-approach-endgame/10069778.article; https://www.pensionpolicyinternational.com/pension-risk-transfer-growth-fuels-uk-insurance-rating; https://www.reinsurancene.ws/record-breaking-year-for-pension-risk-transfer-market-in-2023-legal-general; https://www.ipe.com/analysis/db-schemes-indicate-growing-preference-for-retaining-assets/10127774.article

[334] https://www.pensionsage.com/pa/New-entrants-bolster-pension-risk-transfer-market-volumes-in-2023.php

hedge bulk annuity pricing, i.e., to reduce the risk of bulk annuity prices moving against the scheme. Further, many schemes have 'novated' longevity swaps to bulk annuities.[335]

The market also attracted new entrants.[336] For example, in May, M&G, the global asset manager, announced its intention to enter the bulk annuity market, via its wholly-owned subsidiary the Prudential Assurance Company Limited (UK),[337] to focus on bespoke deals for larger schemes.[338] In October, Resolution Life announced that its Bermudian-based reinsurer, Resolution Re, would enter the market.[339] In November, the Royal London Mutual Insurance Society Limited entered the market.[340]

Existing insurers were also scaling up by employing extra staff, enhancing technology, extending assets and streamlining internal processes. In August, a survey by Standard Life found that 90% of DB pension scheme trustees anticipated approaching an insurer in the next five years about a potential bulk annuity deal.[341] In October, LCP estimated that 1,000 schemes (20% of the total with assets of £275bn out of a total of £1.4trn for DB schemes) were fully-funded on a buy-out basis, while a further 1,250 schemes would reach full funding on a buy-out basis within the next five years. Transfers over the next five years were projected to be £360bn, compared with £155bn over the previous five years.[342]

Despite the new entrants and the increased efficiency of incumbents, there was concern that there would be insufficient capacity in the insurance industry to meet this increase in demand. A particular concern was the shortage of skilled people to meet the growth in the market. Andy McAleese, MVP, Longevity, Europe at Pacific Life Re argues: 'The real constraint in terms of the amount of deals we can do is people. PRT is quite a complex world, transactions are quite challenging to price, structure and execute, they involve a lot of parties, and they are time consuming. There is quite a limited pool of specialist people that can do this, and we're all looking for the same people, and that's a real impediment to growth'.[343] In October, a survey by Standard Life found that 20% of schemes were worried

[335] In the first two cases, these were second swaps; https://www.wtwco.com/en-gb/insights/2024/01/what-happened-in-the-longevity-swap-market-in-2023
[336] https://www.ipe.com/news/uk-sees-record-212bn-transferred-to-insurers-in-first-half-of-2023/10069494.article
[337] Prudential (UK) for short.
[338] M&G Prudential was set up as an asset manager in 2017 as one part of the restructuring of Prudential's UK businesses. The other part included the transfer of £12bn worth of legacy annuity business to Rothesay Life by the end 2019, as previously discussed; https://www.ipe.com/news/mandg-returns-to-uk-bulk-annuity-market/10069007.article
[339] https://www.ipe.com/news/resolution-life-enters-uk-buyout-market/10069742.article
[340] https://www.ipe.com/news/royal-london-kicks-off-entry-into-uk-bulk-annuity-market/10072130.article
[341] https://www.ipe.com/majority-of-db-schemes-expect-to-approach-an-insurer-about-de-risking-within-five-years/10068188.article
[342] https://www.ipe.com/news/uk-sees-record-212bn-transferred-to-insurers-in-first-half-of-2023/10069494.article
[343] Quoted in Greg Winterton (2023) Change in approach a necessity to combat human capital challenges in uk pension risk transfer market, Life Risk News, 12 July 2023; https://liferisk.news/change-in-approach-a-

about a lack of insurer capacity or interest.[344] LCP found that insurers were becoming more selective with a 20% reduction in the proportion of insurers that agreed to provide a quotation, while the market for sub-£100m transactions had tightened, with most insurers requiring exclusivity below £25m.[345] Nevertheless, pricing remained competitive for well-prepared schemes and LCP felt that insurers were rising to the challenge, and despite short-term resourcing pressures, were confident about their capacity to meet the increase in demand in the coming years.[346]

In January 2023, the UK Prudential Regulation Authority wrote to UK insurance companies warning them that: 'In light of the multiple external uncertainties facing insurers, it is important that firms take proactive steps to assess the adequacy of their risk management and control frameworks. Firms should be able to respond to market and credit risk conditions different from those that prevailed for a long time. Firms need to be prepared for novel risks, changes in risk correlations and increases in distressed assets. We expect firms to assess their credit and counterparty credit risk management capabilities in light of widening credit spreads, rating downgrades, and defaults. … We are paying close attention to whether the continued high level of longevity reinsurance and the emergence of the more complex "funded reinsurance" in the UK life market reduce the protection UK policyholders should have, beyond the risk tolerance. In particular, we see the potential for offshored counterparty concentration risk to arise from rapidly growing levels of reinsurance. These concentrations can arise for firms individually and for the sector as a whole. We expect UK authorized firms to consider their compliance with the Prudent Person Principle (PPP) for the risks associated with their reinsurance activities. Insurers need to consider the reinsurer's resilience over the whole duration of the exposures, as well as the potential impact from a mass recapture event where large concentrations to a small number of counterparties exist. Our own work on counterparty and concentration risk will examine the need for policy action on reinsurance structures and limits, to mitigate systemic risks to policyholders'.[347] In June 2023, the PRA wrote again to UK insurers on the issue of funded reinsurance. It accepted the moderate use of funded reinsurance, but remained concerned about the possibility of too many UK DB assets and liabilities being moved out of the UK and hence outside of the jurisdiction of the UK Pensions Regulator or PRA.[348] In November 2023, the PRA suggested that life insurers should set limits to

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necessity-to-combat-human-capital-challenges-in-uk-pension-risk-transfer-market/?utm_campaign=life-risk-news-volume-2-issue-7-july-2023

[344] https://www.ipe.com/analysis/uk-pension-schemes-concerned-over-insurer-capacity-as-they-approach-endgame/10069778.article

[345] https://www.xpsgroup.com/news-views/insights-briefings/bulk-annuity-market-q4-update-trustees-and-pension-scheme-sponsors

[346] https://www.ipe.com/news/uk-sees-record-212bn-transferred-to-insurers-in-first-half-of-2023/10069494.article

[347] https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/letter/2023/insurance-supervision-2023-priorities.pdf; Charlotte Gerken (2022) Who's concentrating? Trends in the life insurance sector and the need for strong reinsurance and investment risk management, Bank of England, 20 September, https://www.bis.org/review/r220921f.pdf

[348] https://liferisk.news/the-insurance-regulator-takes-a-look-at-funded-reinsurance/

their exposures to funded reinsurance counterparties as they may be highly exposed to illiquid assets and their investment profiles may be too closely correlated to one another. It also said that they may be placing investments with the reinsurers 'without adequately recognising the inherent uncertainties and risks involved'. It added that in 2025 it would stress test insurers' exposure to funded reinsurance transactions, with the focus on the impact of an insolvency of an overseas counterparty reinsurer in relation to a UK insurer's overall book of pension liabilities and the ability to access collateral in order to maintain the liquidity required to pay pensions.[349]

In April 2023, Charlotte Gerken, executive director for insurance supervision at the Bank of England, warned insurers not to overextend themselves in their efforts to win more business from pension schemes keen to offload risks, conjecturing that UK life insurers could take on more than £500bn of pension liabilities over the coming decade. She said: 'As deals become larger and increasingly focused on buy-outs of complete schemes, we observe BPA writers expanding their risk appetite, sometimes outside their current core expertise. Insurers may be tempted to stretch their capabilities in the short term before leaner years arrive. This is a big structural change in the control of long-term investments in the UK, and the decisions that insurers make now will have long term consequences for the performance and development of the broader economy. Insurers will need to hedge their pension risks with interest rate, cross-currency and inflation swaps, increasing the sector's links to the wider financial system. Insurers therefore need to understand, as they take on these vast sums of assets and liabilities, how they may become greater sources or amplifiers of liquidity risk', reminding insurers of the LDI crisis faced by pension schemes in September 2022 when they struggled to find enough liquidity to pay collateral on their leveraged LDI strategies in response to rapidly rising gilt yields.[350]

The LCP *Longevity Report 2023*[351] argued that 'views on life expectancy need to be re-examined in light of the pandemic, recognizing newly emerging trends. …We are moving into a new era for longevity risk'. The report's key findings which are addressed to pension scheme sponsors and trustees, are:

- *We expect a material slowdown from the pre-pandemic expectation for longevity improvements, primarily due to the ramifications of the pandemic and the pressures on the healthcare system.*[352] *Compared to pre-pandemic levels, a fall in life expectancies of 1 to 2% may be a sensible starting point for most schemes.*

[349] https://www.ipe.com/news/bank-of-england-right-to-scrutinise-the-role-of-funded-reinsurance/10071612.article; https://www.bankofengland.co.uk/prudential-regulation/publication/2024/april/pra-business-plan-2024-25

[350] https://www.pensionpolicyinternational.com/bank-of-england-tells-insurers-to-moderate-their-push-into-pensions/

[351] https://indd.adobe.com/view/0fec53c5-dc7b-4171-bf9b-a5a7ec894328

[352] Mortality rates in 2022 were around 4.5% higher than those in 2019, equivalent to around 30,000 additional deaths in the UK. As of January 2023, there were also more than seven million people on NHS England waiting lists, which LCP said was 'worrying given that early consultation and diagnosis can have a significant impact on morbidity and are likely to affect mortality rates over the longer term'.

- *In this challenging environment, a robust longevity assessment is best achieved by sewing together actuarial modelling expertise with expert judgement from healthcare professionals. …The gap between life expectancies for the most and least deprived sections of society is widening. This makes tailored analysis to suit your scheme's membership critical for setting longevity assumptions.*
- *Longevity is a significant unhedged risk for many pension schemes. We estimate it is around 25% of the investment risks for a typical scheme. However, in many cases the tools trustees and sponsors use to analyze and manage this risk have not changed to reflect this.*
- *Insurers and reinsurers are now making allowances in their longevity pricing for the slowdown in improvements. An informed assessment of longevity is essential for negotiating with them effectively.*
- *Climate change was also expected to present mortality risks for DB schemes – comprising direct drivers such as air pollution and heat-related deaths, and indirect drivers such as increased transmission of diseases, damage to infrastructure, adverse economic consequences, and food supply issues*.[353]

In July 2023, the Continuous Mortality Investigation reported that deaths in the UK in June 2023 were 5% higher than in pre-pandemic June 2019. Across the UK, there have been 200,100 more deaths from all causes than expected from the start of the pandemic to 30 June 2023. Of these, 75,600 were in 2020, 56,600 in 2021, 39,400 in 2022 and 28,500 in the first half of 2023. Pension liabilities would be £8bn lower than three years previously anticipated for schemes going through their triennial valuation between September 2022 and September 2023, according to The Pensions Regulator. Stephen Caine, director of retirement at WTW, argued that the longevity slowdown when combined with the significant reductions in liabilities as a result of rising interest rates over the previous 12-18 months could result in the emergence of larger surpluses and bring forward planned de-risking strategies, such as switches from growth assets to matching assets to lock in gains made and insurance hedging solutions.[354]

In August 2023, TPR updated its guidance on pension superfunds. This included increasing the discount rate and lowering the minimum funding requirement to make pension scheme consolidations more attractive. However, some consultants thought this was 'too little, too late', since the TPR's interim regulatory regime was introduced way back in June 2020, no superfund transactions had so far taken place and there remained continuing uncertainty around the ability of superfunds to extract profits prior to securing members' benefits with an insurer. The updated guidance still favoured superfunds, such as Clara-Pensions, that

[353] This issue is discussed in more detail below.
[354] Pamela Kokoszka (2023) Schemes should stay on top of changing mortality rates, *IPE,* 17 July; https://www.ipe.com/news/schemes-should-stay-on-top-of-changing-mortality-rates/10067876.article?

provide a 'bridge to buy-out' solution with an insurer over those that intend to manage the assets and liabilities until full run-off, like the Pension Superfund.[355]

Just a month later, Edi Truell, the owner of the Pension Superfund, announced that he was closing the pension consolidator, after failing three times to get regulatory approval from TPR which, in turn, failed to produce guidance on how profits generated by superfund investments could be distributed to investors. This made the market 'uninvestable' according to Luke Webster, CEO of the Pension SuperFund, since there is 'no line of sight for an investor as to how they might get their money back'. Steve Webb, the former pensions minister and now partner at LCP, thought the 'government has had long enough' to agree on the regulatory framework.[356]

Despite the regulatory challenges, in November 2023, Clara-Pensions announced its first pension superfund transaction with the Sears Retail Pension Scheme and the transfer of 9,600 members and £590m in assets, together with the injection of £30m of ring-fenced capital from Clara. Clara said the deal is 'an important stepping stone' in providing the members with a managed journey to an insured buyout, which is expected to take place within the next decade. The £30m funding will act as a loss-absorbing buffer for the scheme on this journey. Isio will administer the scheme.[357] LCP partner and head of endgame innovation Jonathan Griffith said 'Clara represents one of a growing number of new endgame options for pension schemes to embrace as a way to secure benefits for pension scheme members, while also offering enhanced value for other stakeholders'. Matt Cooper, head of alternative pension solutions at PwC, said that superfunds offered schemes with weaker sponsors an alternative solution to enhance the security of members' benefits, and that around 500 DB schemes with 750,000 members and total assets of £100bn may be suitable candidates for entering into a superfund.[358] Andrew Griffith, economic secretary to HM Treasury, called the deal 'an important innovation to British pension provision' and added 'Economies of scale from superfunds can do wonders for pensions, making people's retirement more secure, whilst enabling a broader range of investments in productive finance', in line with the Mansion House Reforms announced in July 2023.[359]

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[355] https://www.ipe.com/news/tprs-updated-guidance-opens-the-door-to-more-uk-superfund-activity/10068307.article?; https://www.thepensionsregulator.gov.uk/en/document-library/scheme-management-detailed-guidance/db-superfunds

[356] https://www.ipe.com/news/uk-financier-pulls-plug-on-commercial-pension-consolidator/10069044.article

[357] https://www.ipe.com/news/clara-pensions-announces-first-superfund-deal/10069874.article

[358] https://www.ipe.com/news/claras-first-superfund-transaction-marks-significant-milestone-for-uk-pension-industry/10069886.article

[359] https://www.professionaladviser.com/news/4142708/superfund-deal-paves-era-db-schemes. The Mansion House Reforms 'will enable [the UK] financial services sector to unlock capital for [the UK's] most promising industries and increase returns for savers, supporting growth across the wider economy. Firstly, the [UK] government is announcing a series of measures to boost outcomes for savers and increase funding liquidity for high-growth companies through reforms to the UK's pension market. Secondly, the government is setting out ways to incentivise companies to start and grow in the UK by strengthening [its] position as a listing destination. And finally, the government is seizing the opportunities of the future by

Some organizations have proposed solutions that exploit economies of scale but which go short of full consolidation between pension schemes. For example, Dalriada Trustees has launched an integrated streamlined consolidation service for UK pension schemes to deliver trusteeship, governance and administration, while the schemes retain control of their investments and scheme journey planning.[360] Similarly, Brightwell, the former British Telecom Pension Scheme Management company, has begun offering investment and administrative services to other pension schemes, including the design of mandates and the selection and oversight of investment managers; but again there is no pooling of assets or sharing risks across schemes. Brightwell is seeking partners that share the BT scheme's strategic decision to run the scheme towards self-sufficiency, instead of targeting an insurance buyout.[361]

Other organizations have even argued that the return of pension fund surpluses allows schemes to delay either buying out or selling out to a superfund and instead continue to operate as independent schemes but change their asset allocation in order to enhance investment returns. Van Lanschot Kempen Investment Management estimates that a £1bn DB scheme could lose £200m in value by defaulting to buy-out over the next decade and a further £50m in missed returns. These could be used to benefit members and sponsors, and to 'stimulate the UK economy and promote wider societal benefits'.[362]

A variation on this is capital-backed funding arrangements (CBFA)[363] proposed by the UK Institute and Faculty of Actuaries. The IFoA argues that, despite strong funding, some DB schemes might not believe that an insurance buy-out is best short-term option for a number of reasons, including: not able to buy out liabilities in full with an insurer, concerns around corporate accounting implications, and the potential loss of future surplus that might be used to pay for discretionary pension increases or a defined contribution (DC) section, or be refunded to the company. In comparison with a buy-out or superfund solution where there is a 'step-change in a governance arrangement', a CBFA is principally a time-limited investment decision within the remit of the existing trustee board. A capital provider injects cash into the scheme in order to achieve a specific objective, such as the scheme being fully funded on a self-sufficiency basis in 10 years. In return, the capital provider will work the assets harder in order to generate a higher return than the required threshold by taking greater investment risk. If successful, the capital provider will make a profit. CBFAs can potentially improve member outcomes by, e.g., reducing downside investment risk by underwriting the risk of poor investment returns, pay benefit cashflows with added security

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reforming and simplifying [the] financial services rulebook to ensure [the UK has] the most growth-friendly regulation of any financial services centre, without compromising [the government's] commitment to stability'; https://www.gov.uk/government/collections/mansion-house-2023

[360] https://www.ipe.com/news/dalriada-trustees-launches-alternative-pension-consolidation-solution/10071057.article

[361] https://www.ipe.com/pension-funds/benefits-of-travelling-together-in-pensions-wyn-franciss-journey-from-bt-to-brightwell/10070368.article

[362] https://www.ipe.com/news/ifoa-highlights-benefits-of-capital-backed-funding-arrangements/10068493.article

[363] Also known as capital backed journey plans.

while retaining some investment upside and flexibility, and supplement the sponsoring employer's covenant.[364]

Mercer's Pensions Risk Survey in November 2023 predicted that companies with pension fund surpluses could be the subject of restructuring and merger and acquisitions (M&A) activity, with the pension scheme being perceived as a valuable addition to any deal. Mercer senior corporate consultant, Shane Tuohy, said: 'Some [potential company buyers] might be able to take the scheme off company books at little or no cost by securing the benefits with an insurer. Others might choose to run schemes on to extract value. They might offer enhanced security in exchange for an investment strategy which works harder or insure part of the risk associated with the DB scheme via the use of a captive vehicle'.[365,366]

Corporate sponsors of pension schemes have also been keen to avoid the problem of a 'trapped surplus' which cannot be easily accessed. Under the UK's DB Funding Regulations,[367] schemes will be required to move to a 'low dependency' basis, where asset returns are matched with pension payments without needing any further contributions from the sponsor. This means that, depending on how far schemes are from low dependency, sponsors will still be required to make contributions into their schemes to prevent funding deficits. But unanticipated changes in, say, interest rates or asset returns could result in a 'trapped surplus'. To avoid this possibility, as schemes approach full funding, some sponsors have agreed with trustees to reduce contributions and instead channel contributions to escrow accounts (cash accounts secured in favour of the trustees with a first-rank priority charge) and reservoir trusts (where the contributions can be invested in higher returning assets). These arrangements are permissible under the DB Funding Regulations.[368]

In December, the UK Financial Reporting Council (FRC)[369] revised its 'Technical Actuarial Standard 300: Pensions (TAS 300)' to reflect developments in the pension

[364] https://www.ipe.com/news/ifoa-highlights-benefits-of-capital-backed-funding-arrangements/10068493.article; https://www.xpsgroup.com/news-views/insights-briefings/capital-backed-journey-plans-helping-pensions-schemes-run-for-the-line

[365] https://www.pensionpolicyinternational.com/uk-opportunity-for-buyers-as-db-pension-surplus-growth-continues/

[366] In the November 2023 Autumn statement, the UK Chancellor of the Exchequer reduced the surplus refund tax from 35% to 25% with effect from 5 April 2024.

[367] The DB Funding Code of Practice and the Occupational Pension Schemes (Funding and Investment Strategy and Amendment) Regulations 2024; https://www.gov.uk/government/publications/the-pensions-regulators-defined-benefit-funding-code-of-practice/explanatory-memorandum-to-the-pensions-regulators-defined-benefit-funding-code-of-practice-2024

[368] https://www.pinsentmasons.com/en-gb/out-law/analysis/pension-buy-outs-managing-risk-trapped-surplus-winding-up

[369] The FRC 'regulate[s] auditors, accountants and actuaries, and …set[s] the UK's Corporate Governance and Stewardship Codes. [It promotes] transparency and integrity in business. [Its] work is aimed at investors and others who rely on company reports, audit and high-quality risk management'; https://www.frc.org.uk/about-us/

industry, in particular increased buyout activity and pension superfunds. Practitioners providing advice to a scheme sponsor contemplating a bulk transfer must consider credible alternatives to the potential transaction, any material impact on the protection provided, material risks to the benefits and any changes to the sponsor's ability to make decisions which affect the level of members' benefits. They must also use models that are calibrated appropriately to reflect the time horizon of projections and have sufficient regard to extreme events. Further, communication on superfund capital adequacy must include an explanation of the uncertainty in the actuarial information.[370] In January 2024, the FRC dropped plans to add explicit ESG (environmental, sustainable and governance) requirements in the UK Corporate Governance Code in order to keep administrative burdens on businesses 'to the minimum necessary'. Instead, the Code sets out more generalized expectations for company boards to monitor and review annually their firm's risk management and internal control framework. The new approach is a 'targeted, proportionate and balanced response to meeting enhanced investor and stakeholder expectations for better governance reporting around risk management and internal controls', but would be less intrusive and prescriptive for company boards, and would help to support UK growth, competitiveness,

It has become increasingly popular for trustees of larger UK pension schemes to buy 'residual risks' insurance cover to protect them against the risk of future claims or disputes following a buy-out of the scheme.[371] The limitation period for making a claim is generally a maximum of six years.[372] The cost of the insurance is typically in the region of 1% of the buy-out premium and typically covers:

- claims from missing beneficiaries;
- a beneficiary proving s/he has a right to a higher level of benefits than those insured;
- a future change in law which reveals that higher benefits should have been secured;
- errors in the data file provided to the insurer; and
- the method used for guaranteed minimum pension (GMP) equalization[373] being found to be deficient.

In an article in *Life Risk News* in December entitled, 'Reinsurance concentration risks point to inevitable future for longevity risk transfer market',[374] Greg Winterton interviewed

[370] https://www.ipe.com/news/frc-updates-actuarial-guidance-in-light-of-increased-buyout-activity-superfunds/10070576.article
[371] https://www.pinsentmasons.com/en-gb/out-law/analysis/pensions-risk-transfer-risks-residual-risk-insurance?
[372] https://www.pinsentmasons.com/en-gb/out-law/analysis/pension-buy-outs-claim-limitation-periods-post-winding-up
[373] Guaranteed Minimum Pension (GMP) equalisation, House of Commons Library, 21 September 2023; https://commonslibrary.parliament.uk/research-briefings/cbp-8427/
[374] Greg Winterton (2023) Reinsurance concentration risks point to inevitable future for longevity risk transfer market', *Life Risk News*, 2(12), December; https://liferisk.news/reinsurance-concentration-risks-point-to-inevitable-future-for-longevity-risk-transfer-market/

Avery Michaelson and David Schrager, CEO and CFO, respectively, of Longitude Exchange. They, along with Douglas Anderson and Steven Baxter of Club Vita and Professor Andrew Cairns of Heriot Watt University and Professor David Blake of Bayes Business School, are co-founders of ILMAC (the Index Longevity Market Action Committee) which was set up in May. ILMAC's aim is 'to build a consensus on a framework, ideally a market standard (to be incorporated into regulations such as Solvency UK or Solvency II, and related guidance) for basis risk quantification, combined with a set of principles for the development of an internal model for institutions seeking to use their own approach to basis risk quantification. This is intended to provide clarity on the capital relief that a regulated (re)insurer would achieve from using an index-based hedging structure'.

Michaelson and Schrager discussed the weaknesses of existing hedging arrangements for insurers. Schrager pointed out that 'What insurers are doing – in the UK, the Netherlands, and the US – to avoid being overly exposed to longevity risk is that they transfer it to reinsurers using longevity swaps. But all of these insurers are hedging their longevity risk with the same limited number of life reinsurers'. Michaelson added 'For all life reinsurers, a natural hedge exists on their balance sheets. The problem is that, as a hedge, it's not quite as effective as it might appear on the surface. When an extreme mortality event, such as Covid, occurs, it is almost certain to produce an offsetting move in a reinsurer's longevity exposures in the form of reduced liabilities. However, in extreme longevity scenarios resulting from broad-based increases in life expectancy, it's less certain to produce significant gains from a reinsurer's mortality business as these are typically shorter duration contracts whose pricing can reset to current expectations about mortality'.

The second problem according to Michaelson is that the scope of the offset is not unlimited: 'The pension risk transfer market is growing at a blistering rate as higher interest rates have accelerated a structural change that's been underway for over a decade. For those reinsurers that have been writing longevity swaps for that whole period, a good portion of the mortality offset has been used up, and the demand for longevity risk capacity is growing faster than for mortality'. Sources of capital outside the insurance industry are therefore needed to support the growth in the global PRT market.

ILMAC was set up in response to these issues and to promote the use of index-based longevity hedging as a way of persuading capital markets investors, such as asset managers and sovereign wealth funds, to take on longevity risk in a format, namely an index, with which they are familiar. With this approach, capital markets investors assume the longevity risk above a certain level based on a general population mortality index. By attracting a large and diversified set of new counterparties, this framework would help to reduce the concentration risk in the exiting market.

Nevertheless, involving the capital markets involves challenges, not least getting regulatory approval for an index-based longevity hedge. This provided part of the motivation for setting up ILMAC. At the time of writing, the committee was preparing a

case study that calculates the capital relief a Solvency II insurer could take if it used an index-based hedge and took account of the basis risk that this involved compared with a full-indemnification solution that accounted for the specific mortality experience of the pension scheme being transferred.

Michaelson concluded that 'There could be as much as $500bn of longevity risk transfer demand annually, which is nearly the same size as the entire reinsurance industry. It's not sustainable to move all of the longevity risk globally to just a few balance sheets [those of the small number of global reinsurers] – this could introduce a "too big to fail" situation that regulators are right to be concerned about. The natural solution is to encourage greater involvement from the capital markets'.

Highlights for 2023 in the UK included:

- In February, PIC executed the largest buy-in to date (£6.5bn) with two of the RSA Insurance Group schemes, covering 40,000 members.[375]
- In February, the GKN Group Pension Scheme completed a £513m full scheme buy-in with Just Group, insuring the benefits of some 2,262 pensioners and 1,963 deferred members.[376]
- In March, PIC completed £142m buy-in with the Spirent Communications Staff Pension & Life Assurance Scheme.
- In March, Aviva completed a £34m buy-in with the Chapelthorpe Pension Fund, securing the benefits of the remaining 805 uninsured members in the scheme.
- In March, PIC invested £50m Portsmouth Water to help fund the construction of the Havant Thicket Reservoir, the first major new reservoir in the UK since the 1980s.[377]
- In March, the Shoe Zone Group Pension Scheme completed a £34m buy-in with Rothesay, covering 367 pensioners and 166 deferred members.[378]
- In March, PIC bought a £268m office in Croydon, South London, pre-let to the UK Government Property Agency.[379]
- In April, L&G agreed a £18m buy-in with the Sleepeezee Retirement Benefits Plan, securing the benefits of around 200 retired and deferred members.

[375] https://www.professionalpensions.com/analysis/4077080/rsas-record-breaking-gbp-5bn-means-pensions-risking-market?
[376] https://www.ipe.com/news/uk-roundup-gkn-group-completes-513m-pensions-buy-in-deal-with-just-group/10065404.article?
[377] https://realassets.ipe.com/news/pic-joins-investors-in-portsmouth-waters-uk-reservoir-project/10065631.article
[378] https://www.professionalpensions.com/news/4087363/shoe-zone-scheme-completes-gbp34m-rothesay
[379] https://realassets.ipe.com/news/pic-buys-268m-office-pre-let-to-uk-government-property-agency/10065818.article

- In April, Rothesay secured a £1.4bn buy-in with the Safeway pension scheme, covering 22,500 members.[380]
- In April, Just Group completed a £190m buy-in with the Ibstock Pension Scheme, adding to an existing £340m buy-in policy completing in 2020.
- In May, the Yorkshire and Clydesdale Bank Pension Scheme announced a £1.6bn longevity swap with Zurich Assurance covering 9,000 members, with the longevity risk passed through to Pacific Life Re.[381]
- In May, Aviva completed a £900m buy-in with the Thomas Cook Pension Plan, covering 12,500 members.[382]
- In May, the British Steel Pension Scheme completed a fourth and final buy-in deal worth £2.7bn with L&G, becoming the largest UK scheme to fully insure all its 67,000 retired and deferred members' benefits.[383]
- In May, Just Group announced a £40m buy-in with the BUT Retirement Benefits Scheme**.**
- In May, Mitchells & Butlers, the pub chain, agreed a £1.2bn bulk purchase annuity transaction with Standard Life covering around 20,200 deferred and retired members. This follows a £650m buy-in for the Mitchells & Butlers Executive Pension Plan with L&G at the end of 2021.[384]
- In June, the Aegon UK pension scheme completed a £160m buy-in with Scottish Widows, covering around 500 members.
- In June, the Harrods Group Pension Plan secured the pension benefit of around 1,900 pensioners and 2,100 deferred members with a £400m buy-in agreement with Scottish Widows.[385]
- In June, Standard Life completed a £80m buy-in with MGM Assurance Staff Pension Plan.
- In June, the Nationwide Pension Fund completed a £1.7bn longevity swap, covering around 7,000 pensioner members, with Zurich Assurance and PICA (as reinsurer of the longevity risk).[386]
- In June, Just Group completed a £94m buy-in with the Mabey Pension Scheme in a record time of three months.

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[380] https://www.ipe.com/news/buy-in-roundup-safeway-completes-14bn-deal-with-rothesay/10066289.article
[381] https://www.ipe.com/news/uk-bank-pension-scheme-in-16bn-longevity-swap-deal/10066421.article
[382] https://www.ipe.com/news/uk-travel-pension-fund-secures-900m-buy-in-deal-with-aviva/10066537.article
[383] https://www.ipe.com/news/uk-roundup-british-steel-pension-scheme-in-27bn-buy-in-deal/10066690.article?
[384] https://www.ipe.com/news/uk-roundup-mitchells-and-butlers-scheme-in-12bn-buy-in-with-standard-life/10068002.article
[385] https://www.ipe.com/news/harrods-pension-scheme-completes-buy-in-deal-worth-400m/10067147.article?
[386] https://www.ipe.com/news/nationwide-pension-fund-completes-17bn-uk-longevity-risk-transaction/10067303.article?

- In July, the Chubb Pension Plan and the Chubb Security Pension Fund, both of which are sponsored by subsidiaries of APi Group Corporation, completed a £1bn buy-in with Standard Life.
- In July, British Telecom (BT) announced that it was planning a £30bn buy-in for its pension scheme which has 60,000 members.[387]
- In July, United Utilities insured £1.8bn in pension liabilities through a buy-in with L&G.
- In July, the Hammerson Group Management Limited Pension and Life Assurance Scheme completed a £390m bulk annuity transaction with Just Group, covering all members of the scheme.
- In July, United Utilities executed a £1.8bn buy-in deal with L&G for its two pension schemes, covering two thirds of the schemes' liabilities.[388]
- In July, Aviva completed a £600,000 buy-out with the Singer & James pension scheme, one of the smallest deals of all time.
- In July, PIC completed a £40m buy-in with the Qantas Airways Limited (UK) Retirement Benefits Scheme.
- In July, Canada Life completed its first-ever deferred member buy-in worth £58m with an undisclosed pension scheme.
- In July, Just Group executed a £7m buy-in with the Rannoch Food Group Pension Scheme, covering 46 deferred members and 10 pensioners.
- In July, RGA agreed a £5bn longevity swap with the BT Pension Scheme, covering pensioner liabilities.[389]
- In August, Rothesay completed a £260m buy-in with the Smith & Nephew UK Pension Fund.
- In August, Rothesay also completed a £440m buy-in with the P&O Pension Scheme, covering the retirement benefits of 5,300 members.
- In August, the BT Pension Scheme agreed a £5bn longevity swap with RGA.[390]
- In August, Just Group executed a fifth and final buy-in with the ITB pension scheme (valued at £290m), implying that all of the scheme members' benefits had now been secured.
- In September, the Association of British Insurers (ABI) pension and assurance scheme completed a £18.4m buy-out with Just Group.
- In September, Just Group also completed a £4m buy-out with the KGM pension scheme, covering 14 deferred and 10 pensioner members.

[387] https://www.ft.com/content/78934baa-e97e-4cd1-b07c-b0957d945f7b
[388] https://www.ipe.com/news/united-utilities-pension-funds-secure-18bn-buy-in-deal-with-legal-and-general/10067906.article?
[389] https://www.ipe.com/news/bt-pension-scheme-signs-5bn-longevity-swap-deal/10068085.article?
[390] https://www.ipe.com/bt-pension-scheme-signs-5bn-longevity-swap-deal/10068085.article

- In September, L&G agreed a £340m buy-in with the Cable and Wireless pension scheme, covering around 1,800 retirees and deferred members.[391]
- In September, M&G executed a £331m buy-in with its own pension scheme (M&G Group Pension Scheme), covering 1,414 pensioners and deferred members, together with the transfer of the scheme's illiquid assets to Prudential (UK) as part of the transaction.
- Also in September, M&G concluded a £286m buy-in with the Northern Bank Pension Scheme, covering 1,917 members.[392]
- In October, the London Stock Exchange (LSE) Group Pension Scheme agreed a £335m buy-in with Standard Life, covering 1,740 members across the LSE and London Clearing House sections of the scheme.[393]
- In October, Canada Life executed a £30m buy-in with the Andrew Sykes Group Pension Scheme, covering around 440 members, including 160 deferred members.
- In October, the British Red Cross pension schemes agreed a £30m buy-in with Aviva, covering 360 members.
- In October, the Bayer Group Pension Plan executed a £280m buy-in with Canada Life, covering the benefits of around 1,300 retirees.[394]
- In October, Resolution Re executed its first transaction by reinsuring the longevity and asset risks associated with the UK pension liabilities (both in payment and deferred) of a UK-regulated insurer, thereby extending funded reinsurance capacity for UK PRT writers.[395]
- In November, Aviva agreed a £80m buy-in with the Rotork pension scheme, securing the benefits of 406 pensioners and dependants.
- In November, Just Group completed a £32m buy-in with the Air France (UK) Pension Scheme, covering around 200 members.
- In November, PIC invested £50m to develop 125 affordable and shared ownership homes in partnership with residential developer London Square, in order to generate secure low-risk, inflation-linked cashflows to pay its pensioner policyholders. PIC has invested around £4bn in this sector since 2012.[396]
- In November, Just Group invested £350m in UK real estate and social infrastructure, including around 100 healthcare facilities that provide specialist care

[391] C&W had previously executed buy-ins with Prudential in 2008 and with L&G in 2017 and 2019; https://www.ipe.com/news/cable-and-wireless-superannuation-fund-complete-340m-buy-in-deal/10069038.article

[392] https://www.ipe.com/news/northern-bank-pension-scheme-secures-benefits-of-nearly-2k-members/10069079.article

[393] https://www.ipe.com/news/london-stock-exchange-pension-scheme-in-335m-buy-in-with-standard-life/10069419.article

[394] https://www.ipe.com/news/bayer-group-pension-plan-in-280m-buy-in-with-canada-life/10069715.article

[395] https://www.resolutionlife.com/news-and-insights/resolution-re-announces-first-uk-prt-reinsurance-transaction/

[396] https://realassets.ipe.com/news/pic-invests-50m-in-uk-affordable-and-shared-ownership-homes-project/10069995.article

for patients with high acuity caring needs and childcare centres. These assets also generate long-dated, inflation-linked cashflows.[397]

- In November, Deutsche Bank's UK pension scheme completed a £500m buy-in with L&G, covering 2,000 members, and taking the scheme's total buy-in to £1.5bn, around half of the total liabilities.[398]
- In November, the Marsh McLennan Companies (MMC) UK Pension Fund executed a longevity swap covering £2bn of liabilities for around 14,500 pensioners. The longevity risk was insured via a captive Guernsey insurance cell and immediately reinsured with Munich Re through the same Mercer Marsh longevity captive solution used in 2017. This was the first longevity swap to include active members and was also the second largest UK pension fund swap to cover more non-pensioner members than pensioners. Virtually all the fund's DB section longevity risk had now been insured.[399]
- In November, the Co-operative Pension Scheme agreed a £4bn buy-in with Rothesay, covering around 50,000 members, including 17,655 pensioners and dependants as well as 31,896 deferred members.[400]
- In November, the Boots Pension Scheme completed a £4.8bn buy-in with L&G, covering all 53,000 retirees and deferred members. This is the UK's largest single transaction of its kind by premium size and, for L&G, the largest single transaction by number of members. Boots agreed to pay £670m in additional contributions.[401]
- In November**,** Askews Retirement Scheme completed £11m buy-in with L&G**,** covering the benefits of all 86 scheme members.
- In November, Rothesay agreed a £2.7bn full scheme buy-in with the Thales UK pension scheme, covering around 16,000 members, including 10,512 pensioners and dependants, and 5,915 deferred members.[402]
- In November, the Vector Pension Scheme completed a £114m buy-in with Standard Life, covering all 1,800 members.[403]
- In November, Royal London completed a buy-in with Royal Liver valued £246m, covering all the benefits of 3,000 current and deferred pensioners.[404]
- In December, the Superior Pension Fund executed a £10m bulk annuity deal with Just**,** insuring the pension liabilities of 78 members.

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[397] https://realassets.ipe.com/news/just-group-invests-350m-in-uk-real-estate-with-focus-on-social-infrastructure/10070026.article
[398] https://www.ipe.com/news/deutsche-bank-uk-pension-scheme-completes-500m-buy-in-with-legal-and-general/10070007.article
[399] https://www.ipe.com/news/mmc-uk-pension-fund-completes-first-active-member-longevity-swap/10070069.article
[400] https://www.ipe.com/news/co-op-pension-fund-insures-remaining-4bn-of-liabilities/10070254.article
[401] https://www.ipe.com/news/boots-pension-scheme-completes-largest-single-transaction-with-landg/10070257.article
[402] https://www.ipe.com/news/thales-pension-scheme-secures-27bn-buy-in-with-rothesay/10070427.article
[403] https://www.ipe.com/news/vector-pension-scheme-completes-buy-in-with-standard-life/10071615.article
[404] https://www.ipe.com/news/royal-london-kicks-off-entry-into-uk-bulk-annuity-market/10072130.article

- In December, PIC announced it had provided a secured loan of £60m to enable the MHS Homes Group to increase its stock of social houses.[405]
- In December, PIC completed a £65m full buy-in of the Chemring Group Staff Pension Scheme**.**
- In December, Just Group and Macquarie Asset Management invested £400m in notes related to a portfolio of 55 commercial ground leases relating to Asda supermarket sites in exchange for a 'high-quality, long-term income stream from ground lease payments'.[406]
- In December, the Westminster Abbey pension scheme completed a £25m full-scheme buy-in with PIC**.**
- In December, the St Paul's Cathedral pension scheme agreed a £18m full scheme buy-in with Aviva.
- In December, the NICEIC (or Electrical Safety First) Pension Scheme did a £66m full buy-in with Just Group, securing the retirement benefits for 237 pensioners and 154 deferred members.
- In December, the Haag-Streit UK pension scheme completed a £18m full buy-in with Aviva.
- In December, the Hyde Housing Association pension scheme secured a £60m full buy-in with Just Group.
- During the year, Canada Life completed its first deferred member buy-in – the deal was valued at £58m and covered around 300 deferreds and a further 270 pensioners.[407]
- At the end of the year, Resolution Re reinsured the market and longevity risks of around 90,000 policyholders of an unnamed UK insurer, totalling around £2bn individual in-payment UK annuity liabilities.[408]

There were a number of significant international developments outside the UK in 2023.

US corporate pension plans were on average fully funded for the first time in 15 years (103.5% in June 2023[409]). This was largely because the average discount rate used to value plan liabilities was 5.25%, well above the 2.88% rate used a year before. The increase is explained by the Federal Reserve's increase in the Federal Funds Rate to 5.25% to 5.50% in July in order to control inflation. This was expected to increase pension risk transfer transactions, whether a full termination or lift-out of a select population of retirees and

[405] https://realassets.ipe.com/news/pic-expands-lending-in-uk-social-housing-sector-with-30m-investment/10070518.article; *Insurance Asset Management*, 11 December 2023.
[406] https://realassets.ipe.com/news/macquarie-and-just-group-enter-400m-ground-lease-financing-with-asda/10070645.article
[407] https://www.xpsgroup.com/news-views/insights-briefings/bulk-annuity-market-q4-update-trustees-and-pension-scheme-sponsors
[408] https://www.resolutionlife.com/news-and-insights/resolution-re-announces-new-reinsurance-transaction-in-the-uk/; *Insurance Asset Management*, 17 January 2024.
[409] https://www.pensionpolicyinternational.com/global-pension-risk-transfer-monitor-record-h1-transaction-volumes-in-uk-and-us/

beneficiaries. Corporations also benefited from lower buy-out premiums charged by insurance companies. According to Milliman, the estimated average premium was 99.3% as of March 31. Another contributing factor was the higher premium charged by the Pension Benefit Guaranty Corporation (increased by 9% in 2023 and 5% in 2024 to $101 per participant[410]) which can be avoided following PRT.[411] MetLife's 2023 Pension Risk Transfer Poll in October found that 90% of DB plans expected to fully transfer all their liabilities in an average of 4 years. The main reasons given were inflation (49%), increases in the volume of retirees, market volatility and rising interest rates (all 42%) and attractive annuity pricing (35%). The majority of respondents (55%) said they planned to divest of all their liabilities through multiple transactions, while the rest said they would use a single transaction.[412] While they were waiting to divest, a large number of schemes (44%) were planning to amend their liability-driven investment strategies to improve downside risk protection, according to a survey sponsored by Franklin Templeton.[413] During the first half of 2023, a record $22.5bn in transactions were completed, with $45bn for the whole year. There were a total of 773 transactions, of which 453 were terminations, 310 lift-outs and 10 buy-ins, valued at $12.4bn, $28.7bn and $3.9bn, respectively.[414] Pricing was competitive, close to the value of liabilities that plan sponsors are holding on their balance sheets.[415]

Highlights for 2023 in the US included:

- In May, AT&T Inc announced the third-largest US pension risk transfer to date via its purchase of group annuity contracts from two Athene Holding subsidiaries (Athene Annuity & Life Co. and Athene Annuity & Life Assurance Co. of New York) covering the $8.1bn pension liabilities of 96,000 AT&T plan members and beneficiaries.[416]
- In June, Legal & General Retirement America (LGRA) and RGA agreed a $309m pension risk transfer transaction with PPG, a Fortune 500 paint manufacturer.
- In June, Fidelity Investments registered Soteria Reinsurance in Bermuda in order to 'focus on affiliated reinsurance of US Retail Fixed Annuities and Pension Risk

[410] https://www.pbgc.gov/prac/prem/premium-rates
[411] https://www.ai-cio.com/news/pension-risk-transfers-poised-for-2nd-strongest-year-ever
[412] https://www.pensionpolicyinternational.com/90-of-u-s-companies-with-db-plans-looking-for-exits-via-prt-metlife/
[413] https://www.pensionpolicyinternational.com/us-study-finds-healthier-funding-status-for-db-plans-raising-interest-in-ldi-strategy-reviews/
[414] https://www.pensionpolicyinternational.com/us-pension-risk-transfer-market-expected-to-see-10-billion-in-q3-deal-volume/; https://www.pensionpolicyinternational.com/u-s-prt-transactions-hit-all-time-high-in-2023-aon/
[415] https://liferisk.news/still-plenty-of-capacity-for-growth-in-robust-us-prt-market/
[416] https://www.pensionpolicyinternational.com/us-rising-interest-rates-put-corporate-pension-plans-on-end-game-pat/; https://www.pensionpolicyinternational.com/us-pension-risk-transfer-market-off-to-strong-start-this-year/

Transfer Opportunities of existing and new Fidelity Investment Life Insurance Company (FILI) business'.[417]

- In August, Prudential Financial announced the transfer of around $1bn in pension liabilities from PSEG, a utilities provider, for 2,000 participants. The deal is a 'retiree only lift-out', with only the liabilities of these retirees being annuitized.[418]
- In November, MetLife completed a risk transfer transaction with Global Atlantic Financial Group, a retirement and life insurance company. The deal contributed to the run-off of MetLife's closed-block of US retail business, representing $19bn of statutory reserves. MetLife will remain as administrator and service provider for the reinsured policies and MetLife Investment Management will also manage a significant amount of the assets for the next five years.[419]

One of the most significant events during the year was establishment in September of Prismic Life Re, a licensed Class E Bermuda-based life and annuity reinsurance company. Prismic is backed by $1bn in equity capital, with the lead investors being Prudential Financial and Warburg Pincus, with equity holdings of 20% and 15%, respectively. Prudential plans to reinsure to Prismic a block of structured settlement annuity contracts[420] with reserves of approximately $10bn. Prudential's obligations to the holders of these annuities will remain unchanged and Prudential will continue to administer the contracts. Prismic will be a strategic reinsurance partner for Prudential in the years ahead. PGIM (Prudential Global Investment Management) and Warburg Pincus will provide asset management services to Prismic: PGIM's expertise is in public fixed income, private credit and real estate, while Warburg Pincus specialises in private market investments. Prismic will become a client of PGIM Portfolio Advisory, a newly established affiliate within PGIM that combines asset-liability management expertise with portfolio strategy and asset allocation to deliver integrated solutions across public and private asset classes. Prismic's first CEO is Amy Kessler, who was the founding leader of Prudential's international reinsurance business.

Charles Lowrey, chairman and CEO of Prudential Financial, said: 'This unique reinsurance platform will play an important role in our vision to be a global leader in expanding access to investing, insurance, and retirement security for people around the world. Prismic will enhance our ability to address the evolving needs of our insurance customers and clients while continuing to meet our obligations to policyholders. It represents a formidable combination of industry-leading expertise, global capabilities, and the backing of two of

[417] https://www.pensionpolicyinternational.com/fidelity-investments-forms-retail-annuities-and-pension-risk-transfer-focused-reinsurer/
[418] https://www.ai-cio.com/news/prudential-closes-1-billion-prt-deal-with-pseg/
[419] https://www.bloomberg.com/press-releases/2023-11-16/metlife-completes-risk-transfer-transaction-with-global-atlantic-financial-group
[420] A structured settlement annuity provides regular tax-free payments and is used in cases of personal injury and legal settlements, such as workers' compensation, medical malpractice and wrongful death; https://www.annuity.org/structured-settlements/

the world's leading insurance and asset management firms'.[421] This event is significant because it is one of the first big attempts to bring third-party capital into reinsurance industry in order to sustain its extraordinary recent growth.

At the same time, the increasing involvement of private equity (or private capital) firms (sometimes in conjunction with other investors, such as sovereign-wealth funds) has attracted the attention of US politicians and regulators. McKinsey reported in 2022 that the five largest PE firms by assets have investments in life insurers with exposures ranging from 15 to 50% of their total assets under management and that private investors owned in excess of $900bn of life and annuity assets in Europe and North America.[422] In August 2023, Senator Sherrod Brown, Chair of the US Senate Committee on Banking, Housing, and Urban Affairs, started to question the role of PE in insuring pension payments.[423] The Federal Insurance Office (FIO) pointed out in a response to Senator Sherrod Brown that 'As private markets have expanded over the last decade, far outpacing the growth of public markets, private equity firms have reshaped their business models and increased involvement in the life insurance sector. Previously, the focus of private equity was largely on buy-outs. Now, some private equity firms are increasingly pivoting their business objective to the private credit market'.

The McKinsey report points out that PE has been involved in the US insurance industry since at least 1967 when Berkshire Hathaway acquired National Indemnity. One of the key attractions is that ownership of a life insurer gives access to 'permanent capital', funds which do not have to be returned to investors on a specific timetable or at all. This permanent capital therefore saves PE investors time and effort on fundraising and offers them the flexibility to invest 'at times, like a crisis, when other forms of capital can become scarce'. Another attraction is that the returns on PE shareholders' equity can be increased by between 4-7 percentage points annually (to between 10-14%) by applying their investment management capabilities to earn alpha on some asset classes, such as asset-backed securities (primarily collateralized loan obligations) and private loans. Further, the relatively high (ten times) asset-to-equity ratio typical of insurers amplifies the impact of strong investment performance. The report says that 'The core attraction is straightforward. The balance sheets of life and annuities companies [are one form of permanent capital and] are well stocked with assets…but until payout, these assets need to be invested to generate returns. And in many cases, the cost of servicing the liabilities is significantly lower than the potential investment return. The spread represents an attractive margin'.

However, Charles Decker, a researcher at the Unite Here trade union, has argued that 'The whole private debt sector has grown hand-in-hand with the low interest rate environment

[421] https://news.prudential.com/prudential-financial-inc-and-warburg-pincus-announce-launch-prismic-life-re.htm
[422] https://www.mckinsey.com/industries/private-equity-and-principal-investors/our-insights/why-private-equity-sees-life-and-annuities-as-an-enticing-form-of-permanent-capital
[423] https://www.brown.senate.gov/newsroom/press/release/sherrod-brown-continues-push-private-equity-firms-involvement-insurance-industry

and there are reasons to be concerned about an asset class which has not been tested by either a period of prolonged high interest rates, or a major recession. But [our] greatest concern is just how opaque these assets are, it's very difficult to find out exactly what these private equity-backed insurers are investing in'.[424] There is also concern about the 'maturity wall' of low-grade corporate bonds that were issued during the period of ultra-low interest rates and which will mature over the next few years ($38bn in the US in 2024 and increasing to $235bn in 2028). These bonds will need to rolled over in the world of much higher interest rates that central banks have introduced to control inflation. But according the Federal Reserve, 10% of US companies have a so-called 'zombie' status and are unable to cover their interest expenses from operating income. A report by BCA (Bank Credit Analyst) Research found that 'Zombie companies… are multiplying [and] are highly sensitive to surging borrowing costs'.[425] Joe Engelhard, Senior Counsel, US Policy & Regulation at the Alternative Investment Management Association (AIMA), the global trade body for the private equity industry, responded to criticisms like this by arguing that 'In the US, the pension risk transfer market is regulated at both the federal and state levels, and insurers have a great track record over many decades of providing benefits to annuitants'.[426]

In December 2023, the IMF published a Global Financial Stability Note[427] on the growing trend of private equity investments in the life insurance industry. It noted that many PE firms have opened offices in Bermuda, where most of the long-term insurance gets reinsured. Apollo, KKR and Carlyle, for example, manage half of all long-term reinsurance assets on the island. It added that, while Bermuda's solvency regime has been granted equivalent status to those in the US and UK, 'it appears possible to gain recognition for the premium earned on illiquid investments when determining the discount rate for valuing technical provisions more often than in other regimes': allocations to illiquids by PE-influenced reinsurance in Bermuda averages 20% of portfolios compared with 6% for a sample of 50 major insurers globally.

The median solvency ratio of Canadian corporate DB pension plans was 119% at the end of June 2023, with 85% of the plans in surplus on a solvency basis. In order to protect these surpluses and de-risk their portfolios, plan managers were buying annuities from life insurance companies to transfer pension risk (around C$8bn annually), increasing liability-driven investments, and swapping shorter-dated for longer-dated bonds to increase the

[424] https://liferisk.news/spotlight-falls-on-us-life-insurers-private-debt-investments
[425] https://www.ai-cio.com/news/weak-companies-low-yielding-bonds-set-to-hit-maturity-wall/
[426] https://liferisk.news/spotlight-falls-on-us-life-insurers-private-debt-investments
[427] Fabio Cortes, Mohamed Diaby and Peter Windsor (2023) Private Equity and Life Insurers, *International Monetary Fund Global Financial Stability Note*, 19 December 2023;
https://www.imf.org/en/Publications/global-financial-stability-notes/Issues/2023/12/13/Private-Equity-and-Life-Insurers-541437

maturity matching with liabilities.[428] In 2023, there were 190 PRT deals totalling C$7.8bn (with an average size of C$40mn).[429]

In March, Legal & General entered the Dutch buy-out market in partnership with Dutch insurer Lifetri to arrange future buy-outs with pension funds that do not want to make the transition to the new defined contribution system and would provide 'insurance-based, capital-backed guarantees for members'. Lifetri had previously executed only one buy-out deal, namely a €850m buy-out of the pension benefits of Pensioenfonds Allianz in 2020. To date, buy-outs have not been common in the Netherlands. In 2022, there was just one buy-out, with the closed Dutch pension fund of A.C. Nielsen executed by Zwitserleven.[430]

In December, NN Life (a subsidiary of NN Group) completed two transactions to transfer the full longevity risk associated with €13bn of pension liabilities across 300,000 policies in the Netherlands to Prudential Financial and Swiss Re.[431] The reinsurance agreements will continue until the portfolio has run off and do not impact the services and guarantees that NN provides to its policyholders. The aim of the agreements is to reduce NN's exposure to longevity risk and hence strengthen NN's capital position. David Knibbe, CEO of NN Group, said: 'The capital uplift and economics from these transactions are very attractive compared to the limited impact on operating capital generation. It underscores our efforts to continually look for value creating opportunities, reduce longevity risk in the Dutch market, and actively manage our balance sheet'. Prior to the transaction, the Solvency II ratios for NN Group and NN Life were 205% and 187%, respectively. Following them, there will be an upfront capital benefit which will increase the Solvency II ratios for NN Group by 8 percentage points and for NN Life by 17 percentage points. The lower risk profile will lead to a limited decrease in operating capital generation for the first five years in the range of €30-35m per year. In the following years, the negative impact will decrease over time in line with the run-off of the portfolio.

2024

PRT volumes in 2024 were slightly lower than in 2023, with £48bn of bulk annuity transactions and £790m of longevity swaps, although the total number of transactions was 299, the highest ever.[432] More schemes would be choosing full scheme buy-ins 'as a stepping stone to buy-out', although superfunds would continue to see 'momentum' as part of the market. Further, some schemes might decide to 'pause for thought',[433] as they consider if running-on or delaying a move to buy-out could provide additional value if

[428] https://www.ai-cio.com/news/canadian-pension-plans-look-to-annuities-fixed-income-to-preserve-pension-surplus
[429] https://liferisk.news/canadian-pension-risk-transfer-market-set-for-record-year-even-as-interest-rates-fall/
[430] https://www.ipe.com/news/landg-to-enter-dutch-buyout-market-with-lifetri-partnership/10065654.article
[431] https://www.nn-group.com/news/nn-life-completes-two-longevity-transactions/
[432] *XPS Risk Settlement Watch*, January 2025; *Insurance Asset Management*, 24 March 2024.
[433] In the light of the Mansion House reforms.

legislative change makes it easier to extract surplus: 'If this is the case, it's unlikely that these schemes would wish to run unrewarded risks and consequently could look to hedge their demographic risks through the use of longevity swaps'.[434] A survey by Russell Investments found that, despite significant recent improvements in funding (out of total UK DB assets of £1.2trn, around a third of schemes (by value) were in surplus on a buyout basis), nearly a third of schemes had not yet decided on their endgame target and may decide to run on/off; although for those with an endgame target, buy-out is the preferred long-term option.[435] Aon's *Global Pension Risk Survey 2023/24* of UK DB schemes suggested that 55% of schemes had buy-out as their long-term target,[436] with 53% of large DB schemes planning a buy-in or buy-out within the next three years, according to Legal & General.[437]

PRT volume during the year was driven by small schemes (below £100m), for which some insurers had introduced streamlined solutions (sometimes called templated transfer or 'off the shelf' processes), such as: Aviva's Clarity streamlined bulk purchase annuity service for smaller (sub-£100mn) schemes, offering an 'efficient and robust process that enables well-prepared schemes to secure attractive pricing' (April);[438] PIC's small schemes solution, called Mosaic, for sub-£100mn schemes looking to complete a buyout, which offers price monitoring and standard processes and contracts;[439] L&G's Flow solution for sub-£150mn schemes (September); and Just Group's Beacon solution. Sub-£100mn schemes account for 75% of the UK's 5,000 DB pension schemes, and they accounted for 80% of completed deals in 2024.[440]

In July, two new companies announced that they were entering the UK PRT market. The first was Canadian financial services firm Brookfield which created Brookfield Reinsurance and filed paperwork with the PRA for approval. The second was Utmost Life and Pensions, previously called Reliance Life until it was bought by the Utmost Group in 2018; it already had 300,000 customers, including former Equitable Life customers. There was also some consolidation in the market: in March, Rothesay bought the £6bn Scottish

[434] https://www.professionalpensions.com/news/4166008/2024-gbp80bn-db-risking-deals-wtw-predicts
[435] https://www.ipe.com/analysis/db-schemes-indicate-growing-preference-for-retaining-assets/10127774.article
[436] https://www.pensionpolicyinternational.com/analysis-2024-to-be-the-biggest-year-for-uk-pension-de-risking/
[437] https://www.pensionpolicyinternational.com/majority-of-u-k-db-plans-looking-for-buy-in-or-buyout/
[438] https://www.ipe.com/news/aviva-launches-streamlined-bulk-purchase-annuity-service-for-smaller-schemes/10072650.article
[439] https://www.ipe.com/news/pic-launches-streamlined-solution-for-small-pension-schemes/10072883.article
[440] https://funds-europe.com/prt-market-in-uk-and-us-set-to-reach-250bn-within-three-years; https://liferisk.news/streamlined-pension-risk-transfer-deals-widen-small-scheme-opportunities/

Widows' in-force bulk annuity portfolio from Lloyds banking group, covering 42,000 annuitants.[441] In total, there were now 11 PRT providers in the UK.[442]

However, a report from Standard Life found that pension schemes' holdings of illiquid assets were delaying PRTs. Standard Life found that 40% of schemes planning to derisk had illiquid assets to offload and consultants reported that issues with such assets had delayed a transaction. This is because they were 'generally not a good fit for insurers' annuity portfolios due to regulatory requirements'. Illiquid assets, like real estate, can often not be sold at short notice without a significant reduction in value as well as the expense of using a broker. However, two new platforms (XPS Group's i Xchange and Isio's Fund Liquidity Option or i-FLO) have been established to help schemes sell their illiquid assets by finding the best price without using a broker. In August, the Britannia Pension Scheme became the first of Isio's clients by selling a £72mn investment in a private credit fund. Other alternatives have been to use the illiquid asset as a premium or deferred premium payment. The insurer uses the asset to back the bulk purchase annuity or uses it somewhere else in its balance sheet (e.g., with-profits fund); this is still a complex, lengthy process and the asset is still sold at a discount, but the discount might be lower than using a broker.[443]

There was a significant innovation during the year, the introduction of the Value Share Bulk Purchase Annuity. In November, an unnamed UK pension scheme executed a £500m Value Share Bulk Purchase Annuity with M&G, in what is believed to be the market's first BPA deal to share value with a corporate sponsor, allowing corporate sponsors to participate in the risk and reward generated from insuring their scheme. Max Koe, associate director of corporate risk solutions at M&G said: 'A lot of sponsors look at their schemes that are overfunded or have a surplus now and think "Well, why don't you run on, maybe stop investing in Gilts, invest in something slightly more attractive, like corporate bonds, and generate a surplus, and then we can share the surplus later down the line". The issue is the trustee. The trustee's main job is to secure the benefits for its members – so what's the incentive for them or for the members? With this proposition, M&G gives trustees and scheme members "ultimate security" as with a BPA transaction. And then what we do on the back end, which the trustee doesn't care about or see, really, is just reinsure some of that risk to the sponsor. The proposition also works for the insurer because by passing some of the risk over to the sponsor, we don't have to hold as much capital as we would with a normal core BPA'.[444]

In February, the Bank of England announced that it would stress test UK insurers on their exposure to reinsurance firms. It said it was concerned that the offshore arrangements

[441] https://www.ipe.com/news/scottish-widows-and-rothesay-complete-6bn-in-force-bulk-annuity-deal/10072190.article
[442] https://www.pensions-expert.com/Defined-Benefit/Brookfield-and-Utmost-to-enter-bulk-annuity-market
[443] https://liferisk.news/illiquid-assets-a-blessing-and-a-curse-for-pension-schemes-en-route-to-a-bulk-purchase-annuity-solution/
[444] https://www.ipe.com/news/mandg-launches-value-share-bulk-purchase-annuity-with-500m-transaction/10126504.article

involved could be increasing risk to pensioners.[445] In the same month, Hymans Robertson released a digital tool called PACE (Plan, Aim, Check, Execute) to help UK DB schemes build and implement a cohesive buy-out strategy. PACE integrates affordability, investment and due diligence considerations to build a robust plan, making the best use of the time leading-up to the transaction to get schemes ready for buyout. In particular, it uses dynamic annuity pricing to let schemes see how close they are to buy-out. At the appropriate time, the Hymans Robertsons risk transfer team will execute the deal.[446]

In April, the Pensions Protection Fund proposed the introduction of a public consolidator, a statutory fund under the management of the board of the PPF. It pointed out that there were £1.4trn assets in DB schemes, 75% of which have assets below £100m. It estimated that up to 2,300 schemes, with 960,000 members and assets of £130bn, could be interested in transferring to a public consolidator. This could unlock £10bn to invest in UK growth assets. Michelle Ostermann, PPF CEO, said: 'International experience shows that pension consolidation can drive better member outcomes and support productive investment'.[447]

In May, the Pensions Regulator released a new three-year corporate plan. At the centre of the plan was consolidation with the regulator working towards an industry with fewer more efficient pension schemes.[448] TPR said: 'We believe that the benefits of economies of scale, strong governance and access to investment expertise in larger, better-resourced schemes will help to drive stronger outcomes for savers'. It also wanted to see an emerging competitive superfunds market that offers 'enhanced security for savers'.[449]

In July, TPR updated its guidance on both the amount of capital and the release of capital from superfunds. Previous guidance stated that when a DB scheme is transferred to a superfund, new capital had to be provided at a level which (taking into account the value of the assets and liabilities of the transferred scheme) would satisfy capital requirements if that pension scheme were considered in isolation (the standalone test). The previous guidance also only allowed capital to be released when benefits were bought out. The new guidance removes the standalone test as long as the superfund as a whole is funded above the level at which capital can be released. If this is the case, capital could be released up to twice a year. TPR also relaxed standard capital adequacy requirements where a pension scheme's sponsoring employer becomes insolvent and the scheme is unable either to afford the buyout of full benefits or to enter a superfund or capital-backed arrangement on full capital adequacy terms. The transaction would have to be in the members' best interests and the level of benefits would have to be materially higher than buying out with an insurer

[445] *Insurance Asset Management*, 13 February 2024.
[446] https://www.ipe.com/news/hymans-robertson-sets-up-digital-tool-to-help-schemes-buyout-journey/10071817.article
[447] https://www.ipe.com/news/ppf-run-pensions-consolidator-could-unlock-10bn-in-uk-investment/10072813.article
[448] https://www.ipe.com/news/tpr-focuses-on-driving-consolidation-in-new-corporate-plan/10073062.article
[449] https://www.ipe.com/news/uk-regulator-committed-to-supporting-further-innovation-in-db-market/10072898.article

on PPF+ benefits levels, even if the capital adequacy basis is lower. The regulator said its aim was to protect scheme members, while supporting innovation in the market.

The updated guidance was welcomed by Simon True, CEO of Clara-Pensions, as an 'important step forward' for the superfund model, enabling more schemes to access consolidation and ensuring greater security for more members. Iain Pearce, head of alternative risk transfer solutions at Hymans Robertson, argued that the previous guidance had effectively restricted superfunds to being a temporary 'bridge to a buy-out', as with Clara's first transaction. However, the new guidance means that the superfund market is 'truly open for business and innovation'.[450]

In August, the PRA issued a new policy statement giving its expectations on funded reinsurance (FundedRe), following concerns that the current growth in the FundedRe market could, if not properly controlled, lead to a rapid build-up of risks in the sector. The policy statement is targeted at insurers entering into or holding funded reinsurance arrangements as cedants. It outlined its expectations on: the ongoing risk management of funded reinsurance arrangements; the modelling of the solvency capital requirement associated with funded reinsurance arrangements; and how firms should consider the structuring of funded reinsurance arrangements. The PRA said it would monitor closely the volume of FundedRe transacted by firms, any change in the quality of the collateral and the nature of FundedRe counterparties active in the market, and the progress firms make in implementing risk management and control arrangements. It warned that, if firms were not meeting expectations on the risk management practices needed to mitigate the risks FundedRe poses, it would consider whether it was appropriate to take further action. This could include, for example, consideration of explicit regulatory restrictions on the amount and structure of FundedRe, or measures to address any underestimation of risk, or regulatory arbitrage, inherent in these transactions.[451]

In October 2024, a study by Better Society Capital found that pension funds were the most active investors in the UK's social and affordable housing sector, representing just over 40% of the market. The sector was worth £10bn in 2023. Pension funds accounted for 21% of the UK's total social impact investment market, with most of their funds being directed towards social and affordable housing.[452]

In November, the Bank's Financial Stability Report warned of the consequences of the increasing number of private equity firms that have bought the US reinsurers to which UK

[450] https://www.ipe.com/news/uk-regulator-clarifies-capital-release-expectations-for-superfunds/10074899.article

[451] https://www.pensionsage.com/pa/PRA-issues-new-funded-reinsurance-expectations-BPA-market-not-expected-to-be-impacted.php

[452] Endowments and charities were the second biggest social impact investors (14%), followed by asset and wealth managers (13%), high-net-worth individuals and family offices (9%) and government bodies (including local authorities) and banks (both at 8%); https://impact-investor.com/pension-funds-biggest-investors-in-uks-10bn-social-impact-investment-market/

insurers have transferred some of their risk. PE-backed reinsurers target higher returns via greater risk-taking, often by investing in illiquid private assets. A potential sharp and correlated deterioration in these investments could amplify risks across global insurers, leading to 'asset fire sales' which would disrupt corporate funding markets. Loss of policyholder confidence could also create a liquidity stress. In addition, UK insurers could experience falls in solvency ratios that trigger termination of the reinsurance contracts and a recapture event, whereby the original insurer take back the risk. The subsequent increase in capital requirements may force insurers to sell assets at steep discounts to raise cash, exacerbating market stress.[453]

In December, the Prudential Regulation Authority proposed new liquidity reporting requirements for large UK life insurers. This was in response to prominent market stress episodes, such as the 'dash for cash' at the onset of the Covid-19 pandemic in March 2020, and the liability-driven investment (LDI) crisis in September 2022. According to the PRA, these episodes highlighted gaps in the UK insurers' liquidity risk frameworks and in some cases led to strains on liquidity, driven by sharp rises in margin requirements under derivatives contracts. The PRA proposed the collection of timely, consistent, and comparable data on the liquidity positions of large UK life insurers. The information collected is also intended to help firms manage their own liquidity positions and decide on appropriate risk management actions.[454]

In December, SEI and PIC announced a strategic partnership to provide pension scheme trustees with the means to bulk transfer DC pension benefits into the SEI Master Trust as part of their buy-out arrangements. This gives DB scheme members who also have a DC pension component access to SEI's wide range of investment options, thereby enhancing member outcomes, prior to entering a buy-out of their DB component.[455] Also in December, Resolution Life was acquired by Nippon Life for $10.6bn.[456]

Highlights for 2024 in the UK included:[457]

- UK insurers were estimated to represent 85% of the £5bn-£6bn institutional market for commercial ground rents.[458]
- In January, Royal London agreed a bulk annuity deal with the Royal London Group pension scheme valued at £348m. [459]

[453] https://www.bloomberg.com/news/articles/2024-11-29/private-equity-tie-ups-with-insurers-create-risks-boe-says
[454] https://www.bankofengland.co.uk/news/2024/december/the-pra-consults-on-liquidity-reporting-reforms-for-insurers
[455] https://www.ipe.com/news/sei-joins-forces-with-pic-to-facilitate-master-trust-access-for-db-scheme-members/10127839.article
[456] https://www.resolutionlife.com/news-and-insights/resolution-life-announces-acquisition-by-nippon-life/
[457] What is noticeable is the increasing number of small scheme transactions.
[458] *Insurance Asset Management*, 17 January 2024.
[459] https://www.ipe.com/news/royal-london-kicks-off-entry-into-uk-bulk-annuity-market/10072130.article

- In January, the CP Pharmaceuticals pension scheme agreed a £28m full buy-in with Just Group, covering 317 members.[460]
- In January, Just Group completed a £1.5m full scheme buy-in with the Intersil Limited Superannuation Fund.[461]
- In January, the Guilbert UK Retirement Benefits Plan has completed a £140m full scheme buy-in transaction with Aviva, covering all 1,500 scheme members.[462]
- In January, two Unisys pension schemes completed a £300m full-scheme buy-in with Standard Life, covering 2,400 scheme members.[463]
- In January, the Rexam Pension Plan executed a £1.4bn full scheme buy-in with Rothesay, covering around 14,000 members, including 9,790 pensioners and dependants, and 4,330 deferred members.[464]
- In January, an unnamed innovation and technology pension scheme completed a £400m full scheme buy-in transaction with Just Group, covering 2,500 pensioners and dependants and 1,500 deferred members of the scheme.[465]
- In February, the DAS Legal Expenses Insurance Company Limited Pension and Life Assurance Scheme did a £72m full scheme buy-in with Canada Life, covering 444 deferred members and 134 pensioners.[466]
- In February, the Birmingham Chamber of Commerce Pension Fund agreed a £9m full scheme buy-in with Just Group, covering around 100 pensioners and 40 deferred members.[467]
- In February, Just Group entered a £33m real estate ground rent investment in specialist healthcare facilities, via AlphaReal, in order to secure long-dated, inflation-linked cashflows, secured against 33 specialist healthcare facilities providing essential social infrastructure.[468]
- In February, the Vector Pension Scheme completed a £114m buy-in with Standard Life, covering 1,800 scheme members.[469]
- In February, PIC made a £30m debt investment in Northern Ireland's Apex Housing Association, to help fund a social housing development which in return will provide 'low risk, long-term, secure cashflows that match our pension liabilities for decades into the future'.[470]

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[460] *Insurance Asset Management*, 4 January 2024.
[461] *Insurance Asset Management*, 12 January 2024.
[462] *Insurance Asset Management*, 16 January 2024.
[463] *Insurance Asset Management*, 24 January 2024.
[464] https://www.ipe.com/news/rexam-pension-plan-in-14bn-buy-in-deal-with-rothesay/10071256.article
[465] https://www.ipe.com/news/uk-innovation-and-tech-pension-scheme-in-400m-buy-in-deal-with-just-group/10071337.article
[466] *Insurance Asset Management*, 5 February 2024.
[467] *Insurance Asset Management*, 14 February 2024.
[468] https://realassets.ipe.com/news/just-group-invests-in-uk-long-income-healthcare-assets-via-alphareal/10071606.article
[469] *Insurance Asset Management*, 16 February 2024.
[470] https://realassets.ipe.com/news/pic-invests-further-30m-in-northern-ireland-social-housing/10071660.article

- In February, the Spar UK Limited Pension Fund completed an £11m buy-in deal with Just Group.[471]
- In March, the Greenhous Group (2015) Retirement Benefits Scheme executed a £19m full buy-in deal with Just Group.[472]
- In March, three Thomas Cook Travel pension schemes completed full-scheme buy-ins with PIC for a total of £50m.[473]
- In March, the Transport for London Pension Fund purchased the 26MW Wadlow offshore wind farm from a DIF Capital Partners-managed infrastructure fund.[474]
- In March, the Ockham Pension Scheme completed a £110m buy-in with Just Group.[475]
- In March, the Debenhams Retirement Scheme completed a £600m bulk transfer to Clara-Pensions, exiting the Pensions Protection Fund and restoring full benefits for its 10,000 members.[476]
- In March, M&G agreed a £309m bulk purchase annuity deal with an unspecified counterparty.[477]
- In March, the Next Group Pension Plan completed a full scheme buy-in with PIC for £510m, covering 3,600 pensioners and deferred members.[478]
- In March, the Standard Group UK Pension Scheme agreed a £26m buy-out with Just Group.[479]
- In March, Lucite International UK Pension Fund, a subsidiary of Mitsubishi Chemical UK, completed a £130m buy-in deal with Just Group, covering156 pensioners and 282 deferred members.[480]
- In March, the Menzies Pension Fund agreed a £260m buy-in with Just Group, covering 3,000 members.[481]
- In April, De Beers UK Pension Scheme completed a £850m full buy-in deal with PIC, covering 464 pensioners and 473 deferred members.[482]

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[471] *Insurance Asset Management*, 21 February 2024.
[472] *Insurance Asset Management*, 4 March 2024.
[473] *Insurance Asset Management*, 7 March 2024.
[474] https://realassets.ipe.com/news/transport-for-london-pension-buys-26mw-offshore-uk-wind-farm-from-dif/10072159.article
[475] https://www.ipe.com/news/ockham-pension-scheme-completes-110m-buy-in-deal-with-just-group/10072192.article
[476] The Debenhams scheme had been in PPF assessment since 2019, when Debenhams became insolvent; https://www.ipe.com/news/clara-pensions-completes-second-transaction-with-debenhams/10072214.article
[477] *Insurance Asset Management*, 21 March 2024.
[478] https://www.ipe.com/news/next-group-completes-510m-buy-in-deal-with-pension-insurance-corporation/10072419.article
[479] *Insurance Asset Management*, 28 March 2024.
[480] https://www.ipe.com/news/lucite-international-pension-fund-in-130m-buy-in-with-just-group/10072662.article?
[481] *Insurance Asset Management*, 2 July 2024.
[482] https://www.ipe.com/news/de-beers-pension-scheme-completes-850m-full-buy-in-deal-with-pic/10072506.article

- In April, the Energizer UK Pension Plan agreed a £44m full buy-in with Just Group**,** covering 409 pensioners and 358 deferred members.[483]
- In April, the Riverstone Management pension scheme agreed a £95m full buy-in with Standard Life, covering 388 members.[484]
- In April, the Epson (UK) Limited Pension Scheme executed a £60m buy-in with Just Group, covering 113 pensioners and 289 deferred members.[485]
- In April, the Epson Telford Limited Pension and Life Assurance Scheme completed a £50m full scheme buy-in with PIC, covering 368 pensioners and 493 deferred members.[486]
- In April, the Lexmark Pension Plan agreed a £46m buy-in with Canada Life, covering 93 pensioners and 84 deferred members.[487]
- In April, L&G completed a £16m buy-in with the John Graham (Dromore) Limited Pension and Life Assurance Scheme, covering the benefits of 172 retirees and deferred members.[488]
- In May, the Rathbones pension scheme agreed a £100m buy-in with Canada Life, covering 480 members.[489]
- In May, the Norgine Limited Retirement Benefits Scheme completed a full buy-in transaction for £28m with Canada Life.[490]
- In May, the ICI Pension Fund executed a £900m buy-in with L&G, covering 7,000 retirees.[491]
- In May, the Telereal Pension Plan completed a £130m full scheme buy-in with Aviva, covering 500 members.[492]
- In May, L&G completed the third and final buyout with Nortel Networks UK Pension Plan.[493]
- In May, the Arqiva Defined Benefit Pension Plan executed a £204m full scheme buy-in with PIC.[494]
- In June, the Medical Protection Society Pension Scheme completed a £125m full scheme buy-in with Rothesay, covering 618 scheme members.[495]
- In June, the Sibelco UK Occupational Pension Scheme has agreed a £165m full buy-in with Aviva, covering all 1,200 members.[496]

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[483] *Insurance Asset Management*, 3 April 2024.
[484] *Insurance Asset Management*, 3 April 2024.
[485] *Insurance Asset Management*, 8 April 2024.
[486] *Insurance Asset Management*, 16 April 2024.
[487] *Insurance Asset Management*, 24 April 2024.
[488] *Insurance Asset Management*, 29 April 2024.
[489] *Insurance Asset Management*, 10 May 2024.
[490] *Insurance Asset Management*, 14 May 2024.
[491] *Insurance Asset Management*, 22 May 2024.
[492] https://www.ipe.com/news/telereal-pension-plan-completes-130m-buy-in-with-aviva/10073487.article
[493] *Insurance Asset Management*, 28 May 2024.
[494] *Insurance Asset Management*, 29 May 2024.
[495] *Insurance Asset Management*, 11 June 2024.
[496] https://www.ipe.com/news/sibelco-pension-scheme-completes-165m-buy-in-with-aviva/10074059.article

- In June, the Rolls-Royce & Bentley Pension fund completed a £880m full scheme buy-in with Standard Life, covering 6,000 members. Standard Life also concluded a £300m deal with Unisys and a £114m deal with Vector Pension Scheme.[497]
- In June, the Contship Containerlines Limited 1979 Pension Scheme completed a £25m full scheme buy-in with L&G, covering 150 members.[498]
- In June, the Merseyside Pension Fund completed a £200m buy-in with Aviva, covering 2,500 scheme members.[499]
- In July, the Taunton School pension scheme completed a full buy-in with Aviva for an undisclosed amount.[500]
- In July, M&G completed a £309m buy-in with the NSK's UK pension scheme, covering 3,700 members.[501]
- In July, the TotalEnergies UK Pension Plan agreed a £1.2bn buy-in with PIC, covering 2,000 pensioners and 3,500 deferred members.[502]
- In July, the Leprosy Mission Central Pension Scheme executed a £21m buy-in with L&G, covering 197 retirees and 88 deferred members.[503]
- In July, the Institution of Civil Engineers Staff Retirement Benefits & Life Assurance Scheme completed a £35m full scheme buy-in with Aviva.[504]
- In July, the Haberdashers Company Pension Scheme agreed a £3m buy-in with Just Group.[505]
- In July, Standard Life executed a 100m buy-in with two travel catering pension schemes.[506]
- In July, Greggs pension scheme executed a £100m buy-in with Aviva.[507]
- In July, the Moog Retirement Benefits Plan completed a £25m buy-in with Just Group, covering the scheme's remaining 28 deferred members and 139 current pensioner members.[508]
- In August, L&G agreed a £1.1bn buy-in with the SCA UK Pension Plan, covering 5,900 retirees and 3,600 deferred members.[509]
- In August, the BPT Retirement Benefits Scheme executed a £20m full scheme buy-in with Aviva, covering 49 deferred members and 50 pensioners.[510]

[497] https://www.ipe.com/news/rolls-royce-and-bentley-pension-fund-inks-880m-buy-in/10074219.article
[498] *Insurance Asset Management*, 24 June 2024.
[499] https://www.ipe.com/news/merseyside-pension-fund-in-200m-buy-in-with-aviva/10075651.article
[500] *Insurance Asset Management*, 1 July 2024.
[501] *Insurance Asset Management*, 2 July 2024.
[502] *Insurance Asset Management*, 3 July 2024.
[503] *Insurance Asset Management*, 3 July 2024.
[504] *Insurance Asset Management*, 10 July 2024.
[505] *Insurance Asset Management*, 16 July 2024.
[506] *Insurance Asset Management*, 25 July 2024.
[507] *Insurance Asset Management*, 30 July 2024.
[508] *Insurance Asset Management*, 31 July 2024.
[509] *Insurance Asset Management*, 1 August 2024.
[510] *Insurance Asset Management*, 7 August 2024.

- In August, the Rawle Gammon & Baker Ltd Pension & Assurance Scheme completed a £23m full buy-in with Just Group, covering 113 deferred members and 154 pensioners.[511]
- In August, Railpen, the rail transport pension scheme, announced it had partnered with GreenPower to co-develop the 66MW Barachander onshore wind farm in North Argyll, Scotland; they already run the 46MW Carraig Gheal wind farm. Railpen aims to provide long-term returns for its members, while having 'a positive impact on the world in which they live'.[512]
- In August, the UK Universities Superannuation Scheme (USS) acquired a £405m portfolio of over 3,000 shared-ownership homes across the UK from a Blackstone and Regis Group partnership. The deal is the largest shared-ownership portfolio acquisition since 1990, marking a major investment by a UK institutional investor. This investment allows USS to use its long-term capital to support …the UK social-housing sector.[513]
- In August, the Macmillan Cancer Support Pension Scheme executed a £33.7m buy-in with Aviva, covering all members.[514]
- In August, the Scottish Milk Limited Retirement Benefits Plan has agreed a £42m buy-in with Just Group, covering all 452 members.[515]
- In September, the Coats Pension Scheme completed a £1.3bn buy-in with PIC, covering and 80% of the scheme's liabilities (and 18,042 scheme members), having executed a £350m buy-in with Aviva in 2022, covering 20% of the liabilities.[516]
- In September, the Charities Aid Foundation Pension Scheme agreed £12m buy-in with Just Group, covering 64 pensioners and 155 deferred members.[517]
- In October, the Retreat York Pension Scheme agreed a £30m full scheme buy-in with Royal London, covering 202 pensioners and 108 deferred members.[518]
- In October, the Thomas Miller Retirement Benefits Scheme completed a £140m full-scheme buy-in with Aviva.[519]
- In October, the Church of England Pensions Board completed a final £145m buy-in with Aviva for the Church Workers Pension Fund (having previously completed buy-ins with Prudential in 2013 and Aviva in 2022).[520]

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[511] *Insurance Asset Management*, 8 August 2024.
[512] https://realassets.ipe.com/news/railpen-and-greenpower-to-develop-66mw-scottish-onshore-wind-project/10075149.article
[513] https://realassets.ipe.com/news/uss-buys-405m-uk-residential-assets-from-blackstone-and-regis/10075174.article
[514] *Insurance Asset Management*, 19 August 2024.
[515] *Insurance Asset Management*, 27 August 2024.
[516] https://www.ipe.com/news/coats-group-scheme-completes-13bn-buy-in-deal-with-pic/10075452.article
[517] *Insurance Asset Management*, 10 September 2024.
[518] *Insurance Asset Management*, 2 October 2024.
[519] https://www.ipe.com/news/thomas-miller-and-co-complete-140m-buy-in-with-aviva/10076013.article
[520] https://www.ipe.com/news/church-of-england-pensions-board-completes-145m-buy-in-with-aviva/10076154.article

- In October, the Michelin Pension and Life Assurance Plan agreed a £1.5bn full-scheme buy-in with Aviva, covering 15,000 scheme members.[521]
- In October, the Rotork Pension and Life Assurance Scheme executed a £70m buy-in transaction with Aviva, covering the pension benefits for 19 current pensioners and dependants and 322 deferred members.[522]
- In October, the RAC (2003) Pension Scheme completed a £1.3bn buy-in with Aviva, covering all the scheme's 19,000 members.[523]
- In October, Deutsche Bank and L&G agreed a £1.1bn full buy-in deal, covering 4,000 scheme members, following a £570m deal in 2021 and a £500m deal in 2023.[524]
- In October, the St Modwen Pension Scheme completed £18m full-scheme buy-in with Just Group.[525]
- In October, the Armfield Limited Pension and Life Assurance Scheme agreed a £7m buy-in with Just Group, covering 24 pensioners and 15 deferred members.[526]
- In October, the National Grid Electricity Group of the Electricity Supply Pension Scheme completed a £1.7 billion buy-in with Aviva, covering 5,800 pensioners.[527]
- In November, PIC, Muse and Homes England (the government's housing and regeneration agency) formed a £54m joint venture development vehicle to build 3,000 low-carbon, low-energy affordable homes for rent.[528]
- In November, the West Bromwich Building Society Staff Retirement Scheme completed a £70m buy-in with Canada Life, covering 490 deferred members and 400 pensioner members.[529]
- In November, the Atradius UK Pension Scheme agreed a £190m buy-in with PIC, covering 361 current pensioners and dependants, 344 deferred members and 66 active members.[530]
- In November, the Halma group pension schemes executed £250m buy-ins with Standard Life, covering 2,200 members.[531]
- In November, the Natwest Group agreed a £11bn buy-in with Rothesay.[532]

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[521] https://www.ipe.com/news/michelin-pension-scheme-completes-15bn-buy-in-with-aviva/10076118.article
[522] *Insurance Asset Management*, 22 October 2024.
[523] *Insurance Asset Management*, 28 October 2024.
[524] https://www.professionalpensions.com/news/4374176/deutsche-bank-agree-gbp-1bn-deal
[525] *Insurance Asset Management*, 29 October 2024.
[526] *Insurance Asset Management*, 31 October 2024.
[527] https://www.pensionpolicyinternational.com/uk-aviva-completes-a-1-7-billion-buy-in-with-the-national-grid-electricity-group-of-the-electricity-supply-pension-scheme/
[528] https://realassets.ipe.com/news/pic-muse-form-joint-venture-with-homes-england-to-provide-affordable-housing/10076620.article
[529] *Insurance Asset Management*, 6 November 2024.
[530] *Insurance Asset Management*, 7 November 2024.
[531] *Insurance Asset Management*, 7 November 2024.
[532] *Insurance Asset Management*, 7 November 2024.

- In November, an unnamed pension scheme in the mechanical and electrical industry completed a £2m full buy-in with L&G, covering 16 pensioners and 3 deferred members.[533]
- In November, an unnamed pension scheme agreed a £20m buy-in with Utmost Life and Pensions.[534]
- In November, the G4S Pension Scheme executed a £1.8bn full buy-in deal with Just Group, covering 22,500 members.[535]
- In November, the Walkers Shortbread Limited Retirement Benefits Scheme completed a £34m buy-in with L&G, covering 161 retirees and 238 deferred members.[536]
- In November, the New Crown Motor Sales Limited Staff Pension Scheme agreed a £2.2m buy-in with Just Group, covering benefits of 36 members.[537]
- In November, the Wednesbury Pension Scheme completed a £43m buy-in with Just Group.[538]
- In November, the Mitchells & Butlers Executive Pension Plan agreed a full scheme buyout with L&G.[539]
- In December, the KION Group executed a £250m full scheme buy-in transaction with Canada Life, covering around 3,000 members.[540]
- In December, the Merchant Navy Ratings Pension Fund (MNRPF) agreed a £450m longevity swap of pensioner and dependant liabilities with Metropolitan Life Insurance Company (MetLife). The transaction is structured as an insurance contract with a captive insurer in Guernsey (managed by WTW Guernsey) and onwards reinsurance to MetLife.[541]
- In December, the Avimo Pension Scheme completed a £50m buy-in with Rothesay, covering all 611 scheme members, including 416 pensioners and dependants and 195 deferred members.[542]
- In December, the Hays Pension Scheme agreed a £370m buy-in with PIC, covering 853 pensioners and dependants and 3,368 deferred members. In 2018, the scheme bought a bulk annuity policy from Canada Life for a premium of £270.6m.[543]
- In December, the Clara-Pensions superfund took over the Wates Group DB pension fund with 1,500 members, with an additional £19m of funding from Wates. The members will be transferred to an insurer via a buyout within 5-10 years. It is the

[533] *Insurance Asset Management*, 11 November 2024.
[534] *Insurance Asset Management*, 13 November 2024.
[535] https://www.ipe.com/news/g4s-pension-scheme-completes-18bn-buy-in-deal-with-just-group/10076831.article
[536] *Insurance Asset Management*, 13 November 2024.
[537] *Insurance Asset Management*, 21 November 2024.
[538] *Insurance Asset Management*, 26 November 2024.
[539] *Insurance Asset Management*, 27 November 2024.
[540] https://www.ipe.com/news/kion-group-completes-250m-buy-in-deal-with-canada-life/10126690.article
[541] https://www.ipe.com/news/merchant-navy-ratings-pension-fund-completes-450m-longevity-swap/10126694.article
[542] *Insurance Asset Management*, 4 December 2024.
[543] https://www.ipe.com/news/hays-pension-scheme-completes-370m-buy-in-with-pic/10127699.article

first superfund transaction to be completed by an active and non-distressed business.[544]

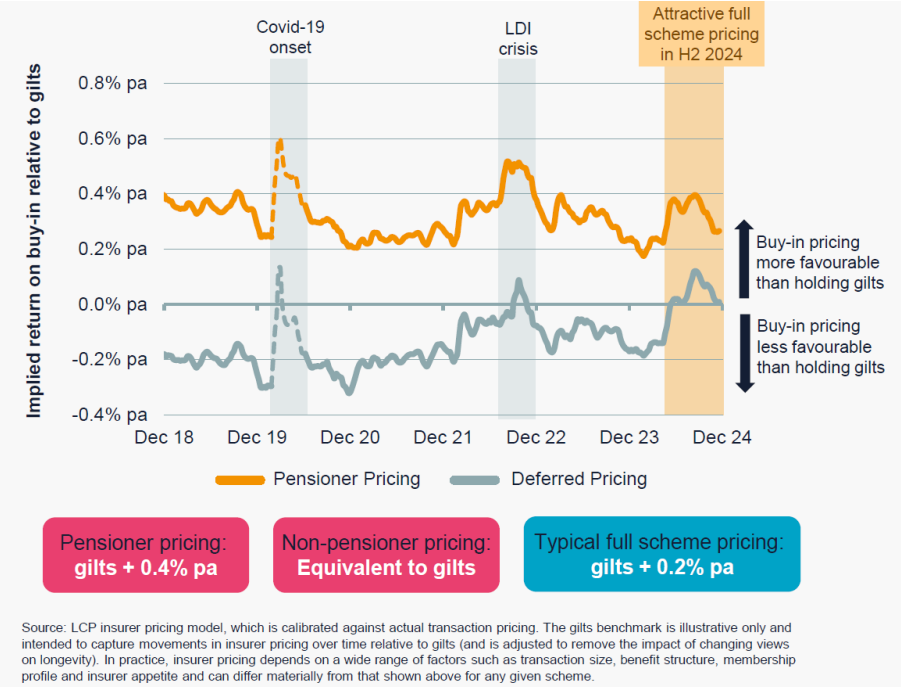
- In December, the Tennants Consolidated Limited Pension Scheme completed a £102m full scheme buy-in with Royal London, covering 463 pensioners and 241 deferred members.[545]
- In December, the Hunt Brothers and Company Limited Pension Fund agreed a £1.4m full scheme buy-in with Just Group, covering the benefits of 8 pensioner members.[546]
- In December, the G R Wright & Sons pension scheme completed a £4m full scheme buy-in with Just Group, covering the benefits of all 13 members.[547]
- In December, the (British) Airways Pension Scheme completed a £340m longevity swap with Metlife and Zurich Assurance. The swap was structured as an insurance arrangement between the scheme trustees and Zurich UK, and a back-to-back reinsurance arrangement between Zurich UK and MetLife using Zurich UK's pass-through solution. MetLife assumed 100% of the longevity risk associated with around 1,100 members of the scheme.[548]
- In December, PIC executed its first buy-in transaction using Mosaic, its streamlined service for small pension schemes. It was a £20m deal with the General Council of the Bar (GCB) Pension and Life Assurance Fund and covered the pensions of 103 members.[549]
- In December, Chesnara acquired a closed portfolio of unit linked bonds and legacy pension business with approximately 17,000 policies and £1.5bn in total assets under management from Canada Life UK.[550]
- In December, the Finning Pension Scheme agreed a £250m bulk purchase annuity buy-in with Standard Life, covering all 2,170 scheme members.[551]
- In December, the ELG Haniel Metals Limited Pension and Assurance Scheme completed a £28m buy-in with Just Group, covering 99 deferred members and 81 pensioners.[552]
- K3 Advisory, in partnership with Cartwright, reported the completion of five small scheme buy-ins, all insured by Just Group.[553]

Figure 1 shows that in December 2024, pensioner pricing was based on a 'gilts + 0.40%' discount rate to value liabilities; this is less than the best peak pricing rate of 'gilts + 0.50%' at the end of 2022, and reflects the hardening of prices as insurer capacity bites. Similarly,

[544] https://www.ipe.com/news/clara-superfund-takes-over-wates-groups-1500-members/10127761.article
[545] *Insurance Asset Management*, 16 December 2024.
[546] *Insurance Asset Management*, 16 December 2024.
[547] *Insurance Asset Management*, 18 December 2024.
[548] https://www.ipe.com/news/airways-pension-scheme-completes-340m-longevity-swap/10127891.article
[549] https://www.ipe.com/news/pic-completes-first-transaction-under-streamlined-service-mosaic/10127936.article
[550] *Insurance Asset Management*, 23 December 2024.
[551] *Insurance Asset Management*, 12 February 2025.
[552] *Insurance Asset Management*, 24 April 2025.
[553] *Insurance Asset Management*, 5 February 2025.

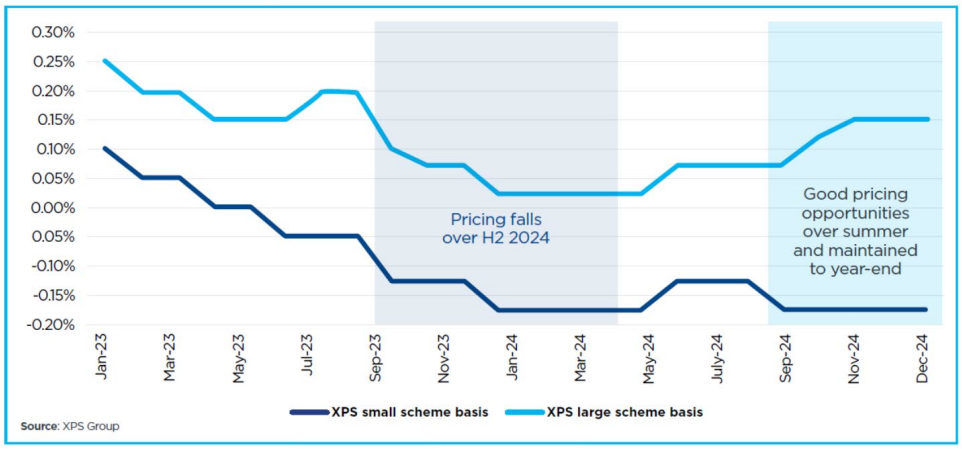
the pricing of deferred pensioner liabilities was based on a 'gilts', down from 'gilts – 0.15%' at the end of 2022. Both were also slightly more expensive than at the end of 2019. Figure 2 shows that over the period January 2023-December 2024, small scheme liabilities were discounted at a 0.2%-0.325% lower rate compared with large scheme liabilities. To illustrate, in December 2024, the rate was 'gilts – 0.175%' for small schemes and 'gilts + 0.15%' for large schemes.

Figure 1: Bulk annuity pricing December 2018-December 2024 – average pricing relative to gilt yields for pensioners and deferred members



Source: LCP's predictions for the pension risk transfer market in 2025, January 2025; https://insights.lcp.com/rs/032-PAO-331/images/LCP-predictions-for-the-PRT-market-Janurary-2025.pdf

Figure 2: Bulk annuity pricing January 2023-December 2024 – average pricing relative to gilt yields for small schemes and large schemes



Note: The pricing is based on observed market pricing and model points from bulk annuity insurers. Actual bulk annuity pricing is specific to a particular scheme's demographic and benefit profile, and other wider factors influencing appetite for a transaction. Source: XPS Bulk annuity market January 2025 trustee update; https://www.xpsgroup.com/news-views/insights-briefings/bulk-annuity-market-january-2025-trustee-update/

In the US, there were 21 PRT insurers at the end of December. The regulatory burden on US life insurers has been described as 'arguably less onerous' than that facing UK life insurers which has enabled the former to invest more heavily in private assets, such as private and structured credit and private equity, via asset management firms, such as Apollo (which merged with insurer Athene), Blackstone and KKR.[554]

According to the Milliman Pension Buyout Index, 'retiree buyout costs open 2024 at their lowest level in almost six months–despite another sizable drop in accounting discount rates'.[555] As of 31 July, the PRT cost was 102.5% of a typical plan's accounting liabilities (ABO), while, the average annuity purchase cost across all insurers was 104.9%, implying that the competitive bidding process amongst PTR providers saved plan sponsors 2.4% of PRT costs.[556] The aggregate funded status of US corporate pension funds was at 100% at the end of 2024, the first time since before the Global Financial Crisis that pension funds closed the year fully funded or better.[557] The full year PRT market volume was $49.81bn (with 800 transactions[558]), the second largest on record behind the $51.8bn executed in

[554] https://liferisk.news/how-many-more-asset-managers-can-the-us-pension-risk-transfer-market-absorb/
[555] https://www.pensionpolicyinternational.com/milliman-analysis-competitive-pension-risk-transfer-costs-decrease-from-101-8-to-100-5-in-december/
[556] https://www.pensionpolicyinternational.com/milliman-analysis-competitive-pension-risk-transfer-costs-climb-from-100-3-to-102-5-in-july/
[557] https://www.ai-cio.com/news/u-s-corporate-pension-funds-ended-2024-strong
[558] https://www.pionline.com/pension-risk-transfer/pension-risk-transfer-volume-hits-record-14-billion-through-q3-2024-according

2022.[559] It also predicted that total UK and US PRT volumes would exceed £250bn during 2024-27.[560] George Palms, President at Legal & General Retirement America (LGRA) said: 'In the US, there are more than $3trn in DB pension liabilities and only about 10% of that has been de-risked so far. The steady march up in terms of taking liabilities off the balance sheet will continue due to secular trends around se-risking and string funding levels'.[561]

Erik Pickett, Actuary at Club Vita, commented: 'We've noticed a growing sophistication in mortality modelling in the US PRT market, with the majority of insurers using multi-factor models in their baseline assumptions to capture the predictive power of factors such as ZIP+4, collar type, benefit amount and gender. Insurers are now commonly using multiple factors simultaneously to capture differences in mortality rates at the individual member level, and those not using such models run the risk of adverse selection. We've also seen a growing focus on mortality improvements as insurers face the uncertainty of the long-term impact of the Covid-19 pandemic. This is the area of greatest divergence in mortality assumption setting, although there does seem to be an increasing consensus to reflect higher expected mortality improvements in the DB pensioner population over the general population. With a greater dependency on data to set mortality assumptions, the value of complete clean data from pension plans looking to transact is high. When this is unavailable, it is common for insurers to add extra margin to deals to cover the uncertainty introduced'.[562]

In March, four former AT&T pension scheme members filed a claim in the US District Court for the District of Massachusetts alleging that the 2023 PRT with Athene placed its former retirees in danger and that AT&T gained approximately $363m from the transfer, since it will save $9.6m annually in flat-rate PBGC premiums. AT&T has placed 'its retirees' futures in the hands of a risky new insurance company that is dependent on its Bermuda-based subsidiary and which has an asset base far riskier than AT&T. …[One-fifth of Athene's portfolio is invested in] risky asset-backed securities and leveraged loans made to companies highly in debt. …[Further], approximately 80% of Athene's PRT liabilities are reinsured through Bermuda affiliates owned by Athene's parent, Apollo', according to the claim. AT&T was therefore in breach of its fiduciary duties under the Employee Retirement Income Security Act (ERISA). The claimants wanted AT&T to guarantee the retirement benefits that were part of workers' employment bargain with AT&T.[563] AT&T's defence was that the decision to purchase an annuity was a 'settlor decision' that is 'unassailable under ERISA's fiduciary requirements, [and hence] was not

[559] https://www.pionline.com/pension-risk-transfer/us-pension-risk-transfer-volume-tops-50-billion-2024-just-short-2022-record?utm_source=PIDailyWrap&utm_medium=email&utm_campaign=20250317
[560] https://funds-europe.com/prt-market-in-uk-and-us-set-to-reach-250bn-within-three-years
[561] https://liferisk.news/us-pension-risk-transfer-market-to-continue-bull-run-in-2025-and-beyond/
[562] https://liferisk.news/us-pension-risk-transfer-market-to-continue-bull-run-in-2025-and-beyond/
[563] https://www.ai-cio.com/news/att-sued-over-2023-pension-annuitization-with-athene. A second lawsuit was filed a few days later, see: https://www.pensionpolicyinternational.com/us-att-faces-second-lawsuit-over-pension-plan-risk-transfer/

a fiduciary decision, and thus AT&T couldn't have breached any ERISA fiduciary duties in making that decision'. Further, 'While plaintiffs allege that Athene might default on its obligations at some unknown point in the future if it does a poor job of managing its assets, this allegation is far too speculative to give rise to Article III standing. To establish a case or controversy under Article III, Plaintiffs must allege an imminent threat of harm, and none of plaintiffs' allegations, either individually or in the aggregate, comes close to meeting that requirement'.[564]

Also in March, a similar claim was filed in the US District Court for the District of Maryland by former Lockheed Martin pension scheme members against the decision to transfer pension obligations to Athene: 'Instead of selecting the safest possible annuity to ensure that their employees and retirees would have continued financial security of Lockheed employees and retirees, Lockheed Martin selected Athene, which is substantially riskier than numerous traditional annuity providers'. In both cases, the plaintiffs were appealing to Interpretive Bulletin IB 95-1 (IB95-1), issued by the Department of Labor in 1995 (following the collapse of Executive Life) which specifies the fiduciary standards required to select an annuity provider for a PRT. These include considerations of the provider's investment portfolio, size relative to the annuity contract, level of capital and surplus, liability exposure and availability of state government guaranty associations. In short, IB95-1 requires the purchase of the 'safest annuity available'.

Under the SECURE 2.0 Act of 2022, the DOL was mandated to review Interpretive Bulletin 95-1 on pension risk transfers and recommend possible modifications to Congress.[565] In May 2024, the Employee Benefits Security Administration (part of the DOL) said it was preparing a report for Congress and was considering changes to the guidance in IB 95-1 concerning standards for employers in selecting third-party insurers to convert plan funds into annuity contracts. The current guidance requires plans to consider the 'safest available annuity' in choosing an insurer for PRTs. Ada Dolph, partner at Seyfarth Shaw LLP, pointed out that 'With the lawsuits that have been happening, there's been increased focus on private equity getting into this area of risk transfers, and a lot of concern that private equity is supported by investments that may be at some level riskier than a traditional insurance company'. Dolph also said that EBSA might require that fiduciaries consider an insurance company's ownership, control, and ability to administer payment of benefits, as well as providing a model statement that fiduciaries can show to participants explaining the risk transfer.[566] The report was released in June 2024, but it did not recommend any specific changes to IB 95-1 at that time, instead concluding that: 'Further exploration into developments in both the life insurance industry and in pension risk transfer practices is necessary to determine whether some of the Interpretive Bulletin's

[564] https://www.pensionpolicyinternational.com/att-seeks-dismissal-from-two-lawsuits-targeting-prt-deal-with-athene/
[565] https://www.pensionpolicyinternational.com/us-pension-risk-transfers-trigger-new-erisa-litigation/
[566] https://www.pensionpolicyinternational.com/us-pending-dol-report-to-consider-pension-risk-transfer-changes/

factors need revision or supplementation and whether additional guidance should be developed'.[567]

In August, the US National Association of Insurance Commissioners (NAIC) discussed the issue of funded reinsurance. Like the PRA, the NAIC, while recognizing the role of reinsurance in managing risk and capital, was concerned about the concentration of risks in a small number of offshore counterparties often based in Bermuda, correlations in risk due to the dependence of many reinsurers' business models on credit, and the risk associated with illiquid assets, especially in scenarios when it is necessary to recapture reinsured liabilities. The NAIC considered proposals put forward by the Life Actuarial Task Force (LATF) which would require asset adequacy testing using cash flow methodologies for ceded reinsurance transactions. The International Association of Insurance Supervisors (IAIS) was also monitoring the growth of cross-border reinsurance, according to a report by Hogan Lovells.[568]

In October, Oliver Wyman and Mercer (both subsidiaries of Marsh McLennan) introduced a new pension risk transfer longevity model that will enable pension plan sponsors, direct insurers and reinsurers to better price and manage longevity risk. The model is based on Mercer's US longevity dataset of over one million pension lives, which incorporates socioeconomic and demographic factors. It has been designed to allow users to extract tailored insights and analytics. These will assist in enhancing the prediction, understanding, and effective management of longevity risk within a PRT transaction: 'Having a more comprehensive understanding of their plan's longevity risk will make these transfers more attractive to insurers'.[569]

Highlights for 2024 in the US included:

- In February, Prudential Financial completed a pension risk transfer deal with Shell USA for $4.9bn, covering around 21,500 of the company's US retirees.[570]
- In March, Prudential Financial and RGA were selected to execute a PRT with Verizon Communications valued at $5.9bn covering 56,000 pensioners.[571] However, in December, the pensioners filed a lawsuit against Verizon management and State Street Global Advisors for allegedly breaching fiduciary duties under ERISA, claiming that the company chose the 'cheapest' rather than the 'safest'

[567] https://www.ai-cio.com/news/no-recommendations-yet-from-the-labor-department-on-prt
[568] https://www.pensionpolicyinternational.com/regulators-increase-scrutiny-on-funded-reinsurance-amid-pension-de-risking-surge/
[569] https://www.pensionpolicyinternational.com/new-pension-longevity-model-launched-by-oliver-wyman-and-mercer/; https://www.oliverwyman.com/media-center/2024/oct/oliver-wyman-and-mercer-launch-new-pension-risk-transfer-longevity-model.html
[570] *Insurance Asset Management*, 8 February 2024.
[571] *Insurance Asset Management*, 7 March 2024.

annuity provider, exposing them to undue risk. Verizon denied the claims and pledged a strong defense.[572]

- In March, IT technology company Unisys closed an agreement with F&G Annuities & Life to purchase $200 million in group annuity contracts. Since 2021, Unisys has offloaded around $2 billion in pension liabilities, including those from subsidiaries' pension plans in the Netherlands and Switzerland.[573]
- In June, 3M transferred $2.5bn in pension liabilities, covering 23,000 retirees, to Metropolitan Tower Life, a subsidiary of MetLife.[574]
- In August, PICA completed the first PRT involving a multiemployer pension plan. The $221m deal with Sound Retirement Trust, based in Seattle, covers 8,700 retirees and beneficiaries.[575]
- In September, PICA agreed a second PRT deal (for $6bn) with International Business Machines Corporation (IBM), covering 32,000 retirees.[576]
- In December, MetLife and General Atlantic established Chariot Re, a Class E Bermuda-based life and annuity reinsurance company.[577]

In February, Ford of Canada's pension plan agreed a C$923m group annuity buy-out for 2,700 plan members with RBC Insurance, Sun Life and Desjardins Group. In March, RGA Life Reinsurance Company of Canada (RGA Canada) completed a C$5.8bn life reinsurance transaction with Manulife, the largest universal life reinsurance transaction in Canada to date.[578] In October, IBM Canada concluded a C$1.5bn buy-out for 6,000 plan members with Blumont Annuity and RBC Insurance. The Canadian PRT market reached a new peak in 2024 with 130 transactions worth C$11bn. An unusual feature of the Canadian market, in comparison with the US and UK markets (with 20 and 11 insurers, respectively), is that often more than one insurer is involved in the transaction, although there is one lead insurer and the other insurers are doing a buy-in of the main insurer. The market is highly concentrated with six insurers – Sun Life, Blumont Annuity, AI Financial Group, BMO insurance, RBC Insurance and Desjardins Group – accounting for 99% of the market. They are well capitalized under Canada's Life Insurance Capital Adequacy Test (LICAT). The 2023 Pension Protection Act gave super-priority status for pension deficits in the event of corporate insolvency and this led to an increased demand for annuity purchases to hedge pension-related risks. By the end of 2014, only 15% of the Canadian pensions had de-risked.[579]

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[572] pionline, 3 January 2025.
[573] https://www.pensionpolicyinternational.com/us-unisys-announces-200m-pension-risk-transfer/
[574] https://www.ai-cio.com/news/3m-to-transfer-2-5b-in-pension-liabilities-to-met-tower-life
[575] https://www.pensionpolicyinternational.com/us-prudential-to-complete-industrys-1st-multiemployer-pension-risk-transfer/
[576] https://www.pensionpolicyinternational.com/ibm-completes-6-billion-pension-buyout-with-prudential-its-second-in-2-years/
[577] *Insurance Asset Management*, 12 December 2024
[578] *Insurance Asset Management*, 25 March 2024.
[579] https://liferisk.news/canadian-pension-risk-transfer-market-set-to-establish-higher-floor-as-aggregate-deal-value-surges/

The Dutch market PRT market was relatively quiet in 2022-23 with only around €100m of transfers from pension funds to insurers, e.g., NN bought out the accrued pension liabilities of Metro. The plan for a national switch from a DB to a DC pension system, which passed into law in July 2023, has been put on hold due to the absence of an agreed government following the November 2023 general election – one of the parties, the Freedom Party (PVV), promised to reverse the switch. If the switch does go ahead, this could lead to transfers from the small number (around 44) of company-sponsored schemes that intend to liquidate their existing scheme rather than transition members to DC in line with the new law. This could result in around €25bn being transferred to insurers.[580] At the start of 2024, there were four buy-out insurers: NN, Zwitserleven (bought by by Bermuda-based Athora Holdings in 2020), ASR and Lifetri. In May, Lifetri pulled out of the market, having secured only one pension fund buy-out in the previous four years (with the Dutch pension fund of Allianz in 2020), selling its business to Dutch insurer Achmea. In November, NN concluded a €45m buy-out with the pension fund of Calpam and Zwitserleven concluded a €650m buy-out with the pension fund of Yara.[581] In December, ASR completed a €1.6bn buy-out of the closed professional scheme for dentists.[582] Despite strong funding ratios, many companies prefer to transition to DC on their own or join a pooled pension fund (APF), both of which allow funds to continue investing in risk assets which can be used to compensate members who are disadvantaged by the move to DC.[583] In December, Dutch insurer Achmea and US investment firm Sixth Street Partners announced a joint (80:20) venture to enter the Dutch pension buy-out market under the name Achmea Pensioen & Leven (Pension & Life).[584]

The pension risk transfer and buyout market has been slow to develop in Germany, but this is about to change. Prior to 2002, German companies provided pensions to their employees on a 'book reserve' basis. Employees were given a 'direct promise' (Direktzusagen) and the resulting liability accrued on the corporate balance sheet and was financed from free cash flow. In 2002, International Accounting Standards (IAS) were incorporated in EU law which required companies to recognize the net present value of pension surpluses or deficits in their profit and loss account. Since then, companies have funded pension liabilities through Pensionsfonds vehicles or contractual trust (CTA) structures, while continuing to bear the risks, although some risks have been hedged with insurance solutions.

In February 2024, it was reported that Allianz Global Investors (AllianzGI) and Deutsche Betriebsrenten Holding (DBR) had agreed a PRT partnership. The pension liabilities of DBR were demerged in line with the German Transformation Act (Umwandlungsgesetz)

[580] https://www.ipe.com/special-reports/risk-transfer-special-report-pension-liabilities-shift-to-insurers/10071342.article
[581] https://www.ipe.com/news/dutch-funds-yara-and-calpam-conclude-buyouts/10076709.article
[582] https://www.ipe.com/news/nedlloyd-fund-concludes-950m-buyout-with-zwitserleven/10129954.article
[583] https://www.ipe.com/news/why-the-dutch-buyout-market-fails-to-fulfil-its-promise/10074113.article
[584] https://www.ipe.com/news/achmea-and-sixth-street-merge-to-enter-dutch-buyout-market/10126683.article?

and transferred to a separate company (known as a pension corporation, pensioner company or Rentnergesellschaft). The pension corporation, which will pay the pensions, was acquired by DBR, acting as the external risk carrier. This structure is based on German corporate law rather than insurance law. It gives a high degree of flexibility and more attractive price for the ceding company. In particular, it allows the option to transfer the liabilities to an external pension corporation over time, while preserving liquidity. The ultimate goal is, according to DBR's managing partner Thomas Bloch, a 'full and final release of the corporate groups from the pension obligations, economically, financially and operationally'. To achieve this, sufficient assets needed to be transferred in order to meet all future pension payments and associated expenses. The costs of the transfer were close to the company's book value of pension liabilities. AllianzGI will provide asset-liability management (ALM) and asset management expertise, insolvency protection and cash flow management via the Allianz CTA.

AllianzGI plans to offer this PRT solution to other German companies, international companies (e.g., Japanese, Finnish and French) with German subsidiaries, and companies based in other countries, such as Japan, France, the UK, US and Benelux. According to Bloch, 'pension buyouts are also highly relevant in M&A transactions. Addressing this aspect at an early stage increases the M&A readiness of companies and enables smoother and better deals'. PRT's via a Rentnergesellschaft strengthen the sponsor's equity ratio, avoiding future volatility, allowing companies to focus on the core business. Further, the transfer does not require approval by pension beneficiaries, works councils (Betriebsräte), regulatory authorities such as BaFin, or the lifeboat pensions insurer PSVaG. Bloch added: 'In Germany, pensions have to be increased according to inflation; longevity risks are not captured by accounting values, a very significant difference to the UK, and there are operational and legal risks'.[585] In December, Allianz set up a new life rereinsurer in Bermuda called Sconset Re, with equity capital from institutional partners.[586]

Other German companies are considering using pension corporations as a means of transferring pension obligations to a separate company through a demerger, or all-share deals, to free themselves up from liabilities, according to Aon Wealth Solutions Germany. The assets required to fund the pension corporation are significantly lower than the contributions that would be necessary if the transfer were made to an insurance company. In 2021, pension assets in Germany totalled €690b, of which €318.8bn were direct promises, €171bn were current pensions and €147bn were vested entitlements. The buy-out market has been slow to develop in Germany because of caution over legal and reputational risk, and also a lack of actuarial corporate pension expertise.[587]

[585] Luigi Serenelli (2024) AllianzGI partners with DBR to offer pension risk transfer, *IPE*, February; https://www.ipe.com/special-reports/allianzgi-partners-with-dbr-to-offer-pension-risk-transfer/10071346.article

[586] *Insurance Asset Management*, 12 December 2024

[587] https://www.ipe.com/country-reports/germanys-pension-buyout-market-shows-signs-of-life/10071861.article

In December, WTW announced it would set up a pension corporation as an external risk carrier in Germany to transfer pension obligations from German corporates. WTW said that pension obligations are a burden on the balance sheets of companies that are changing their business models and need more 'flexible and agile' corporate structures. The level of funding ratios for company pension schemes is at an all-time high, making it easier to implement restructuring through pension buyout solutions. The market is worth potentially €600bn.[588]

In March, RGA announced a longevity asset-intensive reinsurance deal with Japan Post Insurance Company covering a JPY700bn in-force block of individual life annuities. RGA said 'This transaction marks a significant milestone in the Asia-Pacific longevity market as a first-of-its-kind coinsurance transaction in Japan. This is one of a number of recent asset-intensive transactions that RGA has completed demonstrating our deep expertise and strong position in the Japanese and Asia Pacific markets'.[589] In May, Pacific Life Re announced an asset-intensive reinsurance agreement with Japan's Tokio Marine & Nichido Life Insurance Company (Anshin Life). The deal covered in-force whole of life policies and will provide Anshin Life with a new method to reduce long-term interest rate risk and enhance its asset liability management capabilities.[590]

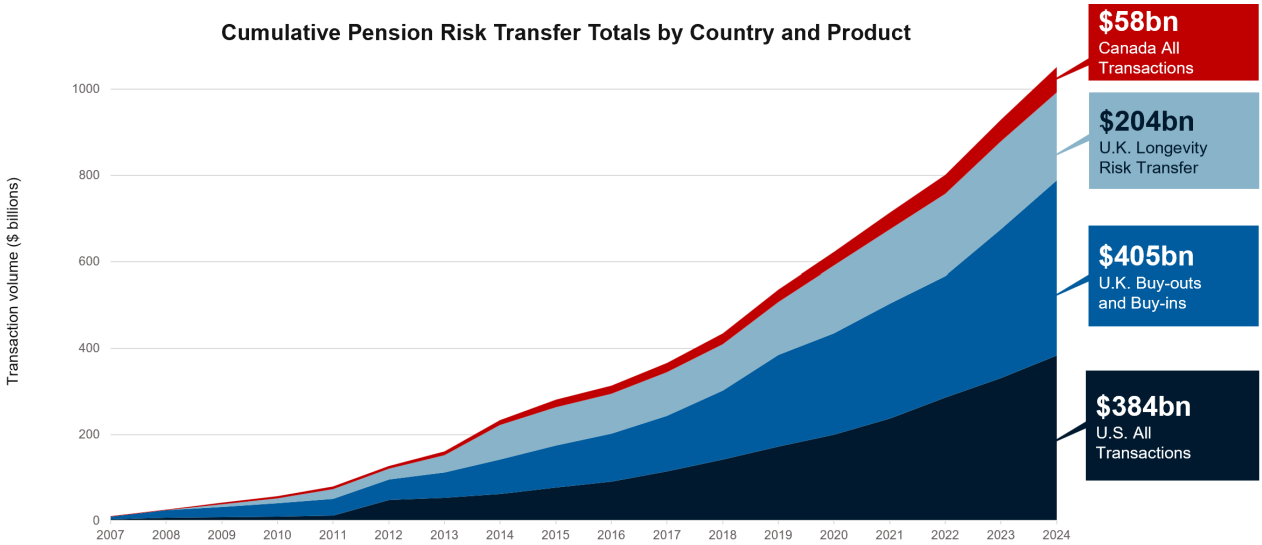
In July, Melbourne-based equity release mortgage originator, Household Capital, completed a Moody's-rated reverse mortgage securitization of its AUD263mn HHC 2024-1 RMBS (Residential Mortgage-Backed Securities) Trust. Investors included life insurers, banks, credit funds and Australian superannuation funds. The first-ever Australian transaction was Bluestone's Emerald Reverse Mortgage Series 2006-1Trust in 2006, but the market has stalled since the Global Financial Crisis.[591]

The Geneva College of Longevity Science (GCLS) was launched in 2024 as the first higher education institution dedicated solely to longevity science.[592] It introduced the GCLS Executive Master in Longevity Science which explores aging from biological, financial and societal angles. The EMSc Longevity is a distance learning master's programme with the following courses: Introduction to Longevity Science, Biomedical Foundations of Aging, Public Health and Epidemiology of Aging, Social and Psychological Dimensions of Aging, Nutrition and Longevity, Exercise Physiology and Aging, Medical Longevity Intervention, Longevity Supplements and Compounds, Technological Innovations In longevity, Ethics and Policy in Longevity Science and a Master Thesis.

[588] https://www.ipe.com/news/wtw-to-set-up-shop-in-germany-for-pension-buyout-deals/10127769.article
[589] https://www.rgare.com/our-company/media/press-releases/press-releases-detail/2024/03/22/rga-announces-700-billion-jpy-longevity-asset-intensive-reinsurance-transaction-with-japan-post-insurance-company
[590] https://www.pacificlifere.com/news/pacific-life-re-announces-new-asset-intensive-reinsurance-deal-with-tokio-marine-and-nichido-life.html
[591] https://liferisk.news/australian-equity-release-mortgage-securitisation-market-set-for-take-off/
[592] https://gcls.study/

Figure 3 shows the growth of the global market in longevity risk transfer between 2007 and 2024. A total of $1,051bn in transactions have been completed during this period in the UK, the US and Canada (which comprises the vast majority of the global market).

Figure 3: Cumulative pension risk transfers by product and country, $bn, 2007-2024



Data in USD billions. Cumulative totals. Sources: LIMRA, Hymans Robertson, WTW and SunLife Canada, 31 December 2024.

Securitizing mortality risk

A number of insurers and reinsurers have used the capital markets to securitize some of the mortality risk on their book of business, in the form of what have become known as mortality-linked (or mortality catastrophe) bonds. Swiss Re has been the most active participant in the market, issuing the first security in 2003, known as Vita I.[593] Vita I was a $400m principal-at-risk variable rate note, where the investors' principal was at risk in certain extreme mortality risk scenarios in exchange for quarterly coupon payments of USD three-month LIBOR[594] plus a spread of 135 basis points. The bond matured on 1 January 2007.

There has been some recent innovation in this market. An example of this is the La Vie Re Limited (Series 2020-1) mortality catastrophe bond issued by the Minnesota Life Insurance Company in October 2020. The bond covers the US and is the first indemnity 144A excess

[593] Swiss Re obtains USD 400 million of extreme mortality risk coverage its first life securitization, news release, 8 December 2003;
https://www.swissre.com/dam/jcr:edf6b706-4c0b-4fc1-85bf-46a338e36208/pr_20031208_en.pdf
[594] LIBOR, the London Interbank Offered Rate, was a benchmark interest rate at which major global banks lent to one another. It was replaced by the Secured Overnight Financing Rate (SOFR) on 30 June 2023;
https://www.investopedia.com/terms/l/libor.asp

mortality bond that models the cedants' portfolio on a loss-ratio basis. The modelling was conducted by Risk Management Solutions which developed an indemnity trigger on loss ratios.[595]

Guy Carpenter (GC), the global risk and reinsurance specialist, argues that risk transfer, reinsurance and insurance-linked securities sectors are well-placed to assist in dealing with climate change.[596] The company highlights catastrophe bonds as a key risk transfer and resilience financing tool for governments and public sector entities. Climate change increases the possibility of severe weather-related losses as well as demographic movements associated with rising sea levels, posing challenges to governments and entities exposed to these changes. GC calls for 'a rethink of how catastrophic events are funded and a greater use of public-private partnerships to manage risk'. According to the company, capital markets have the ability to absorb catastrophe and severe weather-related risks and diversify them away, allowing reinsurers and insurers to leverage its depth and liquidity and help make public sector entities more secure and better able to manage the financial exposure of climate-related risks.[597]

Setbacks

As mentioned before, not all paths to progress are smooth. In recent years, this has been particularly true currently in the largest market dealing with micro-longevity risk, namely life settlements.[598] The life settlements market has been dogged by systematic underestimates of policy holders' life expectancies by certain medical underwriters, issues concerning premium financing, frauds, and ethical issues associated with 'profiting' from individuals dying and policies maturing. In December 2009, Goldman Sachs announced it was closing down its QxX.LS index. This was partly because of the reputational issues associated with life settlements, but mainly because of insufficient commercial activity in the index. While the ethical issues are no different in substance from those relating to the macro-longevity market (see, e.g., Blake and Harrison, 2008), the micro-longevity market needs to learn some important lessons from the macro-longevity (i.e., PRT) market. The macro-longevity market has been very successful at promoting good basic research on the analysis of the stochastic mortality forecasting models it uses and putting these models into

[595] https://www.insurancebusinessmag.com/asia/news/breaking-news/rms-collaborates-on-new-mortality-catastrophe-bond-239994.aspx

[596] Climate change is discussed in more detail below.

[597] Steve Evans (2020) Risk transfer, reinsurance key to address reality of climate change: Guy Carpenter, *Artemis*, 11 March; https://www.artemis.bm/news/risk-transfer-reinsurance-key-to-address-reality-of-climate-change-guy-carpenter/

[598] The market for micro-longevity risk trades assets involving a small number of lives. In the case of life settlements, for example, the products involve individual lives and hence are subject to a significant degree of idiosyncratic mortality risk. This contrasts with the market for macro-longevity risk which deals with pension plans and annuity books and hence involves a large number of lives: here idiosyncratic mortality risk is much less important than systematic mortality risk which is essentially the trend risk of getting life expectancy projections wrong.

the public domain and has also been much more transparent with the data it uses. This suggests a way forward for the life settlements micro-longevity market.

Another setback, this time to the macro-longevity market, occurred in April 2012 when a number of investment banks – Credit Suisse, Nomura and UBS – pulled out of the longevity risk transfer market as a result of additional capital requirements under Basel III. Investment banks had already been disadvantaged in this market by the Dodd-Frank Act which prevented US banks and their affiliates from entering longevity swaps and synthetic trades in life settlements. At around the same time, however, a number of insurers and reinsurers entered the market, e.g., PICA, SCOR and Munich Re. The following year witnessed the start of a process of consolidation in the insurance industry. In August 2013, Lucida was purchased by L&G for £150m; at the time, it had 31,000 pensioners on its books and £1.4bn in pension assets. In February 2014, the buy-out business of MetLife, which entered the market in 2007 and acquired the pension assets of 20,000 pensioners worth £3bn, was sold to Rothesay Life for an undisclosed sum, bringing its total assets to £10bn.

In December 2013, Goldman Sachs sold the majority of its stake in Rothesay Life to Blackstone (28.5%), the Government of Singapore Investment Corporation (GIC) (28.5%), and MassMutual (7%), due to the new regulatory capital requirements faced by banks and insurers.[599] In October 2020, Blackstone sold its 36% stake in Rothesay Life to GIC and MassMutual for an undisclosed sum. This raised GIC and MassMutual's stakes to 49% each and values Rothesay Life at £5.8bn, with £56bn in assets under management.[600]

Academic contributions

At the same time as these practical developments in the capital markets were taking place, academics were continuing to make progress on theoretical developments, building on the original idea of using longevity bonds to hedge longevity risk in the capital markets (Blake and Burrows (2001)). These included:

- Design and pricing of longevity bonds and other longevity-linked products (e.g., Blake et al. (2006a,b, 2014), Bauer (2006), Bauer and Ruβ (2006), Antolin and Bloomestein (2007), Bauer and Kramer (2007), Denuit et al. (2007), Barbarin (2008), Bauer et al. (2010b), Chen and Cummins (2010), Kogure and Kurachi (2010), Bravo (2011), Dowd et al. (2011a), Mayhew and Smith (2011), Zhou et al. (2011, 2013, 2015), Chen et al. (2013), Shen and Siu (2013), Denuit et al. (2015),

[599] In August 2017, Goldman Sachs sold its remaining stake in Rothesay Life to a consortium comprising US buy-out firm Blackstone, Singapore's sovereign wealth fund GIC, and US life insurer MassMutual in a deal valuing Rothesay Life at around £2bn; http://www.cityam.com/269996/goldman-sachs-sells-final-stake-2bn-rothesay-life

[600] Blackstone offloads stake in Rothesay Life, *Pionline*, 1 October; https://www.pionline.com/money-management/blackstone-offloads-stake-rothesay-life

Dong and Wong (2015), Hunt and Blake (2015), Milevsky and Salisbury (2015), Yang et al. (2015), Wang and Li (2016), Chen et al. (2017), Lin et al. (2017b), Blake (2018), D'Amato et al. (2018a), Leung et al. (2018), MacMinn and Richter (2018), Li and Tang (2019), Bahl and Sabanis (2021), Dagpunar (2021), Mayhew et al. (2021), Jevtić et al. (2021), Tang and Li (2021), Bozikas et al. (2022), Arık et al. (2023), Li et al. (2023), Xu et al. (2024), Costabile et al. (2025), So et al. (2025))

- Design and pricing of longevity-linked derivatives (e.g., Shang et al. (2011), Lin et al. (2013), Wang and Yang (2013), Chuang and Brockett (2014), Bravo and Nunes (2021), Kung et al. (2021b), Landriault et al. (2024)) and specifically survivor/longevity swaps (e.g., Dowd et al. (2006), Wang et al. (2013, 2015), Zhou and Li (2013), De Jong and Ferris (2019), Li et al. (2019), Chen et al. (2022b)), survivor/longevity forwards and swaptions (e.g., Dawson et al. (2009, 2010), Zeddouk and Devolder (2020a)), *q*-forwards (e.g., Deng et. Al. (2012), Barrieu and Veraart (2016)), mortality options (e.g., Milevsky and Promislow (2001), Schmeck and Schmidli (2021), Zhou and Li (2021), Lin and Tsai (2023)), guaranteed annuity options (e.g., Gao et al. (2015)), longevity bond options (e.g., Xu et al. (2020), and derivatives related to extreme mortality events (e.g., Huang et al. (2023b))
- Pricing longevity and mortality risk (e.g., Olivieri and Pitacco (2008), Bayraktar et al. (2009), Chen et al. (2010), Li (2010), Li et al. (2023))
- The pricing of longevity-related guarantees (e.g., Yang et al. (2008))
- The pricing and hedging of life settlements (e.g., Deng et al. (2011), Brockett et al. (2013), Zhu and Bauer (2013), MacMinn and Zhu (2017), Kung et al. (2021a))
- Longevity and mortality indices (e.g., Denuit (2009), Li et al. (2011), Chan et al. (2014), Tan et al. (2014), Ortiz et al. (2023), Bacinello et al. (2024), Zhou et al. (2024))
- Securitization of longevity risk (e.g., Dahl (2004), Chen and Cox (2009), Cowley and Cummins (2005), Lin and Cox (2005), Cairns et al. (2006a), Cox and Lin (2007), Biffis and Blake (2010, 2013, 2014), Wills and Sherris (2010), Lane (2011), Mazonas et al. (2011), Blake et al. (2013), Yang and Wang (2013), Michaelson and Mulholland (2014), Li et al. (2017c), MacMinn and Brockett (2017), Bugler et al. (2021), Börger et al. (2023), Zeddouk and Devolder (2023))
- Management and hedging of longevity risk (e.g., Dahl and Møller (2006), Friedberg and Webb (2007), Cocco and Gomes (2008), Tsai et al. (2010), Wang et al. (2010), Cairns (2011, 2013), Coughlan et al. (2011), Koijen et al. (2011), Li and Hardy (2011), and Tzeng et al. (2011), Wang et al. (2010, 2011b), Ngai and Sherris (2011), Barrieu et al. (2012), International Monetary Fund (2012), Li and Luo (2012), Cox et al. (2013a,b), Qiao and Sherris (2013), Cairns et al. (2014), Lin and Tsai (2014, 2020a,b), Zelenko (2014), Zhu and Bauer (2014), Liu and Li (2016, 2017, 2018, 2021), Blackburn et al. (2017), Li et al. (2017a), Wong et al. (2017), Zhou and Li (2017), D'Amato et al. (2018b), Li (2018), Tsai and Liang (2018), Hanbali et al. (2019), Zhou and Li (2019, 2020), Balasooriya et al. (2020), Sherris et al. (2020), Levantesi et al. (2020), Börger et al. (2021a), Broeders et al. (2021), Cairns and El Boukfaoui (2021), Hsieh et al. (2021), Kessler (2021), Li et al. (2021), MacMinn and Zhu (2021), Choulli et al. (2021), Siu and Liu (2021), Clemente et al. (2022),

Feng et al. (2022), Tan et al. (2022), Chen et al. (2023a,b), Li et al. (2023), Yang and Zhou (2023), Kallestrup-Lamb and Laursen (2024))

- Mortality data and modeling, mortality term structure[601] modeling, and mortality forecasting (e.g., Heligman and Pollard (1980), Hobcraft et al. (1982), Arriaga (1984), Alho (1990,1991), Lee and Carter (1992), Wilmoth (1995, 2000), Thatcher et al. (1998), Wilmoth and Horiuchi (1999), Booth et al. (2002a,b, 2006), Brouhns et al. (2002a,b, 2005), Renshaw and Haberman (2003a,b,c, 2006, 2008), Vaupel and Canudas-Romo (2003), Currie et al. (2004), Biffis (2005), Bongaarts (2005), Czado et al. (2005), Cairns et al. (2006b, 2008, 2009, 2011a), De Jong and Tickle (2006), Koissi et al (2006), Pedroza (2006), Schrager (2006), Delwarde et al. (2007), Bauer et al. (2008), Blake et al. (2008), Booth and Tickle (2008), Gourieroux and Monfort (2008), Hari et al. (2008), Kuang, et al. (2008), Haberman and Renshaw (2009, 2011, 2012, 2013), Hatzopoulos and Haberman (2009, 2011), Li et al. (2009, 2013, 2015a,b, 2017b), Plat (2009a,b), Wang and Preston (2009), Bauer et al. (2010a), Biffis and Blake (2010), Biffis et al. (2010), Cox et al. (2010), Debonneuil (2010), Dowd et al. (2010a,b, 2020), Lin and Tzeng (2010), Murphy (2010), Yang et al. (2010), Coelho and Nunes (2011), Currie (2011, 2016, 2020, 2023), D'Amato et al. (2011, 2012a,b), Ediev (2011, 2021), Gaille and Sherris (2011), Li and Chan (2011), Milidonis et al. (2011), Russo et al. (2011), Russolillo et al. (2011), Sweeting (2011), Wang et al. (2011a), Yue and Huang (2011), Zhu and Bauer (2011), Aleksic and Börger (2012), Hainaut (2012, 2018, 2023), O'Hare and Li (2012, 2017), Shang (2012, 2019, 2024), Wilmoth et al. (2012), Bell and Jones (2013), Blackburn and Sherris (2013), Hyndman et al. (2013), Kleinow and Cairns (2013), Mitchell et al. (2013), Alai and Sherris (2014), Nielsen and Nielsen (2014), Hunt and Blake (2014, 2020a,b, 2021a,b,c,d), Villegas and Haberman (2014), Danesi at al. (2015), Hunt and Villegas (2015, 2023), Tomas and Planchet (2015), Leng and Peng (2016), Li et al. (2016), Schinzinger et al. (2016), van Berkum et al. (2016), Bergeron-Boucher et al. (2017, 2024), Beutner et al. (2017), Deprez et al. (2017), Gbari et al. (2017), Kleinow and Richards (2017), Li and Lu (2017), Li and O'Hare (2017), Mavros et al. (2017), Milidonis and Efthymiou (2017), Neves et al. (2017), Shang and Hyndman (2017), Tsai and Lin (2017a,b), Börger and Schupp (2018), Chen and Millossovich (2018), Debonneuil et al. (2018b), Ludkovski et al. (2018), McCarthy (2018), Salhi, and Thérond (2018), Shang and Haberman (2018, 2020, 2024), Venter and Şahın (2018), Villegas et al. (2018), Wong et al. (2018, 2023), Apicella et al. (2019, 2024), Guibert et al. (2019), Hilton et al. (2019), Liu et al. (2019), Pitacco (2019), Yang et al. (2019), Zhou (2019), Atance et al. (2020), Balland et al. (2020), Basellini et al. (2020, 2023), Huang et al. (2020), Li et al. (2020a,b), Milevsky (2020), Njenga and Sherris (2020), Pascariu et al. (2020), Richards et al. (2019, 2020), Santolino (2020, 2023), Zeddouk and Devolder (2020b), Barigou et al. (2021, 2023), Börger et al. (2021b), Boumezoued (2021), Boumezoued and Elfassihi (2021), Diao et al. (2021), Dodd

[601] The mortality term structure is the two-dimensional surface showing projected mortality rates at different ages for different future years.

et al. (2021), Guo and Bauer (2021), Gao and Shi (2021), Ghalehjooghi and Lyu (2021), He et al. (2021), Hilton et al. (2021), Li and Kogure (2021), Li and Lyu (2021), Li et al. (2021a), Lin et al. (2021), McCarthy and Wang (2021a), Medford (2021), Odhiambo et al. (2021), Pavía and Lledó (2021), Perla et al. (2021), Rabbi and Mazzuco (2021), Rizzi et al. (2021), Ševčíková and Raftery (2021), Shimizu et al. (2021), Su and Yue (2021), Tsai and Cheng (2021), Yue et al. (2021), Wang et al. (2021a,b), Yan et al. (2021), Zhou and Ji (2021), Albrecher et al. (2022), Awad et al. (2022), Beyaztas and Shang (2022), Bjerre (2022), Caraballo et al. (2022), Chandra and Abdullah (2022), Chen and Khaliq (2022), Djeundje et al. (2022), Huang et al. (2022), Jallbjørn and Jarner (2022), Kessy et al. (2022), Kularatne et al. (2022), Li and Chen (2022), Miyata and Matsuyama (2022), Odhiambo et al. (2022), Redzwan and Ramli (2022), Schnürch and Korn (2022), Scognamiglio (2022a,b), Scognamiglio and Marino (2022), Sliwka and Socha (2022), Spreeuw et al. (2022), SriDaran et al. (2022), Tang et al. (2022), Wang and Chan (2022), Zhou et al. (2022), Zhou and Li (2022), Zhu and Bauer (2022), Alonso-García (2023), Bégin et al. (2023b), Carannante et al. (2023, 2024a,b), Diao et al. (2023), Dyrting and Taylor (2023), Gowen et al. (2023), Haberman (2023), Jena et al. (2023), Jones et al. (2023), Levantesi et al. (2023), Li (2023), Liu and Li (2023), Liu and Shi (2023), Lu and Zhu (2023), Marino et al. (2023), McCarthy and Wang (2023), Odhiambo (2023), Orwat-Acedańska (2023), Rakhmawan et al. (2023), Shimizu (2023), Ungolo et al. (2023, 2024), Wang et al. (2023b), Xiao et al. (2023), Zhu and Zhou (2023), Boateng et al. (2024), Bufalo and Nigri (2024), del Olmo and Navarro (2024), Dimai and Brabec (2024), Garrido et al. (2024), Hsiao et al. (2024), Kogure and Takamatsu (2024), Lam and Wang (2024), Li et al. (2024a,b,c), Mok et al. (2024), Mitsuda and Shimizu (2024), Richards (2024), Risk and Ludkovski (2024), Rostami and Zadeh (2024), Shen et al. (2024), Qiao et al. (2024), Wang (2024), Wu et al. (2024), Zuo et al. (2024), Boonen and Chens (2025), Dastranj and Kolář (2025), De Mori et al. (2025), Dimai (2025), Fu et al. (2025), Guo and Li (2025), Koichubekov et al. (2025))

- Multi-population mortality modeling (e.g., Darkiewicz and Hoedemakers (2004), Li and Lee (2005), Cairns et al. (2011b), Dowd et al. (2011b), Jarner and Kryger (2011), Njenga and Sherris (2011), Torri and Vaupel (2012), Li (2013), D'Amato et al. (2014), Raftery et al. (2014), Zhou et al. (2014), Antonio et al. (2015), Chen et al.(2015), Kleinow (2015), Shang (2016), Yang et al. (2016), Antonio et al. (2017), Biffis et al. (2017), Li et al. (2015c, 2016, 2017d), De Jong et al. (2016, 2020), Enchev et al. (2017), van Berkum et al. (2017), Villegas et al. (2017), Zhu et al. (2017), Diaz et al. (2018), Hunt and Blake (2018), Kang et al. (2018), Pascariu et al. (2018), Pitt et al. (2018), Wang et al. (2018), Jevtić and Regis (2019), Henshaw et al. (2020), Jarner and Jallbjørn (2020, 2022), Shi et al. (2020), Wong et al. (2020), Chang et al. (2021), Li and Shi (2021a,b), Li et al. (2021b), Liu (2021), Lu et al. (2021), Özen and Şahin (2021), Richman and Wüthrich (2021), Schnürch et al. (2021), Shapovalov et al. (2021), Wen et al. (2021), Yang et al. (2021), Zhou and Ji (2021), Djeundje et al. (2022), Fokeer and Narsoo (2022), Gungah and Narsoo (2022), Jiao et al. (2022), Kung et al. (2022), Lin and Tsai

(2022), Robben et al. (2022), Shang et al. (2022), Venter and Şahin (2022), Chang and Shi (2023), Debón et al. (2023), Jevtić et al. (2023), Perla and Scognamiglio (2023), Roshani et al. (2023), Shi et al. (2023), Wang et al. (2023c), Corsaro et al. (2024), De Mori et al. (2024), Euthum et al. (2024), Lizzi (2024), Robben and Antonio (2024), Cheng et al. (2025))

- Mortality modeling by cause-of-death, educational attainment, social class, special patterns, Covid-19, climate change etc (e.g., Beard (1971), McNown and Rogers (1992), Christensen and Vaupel (1996), Gutterman and Vanderhoof (1998), Di Cesare and Murphy (2009), Richards (2009), Hanewald (2011), Murphy and Di Cesare (2012), Arnold and Sherris (2013, 2015, 2016), Janssen et al. (2013), Alai et al. (2014a), Gourieroux and Lu (2015), Alai et al. (2018), Boumezoued et al. (2018), Yue et al. (2018), Li et al. (2019), Dutton et al. (2019), Cairns et al. (2020), Cupido et al. (2020, 2024), Kallestrup-Lamb et al. (2020), Kjærgaard et al. (2020), Lourés and Cairns (2020, 2021), Arnold and Glushko (2021), Lyu et al. (2021, 2023), Nusselder et al. (2022), Schnürch et al. (2022), Cadena and Denuit (2023), Huang et al. (2023a), Jallbjørn et al. (2023), Katsiferis et al. (2023), Navarro and Requena (2023), Pichler and Uhlig (2023), Villegas et al. (2023), Wen et al. (2023), Zhang et al. (2023), Cairns et al. (2024a,b), Delbrouck and Alonso-García (2024), Dimai (2024), Şahin and Özen (2024), Dong et al. (2025), Goes et al. (2025), Sifre-Armengol et al. (2025), van Berkum et al. (2025), Varga (2025))
- Population, births and deaths data – and modeling (e.g., Richards (2008), Cairns et al. (2016), Boumezoued et al. (2019, 2020), Boumezoued (2021), Boumezoued and Elfassihi (2021), Cheng et al. (2022), Hwang and Kim (2023), Tang et al. (2023), Rubilar-Torrealba et al. (2024), Pavía and Lledó (2025))
- Longevity inequality and health (e.g., Mayhew and Smith (2014, 2021), Debón et al. (2017), Mayhew et al. (2020, 2024), Álvarez et al. (2021), Li and Hyndman (2021), Sanzenbacher et al. (2021), Katsiferis et al. (2023), Mayhew (2023), Strozza et al. (2024), Yue et al. (2024a))
- Longevity risk and financial innovation (improvements in the analysis and design of longevity-linked products) (e.g., Gong and Webb (2010), Stevens at al. (2010), Richter and Weber (2011), Cocco and Gomes (2012), Brown and Warshawsky (2013), Bernhardt and Donnelly (2019), Chen and Rach (2019), Chen et al. (2019), Weinert and Gründl (2021))
- Reverse or equity release mortgages (e.g., Wang et al. (2008), Huang et al. (2011), Yang (2011), Alai et al. (2014b), Kogure et al. (2014), Shao et al. (2015), Lee et al. (2018), Dowd et al. (2019), Di Lorenzo et al. (2022), Buckner et al. (2024))
- Longevity risk in investment portfolios and asset-liability management (e.g., Milevsky and Young (2007), Menoncin (2008), Horneff et al. (2008, 2009, 2010, 2015), Maurer et al. (2013), Aro and Pennanen (2017), Gemmo et al. (2020), Maffra et al. (2021), Rogalla (2021), Lin et al. (2023), Jang, Owadally, and Clare (2024))
- Longevity risk in life insurance, pension plans, pension systems, annuities and long-term care, etc (e.g., Milevsky (2005), Huang et al. (2009, 2012, 2017), Richards et al. (2013, 2014), Aro (2014), Bisetti and Favero (2014), Donnelly (2014), Lin et al. (2014, 2015, 2017a), Ai et al. (2015), Wan and Bertschi (2015), Ai et al. (2017),

Hunt and Blake (2017), Bravo and El Mekkaoui de Freitas (2018), Bruszas et al. (2018), Cox et al. (2018), Debonneuil et al. (2018a), Hsieh et al. (2018), Ignatieva et al. (2018), Kurtbegu (2018), Mayhew et al. (2018), Balter et al. (2020, 2021, 2023), Chen et al. (2020), Olivieri and Pitacco (2020, 2022), Wen et al. (2020), Ayuso et al. (2021), Balter et al. (2021), Cox et al. (2021), De Rosa et al. (2021), Dowd et al. (2021), Kogure et al. (2021), Lee et al. (2021), Leung et al. (2021), McCarthy and Wang (2021b), Richards (2021), van Berkum et al. (2021), Bakar and Büyükyazıc (2022), Berstein and Morales (2021), Bravo and Ayuso (2021), Bravo et al. (2021, 2023), Bravo (2022), Cairns et al. (2022), Carannante et al. (2022), Chen et al. (2022a), Coppola et al. (2022), Feng et al. (2022), Li et al. (2022), Li and Kara (2022), Olivieri et al. (2022), Sharma et al. (2022), Zhou et al. (2022), Rong et al. (2023), Agarwal et al. (2023), Bégin et al. (2023a), Bravo et al. (2023), Chen et al. (2023), Mrad et al. (2023), Lin et al. (2023), Lledó et al. (2023), Wang et al. (2023c), Chen et al. (2024), Navarro and Atance (2024), Nguyen et al. (2024), Zhang et al. (2023), Atance et al. (2024), Bégin et al. (2024), Chen et al. (2024), Deelstra et al. (2024), Fuentes et al. (2024), Gasimova et al. (2024), Olivieri and Tabakova (2024), Yue et al. (2024b), Zhou et al. (2024), Aragona et al. (2025), Chen et al. (2025), Di Palo (2025), Ramsay et al. (2025)).

Looking into the future

There are a large number of factors that will influence the future of the PRT market. We now examine the key ones.

Peak cash flows

Pension funds not only need to have assets sufficient to meet liabilities (i.e., be fully funded), they need the cash flows on those assets to match pension payments as they fall due. Absent this, assets would have to be sold (possibly at unfavourable prices) in order to make the payments. It is especially significant for closed schemes which can no longer rely on contributions from active members to help to make pension payments. Further, once a scheme is closed, it matures rapidly and the duration of the liabilities falls. It is important therefore for such a scheme to work out the timing of peak cash flows and then insure that sufficient cash flow generating assets are in place during this period. In the UK, the Pensions Regulator requires schemes to set a long-term funding objective.

For a lot of UK schemes, research by TPR indicates that pension payments may already be close to their peak. Many of these schemes will have been preparing for this by switching out of growth assets, such as equities, into cash-flow generating assets, such as government (gilts) and high-quality high-yielding corporate bonds, as part of liability-driven investment strategy which might also have involved hedging the purchase of these bonds against falling interest rates. As the peak approaches, then more precise cashflow matching is required.

It has been estimated that around £1trn out of a total of £2.2trn UK pension liabilities are exposed to (i.e., were not hedged against) changes in interest rates and inflation. In addition, there will be between £250-£300bn of additional exposure as schemes deleverage their LDI portfolios in preparation for making cash payments.

Given the narrow range of suitable cash-flow generating assets, this is likely to drive up their prices. The total size of the sterling investment grade corporate bond market is only around £375bn. Although issuance has increased significantly with the fall the interest rates due to quantitative easing – £60bn of new sterling corporate bonds were issued in 2019, for example – quality and yields have also fallen. UK pension funds have been forced to increase their exposure to both BBB credit, the lowest class of investment grade bonds, and to sterling bonds issued by non-UK-based corporates (which account for around 50% of sterling issuance). UK pension funds have also looked to source suitable bonds in the Eurozone and US corporate bond markets and then hedge the currency risk.[602]

In August 2020, LGIM launched a range of secure income asset funds aimed at small DB pension schemes following a cashflow-driven investment strategy. The funds have an open-ended pooled structure with a three-year lock-in period and target a return of gilts +2.5% per annum over a rolling three-year period. LGIM has also launched separate unit-linked life funds for senior real estate debt, investment grade infrastructure debt, investment grade private corporate debt, and sub-investment grade infrastructure debt and sub-investment grade private corporate debt, which are suitable for investment horizons of at least seven years.[603]

The volatility of life expectancy trends

In 2016, the UK Office for National Statistics (ONS) reported that longevity improvements rates at very high ages have slowed down since 2011. A number of reasons were put forward to explain this: short-term reasons, such as lower increases in health service[604] and long-term care spending as part of the government's 'austerity' spending cuts following the Global Financial Crisis; and longer term reasons, such as increasing deaths from neurodegenerative disorders, such as dementia and Alzheimer's disease,[605] and the fact that

[602] Nikesh Patel and Arif Saad (2020) Viewpoint: The tipping point for UK pension schemes, *IPE*, 20 November; https://www.ipe.com/viewpoint-the-tipping-point-for-uk-pension-schemes/
[603] LGIM launches secure income range for DB plans, *IPE*, 3 August 2020.
[604] A University of York study published in 2021 estimated that for every 1% real increase in healthcare spending there was a 0.5% improvement in population mortality (cited in Murray et al. (2022); https://bmjopen.bmj.com/content/bmjopen/11/10/e046417.full.pdf).
[605] Dementia is a syndrome, not a disease. A syndrome is a group of symptoms that does not have a definitive diagnosis. Dementia is a group of symptoms that affects mental cognitive tasks such as memory and reasoning. Dementia is an umbrella term that Alzheimer's disease can fall under. It can occur due to a variety of conditions, the most common of which, accounting for up to 70% of cases, is Alzheimer's disease. Other diseases which cause dementia are Parkinson's and Huntington's. See: Dementia and

most of the improvement in life expectancy in the 1990s and 2000s was due to lower mortality from circulatory causes, such as heart disease, arising from the widespread use of statins and there was no longer scope for further improvement.[606] In 2018, the UK ONS reported that healthy life expectancy – the average number of years lived in 'very good' or 'good' general health – fell for women and rose for men, comparing 2015-17 and 2009-11 data. For men, healthy life expectancy at birth increased by five months to 63.1 years, while it fell by three months to 63.6 years for women. At birth, UK men and women can expect to live with a disability for 16.5 and 20.9 years, respectively.[607]

This prompted a debate in the UK about the volatility of life expectancy trends. Mortality improvements for England & Wales males aged 50-89 averaged 0.7% p.a. over the period 2011-16, compared with 3.1% p.a. between 2001-10, 1.8% between 1975-2000, and 0.7% between 1961-75.[608] At the time, the UK actuarial profession took the view that the sharp reduction in the trend improvement was permanent. The Mortality Projections Model of the Institute and Faculty of Actuaries' Continuous Mortality Investigation – which covers England & Wales – published in March 2019 predicted that the average cohort life expectancy of a 65-year old man in 2018 was 19.8 years, down by five months (or 2.4%) compared with 2017; the corresponding figure for a 65-year old woman was 22.4 years, also down by 5 months (or 2.1%).[609] The CMI's best estimate life expectancy growth for the next 40 years from 2022 is between 2.9 and 4.5 years, which is lower than the 6.8 years experienced over the previous 40 years.[610]

Figure 4 shows life expectancy from birth in the UK since 1980. The ONS found that between 2018 and 2020 there was 'virtually no improvement in life expectancy' for women which equalled 82.9 years in 2020. For men, life expectancy in 2020 was 79 years and had actually fallen back to 2012-14 levels. This is the first decline since the 1980s – and it could fall further following the pandemic.[611]

Alzheimer's: What Are the Differences?; https://www.healthline.com/health/alzheimers-disease/difference-dementia-alzheimers

[606] Anthony Hilton (2016) Life line, *Pensions World*, May; *Accounting for Pensions: Reflecting the cost of pension freedoms and life expectancy*, Xafinity Punter Southall, April 2018; page 12 of Willis Towers Watson *De-risking Report 2020*, January. See also www.bbc.com/news/health-4060825.

[607] Stephanie Baxter (2018) 'Healthy' life expectancy falls for women, but improves for men, *Professional Adviser*, 13 December.

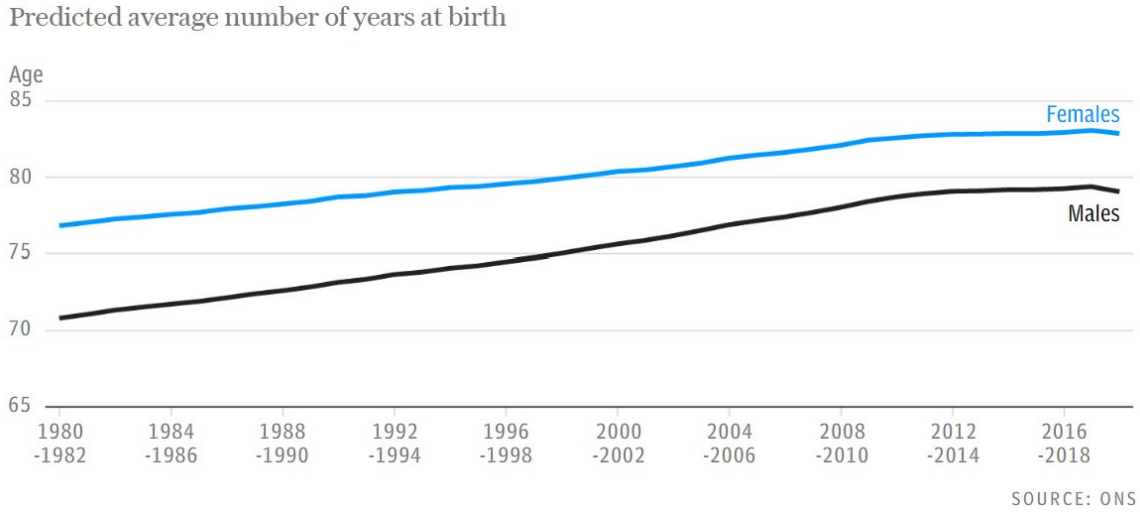
[608] Page 6 of 'Mortality improvements in the next decade, Discussion hosted by SIAS and the CMI Mortality Projections Committee', 11 April 2017, Staple Inn Hall, London; https://www.actuaries.org.uk/system/files/field/document/CMI%20SIAS%20meeting%202017-04-11%20-%20Mortality%20imps%20in%20the%20next%20decade%20v04.pdf

[609] Rachel Fixen (2019) UK schemes set for 2.5% fall in liabilities after CMI model revamp, *IPE*, 8 March.

[610] Murray et al. (2022).

[611] Szu Ping Chan (2023) Why the state pension age may never again reach 70, *Daily Telegraph*, 3 December; https://www.telegraph.co.uk/business/2022/12/03/why-state-pension-age-may-never-reach-70

Figure 4: Life expectancy at birth in the UK



Source: https://www.telegraph.co.uk/business/2022/12/03/why-state-pension-age-may-never-reach-70/

Particularly, striking is what has been happening in the US where the life expectancy of the average American fell from 78.85 years in 2019 to 76.98 years in 2020 and 76.44 years in 2021, a net reduction of 2.41 years, according to a study by Masters et al. (2022). The study said that most of the decline was due to the pandemic, with the rest explained by a rise in accidental deaths and deaths from drug overdoses, heart disease, chronic liver disease and cirrhosis. In contrast, 21 peer countries[612] averaged a smaller decrease in life expectancy between 2019 and 2020 (0.55 years) and a 0.26-year *increase* between 2020 and 2021. This increased the gap in life expectancy between the US and the peer countries to around five years.[613]

Time will tell if there has been a permanent change in trend in these countries or if the trend will again reverse in response to advances in applied biotechnology and in regenerative medicine, as discussed below. Nevertheless, Olshansky et al. (2024) argue that humans are approaching a biologically based limit to life. The biggest boosts to longevity have already occurred through successful efforts to combat disease, leaving the damaging effects of aging as the main obstacle to further extension. Lead author S. Jay Olshansky of the UIC School of Public Health said: 'Most people alive today at older ages are living on time that was manufactured by medicine. But these medical Band-Aids are producing fewer years of life even though they're occurring at an accelerated pace, implying that the period of rapid increases in life expectancy is now documented to be over. That also means extending life expectancy even more by reducing disease could be harmful, if those additional years aren't healthy years. We should now shift our focus to

[612] Australia, Austria, Belgium, Canada, Denmark, England and Wales, Finland, France, Germany, Israel, Italy, Netherlands, New Zealand, Northern Ireland, Norway, Portugal, Scotland, South Korea, Spain, Sweden, and Switzerland.
[613] https://www.nytimes.com/2022/08/31/health/life-expectancy-covid-pandemic.html

efforts that slow aging and extend healthspan. While more people may reach 100 years and beyond in this century, those cases will remain outliers that won't move average life expectancy significantly higher. But [this] doesn't rule out that medicine and science can produce further benefits. There may be more immediate potential in improving quality of life at older ages instead of extending life. More investment should be made in geroscience — the biology of aging, which may hold the seeds of the next wave of health and life extension. This is a glass ceiling, not a brick wall. There's plenty of room for improvement: for reducing risk factors, working to eliminate disparities and encouraging people to adopt healthier lifestyles – all of which can enable people to live longer and healthier. We can push through this glass health and longevity ceiling with geroscience and efforts to slow the effects of aging'.[614]

In December 2018, the CMI published a new version of its SAPS (Self-Administered Pension Scheme) data set. This covers UK members of DB pension schemes and the data has been collected since 2000. The S3 series mortality tables for the period 2009-16 showed that life expectancy in this select group was still increasing when compared with the S2 series mortality tables for the period 2004-11.[615] One year's increase in life expectancy can raise a pension scheme's liabilities by 4%,[616] while if longevity risk is measured on a whole-of-life basis, the potential increase in pensions over 30-40 years could represent an increase in liabilities of 15-20%.[617] In March 2020, the CMI reported that mortality rates in England and Wales were on average 3.8% lower in 2019 than in 2018, the highest year-on-year reduction since 2011. This shows that mortality rates are volatile and confirms the point that longevity trends can go both ways.[618]

The long-term impact of Covid also needs to be taken into account. The ONS estimated that there were 7.2% or 44,255 more deaths in the UK in 2022, compared with the previous five-year average (excluding 2020). There were 8.6% or 28,024 more deaths in the first six months of 2023 than expected. The causes of these excess deaths include the direct effects of Covid-19 infection, as well indirect consequences, such as late diagnosis and treatment of diseases, and the growing NHS backlog of operations.[619] Analysis by consultancy Lane Clark & Peacock (LCP) predicted that, as a consequence, life expectancies could reduce by around nine months, which would equate to a £100m lower funding requirement for a

[614] https://www.pensionpolicyinternational.com/despite-medical-advances-life-expectancy-gains-are-slowing/
[615] XPS Pensions (2019), New 'SAPS3' mortality tables – a confusing message?, *Briefing Note No.3*, January.
[616] Mark Dunne (2020) Breaking free: Bulk annuities, *Portfolio Institutional*, 24 January; https://www.portfolio-institutional.co.uk/features/breaking-free/
[617] Willis Towers Watson *De-risking Report 2020*, January (p.9).
[618] Susanna Rust (2020) Highest reduction in mortality rates in England and Wales since 2011, IPE, 2 March.
[619] Pearson-Stuttard et al. (2024).

£3bn pension scheme.[620] Consultancy Hymans Robertson conjecture that if Covid becomes another endemic disease, with similar severity to the flu, this would mean an additional 20,000 – 30,000 death each year.[621]

In February 2024, the CMI announced that it would give no weight to mortality data for pandemic years 2020 and 2021 in its future life expectancy and mortality projections. It said that 'While mortality experience in 2020 and 2021 will affect actuarial calculations, mortality in both of those years was exceptional and is unlikely to be indicative of future mortality. …We are conscious that the outlook for mortality remains uncertain and there is a range of reasonable projection methods and projected mortality rates'. It also said that more recent mortality has been less volatile and is more likely to be indicative of future mortality. Standardised mortality rates based on registered deaths in England and Wales in 2023 were similar to the 2015-2019 average and lower than in 2020, 2021 and 2022.[622]

All this makes it increasingly challenging for those operating in the PRT market to derive the best estimate of both the trend improvement in life expectancy and the volatility around the trend.

Population aging

There is an emerging global debate covering a wider set of demographic issues than just longevity risk. The debate has centred on population aging and its implications. One aspect of population aging is declining fertility which soon translates into an increase in the average age of the population. One key reason for declining fertility is the choice made by women in developed countries to have fewer children than previous generations.

This has been exacerbated by the Covid-19 pandemic, according to the United Nations. Birth rates have fallen due to 'a postponement of childbearing in the face of the uncertainty regarding the disease and its economic impacts, disruptions in marriage patterns and family formation, and disruptions in the availability and access to sexual and reproductive health-care services, including family planning'.[623] Edward Stanley, an analyst at Morgan Stanley, commented that 'Prior financial crises suggest the suppressant on birth rates can last for three to four years. Moreover, using the 1917-20 Spanish Flu example as a loose proxy, the recovery in the birth rate in 2021 is unlikely to be linear. In 1917-20, with each new wave of virus came a renewed downturn in subsequent births'. The pandemic caused the fertility rate in the UK to plunge to a new low of 1.6 per woman in 2020. Stanley predicts

[620] Jonathan Stapleton (2022) Mortality trend shift could cut funding requirements, *Professional Pensions*, 21 November; https://www.professionalpensions.com/news/4060538/mortality-trend-shift-cut-funding-requirements

[621] Murray et al. (2022).

[622] https://www.ipe.com/news/cmi-ignores-mortality-data-for-pandemic-years/10071586.article

[623] https://www.telegraph.co.uk/business/2022/07/13/europe-faces-ageing-population-nightmare-absolute-collapse

that 70% of the world's population will be below the replacement rate within five years, adding significantly to population aging.[624]

Another explanation for declining fertility is male sperm counts falling so fast across the world that the human race could be infertile within 50 years. There has been a 60% decline in the sperm count of Western men between 1973 and 2011, with 15% of young Western men with a sperm count low enough to impair fertility. A variety of explanations have been put forward to explain this: lifestyle factors, such as alcohol, smoking, stress, obesity, antidepressants, and high doses of ibuprofen; pesticides and industrial pollutants getting into the food chain; sunscreen, containing endocrine-disrupting UV filters; non-stick frying pans, containing poly- and perfluoroalkyl substances; tight underpants; oestrogen in the water supply from the female contraceptive pill; and electromagnetic radiation from wi-fi routers.[625]

Figure 5 shows UN projections of fertility rates out to 2050. Prior to 1970, the average woman had five children. She now has 2.3 which is just above the 'replacement rate' of 2.1, the level which stabilizes the population. Globally, fertility rates are expected to fall to the replacement rate by 2050. Fertility rates in Europe, North America, Australia and New Zealand have been below replacement since the mid-1970s. The OECD reported in 2024 that the birth rate in the 38 most industrialised countries had fallen to 1.5 in 2022 and that these countries should prepare for a 'lower fertility future': 'This decline will change the face of societies, communities and families and potentially have large effects on economic growth and prosperity'. The OECD explained the decline in family formation in terms of a 'second demographic transition', a trend shift in attitudes towards greater individual freedom and alternative life goals and living arrangements.[626]

Figure 6 shows that global population growth has been on a downward trend since the mid-1960s from 2% to around 1% currently and is projected to be 0.5% by 2050. This is due mainly to the decline in fertility. The increase in deaths in 2020-21 caused by Covid-19 is also visible in the figure.

Figure 7 shows that, while life expectancy is expected to increase, the rate of increase is expected to slow down a little. By 2050, the global population aged 60 and over is projected to exceed the population under 15. The global population – which reached 7bn in 2011 and 8bn on 15 November 2022 – is now expected to peak at 10.3bn in the mid-2080s rather than in the 22nd Century as previously predicted.[627] In October 2024, the UK Office for National Statistics reported that fewer people were living to 100. Paul Farmer, Age UK chief executive, said: 'We know that over the last couple of years or so overall life

[624] https://www.telegraph.co.uk/business/2021/07/16/birth-rate-will-take-years-recover-covid-baby-bust/
[625] India Sturgis (2018) Prepare for Spermageddon, *Daily Telegraph Magazine*, 27 January.
[626] https://www.oecd.org/social/declining-fertility-rates-put-prosperity-of-future-generations-at-risk.htm; https://www.oecd.org/publication/society-at-a-glance/2024/
[627] https://www.pensionpolicyinternational.com/world-population-projected-to-peak-at-10-3-billion-in-2080s-new-united-nations-report-says/

expectancy is starting to flatten out. That's partly driven by Covid but also a whole range of other health and health inequality issues. In a sense, it's not surprising that the numbers of centenarians are not increasing'.[628]

Figure 5: Fertility rates are slowing down globally

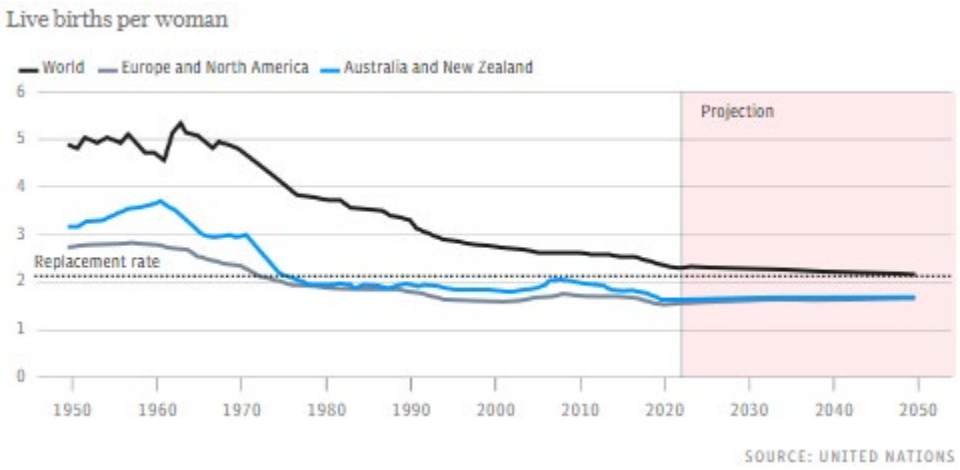
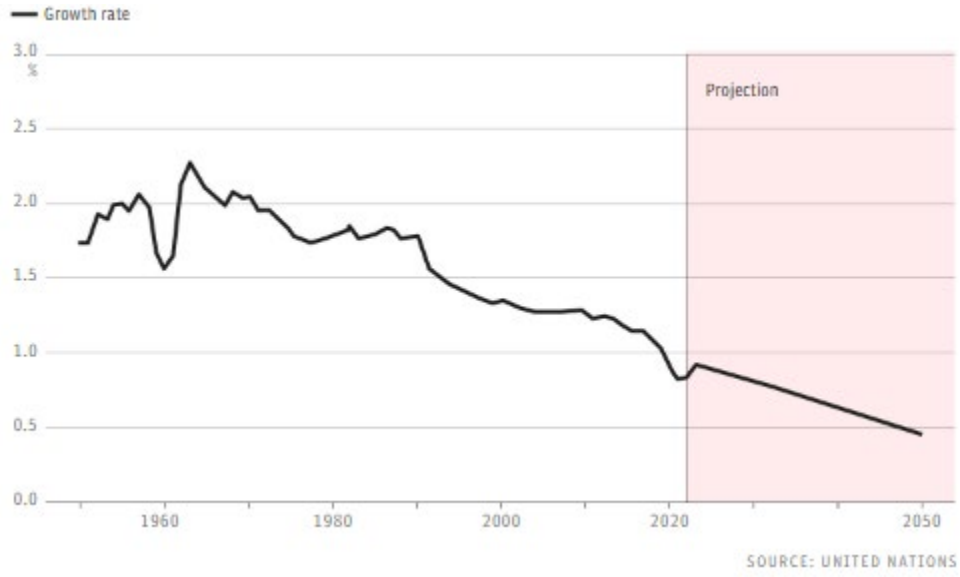
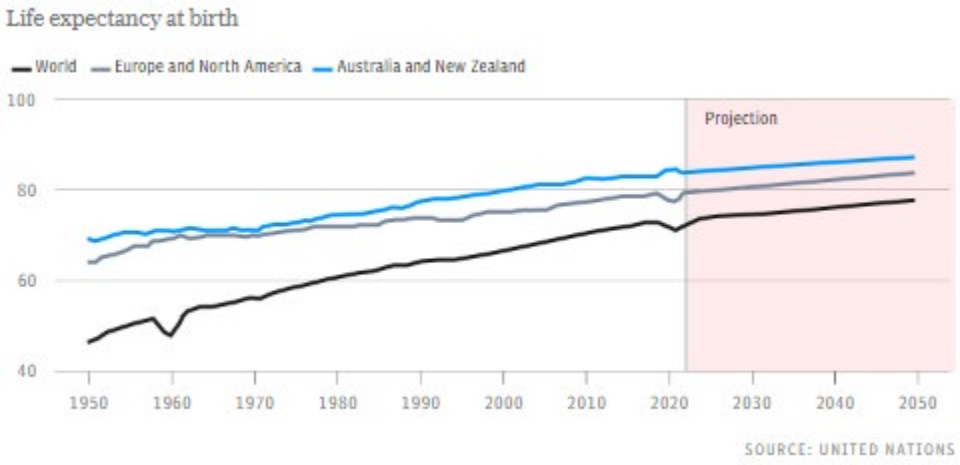


Figure 6: Global population growth is slowing



[628] https://www.telegraph.co.uk/business/2024/10/01/number-people-living-to-100-declines-first-time-since-covid/

Figure 7: The increase in life expectancy is expected to slow



In July 2022, the International Longevity Centre (UK) released five reports on aging in Australia, China, Japan, Indonesia and South Korea. The main findings were:

- Japan's population is aging rapidly. In 2017, 40% of Japan's workers were over 50 – predicted to rise to 47% by 2035. In 2022, Japan recorded the lowest number of births (799,728, a fertility rate of 1.3) and the highest number of deaths (1.58m) since the Second World War.[629] By 2024, 36.25m Japanese were aged over 65, that is 29.3% of the population, the highest proportion of any country – and this could reach 34.8% by 2040. At the same time, the total labor force is projected to fall from 69.3m in 2023 to 49.1 million in 2050. Already in 2024, 51% of companies feel there is a shortage of full-time employees.[630]
- Over 50s made up 29% of Australia's workforce in 2017 – rising to 35% by 2035. Over 2 in 5 of Australian dollars were spent by older households in 2015, around 18% of GDP.
- By 2035, 42% of China's population will be over 50. In China, people over 65 spent 5 more hours a year volunteering than people at other ages.
- In 2018, 37% of South Korea's population was over 50 and by 2035, 51% of people will be over 50. By 2035, more than 6 in 10 South Korean employees could be aged 50 and over.
- In Indonesia in 2018, 72% of people aged 50-64 were in employment and a quarter of Indonesia's population was over 50 – this is set to increase to 28% by 2035.

In May 2021, China announced it was ending its policy of limiting couples to two children and would now allow them to have three.[631] The government said the problem of an aging

[629] https://www.pensionpolicyinternational.com/japan-births-fall-to-record-low-as-population-crisis-deepens/
[630] https://www.pensionpolicyinternational.com/japan-faces-labor-shortages-and-demographic-crisis-as-elderly-population-hits-record-high/
[631] China introduced a one-child policy in 1979 and a two-child policy in 2016.

population was deepening and the change would help to improve the structure of China's population and maintain its advantage in human resources.[632] The Chinese population aged over 65 exceeded 14% of the total population in 2021.[633] China's population fell by 850,000 in 2022 and by 2.08 million in 2023 to 1.409bn. The fertility rate is close to 1.0. President Xi Jinping wants to 'actively cultivate a new culture of marriage and childbearing'. In 2022, 17 government departments released guidelines on supporting policies in finance, tax, housing, employment, and education 'to create a fertility-friendly society and encourage families to have more children'.[634] Jilin province in northeast China is offering up to 200,000 yuan ($31,400) in 'marriage and birth consumer loans' to married couples to promote population growth; it has one of the fastest-shrinking populations in China.[635] In 2024, China introduced a new birth subsidy scheme: women receive a 6,500-yuan (US$897) reward for having two children and an additional allowance of 800-yuan a month until a new baby reaches three years.[636]

However, University of Michigan demographer Zhou Yun points out that fertility decline is often very difficult to reverse and no country with a fertility rate that has fallen below the 2.1 replacement rate has ever managed to raise it above the replacement rate again.[637]

The ILC(UK) reports, while highlighting the global nature of population aging, also emphasize the crucial role of older workers and consumers for post-pandemic recovery in these and other countries – which it calls the 'global longevity dividend'.[638]

The world is also trying to cope with supply shortages, insufficient workers and the financial burden of the rising proportion of pensioners – which will all worsen as the global population switches from boom to bust.

The UN predicts that in Italy, the population will fall from 59m to 55.3m by 2040, while Germany's population will fall over the same period from 83.4m to 81.2m. Holger Schmieding, an economist at Berenberg Bank, says Germany can do more to get people to join the workforce. Also 'There is room to increase the retirement age - it is going up to 67

[632] https://www.pensionpolicyinternational.com/china-introduces-three-child-policy-to-alleviate-problem-of-ageing-population/
[633] https://www.pensionpolicyinternational.com/china-may-see-negative-population-growth-in-2022-12-years-earlier-than-un-prediction-experts/
[634] https://www.pensionpolicyinternational.com/chinas-population-drops-by-2-million-in-2023-due-to-record-low-birth-rate/
[635] https://www.pensionpolicyinternational.com/chinese-province-offers-31000-baby-loans-to-counter-shrinking-population/
[636] https://www.pensionpolicyinternational.com/why-china-is-betting-on-birth-subsidies-to-solve-its-population-crisis/
[637] https://www.pensionpolicyinternational.com/chinas-population-drops-by-2-million-in-2023-due-to-record-low-birth-rate/
[638] https://ilcuk.org.uk/global-longevity-dividend/

already, it probably has to go up further'. Germany is also attractive to migrants which helps companies to keep growing despite the low domestic birth rate.[639]

The US Census Bureau projects that the US population will begin to decline by 2080, resulting in substantial risks for economic and social stability. Fewer young people are having children, so the population ages and there are more retired relative to working-age people. The proportion of Americans over the age of 65 was 9% in 1960, 17% in 2021, and is predicted to be 29% in 2100. As a result, companies will struggle to find workers – the Congressional Budget Office predicts that the size of the US labor force will grow by only 0.2% a year between 2024 and 2031– and Social Security, Medicare and Medicaid programs will become unsustainable. While immigration can help to ease the problem, the natural population decline (population growth without immigration) may be too great. One of the explanations for having fewer children is cost, estimated at around $240,000 over the first 18 years by LendingTree. Another is the preference for younger people (millennials and Gen-Z) to spend their money on leisure for themselves, such as travel, instead of saving for a future family. A 2021 study from the Pew Research Center found that 44% of young non-parents said they are unlikely to have children. A 2022 Harris Poll survey for Fortune found that 65% of non-parents agreed that the freedom that comes with not having children brings them happiness. While sectors of the economy favoured by younger consumers – travel, transport, retail, clothes and entertainment – could benefit, other sectors which are typically associated with higher productivity – such as IT, medicine and legal – or with supply chain security – such certain types of manufacturing – could face challenges attracting young talented staff. Companies in these sectors will have to respond by offering more attractive benefits, such as remote flexibility, professional development opportunities, and student loan assistance. These companies will also need to make greater use of automation. Japan has led the way here by using industrial robots in its manufacturing and later life service sectors. Artificial intelligence applications, such as ChatGPT, will also help boost productivity.[640] Immigration could also alleviate labor shortages in certain sectors – such as agriculture, construction, leisure, hospitality and manufacturing – but since it has been the largest contributor to US population growth for decades, it would need to be significantly scaled-up to impact current population projections. However, countries that have traditionally supplied large numbers of immigrants to the US, namely China and India, are experiencing their own slowdowns in population growth.[641, 642]

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[639] https://www.telegraph.co.uk/business/2022/07/13/europe-faces-ageing-population-nightmare-absolute-collapse

[640] AI and robotics are discussed in more detail below.

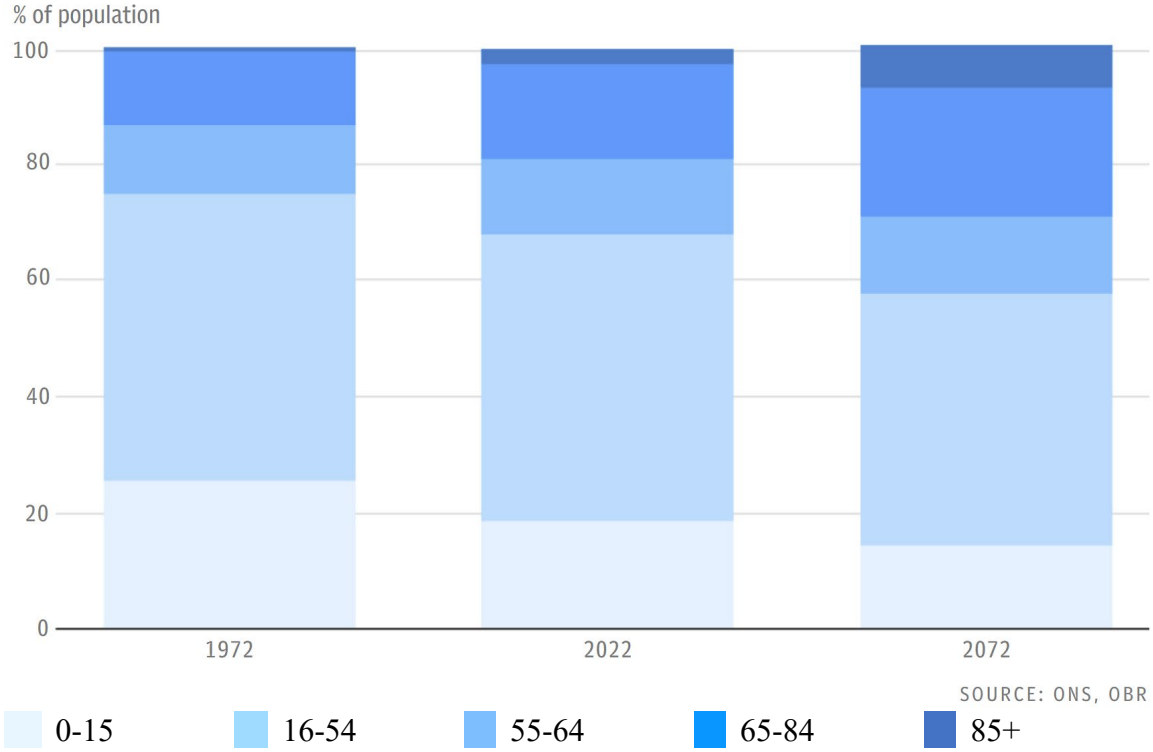
[641] https://www.pensionpolicyinternational.com/anticipated-u-s-population-decline-and-the-risks-ahead/

[642] Some commentators predict the end of the human race within the next 10,000 years. According to Henry Gee, 'The human population will sink to a level that is ultimately unsustainable, and extinction will beckon'. To put this into perspective, hominins (bipedal apes) date back two million years ago, while homo sapiens date back 300,000 years ago. See Henry Gee (2025) *The Decline and Fall of the Human Empire*, Picador; https://www.panmacmillan.com/authors/henry-gee/the-decline-and-fall-of-the-human-empire/9781035030835

The UN predicts that, by 2050, the best-balanced work forces will be in South and Southeast Asia, Africa and the Middle East, potentially reshaping economic growth and geopolitical power balances. This will give these regions a 'demographic dividend', as a growing share of workers compared to dependants promotes economic growth.[643]

Figure 8 shows the UK's population age structure according to calculations made by the Office for Budget Responsibility (OBR). In 1972, 60% of the population was aged between 16 and 64 and this rose to 62.2% in 2022, due to the large number of baby boomers who joined the workforce. Once they retire, the working age population will fall to 56.4% by 2072. By then, almost 30% of the British population will be over 65, more than double the proportion in 1972. The OBR predicts that age-related state spending will rise from 27% of GDP in 2023 to 36.1% in 2071. State pensions will rise from 4.8% to 8.1% of GDP or from £110bn[644] in 2022 to £185bn in 2023 prices.

Figure 8: Population age structure in the UK



Source: https://www.telegraph.co.uk/business/2022/12/03/why-state-pension-age-may-never-reach-70/

This rising cost could be ameliorated by increasing the state pension age. In 2018, the UK state pension age was increased to 66 and is set to rise to 67 by 2028 and to 68 by 2046.

[643] Lauren Leatherby (2023) How a vast demographic risk will reshape the world, New York Times, 16 July; https://www.nytimes.com/interactive/2023/07/16/world/world-demographics.html
[644] https://obr.uk/forecasts-in-depth/tax-by-tax-spend-by-spend/welfare-spending-pensioner-benefits/

The government is considering bringing this forward to 2039. Each year that the pension is not paid saves £10bn and, in addition, people pay in-work taxes for another year. The Institute for Fiscal Studies found the rise in state pension age from 65 to 66 resulted in 25,000 men and 30,000 women aged 65 working for an extra year.

However, John Cridland, who chaired the UK's first state pension age review in 2017, while accepting that the implications for the public finances is 'really concerning', argues that there could be an upper limit to the state pension age: 'while the government may be able to justify bringing forward an increase to 68, telling people to work until they're 69 or even 70 is a much more difficult prospect. The UK has got a lot of people who started work at 16. Many do manual work in hard physical jobs, and expecting them to wait till the age of 70 for a pension is not a reasonable balance. One might need to increase the state pension age beyond 68 in years to come, but I'm talking decades, and only if longevity increases take off again. There has to be a reasonable balance to deliver intergenerational fairness. [Further,] it's not obvious that the working population will have as much healthy life expectancy because of multiple morbidity, where more people suffer from multiple conditions like dementia, obesity, diabetes, that can actually affect the quality of people's lives'. His report recommended that those with poor health or caring responsibilities should be able to access the state pension at 67.[645] This suggests that there could be limits to the longevity dividend identified by the ILC(UK).

Despite this, in February 2024, ILC(UK) released a report which argued that the UK's population was aging so quickly that the state pension age would need to rise to 70 or 71 to maintain the status quo of a constant number of workers per state pensioner – and this could be as early as 2040. While the report accepted that life expectancy increases had paused during the austerity years following the Global Finance Crisis and that Covid-19 had temporarily eased the pressure for increases in state pension age after 2027, it warned that longer-term the pressure will be to increase it. This is because of the fact that many workers are facing long-term ill health earlier in life and that their exit from the workforce before they reach state pension age reduces the tax base to pay for pensions. In addition, a smaller working population and a larger economically inactive population create huge labour shortages that lead to additional funding problems, such as increased welfare benefits. Nevertheless, the report accepted that there were challenges in raising the retirement age to such a high level, since only 50% of adults are disability-free and able to work by age 70. The report concluded 'Our research … suggests a greater focus is needed on preventing ill-health not just in old age but from early age through adulthood. Policymakers can no longer ignore the impact of poor health on wider society and doing so will simply make wider policies related to work or pensions ineffective'.[646]

[645] Szu Ping Chan (2022) Why the state pension age may never again reach 70, *Daily Telegraph*, 3 December; https://www.telegraph.co.uk/business/2022/12/03/why-state-pension-age-may-never-reach-70
[646] https://www.pensionpolicyinternational.com/uks-ageing-population-prompts-calls-to-push-state-pension-age-up-to-71/

Another aspect of population aging is the differential impact on the rich and poor, i.e., health inequalities due to differences in wealth. A 2020 study by the Longevity Science Panel in the UK found that, while life expectancy had increased for all socio-economic groups between 2001 and 2015, it increased most for the richest cohort. The difference in life expectancy between rich and poor was 7.2 years in 2001, but this had increased to 8.4 years in 2015[647] and to 9 years in 2020.[648] Another study found that, while socio-economic status affects the incidence of multimorbidity (two or more of diabetes, coronary heart disease, stroke, chronic obstructive pulmonary disease (COPD), depression, arthritis, cancer, dementia, and Parkinson's disease), it did not affect the risk of mortality after the onset of these adverse health conditions, implying that primary prevention is key to reducing social inequalities in mortality (Dugravot et al (2019)). This is confirmed by a report written by the UK All-Party Parliamentary Group (APPG) for Longevity (*The Health of the Nation: A Strategy for Healthier Longer Lives*) which estimated that up to 75% of new cases of heart disease, stroke and type-2 diabetes, and 40% of cancer incidence and dementia risks could be reduced if individuals cut down on smoking and alcohol, increased physical activity and changed to a healthy diet. The report also found that a key reason for low productivity in certain parts of the country (e.g., the north of England) is that health is worse and reducing the health gap would keep people in work longer and hence increase national output.[649]

These findings will have implications for fairness between different cohorts of the same generation, for example, when governments raise the retirement age for all in line with increasing average life expectancy. In response to these inequalities, the UK government set up the UK Longevity Council to advise it on how best to use innovations in technology products and services to improve the lives of the older population. With the number of people in the UK over the age 65 to double to more than 20 million over the next half century, the government has set itself the Aging Society Grand Challenge which aims to ensure that people in the UK enjoy an extra 5 years of healthy and independent living by 2035, while narrowing the gap between the experience of the richest and poorest.[650]

Similar initiatives are happening in other parts of the world. For example, the Stanford Center on Longevity (SCL), recognizing that half of 5-year-olds in the US are likely to reach the age of 100, has a mission to ensure these 'century-long lives are healthy and rewarding'. It has developed a New Map of Life[651] that seeks to change social institutions, norms and policies that evolved when lives were only half as long, for example, the idea that people will retire and live off their savings at age 65. The SCL envisions a 'future in which all people, regardless of socio-economic status, can make the most of the advantages

[647] Life expectancy gap between rich and poor widens, *BBC News*, 15 February 2018.
[648] Amelia Hill (2020) Being wealthy adds nine years to life expectancy, says study, *Guardian*, 15 January. The same 9-year difference holds in the US. The UK results come from the English Longitudinal Study of Ageing, while the US results come from the US Health and Retirement Study.
[649] Amelia Hill (2020) Health inequality greater than previously thought, report finds, *Guardian*, 12 February.
[650] https://www.gov.uk/government/news/experts-to-help-uk-champion-ageing-society-opportunities
[651] https://longevity.stanford.edu/the-new-map-of-life-initiative/

afforded by increased lifespan—resulting in lives infused at every stage with a sense of belonging, purpose, and worth. We can meet challenges that longevity creates, and make the most of the 100-year opportunity if we act now, guided by these principles:

- Make use of age diversity
- Create longevity-ready communities
- Align health spans to life spans
- Build financial security from the start
- Invest in future centenarians to deliver big returns
- Support life transitions
- Learn throughout life
- Work more years, with greater flexibility
- Harness scientific and technological breakthroughs to transform the future of aging
- Ensure that advances are distributed to the entire population'.

The World Economic Forum's (WEF) *Global Risks Report 2025* predicts that a first pillar pension crisis 'will start to bite' over the next decade in super-ageing societies – where over 20% of a country's population is over 65 years old – such as Japan, Italy and Germany. Globally, the number of people aged 65 and older is expected to increase by 36% from 857mn in 2025 to 1.2bn in 2035. The report said: 'Over the next decade the pensions crises and their implications will start hitting home in super-ageing societies, as it becomes clear that current state pension systems were designed for a much younger demographic with fewer years of retirement that needed funding'.

The second pillar will also struggle because many countries are moving away from DB systems to DC systems: 'For many people, this can be challenging as they may have insufficient income, lack the requisite financial understanding, or fail to make good early decisions about savings and retirement. As dependency ratios rise, fewer people will be contributing to employer and private pensions schemes relative to the number of people whose retirements need funding, and with the length of those retirements rising. …Pension shortfalls will also disproportionately affect lower-income workers who have not managed to make significant savings during their careers, even if they have been fully employed. In the EU, for example, already today one in five elderly people face the risk of poverty or social exclusion and this figure is set to rise by 2035. …Women on average have significantly higher pensions gaps than men given time taken out of formal employment over the course of their careers to care for children or elderly relatives, as well as their lower average pay compared to men. In the EU, women's pensions are nearly 30% lower than those of men, meaning that they are at a 35% higher risk of poverty'.

The WEF argues that this could lead to institutional pension funds seeking to increase their returns by allocating higher proportions of their assets to riskier investments, such as crypto assets and private credit: 'These riskier investments will not always pay off, and over time this could worsen the already suboptimal funding ratios of some of these institutions. If

there are extended periods of market underperformance, this could lead to many more individuals facing shortfalls in funding their retirement'. An alternative is for countries with super-ageing populations to raise the statutory retirement age. But the WEF warns that attempts to do this face resistance from voters, a rising proportion of whom are themselves close to retirement: 'This segment of the population tends to have high voter turnout, making it increasingly likely that policy outcomes will be in their favour. Intergenerational tensions could become an ongoing feature of super-ageing societies, with discontented younger working cohorts resenting being called upon to pay more towards funding retiree pensions. … This illustrates the complexity of aligning key stakeholder interests behind pension reform'.[652]

Some of these issues – longer working lives, higher state pension ages, and narrowing the life expectancy gap – will clearly have consequences for the pricing of future PRT deals.

The aging process and anti-aging treatments

Life expectancy is strongly linked to the aging process.[653] Aging results in a progressive deterioration in physiological integrity, leading to impaired function and increased vulnerability to death. This deterioration is the primary risk factor for neurodegenerative diseases, cancer, diabetes, and cardiovascular disorders. López-Otín et al. (2013) show that there are nine candidate hallmarks of aging:[654] genomic instability,[655] telomere attrition,[656] epigenetic alterations,[657] loss of proteostasis,[658] deregulated nutrient sensing,[659]

[652] https://www.pensionpolicyinternational.com/pension-crises-will-start-to-bite-over-next-decade-wef-risk-report-finds/

[653] See, e.g., Andrew Steele (2020) *The New Science of Getting Older Without Getting Old*, Bloomsbury, London; https://www.bloomsbury.com/uk/ageless-9781526608277/

[654] Carlos López-Otín, Maria A. Blasco, Linda Partridge, Manuel Serrano, and Guido Kroemer (2013) The Hallmarks of Aging, *Cell*, 153(6):1194-1217; https://doi.org/10.1016/j.cell.2013.05.039

[655] A high frequency of mutations within a cell's genome.

[656] The telomere ends of chromosomes get shorter as cells divide and eventually become too short for cells to divide further. Shortened telomeres are associated with aging cells that are senescent.

[657] Epigenetics is the study of how your behaviours and environment can cause changes that affect the way your genes work. Unlike genetic changes, epigenetic changes are reversible and do not change your DNA sequence, but they can change how your body reads a DNA sequence; https://www.cdc.gov/genomics/disease/epigenetics.htm

[658] Proteostasis is a balanced state in which the body's production of proteins is stable and without defects. Proteins are molecules that do most of the work in cells and are needed for the structure, function, and regulation of the body's tissues and organs. They are composed of amino acids and are categorised according to their function: antibody, enzyme (carries out most of the chemical reactions that take place in cells), messenger (transmits signals to coordinate biological processes between different cells, tissues, and organs), structural component, and transport/storage. A loss of proteostasis is associated with the production of excess, insufficient or misshapen proteins that send incorrect signals. See: Steve Hill (2018) Hallmarks of Aging: Loss of Proteostasis, 23 May; https://www.lifespan.io/news/hallmarks-of-aging-loss-of-proteostasis/

[659] Metabolism is the balance between anabolism (building up body tissues and energy stores) and catabolism (breaking down body tissues and energy stores to get fuel for body functions). The body has

mitochondrial dysfunction,[660] cellular senescence,[661] stem cell exhaustion,[662] and altered intercellular communication.[663]

López-Otín et al. (op cit) continue: 'Aging research has experienced an unprecedented advance over recent years, particularly with the discovery that the rate of aging is controlled, at least to some extent, by genetic pathways and biochemical processes conserved in evolution. … A major challenge is to dissect the interconnectedness between the candidate hallmarks and their relative contributions to aging, with the final goal of identifying pharmaceutical targets to improve human health during aging, with minimal side effects'.

Dr Eric Verdin, president and CEO of the Buck Institute for Research on Aging[664] explains the origins of aging research: 'The initial discoveries by several groups between 1985 and 1995 suggested that there are genes that can mitigate the aging process. If these genes are mutated to either gain or lose function, one can dramatically impact healthspan and

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multiple nutrient sensing pathways to ensure that it takes in the right amount of nutrition – not too much, not too little. Excess metabolic activity, e.g., anabolic signalling, together with changes in nutrient availability and composition, damage cells and cause them to age faster. These damaging events also deregulate the nutrient-sensing molecules and downstream pathways, for example, signalling greater food intake when the body does not need it. Age-related obesity, diabetes and other metabolic syndromes result. Decreased nutrient signalling, achieved with caloric restricted diets or by stimulation of proteins called sirtuins, promotes healthspan and longevity. See: Deregulated Nutrient Sensing; https://www.merckmillipore.com/GB/en/life-science-research/genomic-analysis/Epigenetics-and-Nuclear-Function/Deregulated-Nutrient-Sensing/FsCb.qB.u04AAAFQ6t52i0ib,nav

[660] Mitochondria are organelles – specialized subunits within cells with a specific function – found in most cells, in which the biochemical processes of respiration and energy production occur. Mitochondrial dysfunction occurs when the mitochondria do not work as they should due to damage, mutation or conditions such as progressive inefficiency of electron transport chain complexes resulting from destabilization or oxidative stress owing to excessive production of reactive oxygen species (ROS). This can affect other diseases, such as Alzheimer's, diabetes and cancer. See: Joshua N. Farr and Maria Almeida (2018) The Spectrum of Fundamental Basic Science Discoveries Contributing to Organismal Aging, *J Bone Miner Res*, 33(9): 1568–1584; doi: 10.1002/jbmr.3564

[661] Irreversible cell cycle arrest driven by a variety of mechanisms, including telomere shortening, other forms of genotoxic stress, or mitogens or inflammatory cytokine. Senescent cells have stopped dividing and hence renewing themselves and so have lost their purpose, but can nevertheless destabilize neighbouring cells and promote inflammation. See: Edward J. Masoro and Steven N. Austad (eds) *Handbook of the Biology of Aging* (seventh edition, 2011); https://www.sciencedirect.com/book/9780123786388/handbook-of-the-biology-of-aging

[662] A reduction in stem cell activity which can lead to diseases and other issues, such as immunosuppression through reduced production of bacteria-killing and virus-killing white blood cells, muscle loss, frailty, and the weakening of bones. See: Patrick Deane (2018) Hallmarks of Aging: Stem Cell Exhaustion, 18 September; https://www.lifespan.io/news/hallmarks-of-aging-stem-cell-exhaustion/

[663] Cells, as they age, show an increase in self-preserving signals that result in damage elsewhere. Altered intercellular communication with aging contributes to a decline in tissue health. In particular, senescent cells trigger chronic inflammation that can further damage aging tissues. See: Altered Intercellular Communication; https://www.merckmillipore.com/GB/en/life-science-research/antibodies-assays/antibodies-overview/Research-Areas/cell-signaling/Altered-Intercellular-Communication/C.qb.qB.O48AAAFQe592i0hr,nav

[664] https://www.buckinstitute.org/

lifespan. …We've learned a number of key lessons. Firstly, we've learned that there are genetic pathways that interact together and appear to control aging. Secondly, these pathways seem to be conserved across different species. So, we find the same pathways in yeast, in worms and in humans. Thirdly, we can speak to these pathways via small molecule drugs to have the same effect as mutating the gene, and subsequently impacting the aging process. Finally, these genes that control aging don't just control lifespan, they also control healthspan'.[665]

There have been a number of significant positive innovations that help to identify and treat noncommunicable diseases associated with aging, such as dementia and cancer. These can be classified as gerotheraputics.[666] Examples include:

- Professor Steve Horvath (UCLA) and Ken Raj (Public Health England) have demonstrated that rapamycin[667] retards the epigenetic aging of human cells – using an epigenetic clock (called the Skin and Blood Clock) which is an accurate biomarker for aging that relies on the mathematical precision of the relationship between chemical modifications on DNA called methylation and changes in age[668]
- The finding that rapamycin, administered to middle aged mice, increased survival significantly in both male and female mice.[669]
- The discovery that mTOR (mechanistic target of rapamycin) has a role in influencing cell growth and proliferation, and, in the case of deregulated cell proliferation, can cause diseases such as cancer and neurodegeneration. Inhibiting mTOR slows cell growth, increases recycling, and enhances cell efficiency. A number of mTOR inhibitors have been developed to treat these diseases, including sirolimus, everolimus, and temsirolimus.[670]
- Potential reversal of aging using a younger person's blood, following successful experiments with mice.[671]
- Professor Tony Wyss-Coray (Stanford) has identified circulating factors in plasma that can rejuvenate or restore function in the aging brain, leading to the

[665] Interview in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.
[666] Gerotherapeutics enhance resilience mechanisms that counter age-related molecular damage to prevent chronic diseases, frailty, and disability, thereby extending healthspan; https://pubmed.ncbi.nlm.nih.gov/37389519/
[667] A bacterial antifungal compound discovered in the soil of Easter Island in the 1970s. It is also an immunosuppressant used in organ transplants.
[668] http://mypharmacynews.com/health-problems/rapamycin-retards-epigenetic-ageing-of-keratinocytes/
[669] Randy Strong, Richard A. Miller, Molly Bogue, Elizabeth Fernandez, Martin A. Javors, Sergiy Libert, Paul Anthony Marinez, Michael P. Murphy, Nicolas Musi, James F. Nelson, Michael Petrascheck, Peter Reifsnyder, Arlan Richardson, Adam B. Salmon, Francesca Macchiarini, and David E. Harrison (2020) Rapamycin-mediated mouse lifespan extension: Late-life dosage regimes with sex-specific effects, *Aging Cell*. 2020;00:e13269. https://doi.org/10.1111/acel.13269
[670] https://pmc.ncbi.nlm.nih.gov/articles/PMC4849280/; https://www.uptodate.com/contents/pharmacology-of-mammalian-mechanistic-target-of-rapamycin-mtor-inhibitors
[671] Undulating changes in human plasma proteome profiles across the lifespan, *Nature Medicine*, 5 December 2019.

development of anti-aging therapies based on the plasma proteome, suitable for treating age-related macular degeneration and neurodegenerative disorders.[672]

- Development of inhibitors for the protein[673] complex TORC1 which extend lifespan and healthspan by, for example, reducing the incidence of respiratory tract infections or treating neurodegenerative diseases by inducing autophagy, a process which by which cells clear out toxic protein aggregates.[674]
- Scientists have converted the cells of a deceased 114-year-old into young pluripotent stem cells, thereby reversing the telomere aging clock in a supercentenarian's cells and providing support for the hypothesis of no upper age limit for reprogramming cellular aging.[675]
- Identification of an inflammatory marker called sCD14 which is linked to cognitive decline and dementia, allowing early intervention.[676]
- Randall J. Bateman (Washington University School of Medicine in St. Louis) has developed a simple blood test that can detect Alzheimer's disease in its earliest stages by measuring levels of the protein amyloid beta which begin to collect in the brain 15 to 20 years before symptoms arise and play a key role in the development of Alzheimer's.[677] Researchers from the University of Gothenburg have developed a cheap test that measures the level of the p-tau217 protein in the blood.[678] Researchers from Aarhus University have developed a blood test to spot Alzheimer's before progression to dementia.[679]
- The development of protein-destroying drugs, capable of degrading the MYC cancer-fuelling protein or the tau protein responsible for Alzheimer's.[680]
- The identification of two natural compounds – CMS121 and J147 – that can reverse age-related cognitive impairment and potentially treat Alzheimer's by restoring

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[672] Steven Braithwaite, Chief Scientific Officer, Alkahest, interviewed in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.
[673] Proteins are the foundation of life.
[674] Joan Mannick, Chief Medical Officer, resTORbio, interviewed in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.
[675] Phil Newman (2020) 114 year-old cells converted to pluripotent stem cells, *Longevity Technology*, 28 February; https://www.longevity.technology/114-year-old-cells-converted-to-pluripotent-stem-cells.See also: Old human cells rejuvenated with stem cell technology, *Science News*, 24 March 2020.
[676] Inflammatory marker linked to dementia, *EurakAlert! Science News*, 9 December 2019.
[677] https://medicine.wustl.edu/news/bateman-receives-potamkin-award-for-alzheimers-research/; https://www.labmedica.com/clinical-chem./articles/294789678/blood-based-biomarker-predicts-onset-of-symptomatic-alzheimers-disease.html; https://www.labmedica.com/hematology/articles/294792023/unique-diagnostic-test-based-on-mass-spectrometry-technique-accurately-identifies-early-stage-alzheimers-disease.html; https://www.labmedica.com/molecular-diagnostics/articles/294793970/blood-test-could-detect-alzheimers-up-to-17-years-in-advance.html
[678] https://www.telegraph.co.uk/news/2024/01/22/alzheimers-blood-test-revolution-for-over-50s-dementia
[679] https://www.labmedica.com/molecular-diagnostics/articles/294801080/advanced-blood-test-to-spot-alzheimers-before-progression-to-dementia.html
[680] Protein-slaying drugs could be the next blockbuster therapies, *Nature Feature*, 20 March 2019.

mitochondrial function, such as cell respiration and energy production, in the aging brain.[681]

- The discovery that higher levels of humanin, a peptide[682] encoded in the small genome of mitochondria, are associated with longer lifespans, better health, and a lower risk for diseases such as Alzheimer's.[683]
- The development of an antibody that stimulates microglia, the brain's immune cells, in such a way that they live longer, divide more quickly and detect aberrant substances more easily, thus helping to prevent the progression of Alzheimer's.[684]
- The discovery that Alzheimer's establishes itself independently at various points in the brain from an early stage and it is the rate at which these clusters grow that determines the speed of a patient's deterioration, not the speed at which they spread. Previously, it was was believed that it started at one specific point in the brain and then spread to other parts in a chain reaction.[685]
- The success of the drug donanemab in slowing down the progression of Alzheimer's by more than 20%, with greater impact in people at an earlier stage of the syndrome.[686]
- The success of the drug lecanemab in slowing cognitive decline of Alzheimer's sufferers by 27%. The drug was authorized for use in the US in January 2023, with an annual cost of $26,500 per patient. However, there are potential side effects, including swelling and potential bleeding in the brain.[687]
- The discovery that brain cells in Alzheimer's patients survived when they were able to block the protein MEG3 that was triggering cell suicide and necroptosis, the removal by the body of dead cells. Alzheimer's patients build-up two toxic proteins, tau and amyloid beta. Amyloid is believed to accumulate in spaces between neurons in brain cells, leading to brain inflammation. Tau tangles then begin to appear and the brain cells gradually start to die. Scientists believe that drugs that mimicked the blockage of MEG3 could prevent necroptosis.[688]

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[681] Carla Heyworth (2020) Targeting mitochondria to fight aging, *Longevity Technology*, 22 January; https://www.longevity.technology/targeting-mitochondria-to-fight-aging/

[682] A peptide is a 'short chain of amino acids. The amino acids in a peptide are connected to one another in a sequence by bonds called peptide bonds. Typically, peptides are distinguished from proteins by their shorter length, although the cut-off number of amino acids for defining a peptide and protein can be arbitrary'; https://www.nature.com/scitable/definition/peptide-317/

[683] Protein in mitochondria appears to regulate health and longevity, *Science Daily*, 24 June 2020; https://www.sciencedaily.com/releases/2020/06/200624151613.htm

[684] Stimulating immune cells to protect against Alzheimer's, *Neuroscience News*, 10 March 2020.

[685] https://www.telegraph.co.uk/news/2021/10/29/scientists-pinpoint-exactly-alzheimers-grows-brain-breakthrough

[686] https://www.alzheimers.org.uk/news/2023-07-17/new-drug-donanemab-turning-point-alzheimers

[687] https://www.telegraph.co.uk/news/2024/08/21/alzheimers-wonder-drug-lecanemab-approved. Lecanemab contains antibodies which target the protein amyloid it starts to join with other amyloids to form clumps called fibrils which, in turn, join together to form plaques which disrupt neuron function.

[688] Sarah Knapton (2023) Alzheimer's could cause brain cells to kill themselves, *Daily Telegraph*, 15 September; https://www.telegraph.co.uk/news/2023/09/15/dementia-researchers-uncover-why-brain-cells-die/.

- The invention of a blood test for identifying Parkinson's disease ten years before symptoms emerge, allowing the early application of precision therapies. It is the second most prevalent neurodegenerative disorder globally and is caused by the brain cells' inability to process a protein called alpha-synuclein. As a result, abnormal clusters of the protein form and damage nerve cells, resulting in movement disorder.[689]
- The Institute of Ageing at Newcastle University and the Mayo Clinic in the US have demonstrated that senescent cells can be selectively killed (using a process known as senolytics) and this helps to postpone multiple age-related disabilities and disease.[690]
- The introduction of rejuvenation medicine that turns back biological age,[691] rather than just slowing it down, by the restoration of the molecular and cellular structure and composition of tissues and organs. One example is the removal of 'zombie' cells, senescent cells that no longer divide, but remain alive, creating difficulties for their environment.[692] Another example is organ regeneration using lymph nodes to regrow functioning organs within a patient's own body, eradicating the problem of organ rejection in transplant patients and solving the problem of organ supply scarcity.[693, 694]
- The use of hyperbaric oxygen therapy to reverse two key indicators of biological aging: telomere length and senescent cells accumulation. In a clinical study, 35 adults over 64 years were placed in a pressurized chamber and given pure oxygen for 90 minutes a day, five days a week for three months. At the end of the trial, the participants' telomeres had increased in length by an average of 20%, while their senescent cells had been reduced by up to 37%.[695]
- The development of EpiAgePublic, a low-cost method to estimate biological age by analyzing just three key DNA sites in the ELOVL2 gene, a well-known aging

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[689] https://www.labmedica.com/molecular-diagnostics/articles/294799502/index.php

[690] Danny Buckland (2019) We're living much longer, but are we healthier?, Raconteur.net, 23 May. Ellie Dolgin (2020) Send in the senolytics, *Nature Biotechnology*, 12 November,

[691] Some scientists argue that biological age is a more useful indicator than chronological age. For example, Prof Jamie Timmons of King's College London argues that 'There's a healthy ageing signature [in your body's cells], and it appears to be prognostic for a number of things including longevity and cognitive decline. It looks like from the age of 40 onwards you can use this to give guidance on how well an individual is ageing'; https://www.bbc.co.uk/news/health-34153135

[692] Aubrey de Grey, co-founder and chief scientific officer, SENS Research Foundation, interviewed in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.

[693] *Longevity Trends 2020*, published by Longevity Leaders, January 2020.

[694] Some scientists question whether it is currently possible to measure biological age accurately. One example is Jay Olshansky, chief scientific officer, Lapetus Solutions. Nevertheless, he has developed a metric based on face age 'which illustrates the documented relationship between how young or old you look relative to your chronological age. It's not a statement that you're this many years younger or older, but it seems to be a reasonable biomarker giving you a clue that you might be aging more slowly or more rapidly'. Interviewed in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.

[695] Anthony Cuthbertson (2020) Human aging reversed in 'Holy Grail' study, *Independent*, 30 November; https://www.independent.co.uk/life-style/gadgets-and-tech/anti-ageing-reverse-treatment-telomeres-b1748067.html

marker. The method uses only saliva samples, and contrasts with traditional methods that require the analysis of thousands of DNA regions. The new approach streamlines the process without sacrificing accuracy.[696]

- Demonstration in an animal model that age-related frailty and immune decline can be halted and even partially reversed using a novel cell-based therapeutic approach. It is known that visceral adipose tissue or belly fat contributes to the development of chronic low-grade inflammation. Researchers at the University of Bern report that certain immune cells in the belly fat play an essential role in regulating chronic low-grade inflammation and downstream aging processes. They show that these immune cells may be used to reverse such processes.[697]
- The identification of 10 genomic loci which influence three key phenotypes[698] (years lived in good health (healthspan), total years lived (lifespan), and survival until an exceptional old age (longevity)). Of these five (FOXO3, SLC4A7, LINC02513, ZW10, and FGD6) have not been reported previously as of genome-wide significance. The majority of these 10 loci are associated with cardiovascular disease and some affect the expression of genes known to change their activity with age. The study also showed the importance of gene sets linked to how the body metabolizes iron, with too much iron in the blood appearing to increase risk of dying earlier. Professor Paul Timmers, one of the authors of the study, said: 'We speculate that our findings on iron metabolism might also start to explain why very high levels of iron-rich red meat in the diet has been linked to age-related conditions such as heart disease'.[699]
- The identification of proteins associated with aging and increased frailty.700 A study of 4265 proteins measured in plasma found that 55 were positively associated with frailty, in particular, fatty acid-binding protein FABP and ANTR2.701

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[696] https://www.labmedica.com/molecular-diagnostics/articles/294804161/index.php

[697] Daniel Brigger, Carsten Riether, Robin van Brummelen, Kira I. Mosher, Alicia Shiu, Zhaoqing Ding, Noemi Zbären, Pascal Gasser, Pascal Guntern, Hanadie Yousef, Joseph M. Castellano, Federico Storni, Neill Graff-Radford, Markus Britschgi, Denis Grandgirard, Magdalena Hinterbrandner, Mark Siegrist, Norman Moullan, Willy Hofstetter, Stephen L. Leib, Peter M. Villiger, Johan Auwerx, Saul A. Villeda, Tony Wyss-Coray, Mario Noti, Alexander Eggel (2020) Eosinophils regulate adipose tissue inflammation and sustain physical and immunological fitness in old age, *Nature Metabolism*; DOI: 10.1038/s42255-020-0228-3

[698] Phenotypes are the observable characteristics of an organism that result from the interaction of its genotype (total genetic inheritance) with the environment. For individuals, this includes characteristics such as height, eye colour and blood type (https://www.britannica.com/science/phenotype; https://www.genome.gov/genetics-glossary/Phenotype).

[699] Paul R. H. J. Timmers, James F. Wilson, Peter K. Joshi, and Joris Deelen (2020) Multivariate genomic scan implicates novel loci and haem metabolism in human aging, *Nature Communications* volume 11, Article number: 3570 (2020); https://doi.org/10.1038/s41467-020-17312-3. David Nield (2020) Study of Over 1 Million People Finds Intriguing Link Between Iron Levels And Lifespan, *Science Alert*, 17 July; https://www.sciencealert.com/a-study-of-1m-people-finds-a-strange-link-between-iron-levels-and-long-life

[700] Frailty is a state of decreased physiological reserve and increased vulnerability to adverse outcomes in aging, and is characterized by dysregulation across various biological pathways.

[701] Sanish Sathyan, Tina Gao, Sofiya Milman, Nir Barzilai, Joe Verghese, Sanish Sathyan and Emmeline Ayers (2020) Plasma proteomic profile of frailty, *Aging Cell,* https://doi.org/10.1111/acel.13193

- The development by biotech company Elevian of drugs based on GDF11 (growth differentiation factor 11), a Harvard University-discovered protein linked to age-related diseases. The work on GDF11 – which involved a technique called parabiosis in which the circulatory systems of young and old mice were combined to allow blood to flow between the animals – suggested that injecting the protein into old mice regenerated cardiac, brain and muscle tissue.[702]
- By increasing the amount of the protein sestrin in fruit flies, researchers have been able to extend their lifespan and at the same time these flies were protected against the lifespan-shortening effects of a protein-rich diet. The researchers could further show that sestrin plays a key role in stem cells in the fly gut thereby improving the health of the fly.[703]
- The detection of cell senescence using fluorescence imaging and flow cytometry analysis.[704]
- The discovery that pro-inflammatory cytokines[705] induce cellular senescence and hence aging by activating EGFR (Epidermal Growth Factor Receptor) signaling. The activity of five senescence-inducing cytokines (IL-1β, IL-13, MCP-2, MIP-3α, and SDF-1α) could be significantly inhibited by treatment with cetuximab (an antibody targeting EGFR), gefitinib (a small molecule inhibitor of EGFR), and EGFR knockdown (the targeted reduction rather than inhibition of the EGFR peptide).[706]
- The discovery that lysine glycation in collagen appears to contribute to tendon stiffening with age and in diabetes.[707]
- A study led by University College London suggests that weight management could play a significant role in reducing the risk of developing dementia, after finding that obesity increases the risk of dementia up to 15 years later. The study showed that people who are obese in late adulthood face a 31% increased risk of dementia

[702] Ben Adams (2020) Anti-aging biotech Elevian raises $15M as it looks to the clinic,*Fierce biotech,* 24 November; https://www.fiercebiotech.com/biotech/anti-ageing-biotech-elevian-raises-15m-as-it-looks-to-clinic

[703] Jiongming Lu, Ulrike Temp, Andrea Müller-Hartmann, Jacqueline Esser, Sebastian Grönke, Linda Partridge. Sestrin is a key regulator of stem cell function and lifespan in response to dietary amino acids, *Nature Aging*, 2020; doi: 10.1038/s43587-020-00001-7

[704] For example, by using Cell Meter™ Cellular Senescence Activity Assay Kits.

[705] Cytokines are a broad category of small proteins or peptides – such as chemokines, interferons, interleukins, lymphokines, and growth factors – which are secreted by certain cells of the immune system and have an effect on – by sending signals to – other cells; https://en.wikipedia.org/wiki/Cytokine

[706] Dongsheng Shang, Danlin Sun, Chunyan Shi, Jun Xu, Mingxiang Shen, Xing Hu and Hanqing Liu (2020) Activation of epidermal growth factor receptor signaling mediates cellular senescence induced by certain pro-inflammatory cytokines, *Aging Cell*, 22 April; https://doi.org/10.1111/acel.13145

[707] Melanie Stammers, Irina M. Ivanova , Izabella S. Niewczas, Anne Segonds-Pichon , Matthew Streeter , David A. Spiegel , and Jonathan Clark (2020) Age-related changes in the physical properties, cross-linking, and glycation of collagen from mouse tail tendon, *J Biol Chem*; doi: 10.1074/jbc.RA119.011031

compared with those whose body mass index is normal. The risk is particularly high for women.[708]

- Researchers at the University of Bonn have discovered a receptor in mice that regulates both increasing abdominal girth and shrinking muscles, two common side effects of aging. Experiments with human cell cultures suggest that the corresponding signaling pathways might also exist in humans.[709]
- Adoptive cell therapies (ACTs) which involve the use of immune cells as anti-cancer agents and hold promise for the treatment of adult and paediatric cancer, ranging from liquid to solid tumors. One type of ACT involves chimeric antigen receptor (CAR)-engineered immune cells, with two CAR T-cell-based therapies recently approved by the US Food and Drug Administration, paving the way for the development of additional ACT therapies.[710]
- The discovery that CAR-T (chimeric antigen receptor cell therapy) can also be used in the treatment of autoimmune diseases, such as lupus, which results from the immune system attacking healthy cells, leading to fatigue and joint pain.[711]
- Identification of a biomarker for tumour initiating (or cancer stem) cells.[712]
- Early diagnosis of certain cancers (e.g., ovarian and brain) by identifying genetic errors in DNA.[713]
- A new DNA test evaluates biomarkers in 517 cancer-relevant genes across 30 types of solid tumours.[714]
- The development of a DNA biosensor to enable early diagnosis of cervical cancer.[715]
- A new metabolism-based blood test detects multiple cancer types prior to symptoms.[716]
- The development of a sterilizable nanowire-based device that can extract urinary microRNAs and use it as a liquid biopsy to detect cancers of the central nervous system.[717]

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[708] Obesity linked to higher risk of dementia, *Pharma Times*, 29 June 2020; http://www.pharmatimes.com/news/obesity_linked_to_higher_risk_of_dementia_1343249

[709] University of Bonn. Receptor makes mice strong and slim: Molecule that regulates two side effects of aging identified, ScienceDaily, 25 June 2020; www.sciencedaily.com/releases/2020/06/200625115916.htm

[710] Katy Rezvani, Marco Ruella, and Robbie Majzner (2020) Advances in Adoptive Cell Therapies, Cell Press webinar, 16 July.

[711] https://www.ft.com/content/a974f4c1-bb8a-4a1b-9d88-a2cf14be5c6e

[712] Labmedica.com, 28 November 2019.

[713] Rhys Blakely (2020) Cancer code offers hope of treatment decades early, *The Times*, 6 February.

[714] https://www.labmedica.com/molecular-diagnostics/articles/294792025/groundbreaking-dna-test-evaluates-biomarkers-in-517-cancer-relevant-genes-across-30-types-of-solid-tumors.html

[715] https://www.labmedica.com/technology/articles/294799669/dna-biosensor-enables-early-diagnosis-of-cervical-cancer.html

[716] https://www.labmedica.com/molecular-diagnostics/articles/294793553/index.php; https://www.labmedica.com/molecular-diagnostics/articles/294788864/blood-based-liquid-biopsy-test-accurately-detects-more-than-fifty-types-of-cancer.html;

[717] https://www.labmedica.com/molecular-diagnostics/articles/294788818/a-nanowire-based-liquid-biopsy-method-for-detection-of-tumors-of-the-central-nervous-system.html

- Researchers at the Georgia Institute of Technology in the US have invented a microfluidic chip called the Cluster-Well which can precisely locate each cell in a blood sample and determine if it is cancerous. This could lead to earlier and more targeted treatment.[718]
- A new liquid biopsy blood test can detect brain tumours where a conventional biopsy is not possible.[719]
- Immunotherapy – the re-education of an individual's own immune cells to fight diseases such as cancer.[720] An immunotherapy drug, AFM24, has been shown to work in patients with advanced cancers that had stopped responding to treatment, including bowel, lung and pancreatic cancers.[721]
- The development of tests that can transform cancer treatments. For example, a blood test developed by the Vancouver Prostate Centre and BC Cancer (British Columbia, Canada) analyzes the DNA that metastatic cancers shed into the bloodstream, known as circulating tumor DNA. By sequencing the entire genome of this ctDNA, the test reveals characteristics that are unique to each patient's cancer, giving doctors new tools to develop more personalized treatment plans.[722]
- The development by Moderna and Merck of a personalized cancer vaccine, based on immunotherapy and designed to prime the immune system so the body can generate a response based on a person's specific type of cancer tumour, using the same mRNA technology as in Covid-19 vaccines.[723] When used in combination with Keytruda, it has reduced the risk of death or relapse in patients with the most deadly form of skin cancer by half after three years.[724] In May 2024, the UK started

[718] https://www.labmedica.com/molecular-diagnostics/articles/294794252/index.php: 'Cancer spreads via circulating tumor cells (CTCs) that travel through the blood to other organs, and they are nearly impossible to track. When a tumor starts metastasizing, it sheds its cell into the blood. An individual cell often doesn't survive the bloodstream on its own, but clusters of cells are much more robust and can travel to other organs, effectively pushing the cancer to a metastatic state [i.e., stage 4]. CTCs have proven difficult to study, let alone treat. Blood contains billions of cells per milliliter, and only a handful of those cells would be CTCs in a patient with metastatic cancer'.

[719] https://www.labmedica.com/molecular-diagnostics/articles/294795854/blood-test-helps-diagnose-inaccessible-brain-tumors.html

[720] Siddhartha Mukherjee (2022) *The Song of the Cell: An Exploration of Medicine and the New Human*, Simon & Schuster; https://www.simonandschuster.com/books/The-Song-of-the-Cell/Siddhartha-Mukherjee/9781982117351

[721] https://www.telegraph.co.uk/news/2022/04/08/new-killer-cancer-treatment-stops-one-three-tumours-growing

[722] https://www.labmedica.com/molecular-diagnostics/articles/294793945/first-of-its-kind-blood-test-could-transform-cancer-treatment.html

[723] https://www.telegraph.co.uk/news/2022/12/13/skin-cancer-vaccine-based-covid-jab-technology-hailed-game-changer; https://www.cancerresearch.org/treatment-types/cancer-vaccines;, https://www.cancer.net/navigating-cancer-care/how-cancer-treated/immunotherapy-and-vaccines/what-are-cancer-vaccines

[724] https://www.cnbc.com/2023/12/14/moderna-merck-cancer-vaccine-reduces-risk-of-skin-cancer-return.html

the world's first bowel cancer trial designed in partnership with BioNTech (which had co-developed the first-ever mRNA Covid-19 vaccine).[725]

- Scientists at the US cancer research hospital City of Hope[726] have made a breakthrough against the proliferating cell nuclear antigen (PCNA) protein which in a mutated form helps to replicate expanding cancer tumours. They have developed a molecule, named AOH1996, which targets and kills the mutated PCNA. If clinical trials are successful, AOH1996 could be incorporated in a cancer-stopping pill which would provide protection against breast, prostate, brain, ovarian, cervical, skin and lung cancers.[727]
- The development of an in vitro diagnostic test to detect hundreds of genetic variants that could indicate a higher likelihood of developing specific kinds of cancer.[728]
- The development of an implantable ultrasound device that can open the blood-brain barrier and hence offers the possibility of more effective treatment for the range of neurocognitive diseases (including brain cancer) that previously had limited treatment options due to the blood brain barrier.[729]
- The development of an mRNA cancer vaccine to target glioblastoma, the most aggressive form of brain tumor.[730]
- The introduction of a new assay to detect and treat acute myeloid leukemia.[731]
- Anastrozole, taken daily, halves the risk of breast cancer (at a cost of £0.04 per day).[732]
- The introduction of relugolix, an androgen deprivation therapy (ADT) for treating prostate cancer in the form of a pill, saving on hospital injections.[733]
- The development of nanomedicine, the application of nanomaterials in targeted drug delivery for tumors, is helping to improve chemotherapy outcomes. Nanoparticle drug delivery systems can enhance drug solubility, alter drug distribution in the body, improve drug targeting, thereby enhancing therapeutic effects, and reducing adverse reactions. A number of nanocarriers have been developed for drug delivery, such as lipid-based nanocarriers, inorganic nanocarriers, and polymer nanoparticles. These have good biocompatibility and

[725] https://www.telegraph.co.uk/news/2024/05/31/nhs-patients-personalised-cancer-vaccines-world-first-trial
[726] https://www.cityofhope.org/
[727] The molecule is named after Anna Olivia Healey who was born in 1996 but who sadly did not survive cancer; https://metro.co.uk/2023/08/01/cancer-cure-pill-treatment-scientists-19228101/
[728] https://www.labmedica.com/molecular-diagnostics/articles/294798809/first-of-its-kind-dna-test-can-assess-predisposition-for-dozens-of-cancer-types.html
[729] Dr Adam Worthalter, neurosurgeon at Northwestern Memorial Hospital, speaking at the Fasano Longevity Conference, Washington DC, 6 November 2023.
[730] https://medicalxpress.com/news/2024-05-mrna-cancer-vaccine-triggers-fierce.html
[731] https://www.labmedica.com/molecular-diagnostics/articles/294799362/new-assay-to-revolutionize-detection-and-treatment-of-acute-myeloid-leukemia.html
[732] https://www.telegraph.co.uk/news/2023/11/07/breast-cancer-risk-halved-daily-pill-anastrozole-nhs
[733] https://www.telegraph.co.uk/news/2024/07/19/home-pill-for-advanced-prostate-cancer-on-nhs/

biodegradability and can stably transport drugs, improve drug solubility, and stability.[734]

- The levels of antibodies against ALDOA and FH provide novel predictors of ischemic stroke, including transient ischemic attack (TIA) and cerebral infarction (CI), which are induced by atherosclerosis.[735]
- A new blood-based cardiovascular risk test for more accurate risk prediction (of heart disease and sudden cardiac arrest) and patient management.[736]
- The importance of selenium in antioxidant mixtures designed to reduce all-cause mortality, in particular, from cardiovascular disease and cancer.[737]
- A new genetic testing procedure combined with ultrasound to detect high cardiovascular risks.[738]
- The development of technology by Bit.Bio to reprogram stem cells to make any human cell desired.[739] In June 2023, scientists at the University of Cambridge and the California Institute of Technology revealed that they have used stem cells to create synthetic human embryos, avoiding the need for eggs or sperm. The embryos resemble those in the earliest stages of human development and could be used to gain a better understanding of genetic disorders.[740]
- The start of a research program on reproductive longevity and equality as it relates to aging and ending the threat of age-related disease at a new Center for Reproductive Longevity and Equality (CRLE) at the Buck Institute. The center's goal is 'is to conduct basic research to understand the mechanisms of female reproductive aging and develop strategies to prevent or delay ovarian aging. The end of fertility sets off a cascade of negative health effects in women's bodies that impact bone, cognitive, cardiovascular and immune function. We want to understand why human women undergo a decline in fertility (menopause), why it varies between individuals, and why it correlates with life span. We think that

[734] Nanotechnology revolution: Exploring various pathways for drug delivery, *Medchemexpress*, 23 July 2024.
[735] Hardening of the arteries caused by a buildup of plaque in the inner lining of an artery; https://www.labmedica.com/clinical-chem./articles/294789093/aldoa-and-fh4-antibodies-associated-with-cerebrovascular-disease.html
[736] https://www.labmedica.com/hematology/articles/294792002/elisa-blood-test-uses-innovative-biomarker-to-detect-heart-disease-and-sudden-cardiac-arrest.html; https://www.labmedica.com/hematology/articles/294789202/novel-ai-driven-cardiac-blood-test-provides-highly-accurate-prediction-of-one-year-risk-for-heart-attack-stroke-or-cardiac-death.html
[737] David J A Jenkins, David Kitts, Edward L Giovannucci, Sandhya Sahye-Pudaruth, Melanie Paquette, Sonia Blanco Mejia, Darshna Patel, Meaghan Kavanagh, Tom Tsirakis, Cyril W C Kendall, Sathish C Pichika, John L Sievenpiper, Selenium, antioxidants, cardiovascular disease, and all-cause mortality: a systematic review and meta-analysis of randomized controlled trials, *The American Journal of Clinical Nutrition*, nqaa245, https://doi.org/10.1093/ajcn/nqaa245
[738] https://www.labmedica.com/molecular-diagnostics/articles/294801033/new-genetic-testing-procedure-combined-with-ultrasound-detects-high-cardiovascular-risk.html
[739] Tom Whipple (2020) Bit.Bio: British firm cracks code for stem cells, *The Times*, 27 October.
[740] https://www.theguardian.com/science/2023/jun/14/synthetic-human-embryos-created-in-groundbreaking-advance

understanding the limits on mammalian female reproductive capacity may provide important clues about aging in other tissues'.[741]

- A breakthrough in biosensing technology enables new methods of early disease detection. Nanopores are tiny openings that can detect individual molecules as they pass through, enabling the analysis of biomolecules like DNA and proteins found in the early stages of diseases. In the past, detection at extremely low concentrations has been challenging, but there have been new developments in nanotechnology for biomolecule detection and analysis. Researchers at SMU Lyle (Dallas, TX, USA) have combined DNA structures with solid-state nanopores (creating a 'hybrid nanopore' system) to enhance the detection of low-concentration proteins. Many diseases, such as cancer and neurodegenerative disorders, are marked by proteins present in very small quantities. The hybrid nanopore's ability to detect these low-concentration proteins could lead to earlier diagnoses and more effective treatment outcomes.[742]

Huge advances are expected to follow the final decoding of the entire human genome[743] in March 2022.[744] Cost and speed have fallen dramatically. A whole genome cost $100m in 2001, but in 2022 it was $400 and is anticipated to be just $100 by 2024. The development of CRISPR technology for editing genomes allows scientists to change DNA sequences and modify gene function, so that, for example, genetic defects can be corrected and the spread of diseases can be prevented.[745] Scientists claim that this will open the way to precision medicine for everybody. Professor Sir Mark Caulfield, former chief scientist at Genomics England, said: 'We have got a fabulous future. We have only scratched the surface of what the whole genome can offer'. The first benefit will be the early diagnosis of illness and personalized medicine. This will be followed by the correction of faulty genes

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[741] https://www.buckinstitute.org/lab/center-for-reproductive-longevity-and-equality/. See also: Hannah Kuchler (2024) Ovaries are an enigma that could unlock human lifespan, *Financial Times*, 1 February; https://www.ft.com/content/9599c28e-aa49-46fe-ace9-266bd4fe1023

[742] https://www.labmedica.com/clinical-chem./articles/294803382/biosensing-technology-breakthrough-paves-way-for-new-methods-of-early-disease-detection.html

[743] A human's complete set of DNA.

[744] Timeline - Genetic breakthroughs:

- December 1999 - First human chromosome is sequenced
- April 2003 - Heads of government of Britain, the US, Japan, France, Germany, and China announce the successful sequencing of the entire human genome
- September 2005 - The chimpanzee genome is sequenced
- December 2009 - The first comprehensive analysis of cancer genomes is published, including lung cancer and malignant melanoma
- May 2010 - The Neanderthal genome is sequenced
- December 2018 - The 100,000 genomes project is completed, sequencing 100,000 genomes from patients affected by a rare disease or cancer
- March 2022 - Scientists finally decode the entire human genome

Source: https://www.telegraph.co.uk/business/2022/08/19/britains-path-economic-national-renewal-genome-revolution

[745] Su Bin Moon, Do Yon Kim, Jeong-Heon Ko and Yong-Sam Kim (2019) Recent Advances in the CRISPR Genome Editing Tool Set, *Experimental & Molecular Medicine*, 51: 1–11.

via gene therapy. As an early example of gene therapy, scientists, using a technique called optogenetics, have added light-sensitive proteins to a man's retina, partially restoring his sight.[746] All this will help to reduce working age sickness and extend the working life, with knock-on benefits for the sustainability of the pension system.[747] Another example is the use of gene therapy to repair hearing loss caused by auditory neuropathy disrupting nerve impulses travelling from the inner ear to the brain as a result of a faulty gene.[748]

The success in the decoding of the human genome has led to the introduction of gnomic medicine which uses genomic information about an individual as part of their clinical care (e.g., for diagnostic or therapeutic decision-making).[749] Further, according to Yurkovich et al. (2023), 'By assessing and optimizing the health trajectory of each individual using a data-driven personalized approach that reflects their genetics, behaviour and environment, we can start to address [the challenges of an ageing population and its inherent burden of chronic diseases and rising costs]. This assessment includes longitudinal phenome measures, such as the blood proteome and metabolome, gut microbiome[750] composition and function, and lifestyle and behaviour through wearables and questionnaires'.[751] The first Center for Phenomic Health, whose aim is to 'fuel the future of healthy aging', was set up at the Buck Institute.[752]

Dr Verdin expects the first anti-aging drugs to become available on the market in the next 5-10 years, following the completion of successful clinical trials. He also believes the new drugs will revolutionize the whole process of medical intervention which have traditionally focused on treating a specific disease, like heart or lung disease: 'Aging biology presents a different way of organizing medicine and of treating disease. Aging affects every single organ, so if your intervention targets an aging pathway, you will affect the development of diseases in different organs. That doesn't fit in the traditional field of medicine. So, one of the biggest challenges we face… is convincing people that we should be studying disease in the context of pathways that are universal across different organs. We need to change the way that we practice medicine to aim for a preventative approach'.[753] This point is reinforced by Steven Braithwaite, chief scientific officer of Alkahest: 'Our long-term goal

[746] https://www.nytimes.com/2021/05/24/science/blindness-therapy-optogenetics.html
[747] https://www.telegraph.co.uk/business/2022/08/19/britains-path-economic-national-renewal-genome-revolution
[748] https://humanprogress.org/uk-toddler-has-hearing-restored-in-world-first-gene-therapy-trial/
[749] https://www.genome.gov/health/Genomics-and-Medicine;
https://www.genomicsengland.co.uk/genomic-medicine
[750] The collection of all microbes, such as bacteria, fungi, viruses, and their genes, that naturally live [in the gut]; https://www.niehs.nih.gov/health/topics/science/microbiome#.
[751] Yurkovich, J.T., Evans, S.J., Rappaport, N., Boore, J. L., Lovejoy, J. C., Price, N. D., and Hood, L. E. (2023) 'The Transition from Genomics to Phenomics in Personalized Population Health', *Nature Reviews Genetics*, https://doi.org/10.1038/s41576-023-00674-x. Phenomics is the systematic measurement and analysis of qualitative and quantitative traits, including clinical, biochemical, and imaging methodologies, for the refinement and characterization of a phenotype (https://www.sciencedirect.com/topics/medicine-and-dentistry/phenomics).
[752] https://www.buckinstitute.org/lab/center-for-phenomic-health/
[753] Interviewed in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.

is that we will develop therapeutics that modulate the biology of aging and will have impact across multiple disorders'.[754] Joan Mannick, chief medical officer of resTORbio, goes further: 'In the future we may be able to personalize aging-related therapeutics. For instance, it would be useful to develop biomarkers of aging-related biochemical pathways and then use therapeutics targeting specific biochemical pathways in …specific patients', similar to how cholesterol became a biomarker for the use of statins.[755] A huge investment is being made in healthcare innovation to slow the aging process by organizations like the Deep Knowledge Group.[756]

Governments are also setting up life science strategies. For example, the UK government introduced one in 2017 and updated it in 2021, building on the knowledge gained from the Covid-19 pandemic to tackle future disease missions, such as dementia research, the early-stage diagnosis and treatment of diseases such as cancer, and prevention of cardiovascular diseases. There will be greater use of genomics and health data to provide much deeper, real world evidence about the safety of new medicines and health technologies.[757] There will also be greater use of oncology medicines, such as AstraZenica's Enhurtu (for treating breast cancer), Tagrisso (lung cancer), Imfinzi (limited-stage small cell lung cancer) and Lynparza (ovarian cancer). Dave Frederickson, head of oncology at AZ, believes it will soon be possible 'to eliminate cancer as a cause of death'.[758]

In April 2022, leading life sciences companies and Innovate UK called for the development of a national vision on cell and gene therapies (CGTs) in the UK.[759] CGTs are treatments based on human cells or genes and a form of advanced therapy medicinal product (ATMPs). Compared to small molecules and protein-based treatments, such as monoclonal antibodies, which require repeated administration to treat the underlying conditions, CGT treatments offer a solution in which a single dose can provide a durable therapeutic effect. Nearly 300 new CGTs were currently in development, but the UK needs to scale-up its manufacturing capacity to meet demand for CGTs in future. There was also a compliance challenge, since CGTs often have a very short shelf life.

Genetic modifications in animals are helping to extend human life expectancy. An example is the first transplant of a genetically modified pig kidney into a living human at Massachusetts General Hospital in Boston in March 2024. Genetically modified pigs can

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[754] Steven Braithwaite, chief scientific officer, Alkahest, interviewed in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.
[755] Joan Mannick, chief medical officer, resTORbio, interviewed in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.
[756][756] https://www.dkv.global/
[757] https://www.pinsentmasons.com/out-law/news/genomics-and-health-data-central-to-uk-life-sciences-vision
[758] https://www.telegraph.co.uk/business/2023/01/27/meet-scientist-working-eliminate-terminal-cancer/; https://www.telegraph.co.uk/business/2024/04/05/pioneering-lung-cancer-drug-offers-hope-for-patients/
[759]
https://ct.catapult.org.uk/sites/default/files/publication/National%20Cell%20and%20Gene%20Therapy%20Vision%20for%20the%20UK.pdf

provide kidneys, livers, and hearts to help overcome the shortage of these organs for people who need transplants. The pigs' DNA is genetically modified so the organs will not be rejected by the human body. Other gene-editing and cloning technologies are also being used to solve the shortage of organs for human transplantation.[760]

Neuroscientist Ariel Zeleznikow-Johnston predicts that one day it will be possible to 'abolish death' by recording an individual's 'connectome' (a map of brain connections) before they died and then using low-temperature 'vitrification' to preserve the brain in such a state that future technology would be able to read its connectome and recreate it.[761]

Amongst these positive developments, there have been some negative ones. A key example in 2022 was the exposure by the journal *Science* in July that the study by Lesné et al (2006) published in the journal *Nature* on the causes of Alzheimer's disease may have been based on evidence tampering using 'manipulated' data.[762] The 2006 study concluded that Alzheimer's is triggered by a build-up of amyloid beta plaques in the brain following experiments in which amyloid beta injected into young mice brought on dementia. However, the *Science* investigation claims to have found evidence that the images of amyloid beta in mice had been doctored by combining photos from different experiments. German psychiatrist Alois Alzheimer first identified plaques in the brains of dementia patients in 1906 and in 1984 amyloid beta was found to be their main component. Hundreds of different therapies targeting amyloid in the brain were trialled, but since they all failed, futher experimentation was abandoned until the 2006 paper. Since then billions of dollars have been spent trialling new therapies to remove amyloid from the brain – again without success. Yet in June 2022, the US Food and Drug Administration approved the drug aducanumab (marketed as Aduhelm) to slow cognitive decline in people with mild memory and thinking problems. It was the first approved treatment to attack the disease process of Alzheimer's instead of just addressing dementia symptoms. This was despite the fact that the FDA's own independent advisory committee argued that there was insufficient evidence that the drug – which costs $56,000 a year – can help patients.[763] The authors of the 2006 paper responded by saying they 'still have faith' that amyloid is a cause of Alzheimer's. Alzheimer's Research UK said: 'the research that has been called into question is focused on a very specific type of amyloid, and these allegations do not compromise the vast majority of knowledge built up during decades of research into the role of this protein in the disease'.[764]

[760] https://www.npr.org/sections/health-shots/2024/03/21/1239790816/first-pig-kidney-human-transplant
[761] Ariel Zeleznikow-Johnston (2024) *The Future Loves You: How and Why We Should Abolish Death*, Allen Lane, London.
[762] https://www.science.org/content/article/potential-fabrication-research-images-threatens-key-theory-alzheimers-disease
[763] https://www.nytimes.com/2021/06/07/health/aduhelm-fda-alzheimers-drug.html
[764] https://www.telegraph.co.uk/news/2022/07/21/manipulated-alzheimers-data-may-have-misled-research-16-years/

Another negative development is the finding by Binghamton University in the US that early retirement can accelerate cognitive decline at older ages. The finding was based on an examination of China's New Rural Pension Scheme (NRPS) and the Chinese Health and Retirement Longitudinal Survey (CHARLS). The most significant indicator of cognitive decline was delayed recall which is an important predictor of dementia and was associated with increased social isolation. The findings were similar to those in higher income countries, such as the US, UK, and EU.[765]

Yet another negative development is what has been described as a mysterious new 'epidemic' of abdominal cancers in younger people. It could be partly genetic. For example, one in 350 people have Lynch syndrome, a hereditary cause of bowel, womb, ovary and pancreatic cancers. Increasing survival rates will increase the numbers with the syndrome in subsequent generations. It could also be due to changes to the gut microbiome, since the composition of gut bacteria – as a result of dietary or environmental factors – can influence inflammation levels and increase the risk of early-onset cancer.[766]

As a final example, Gilmer et al. (2023) point out that female-specific aging trajectories are understudied. While the use of model organisms, such as worms, fruit flies, and mice, has helped researchers understand many aging processes, most do not match human sex specificity. As a result, there is a lack of data on how pregnancy, breastfeeding, and menopause impact aging-related diseases. Animal research is based on the assumption that the model organisms and humans have similar physiological characteristics, but there are significant differences between the physiology of these organisms and female reproductive biology. One example is bone mass: the bone mass of female rodents does not decline more than that of male rodents, but human females experience osteoporosis four times more often than human males. Similarly, with Alzheimer's disease and other types of dementia: these are more common in human females than age-matched human males, but female rodents have better retained memory-related functions over time than age-matched male rodents. The consequence is worse health outcomes with higher morbidity in the female population than age-matched human males. The authors recommend funding for more research on the impact of menopause, pregnancy, and breastfeeding on aging and disease progression and the use proper animal models and experimental setups, thus improving how their studies handle the particular ways in which females age.[767]

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[765] https://www.pensionpolicyinternational.com/early-retirement-can-accelerate-cognitive-decline-among-the-elderly-research-shows/

[766] https://www.telegraph.co.uk/news/2024/03/23/doctors-warn-abdominal-cancer-epidemic-princess-diagnosis/

[767] Gabrielle Gilmer, Zachary R. Hettinger, Yetsa Tuakli-Wosornu, Elizabeth Skidmore, Julie K. Silver, Rebecca C. Thurston, Dawn A. Lowe and Fabrisia Ambrosio (2023) Female aging: when translational models don't translate, Nature Aging, 3: 1500–1508.

Preventative health care and later life wellness

The previous subsection highlights the importance of preventative health care – given how expensive it is to treat noncommunicable diseases, such as heart disease, cancer, diabetes, and dementia, which account for around 70% of deaths globally.

The OECD estimates that around 40% of cancer cases are preventable and mortality can be reduced through earlier diagnosis and the provision of more timely and effective treatments. Confirmation of this comes from the UK. Lung cancer is the most lethal form and in the UK it causes an average of 35,000 deaths per year, where the average stage of diagnosis is Stage 3. There was no nationwide screening program, but in 2019, the NHS introduced a lung cancer screening pilot scheme using low dose CT scanning for current and ex-smokers aged between 55 and 75, with 77% of patients being diagnosed with lung cancer at Stages 1 or 2 (compared with 33% previously). In October 2022, the NHS began to roll out of the program nationally.[768]

A multi-cancer early detection test has been developed by Galleri.[769] It is a simple blood test that screens for many of the deadliest cancers before they become symptomatic. Currently, only five cancer types have specific screening tests: colorectal, lung, breast, cervical, and prostate. The Galleri test can detect more than 50 kinds of cancer. According to Professor Eric Klein of the Glickman Urological Kidney Institute: 'Twelve cancers, including anal, bladder, colorectal, esophageal, head and neck, liver/bile-duct, lung, lymphoma, ovary, pancreatic, plasma-cell neoplasm and stomach cancer, account for about two-thirds of all cancer deaths in the US. For these 12, Galleri finds about 40% of stage I cancers, 67% of stage II cancers, 80% of stage III cancers and 95% of stage IV cancers. Galleri can detect these cancers because of the DNA it sheds into your bloodstream. That means it doesn't detect cancers that don't shed DNA into your bloodstream, like brain cancer. Galleri has a 0.5% false-positive rate, which means it's highly accurate. It finds 51.5% of cancers. And it's 89% effective in predicting where the cancer started'.[770]

Around a million people in the UK have dementia, mostly Alzheimer's. About a third of people born in the UK are likely to experience dementia in their lifetime, according to recent estimates. It is the main cause of death, but current drugs (which cost £34.7bn annually) only help symptoms and do not stop progression.[771] A 2019 analysis based on the Global Burden of Disease database predicted that the number of people with dementia would increase from 57.4m cases globally in 2019 to 152.8m cases in 2050. However, although dementia has been increasing globally, there is evidence that, when controlling for population aging, the prevalence has actually fallen in recent years. A 2020 study – led

[768] Murray et al. (2022).
[769] https://www.galleri.com
[770] https://health.clevelandclinic.org/the-galleri-test
[771] Sarah Knapton (2023) Alzheimer's could cause brain cells to kill themselves, *Daily Telegraph*, 15 September; https://www.telegraph.co.uk/news/2023/09/15/dementia-researchers-uncover-why-brain-cells-die/

by Francine Grodstein, professor of internal medicine at the Rush Alzheimer's Disease Center in the US – that followed the health of around 50,000 over-65s found the incidence rate of new cases of dementia in Europe and North America had dropped 13% per decade over the past 25 years.

The reasons are not currently well understood, but some scientists have put it down to improved cardiovascular health (how effectively the body's arteries and veins carry blood to and from the heart) and especially the vascular health of the brain.[772] Professor Albert Hofman, chair of the department of epidemiology at the Harvard TH Chan School of Public Health, says that: 'In North America and in Western Europe, there has been for 50 years now an enormous emphasis on preventing cardiovascular diseases . . . that led to heart attacks and strokes', adding that a third of the population over 50 now takes pills to control high blood pressure and the use of statins to reduce cholesterol has soared. Carol Brayne, professor of public health medicine at the University of Cambridge and the lead investigator of the Cognitive Function and Ageing Studies, argues that reducing the incidence of dementia requires 'optimizing neurological function' throughout the course of a person's life by improving brain and physical health. A 13% decline would mean 15m fewer dementia cases by 2040 in high-income countries. Another important factor is 'cognitive reserve': people with more active brains are better able to delay the effects of dementia. Brayne found, using brain samples, that 'the higher the level of education, in terms of years of exposure, the less likely you were to express dementia during your lifetime'. Brayne also discovered that the fall in dementia cases was lower in deprived areas, suggesting that there was a social link between dementia and the quality of nutrition and housing. Responding to this finding, Dr Susan Mitchell, head of policy at Alzheimer's Research UK, said: 'with [the] increased prevalence of diabetes [and] obesity [which are] risk factors for dementia, we may see the incidence rates start to increase in the future'. As supporting evidence for this, a 2023 study published by *The Lancet Public Health*, indicated that dementia incidence decreased in England and Wales by 28.8% between 2002 and 2008, but increased again by 25.2% between 2008 and 2016.

A 2020 *Lancet* study found that about 40% of dementia was preventable if people improved their mid-life health. Jonathan Schott, professor of neurology at the Dementia Research Centre at UCL, argues that 'it may well be that the lowest hanging fruit in terms of preventing dementia, in the western world at least, has already been [reaped]. But considerable scope remains to improve things in more disadvantaged communities and in poorer countries. So there's still a huge amount to be done in the developing world where those vascular risk factors perhaps aren't being looked after as well'. Scientists now believe

[772] The US Centers for Disease Control and Prevention defines brain health as an ability to perform all the mental processes of cognition, including the ability to learn and judge, use language, and remember (What is a Healthy Brain? New Research Explores Perceptions of Cognitive Health Among Diverse Older Adults. Centers for Disease Control and Prevention: Healthy Aging; https://www.cdc.gov/aging/pdf/perceptions_of_cog_hlth_factsheet.pdf) and has established the Healthy Brain Initiative Road Map (Road Map for State and Local Public Health: Healthy Brain Initiative. Centers for Disease Control and Prevention: Alzheimer's Disease and Healthy Aging program; https://www.cdc.gov/aging/healthybrain/roadmap.htm).

that preventive measures combined with new drugs is the best way of dealing with dementia.[773]

Professor Andrew Scott points out: 'The dominant cause of many noncommunicable diseases is age itself. This suggests that efforts to slow the aging process should play a more prominent role in treatments rather than targeting particular diseases, such as cancer. A growing research program is focusing on understanding why we age and developing treatments that, if successful, could lead to dramatic changes in the malleability of age'.[774]

Examples of these developments include:

- Periodic fasting or caloric restriction has been shown to be one of the most effective ways of preventing age-related disorders and promoting life expectancy and health span. The first study to examine caloric restriction in humans was the Comprehensive Assessment of Long-Term Effects of Reducing Intake of Energy (CALERIE) at Duke University.[775] It showed that two years of caloric restriction could slow biological aging and reduce age-related markers, such as oxidative stress.[776]
- Diets and food supplements designed to treat age-related disorders. The Buck Institute's Dr Eric Verdin reports the development of fasting-mimicking diets. There are also caloric restriction mimetics, supplements that offer the health-promoting effects of fasting, without the need for fasting. Metformin (previously used in the treatment of type-2 diabetes) is being examined as a drug for increasing healthspan by Dr Nir Barzilai, Professor of Medicine and Genetics and Director of the Institute for Aging Research at the Albert Einstein College of Medicine in New York, in his TAME (Targeting Aging with Metformin) trial.[777] Similarly, methionine, an amino acid that plays an important role in the metabolism, is being considered for the treatment of age-related disorders. Singapore-based Senescence Life Sciences aims to use nutraceuticals – ingredients and raw materials for dietary supplements – to combat natural brain aging by targeting an enzymatic process that has been shown to restore classical neuronal indicators of age – including learning, memory and decision-making performance.[778] Food companies are promoting

[773] Sarah Neville (2023) What is behind the unexpected decline in dementia?, *Financial Times*, 30 October; https://www.ft.com/content/184f6e81-d9ce-4a14-84f0-5190ea36e798.
[774] Andrew Scott (2020) The Long, Good Life: Longer, more productive lives will mean big changes to the old rules of aging, *Finance and Development*, March.
[775] https://calerie.duke.edu/
[776] Carla Heyworth (2020) Metabolic aging, fasting and metformin, *Longevity Technology*, 10 March; https://www.longevity.technology/metabolic-aging-fasting-and-metformin/
[777] Carla Heyworth (2020) Metabolic aging, fasting and metformin, *Longevity Technology*, 10 March; https://www.longevity.technology/metabolic-aging-fasting-and-metformin/
[778] Danny Sullivan (2020) Nutraceuticals to beat cognitive decline before it starts, *Longevity Technology*, 16 March; https://www.longevity.technology/nutraceuticals-to-beat-cognitive-decline-before-it-starts

'future food' which combines healthier eating and leveraging agricultural gene editing.[779]

- Recognition that low concentrations of circulating 25-hydroxyvitamin D (25[OH]D), a metabolite used as a clinical indicator of vitamin D status, are associated with an increased risk of cardiovascular disease and all-cause mortality, as well as other chronic diseases.[780]
- Developing a wearable device to detect early signs of Alzheimer's disease as part of the Early Detection of Neurodegenerative diseases (EDON) project run by Alzheimer's Research UK. EDON will analyze data from existing studies using artificial intelligence and use the results to design a prototype device within three years. The wearable will then collect data on gait, heart rate and sleep patterns etc which can be used to identify signs of the disease years before symptoms develop.[781]
- Neural engineering to deal with destructive addictions, such as alcohol and drug dependency. Addictions and also neurological conditions like Parkinson's disease are linked to dopamine, the so-called pleasure chemical. Parkinson's gradually kills off dopamine-producing cells in the brain, but new therapeutic approaches involve replacing the lost dopamine. One example involves delivering the gene for the protein glial-derived neurotrophic factor (GDNF) into the brain, which then encourages dopamine production. Professor Krystof Bankiewicz from Ohio State University has published a study in *Nature Medicine* which assesses whether delivering GDNF to brain areas associated with addiction and reward through gene therapy could help reconfigure the dysfunctional brain pathways of alcoholics. The study involved macaque monkeys which, like humans, enjoy alcohol, but lost interest when given GDNF therapy. Bankiewicz said 'we have to view all brain disorders, such as addictions, through the lens of different wiring. The brain is incredible at organizing connections, but certain individuals are more predisposed to being wired in certain ways'. Re-engineering the brain to alter human behaviour is a new field in medicine and is a response to the ineffectiveness of traditional psychotherapies, such as cognitive behavioural therapy where 60% of patients with alcohol dependency relapse within a year. Research is now showing that addictions also have a genetic origin. Certain genes (and their mutations) in the brain, linked to impulsivity, can create innate urges when exposed to addictive substances. For example, the melanocortin 4 receptor (MC4R) gene senses fatness and a mutation causes some people's brain to believe they are less fat than they are, leading to overeating.
- Semaglutide-based weight-loss drugs, such as Wegovy (which is licensed as Ozempic for type-2 diabetes), deliver a synthetic version of the hormone GLP-1 (Glucagon-Like Peptide-1) which acts on the brain to create a sense of fullness. An Oxford University study found that Ozempic reduced the risk of Parkinson's

[779] Aging Analytics Agency, *Advancing Financial Industry: Longevity/AgeTech /WealthTech*
[780] https://www.labmedica.com/clinical-chem./articles/294790627/vitamin-d-deficiency-has-greater-risk-for-all-cause-mortality.html
[781] Jane Wakefield (2020) Wearable to spot Alzheimer's being developed, *BBC News*, 13 February.

disease and dementia by up to 48%, as well as the risk of developing the brain inflammation encephalitis.[782] It could also be used to treat addictions, since it helped to reduce alcohol and nicotine use.[783] A number of studies presented at the European Society of Cardiology Conference 2024 suggested that Ozempic could offer 'the fountain of youth' by turning back the clock on a number of diseases, in addition to Alzheimer's and Parkinson's, such as diabetes and cancer. These diseases have been linked to inflammation of the immune system which Ozempic helps to reduce. It could also control previously untreatable blood pressure, reverse kidney disease, and 'revolutionise cardiovascular care'. However, there could be side effects, such as nausea, bloating and gas.[784]

- There are also examples of non-invasive brain stimulation which avoid the potential side effects associated with pharmacological drugs. One is transcranial magnetic stimulation (TMS) which can help people stop smoking, according to a study published in *Nature Communications* and led by Professor Barbara Sahakian from the University of Cambridge. She said: 'In smoking, this area of the brain [the left ventromedial prefrontal cortex which is involved in willpower and feelings of pleasure] gets reduced, so then behaviour becomes disinhibited and that may be why smoking cigarettes can often lead on to marijuana and alcohol use. The hope might be that this reduction can be mitigated by transcranial stimulation, and thereby you could re-establish inhibitory control'. The aim of TMS is to adjust the brain's reward, motivation and decision-making circuits in a way which reduces the cravings. In a similar vein, a study published in *Current Psychology* by scientists at the University of Messina in Italy found that applying low-level electrical activity to areas of the prefrontal cortex, which influences social skills, could help limit aggression, impulsivity and promote empathy – and hence help to reintegrate those with antisocial personality disorders, such as criminals, back into society. These are all different approaches for adjusting the chemicals, hormones and networks in the brain to alter damaging behaviour. However, this raises ethical issues, as Professor Bankiewicz points out: 'I believe that these therapies will drive a permanent change in those who have incurable addictions. But would that predispose them to be more reckless, knowing that there is something available? It's a good question, and I don't know the answer. Perhaps in some people, maybe not in others'. There are also safety concerns when it comes to gene therapy, such as the possibility that it could lead to cancer, as well as the ethical issues associated with changing an individual's behaviour and personality, possibly permanently. Bankiewicz argues that such therapies require weighing up the risks and benefits,

[782] There is another ongoing study, called Evoke/Evoke+, which is investigating the use of semaglutide in people with early Alzheimer's disease and is sponsored by Novo Nordisk, the developer of Wegovy; https://www.alzheimer-europe.org/research/clinical-trials/evoke-0

[783] https://www.telegraph.co.uk/news/2024/07/11/ozempic-could-cut-the-risk-of-dementia-by-half-oxford-study

[784] https://www.telegraph.co.uk/news/2024/08/30/ozempic-offers-fountain-of-youth-studies-find; https://www.bbc.com/news/articles/ce81j919gdjo; https://www.telegraph.co.uk/news/2024/12/25/ozempic-could-help-patients-with-alzheimers/

and they should only be considered for those with very severe addictions and where all other approaches have failed.[785]

- The development of the Lenacapavir jab which protects against HIV for six months. The cost of the treatment exceeds $40,000 per annum, but it is hoped that this can be reduced to as little as $100.[786]

Equally important are measures that contribute to later life wellness, which, in turn, are likely to increase both lifespan and healthspan. Examples include:

- Lifestyle medicine management. This has six pillars: restorative sleep, stress management and mental wellbeing, healthy eating, exercise, avoiding substance abuse, and healthy relationships. The most important of these is exercise (a minimum of three times a week for 20 minutes each, ideally outdoors in order to commune with Nature (i.e., biophilia)).[787] But much more work needs to be done to understand the link to life expectancy, as Dr Verdin points out: 'How exactly does exercise impact longevity? We know it does, but we don't know what forms of exercise are effective – endurance vs high intensity interval training? 10,000 steps vs 4,000 steps? We need molecular-level data to increase our knowledge'.[788,789]
- Reducing non-adherence to medication. The World Health Organization has estimated that adherence to medication for chronic conditions is as low as 50% in developed countries and even lower in developing countries. The annual costs of medication non-adherence range from $100bn to $290bn in the USA, €125bn in Europe and AU$7bn in Australia. Around 10% of hospitalizations in older people are attributed to non-adherence. The typical non-adherent patient requires three extra medical visits per year, leading to increased treatment costs of $2,000 per annum. The International Longevity Centre (UK) said: 'We could see a considerable improvement in health outcomes (and consequently longevity), not only by developing new drugs, but by helping people adhere to existing treatment regimens that have already been researched, tested and prescribed for them'.[790]

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[785] David Cox (2023) New research suggests neural engineering could spell the end of humanity's destructive addictions – but at what cost?, *Daily Telegraph*, 2 September; https://www.telegraph.co.uk/health-fitness/mind/brain-tweaking-addiction-transcranial-magnetic-stimulation/

[786] https://www.telegraph.co.uk/global-health/science-and-disease/miracle-hiv-drug-lenacapavir-to-revolutionise-prevention

[787] Noel McDermott, CEO of Mental Health Works; https://bslm.org.uk/lifestyle-medicine/what-is-lifestyle-medicine/

[788] Interview in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.

[789] A variation of this is the ReCODE (reversal of cognitive decline) Protocol proposed by Dr Dale Bredesen. This involves increasing brainspan by avoiding: ultra-processed food, obesity, poor oral health, viruses and inflammation, stress, and toxins. See: Dale Bredesen (2025) *The Ageless Brain: How to Sharpen and Protect Your Mind for a Lifetime*, Ebury Publishing , London.

[790] https://ilcuk.org.uk/doctors-orders/

- The living environment. Where you live can have a significant impact on the likelihood that you will reach centenarian age, according a study from Washington State University's Elson S. Floyd College of Medicine. Washingtonians who live in highly walkable, mixed-age communities may be more likely to live to their 100th birthday. The study also found socioeconomic status to be correlated, and an additional analysis showed that geographic clusters where the probability of reaching centenarian age is high are located in urban areas and smaller towns with higher socioeconomic status. Existing research estimates that heritable factors such as genes only explain about 20% to 35% of an individual's chances of reaching centenarian age.[791]
- Targeting products and services at older people with the intention of improving their wellbeing and indirectly their life and healthspans. Companies doing this are not being altruistic. Rather they recognize the financial resources available to this demographic in developed countries. In the US, for example, people over 50 control 75% of net wealth and 50% of disposable income and will spend around $4trn over the next twenty years. Tech companies like Amazon, Apple and Google are looking at designing new products and services for this group. Agetech[792] in the form of digital health platforms and telemedicine is providing access to cost-effective healthcare, in combination with medical software and apps.[793] Agetech also targets other aspects of wellbeing, such as education and financial wellness.[794]
- The promotion of a 'positive outlook' to reduce memory decline. A study finds that people who feel enthusiastic and cheerful – what psychologists call 'positive affect' – are less likely to experience memory decline as they age, controlling for age, gender, education, depression, negative affect, and extraversion. This result adds to a growing body of research on positive affect's role in healthy aging.[795]

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[791] Centenarian study suggests living environment may be key to longevity, Washington State University, 17 June 2020; https://news.wsu.edu/2020/06/17/centenarian-study-suggests-living-environment-may-key-longevity/

[792] Defined as the digital-enabled market of consumers over 50. It relies on this age group being willing and able to access the market digitally.

[793] Angela Tyrrell (2020) Eight sectors to be disrupted by longevity, *Longevity Trends 2020*, published by Longevity Leaders, January 2020.

[794] Angela Tyrrell, SVP, Longevity Leaders, identifies ten consumer trends driving the preventative wellness market: 1) digital tracking tools (e.g., for counting steps, logging calories, tracking ovulation or recording sleep patterns), 2) consumer biological testing (e.g., personalized DNA testing to improve lifetime health management), 3) personalization (of, e.g., nutrition and skincare), 4) responding to climate change (e.g., by driving less and walking or cycling more), 5) meat alternatives, 6) alcohol alternatives, 7) natural products (without preservatives, sugar and salt), 8) mental health awareness (leading to diagnoses and treatments that reduce cognitive decline in later life), 9) meditation and mindfulness programs (to reduce stress, improve sleep quality or breathing, or accompany a physical activity such as yoga), and 10) Ethical leadership (e.g., via a corporate and social responsibility policy that enhances a company's reputation with its customers and, as a consequence, has long-term benefits for the health of its employees). See *Longevity Trends 2020*, published by Longevity Leaders, January 2020.

[795] Emily F. Hittner, Jacquelyn E. Stephens, Nicholas A. Turiano, Denis Gerstorf, Margie E. Lachman, Claudia M. Haase (2020**).** Positive Affect Is Associated With Less Memory Decline: Evidence From a 9-Year Longitudinal Study, *Psychological Science*, 31(11), 1386-1395.

- In 2023, Peter Attia MD published 'Outlive: The Science & Art of Longevity', which explores the science of not just prolonging life, but also prolonging aliveness. The book is described as a 'groundbreaking manifesto on living better and longer that challenges the conventional medical thinking on aging and reveals a new approach to preventing chronic disease and extending long-term health'. Attia argues that mainstream medicine has failed to make much progress against the diseases of aging that kill most people: heart disease, cancer, Alzheimer's disease, and type 2 diabetes. Too often, it intervenes with treatments too late to help, prolonging lifespan at the expense of healthspan, or quality of life. He recommends that we must replace this outdated framework with a personalized, proactive strategy for longevity, one where we take action now, rather than waiting.

These developments led Bank of America to conclude that the human lifespan could soon pass 100 years for significantly more people than historically,[796,797] with one of the biggest investment opportunities over the next decade being in companies working to delay human death, a market expected to be worth at least $600bn by 2025.[798] To illustrate, in June 2021, M&G Investments launched the Better Health Solutions fund which will invest in companies whose products or services are designed to promote better health and wellbeing.[799] Investment in the biotech sector reached $5.2bn globally according to analysts at Longevity.Technology, with 130 deals in 2022.[800] This compares with $6.2bn (190 deals) in 2021 and $3.0bn (148 deals) in 2020. The largest investment in 2022 was Jeff Bezos's $3bn financing for Altos Labs which focuses on cellular reprogramming. The

[796] Centenarians make up around 0.03% of the population in both the UK and US, but as the *Economist* conjectures: 'Living to 100 today is not unheard of, but is still rare. …Should the latest efforts to prolong life reach their potential, living to see your 100th birthday could become the norm; making it to 120 could become a perfectly reasonable aspiration'; https://www.economist.com/leaders/2023/09/28/living-to-120-is-becoming-an-imaginable-prospect

[797] Lynda Gratton and Andrew J. Scott's book *The 100-Year Life* provides a 'raft of solutions, showing how to rethink your finances, your education, your career and your relationships and create a fulfilling 100-year life', including:

- How can you fashion a career and life path that defines you and your values and creates a shifting balance between work and leisure?
- What are the most effective ways of boosting your physical and mental health over a longer and more dynamic lifespan?
- How can you make the most of your intangible assets – such as family and friends – as you build a productive, longer life?
- In a multiple-stage life how can you learn to make the transitions that will be so crucial and experiment with new ways of living, working and learning?

The book is 'also fundamentally a call to action for individuals, politicians, firms and governments and offers the clearest demonstration that a 100-year life can be a wonderful and inspiring one' (Gratton and Scott (2016)). A subsequent book, Scott (2024), continues with this theme: 'Our longer lives can be a source of hope and fulfilment if we seize the opportunity to pursue the evergreen agenda, one in which we pursue a sustainable lifestyle both for ourselves as individuals – investing in our finances, health, skills and relationships to support a longer life – and for the planet'.

[798] https://www.cnbc.com/2019/05/08/techs-next-big-disruption-could-be-delaying-death.html

[799] https://www.professionaladviser.com/news/4033150/unveils-impact-fund-focusing-health-wellbeing

[800] https://longevity.technology/news/global-longevity-investment-hit-5-2-billion-in-2022/

Hevolution Foundation was also established. This is a Saudi-backed non-profit organization with an annual budget of up to $1bn to spend on 'independent research and entrepreneurship in the emerging field of healthspan science'.[801] The leading longevity domains are 'Longevity discovery platforms', 'Longevity drugs', renewal therapies ('Regeneration', 'Rejuvenation', 'Cellular reprogramming') and 'Gene therapies'.[802]

In order to take advantage of this increase in human lifespan, companies should exploit the longevity dividend, i.e., recognize the value of their older workforce and do not force them into retirement before they are ready to leave. Forced early retirement can have the effect of harming health and reducing life expectancy because of depression and loss of self-worth which can, in turn, lead to alcoholism, excessive drug use and suicide.[803] Mercer's Next Stage research program, for example, showed that age and experience enhance business performance. Companies that use data analytics and business impact modelling to examine their own organizational demographic data have discovered some key drivers of business performance. To illustrate:

- Experienced workers lower costs because they – and the people they supervise – are less likely to leave. A 5% reduction in turnover saved one of Mercer's clients $66m in cost per unit.
- Experienced workers increase productivity. Branch revenue at one US bank increased by $40m per year for each year of extra service/age of its sales team.

An important aspect of this is life-long learning in order to increase later-life productivity. This is being promoted, for example, as part of a project called 'Living, Learning and Earning Longer'[804] by the OECD, the World Economic Forum, and the American Association of Retired Persons (AARP). Another aspect of the longevity dividend to companies from their employees working longer is potentially lower pension liabilities since additional pensions contributions are made and the pension, when it is paid, is drawn for a shorter period on average.[805] Society also benefits from the increase in healthspan associated with the longevity dividend as a result of lower later-life healthcare costs.[806]

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[801] https://longevity.technology/news/hevolution-ceo-on-how-to-spend-1-billion-a-year-on-longevity/

[802][802] https://longevity.technology/investment/report/annual-longevity-investment-report/

[803] There is some evidence for this in the US. See, for example, Kate W. Strully (2009) Job Loss and Health in the U.S. Labor Market, *Demography*, 46(2): 221–246; Clemens Noelke and Jason Beckfield (2014) Recessions, Job Loss, and Mortality Among Older US Adults, *Am J Public Health*, 104(11): e126–e134; and Anne Case and Angus Deaton (2015) Rising Morbidity and Mortality in Midlife Among White Non-Hispanic Americans in the 21st Century, *Proceedings of the National Academy of Sciences of the United States of America*, December 8, 2015 112 (49) 15078-15083.

[804] https://www.aarpinternational.org/initiatives/future-of-work/living-learning-and-earning-longer

[805] Yvonne Sonsino, Global Co-Leader of Next Stage, Mercer, interviewed in *Longevity Trends 2020*, published by Longevity Leaders, January 2020.

[806] For a typical individual, around 70% lifetime healthcare costs occur in the last 3 years of their life. This is the sum of 47.1% for long-term care costs (average across 5 countries: Denmark, Germany, Netherlands, Taiwan and US) and 22.9% for hospital costs (average across 9 countries: Denmark, Germany, Netherlands, Taiwan, US, England, France, Japan and Quebec). See: Eric B. French et al. (2017) End-of-

Another important aspect is financial wellbeing. The US Consumer Financial Protection Bureau argues that: 'A person's financial wellbeing comes from their sense of financial security and freedom of choice – both in the present and when considering the future. …[A]dults' financial wellbeing [is influenced by]: income and employment; savings and safety nets; past financial experiences; and financial behaviours, skills, and attitudes'.[807] A survey by WTW found that following the pandemic, employers in the UK had become more concerned about the financial wellbeing of their employees, with 80% saying that they were planning to introduce a financial wellbeing strategy. In addition to retirement savings, this could cover debt solutions, emergency savings and saving for housing. The main reasons given were that it supported broader welfare initiatives (including employee health), it enhanced employee benefits at a time of acute labour shortages, and it recognized employer duty of care.[808] Pension schemes have also begun to offer financial wellness services to their members. On example in the UK is the Royal Mail Defined Contribution Pension Scheme which has chosen Destination Retirement from HUB Financial Solutions as a service to support scheme members making key financial choices in the run-up to retirement and beyond.[809]

A 2022 report[810] from the Geneva Association and the Global Aging Institute, while accepting that ensuring financial wellbeing was the core purpose of life insurance, argued that 'traditional business models have come under stress as socio-economic, demographic, health and technological developments, [and] combined with a protracted period of low interest rates, have dented the appeal of savings-oriented life insurance globally'. To counteract this, the report made four recommendations for insurers:

- *Step up efforts to directly affect the determinants of savings and risk protection.* Inherent in the concept of financial wellbeing is an ecosystem of consumer needs that transcends the traditional products offered by life insurers. If life insurers wish to position themselves more strategically, they will have to redefine their role to include directly affecting the determinants of retirement savings and risk protection through pathways such as education, advisory services, mentoring and financial incentives in partnership with government, financial advisers and wealth and asset managers. Doing so will require insurers to either create or buy new capabilities, or else partner to bring them in.
- *Promote financial literacy in young age.* The lack of attention to financial education leaves the young ill-prepared to navigate the insecurities of the current labour market and successfully prepare for their eventual retirement. It also overlooks the opportunity to cement the role of life insurance at an early age. With a relatively

Life Medical Spending in Last Twelve Months of Life is Lower than Previously Reported, *Health Affairs*, 36(7): *Advanced Illness & End-Of-Life Care*; https://doi.org/10.1377/hlthaff.2017.0174

[807] https://www.consumerfinance.gov/data-research/financial-well-being-survey-data/

[808] https://www.wtwco.com/en-GB/Insights/2021/05/future-of-financial-wellbeing-survey-2021

[809] https://www.ipe.com/news/uk-roundup-house-of-fraser-plan-strikes-600m-buyout/10060379.article

[810] Financial Wellbeing: Is it the key to reinventing life insurance?, May 2022; https://www.genevaassociation.org/financial-wellbeing-report

modest investment, insurers can partner with national educational agencies, schools, communities and digital platforms to develop innovative ways of propagating financial knowledge, including by gamifying it, using social media and leveraging word of mouth and 'influencers'.

- *Improve risk exposure through preventive measures.* Very few life insurers cited limiting risk exposure as a primary motivation for developing new financial wellbeing products. Yet there are strong connections between financial wellbeing, general wellbeing and risky behaviours. Altering these behaviours will require insurers to embed data science at the heart of their products and indeed to see it as a key to understanding needs, shifting the paradigm from repair/replace to predict/prevent. Similarly, using data science to better integrate health and wellness products could have significant benefits.
- *Tap into the longevity economy.*[811] Life insurers' efforts to tap into the burgeoning longevity sector are currently modest. There is also little to suggest that their products address changing retirement patterns, such as unretirement, phased retirement and new careers post-retirement, or changing family structures, including shifts in multigenerational living arrangements. New solutions such as silver sabbaticals to enable middle-aged adults to re-skill and to encourage longer working lives as well as supplementary health and care benefits that take over where government leaves off could help insurers unlock the potential of the silver economy and increase their relevance to aging societies.

The silver economy focuses on goods and services for older adults. In October 2024, a study by Technopolis Group and Oxford Economics predicted that the silver economy would contribute €6.4trn to the EU's GDP by 2025 and support 88 million jobs. The key growth areas are healthcare (including telemedicine, smart home technologies, and care services), technology, leisure and tourism. Broader than the silver economy is the longevity economy which recognises the potential for older adults to be active contributors to society, as well as consumers. One way of doing this is to enhance the digital skills of seniors, as is happening in Slovakia, for example: 'New technologies contribute to slowing down aging, improving cognitive functions, and strengthening memory', according to Slovak Minister, Richard Rasi.[812]

[811] This is generally defined as the economic activities of people aged 50 years and over. In the US, four generations are currently involved: the GI Generation (1901-1926), the Silent Generation (1927-1945), the Baby Boomers (1946-1964) and Generation X (1965-1980); https://www.pensionpolicyinternational.com/us-what-the-longevity-economy-means-and-why-its-important/. See also Joseph F. Coughlin (2017) *The Longevity Economy: Unlocking the World's Fastest-Growing, Most Misunderstood Market*, PublicAffairs. Coughlin director of the Massachusetts Institute of Technology AgeLab.

[812] https://www.pensionpolicyinternational.com/from-ageing-to-active-living-working-through-old-age-in-eu/

In January 2024, the World Economic Forum introduced six Longevity Economy Principles with the aim of seizing the opportunities associated with a new era of longevity and generational rebalancing as well as navigating the challenges ahead:[813]

1. Financial Resilience Across Key Life Events: Life is unpredictable. From career breaks to unexpected health issues, financial resilience is crucial. The WEF advocates for robust social safety nets and innovative financial products to help individuals navigate these challenges. This requires collaboration between public policies and private sector innovations to prevent financial hardship and promote stability.
2. Embedding Financial Literacy: The WEF says only a third of people globally could be described as financially literate. This contributes to inequalities not just in wealth but also in life expectancy. Knowledge is power, especially when it comes to managing finances. The WEF emphasizes the need for universal access to financial education. By improving financial literacy, individuals can make informed decisions that enhance their economic security and overall well-being.
3. Prioritizing Prevention for Healthy Aging: A longer life should also mean a healthier life. The principles advocate for shifting the focus of healthcare towards prevention and equitable access to medical services. By promoting health maintenance over disease treatment, societies can ensure that people not only live longer but also enjoy a better quality of life
4. Evolving Jobs and Enabling Lifelong Skill Building: A quarter of people aged 55 and older want to work in old age, but face barriers in finding opportunities. In a world where careers are spanning ever-lengthening decades, companies will want to integrate this workforce. Allowing people to work beyond retirement ages and facilitating return to work after career breaks. Continuous learning will become the essential means to enable this. The WEF calls for both job structures and educational systems to adapt. Lifelong learning and skill development must become more continuous, enabling older workers to remain engaged and productive – at every age and stage.
5. Designing In Social Connection and Purpose: Social isolation is a growing concern in aging populations. The principles highlight the importance of fostering environments that promote social connections and a sense of purpose. This approach is vital for mental and physical health, ensuring that individuals feel valued and engaged in their communities.
6. Addressing Longevity Inequalities: Inequalities in aging, whether based on gender, race, or class, must be addressed. The WEF advocates for targeted actions to reduce these disparities, ensuring that the benefits of longer life spans are accessible to everyone.

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https://www.weforum.org/publications/longevity-economy-principles-the-foundation-for-a-financially-resilient-future/; https://initiatives.weforum.org/financial-resilience-for-every-generation/home

There have also been significant negative developments. Examples include:

- An increase in deaths from heart and circulatory diseases in the UK for the first time in 50 years – as a result of an increase in obesity and type-2 diabetes.[814] However, recent research has shown that taking the weight loss drug Wegovy (Ozempic) for at least three years cuts the risk of heart attack, stroke and cardiac death by 20%.[815]
- Deaths of despair. The 'longevity economy' has not benefited older workers in jobs with low, unstable incomes without employee benefits. Such workers typically accumulate little wealth and savings over their working lives and face a retirement of poverty.[816]
- Increasing antibiotic resistance. The World Health Organization points out that a growing number of infections – such as pneumonia, tuberculosis, gonorrhoea, and salmonellosis – are becoming harder to treat as the antibiotics used to treat them become less effective. Antibiotic resistance occurs naturally, but misuse of antibiotics in humans and animals is accelerating the process. It is one of the biggest threats to global health, food security, and development. It leads to longer hospital stays, higher medical costs and increased mortality.[817] To illustrate, resistance rates to macrolide, an antibiotic used to treat pneumonia, is as high as 90% in parts of Asia; and this has been associated with an increase in child pneumonia cases in China which has spread to Europe.[818]
- The return of illnesses that had been eradicated. For example, the UK has been polio-free since 2003, with the last wild case detected in 1984. However, a polio virus mutation was detected in sewage system in London in early 2022, with tests indicating that it had been imported from a country where polio was still present.[819] In July 2022, a case of polio was reported in New York state, the first in the US since 1993; again, it is believed that the person caught it from someone outside of the US.
- The development and spread of new viruses. For example, the Ebola virus was first discovered in 1976. There was a major outbreak in West Africa in 2014–2016 and in Uganda in 2022.[820]

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[814] Haroon Siddique (2019) UK heart disease fatalities rise for first time in 50 years, *Guardian*, 13 May.
[815] https://www.telegraph.co.uk/news/2024/05/13/weight-loss-jabs-cut-risk-of-heart-death-by-a-fifth
[816] U.S. Deaths of despair - Not everyone benefits from the 'longevity economy', *Pension Policy International*, 14 October 2020; https://pensionpolicyinternational.com/us-deaths-of-despair-not-everyone-benefits-from-the-longevity-economy/
[817] Antibiotic resistance, World Health Organization, 5 February 2018; https://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance
[818] https://www.telegraph.co.uk/global-health/science-and-disease/child-pneumonia-europe-france-ireland-denmark-netherlands
[819] https://www.telegraph.co.uk/news/2022/06/22/polio-back-national-incident-declared-uk-disease-spreads-first
[820] https://www.who.int/health-topics/ebola#tab=tab_1

- Long Covid. Michael Fasano (2023)[821] points out that 'Most patients totally recover from acute Covid within 3 to 4 weeks after onset of infection. Long Covid has been reported in 10% to 30% of those with Covid-19,[822]and in some studies, even more. It is more common in women, non-whites, hospitalized patients and those with a chronic obstructive pulmonary disease and/or smoking history. The World Health Organization characterizes Long Covid, or Post Covid-19 Syndrome, as being associated with:
    - Individuals with a history of probable or confirmed SARS-CoV-2 infection (the virus that causes Covid-19) who experience symptoms impacting everyday life, such as fatigue, shortness of breath and cognitive dysfunction; and
    - Symptoms that usually are present 3 months from the onset of acute Covid-19, that last for at least 2 months and can't be explained by an alternative diagnosis. … Approximately 25% of Americans with long Covid report significant activity limitations'.[823]
- Covid reinfection risk. There is currently conflicting evidence. On the one hand, Michael Fasano (2023)[824] considers a number of studies which show that 'those infected more than once with SARS-CoV-2 have a higher risk of experiencing diseases associated with Long Covid. …However, the severity of the reinfection related impairments is less than that associated with primary infection'. On the other hand, a study published in *Nature Medicine* by Washington University researchers found that people who caught Covid more than once were twice as likely to die and three times more likely to be hospitalized than people only infected once. They were also likely to experience more damage to their lungs, heart, brain, blood, muscles and digestive system. The study was based on data from 500,000 US veterans.[825]

Yet even here, there have been some potentially positive developments. For example, scientists at the University of Exeter have developed a technique which can be used to assess whether a bacterium is likely to respond to antibiotics. It works by examining whether the fluorescent qualities of the antibiotics are taken up by bacteria. If so, the bacteria glow brighter under the microscope, revealing that the antibiotic has infiltrated the membrane and could be effective. The research could contribute to efforts to reduce prescribing, and also enable the development of more effective antibiotics, to help fight the global threat of antibiotic resistance.[826]

[821] Michael Fasano (2023) Long COVID and Reinfection Risk, *Fasano eNewsletter*, February.
[822] Nashville Chest, October 16-19, 2022.
[823] CDC Survey, September 14-26, 2022.
[824] Michael Fasano (2023) Long COVID and Reinfection Risk, Fasano eNewsletter, February.
[825] https://www.telegraph.co.uk/news/2022/11/10/catching-covid-doubles-risk-death
[826] Glowing bacteria to help tackle antibiotic resistance, Open Access Government, 3 July 2020; https://www.openaccessgovernment.org/glowing-bacteria/89771/

Dr Nir Barzilai argues that 'Death is inevitable but aging is not'.[827] This is a key message that needs to be taken into account when quantifying longevity risk and projecting healthy life expectancy going forward. There are also clear implications for the PRT market. For example, Club Vita's Erik Pickett conjectures that 'If we assume that [GLP-1] treatments could help around a third of the population manage their weight from obesity into the healthy range, life expectancy could increase by around 1-2 years for 50-59 year-olds and 0.33-1.33 years for 60-69 year-olds. This could equate to an increase in liabilities for a pension plan or pension risk transfer portfolio of around 4%. To put this into perspective, in the UK, statins (one of the major success stories in public health over the last 30 years) have been estimated to have increased national life expectancy at age 70 by 2-3 years between 1987 and 2010'.[828]

Artificial intelligence, machine learning, robotics and quantum computing

There have been a number of significant developments:

- Combining natural-language processing (NLP) and other artificial intelligence (AI) could reveal clinical insights buried in existing medical records and scans.[829]
- Using AI for many health-related purposes, such as the early detection of heart disease and breast and prostate cancer,[830] diagnosis of leukemia, reading retinal scans with as much accuracy as experienced junior doctors (using Google's DeepMind), the use of minimally invasive procedures in hospitals to improve the quality of patient care, correcting faults in the human nervous system (e.g., robotic arms controlled by brain signals replacing lost human arms) and reducing false results in Covid-19 lateral flow tests.[831]

[827] Amelia Hill (2019) Scientists harness AI to reverse aging in billion-dollar industry, *Guardian*, 21 December; https://www.theguardian.com/science/2019/dec/21/scientists-harness-ai-to-reverse-ageing-in-billion-dollar-industry

[828] https://www.clubvita.net/us/news-and-insights/vitamins-health-glp-1-obesity-medications-will-they-be-as-big-as-statins-for-life-expectancy

[829] Investment Week (2022) Healthcare is on the cusp of a digital revolution, 30 November.

[830] https://www.labmedica.com/molecular-diagnostics/articles/294797129/new-diagnostic-approach-combines-dna-testing-with-ai-analysis-for-coronary-heart-disease-risk-assessment.html; https://www.nytimes.com/2023/03/05/technology/artificial-intelligence-breast-cancer-detection.html; https://www.labmedica.com/pathology/articles/294796508/ai-powered-prostate-cancer-diagnosis-tool-accurately-identifies-and-classifies-tumors.html

[831] Christine Chow (2020) Artificial intelligence in healthcare, Investment Week, 4 December; https://www.investmentweek.co.uk/feature/4023966/artificial-intelligence-in-healthcare-the-do-no-harm-ethos-must-be-extended-to-its-application-in-the-sector/. Startups.co.uk Newsletter, 30 June 2019; https://www.labmedica.com/industry/articles/294787904/artificial-intelligence-ai-in-medical-diagnostics-market-to-reach-usd-386-billion-by-2025.html; https://www.labmedica.com/hematology/articles/294789897/artificial-intelligence-helps-diagnose-leukemia.html; https://www.labmedica.com/covid-19/articles/294795002/ai-takes-guesswork-out-of-lateral-flow-testing.html

- The development of an AI tool called AlphaFold (by DeepMind) which has predicted the structure of almost (98.5% of) the entire human proteome (the full complement of proteins expressed by an organism).[832]
- AI has designed proteins with anti-microbial properties which could be incorporated into new medicines.[833]
- Researchers at Leipzig University are using AI to analyze the genetic structures of pathogens from 10 high-risk viral families that have the potential to mutate and trigger a pandemic. It will then help to develop a new generation of vaccines capable of protecting against the outbreak of a novel pathogen – known as 'Disease X'.[834]
- Using big data and AI to improve and enhance longevity, as a result of, e.g., preventative medicine (such as spotting cancers in scans), accelerating drug discovery, establishing new genetic connections, improving operational efficiency in health delivery.[835] Using microchips to repair motor function in human organs. Elon Musk set up Neuralink in 2016 to explore how to connect the human brain to a computer using the N1 microchip (or 'brain-computer interface'). Musk claims the N1 microchip can repair motor function in the paralysed, restore eyesight and hearing and help those suffering from memory loss through dementia and Alzheimer's. The technology could also allow humans to compete with AI by controlling machines with the power of thought. The N1 microchip is a 4mm square. Each person could have up to 4 implanted in the skull. Attached to the chip are superfine wires. They are placed close to important parts of the brain, recording neuron impulses. The chips connect wirelessly to a device behind the ear containing a Bluetooth radio. This sends signals to control a smartphone or computer. In January 2024, the first experiment using a human began when a patient had the chip inserted under their skull with the aim of sending instructions to the chip using thoughts alone. Neuralink's first successful product would be named 'Telepathy'.[836] In March 2024, it was reported that a 29-year-old patient, paralyzed below the shoulders after a diving accident, was able to play chess on his laptop and move the cursor using his thoughts transmitted via Neuralink.[837]
- Deep brain stimulation combined with improved mapping of the nerve networks in the brain that have become dysfunctional in four neurological disorders – Parkinson's disease, dystonia, Tourette's syndrome and obsessive-compulsive disorder (OCD) – has resulted in substantial improvement in symptoms. A deep

[832] https://www.nature.com/articles/d41586-021-02025-4
[833][833] https://www.newscientist.com/article/2356597-ai-has-designed-bacteria-killing-proteins-from-scratch-and-they-work/
[834] https://www.telegraph.co.uk/global-health/science-and-disease/scientists-ai-artificial-intelligence-vaccine-disease-x
[835] Risk of Living Longer Series, Session 5, ClubVita webinar, 9 July 2024.
[836] Emin Shinmaz (2020) Could Musk 's microchip really boost brainpower, *Daily Mail*, 29 August; Matthew Field (2024) Nine ways Elon Musk's brain implant could change the world, *Daily Telegraph*, 31 January, https://www.telegraph.co.uk/news/2024/01/31/elon-musk-implant-neuralink-brain-epilepsy-neuroscience
[837] https://www.theguardian.com/technology/2024/mar/20/elon-musk-neuralink-brain-chip-patient-chess

brain stimulator acts like a pacemaker for the brain. It has two electrodes that are implanted near the brain's subthalamic nucleus and the settings are adjusted through a pulse generator implanted under the skin of the chest. The device has also been used to help stroke survivors regain their independence.[838]

- The development of a non-invasive blood test to assess the likelihood of someone developing Alzheimer's up to two decades before any symptoms appear. The test is the result of combing nanotechnology and AI to analyze proteins in the blood for early indicators (biomarkers) of neurodegeneration. Previously, identifying proteins with early neurodegeneration markers was like looking for a needle in a haystack. But the new test involves an ultra-thin silicon chip embedded with nanopores (tiny nanometer-sized holes). A blood sample is placed on the silicon chip that is then inserted into a handheld device which employs an AI algorithm to search through the blood sample for protein markers indicative of early-stage Alzheimer's.[839]
- Diagnosis of long COVID in children using an AI-driven blood test.[840]
- The launch of the miLab AI-based electro-dynamic blood and cancer diagnostic platform. It performs diagnostic processes, such as staining, digital imaging, and AI analysis, e.g., on cervical cells, thereby contributing to the early diagnosis of cervical cancer, the fourth largest cancer type for women.[841]
- Gestalt Diagnostics has released the Mitotic Counting AI algorithm which can help to identify the eight types of cancer – cutaneous mast cell tumors, breast cancer, lymphoma, lung cancer, melanoma, neuroendocrine, colon cancer, and bladder carcinoma – across seven scanner models – including Hamamatsu, Leica, 3D Histech and Aperio. Key to the broad applicability of deep learning algorithms is their ability to adapt to new scanners and different types of tissue – a very broad dataset is needed to do this.[842]
- Paige and Microsoft are collaborating to revolutionize cancer diagnosis and treatment by creating the world's largest image-based AI models in the fields of digital pathology and oncology. Building on Paige's Large Foundation Model, which contains around a billion images from half a million pathology slides covering various types of cancer, the new AI model will have billions of parameters and leverage Microsoft's advanced supercomputing capabilities. It aims to capture the full complexities of cancer and is intended to be the cornerstone for future clinical tools and computational biomarkers in oncology and pathology. The model will be accessible to hospitals and labs worldwide via

[838] https://edition.cnn.com/2024/03/15/health/deep-brain-stimulation-ocd-study-wellness/index.html; https://edition.cnn.com/2023/08/14/health/deep-brain-stimulation-stroke
[839] https://www.labmedica.com/molecular-diagnostics/articles/294798677/cheap-non-invasive-blood-test-predicts-alzheimers-risk-20-years-ahead-of-symptoms.html
[840] https://www.labmedica.com/molecular-diagnostics/articles/294803860/ai-driven-blood-test-to-revolutionize-diagnosis-of-long-covid-in-children.html
[841] https://www.labmedica.com/medica-2023/articles/294799318/noul-showcases-ai-driven-blood-and-cancer-diagnostic-platform.html
[842] https://www.labmedica.com/pathology/articles/294798826/new-ai-algorithm-for-use-on-eight-types-of-cancer-trained-on-seven-scanner-models.html

Microsoft's Azure platform. Desney Tan, vice president and managing director of Microsoft Health Futures, said 'Unleashing the power of [generative] AI[843] is a game changer in advancing healthcare to improve lives'.[844]

- Lunit (Seoul, South Korea) has developed the Universal Immunohistochemistry (uIHC) AI model to identify and analyze diverse cancer types, reducing the need for large, stain-specific datasets.[845]
- Researchers from Memorial Sloan Kettering Cancer Center and the Tisch Cancer Institute at Mount Sinai (both in New York, USA) have developed an AI-based model called SCORPIO. This uses routine blood tests to predict whether individual cancer patients will benefit from immune checkpoint inhibitors. These are immunotherapy drugs that release the brakes on immune cells, increasing their ability to attack cancer. But the drugs are expensive, can cause severe side effects, and are ineffective for most patients. SCORPIO helps to select patients most likely to benefit from the drugs.[846]
- PFA, Denmark's largest pension fund, is using an AI model, developed by experts including quantum physicists and data scientists and using only standard data provided by members and 29 data points, to identify scheme members at risk of long-term illness and the measures it has taken – calling in members, discussing their chronic conditions and advising on early and proactive action – has led to a 70% lowering of that risk.[847]
- In February 2024, two new AI models designed to accelerate scientific discovery were introduced. One is Google's 'Co-scientist' which was designed to assist scientists by mirroring 'the reasoning process underpinning the scientific method' in order to generate likely and novel hypotheses. A team from Imperial College London gave the model a prompt about an antibiotic resistance problem they had been working on for 10 year. Within 48 hours, the model had not only reproduced their key hypothesis, it also also provided four plausible alternatives, including one which was completely original. Another model is 'Evo 2' which has been built by the Arc Institute to read, interpret, and design entire genomes. In tests, the model accurately predicted whether certain genetic mutations would cause cancer, which would take human researchers months to do.[848]
- The application by scientists at Flinders University of AI techniques to improve both the quality of DNA profiling and the efficiency of polymerase chain reaction (PCR) cycling conditions. The scientists have built a system that enables a 'smart

[843] Generative AI is capable of scanning test results, diagnosing illnesses, and suggesting treatments. It is also able to detect inefficiencies, advance drug discovery (including the generation new molecules), and improve clinical-trial planning and execution.
[844] https://www.labmedica.com/pathology/articles/294798666/worlds-largest-image-based-ai-models-for-digital-pathology-and-oncology-to-fight-cancer.html
[845] https://www.labmedica.com/pathology/articles/294803454/ai-model-excels-at-analyzing-diverse-cancer-types-and-unseen-ihc-data.html
[846] https://www.labmedica.com/immunology/articles/294803642/index.php
[847] https://www.ipe.com/news/pfa-says-ai-model-has-led-to-70-drop-in-long-term-illness-risk/10070534.article
[848] *Human Progress Newsletter*, 23 February 2025

PCR' process to provide real-time feedback, allowing a machine-learning (ML) algorithm to make instantaneous adjustments to PCR conditions.[849]

- ML can radically reduce the workload of cell counting for disease diagnosis.[850] Researchers at Benihang University (Beijing, China) have developed the new scheme for training a convolutional neural network (CNN) – a type of ML that mirrors the connection structure of the human visual cortex. The number and type of cells in the blood often play a crucial role in disease diagnosis, but the cell analysis techniques currently used to perform such counting of blood cells – involving the detection and measurement of physical and chemical characteristics of cells suspended in fluid – are expensive and require complex preparations. Worse still, the accuracy of cell analyzer machines is only about 90%.[851]
- The use of ML to grow artificial organs, especially to tackle blindness. Researchers from the Moscow Institute of Physics and Technology, Ivannikov Institute for System Programming, and the Harvard Medical School-affiliated Schepens Eye Research Institute have developed a neural network capable of recognizing retinal tissues. Unlike humans, the algorithm achieves this without the need to modify cells, making the method suitable for growing retinal tissue for developing cell replacement therapies to treat blindness and conducting research into new drugs. The method could be adapted to create other human artificial organs.[852]
- The use of ML, matrix factorization, deep learning, and topological data analysis, to improve understanding of the complex relationships between diseases or multimorbidities.[853]
- Combining ML, epigenetics, and next-generation sequencing (NGS) in a blood test for multi-cancer early detection[854]
- Combining AI and ML, e.g., in a blood test to identify cancer before it is visible or symptomatic.[855]

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[849] https://www.labmedica.com/molecular-diagnostics/articles/294802853/ai-powered-smart-pcr-system-to-revolutionize-clinical-diagnostics.html

[850] In a blogpost in July 2024, Rose Nguyen and Diana Philip point out that: 'The human body has about three billion DNA base pairs, 20,000 encoded proteins, and approximately 37 trillion cells. Understanding that level of complexity requires machine learning, as does exploring how the billions of possible chemical compounds in the universe interact with the body to find valuable drugs to treat its diseases'; https://www.bailliegifford.com/en/uk/institutional-investor/insights/ic-article/2024-q2-ai-in-healthcare-10048272/

[851] https://www.labmedica.com/hematology/articles/294793039/machine-learning-radically-reduces-workload-of-cell-counting-for-disease-diagnosis.html

[852] Machine learning will help to grow artificial organs, Open Access Government, 7 July 2020; https://www.openaccessgovernment.org/grow-artificial-organs/89945/

[853] Abdelaali Hassaine, Gholamreza Salimi-Khorshidi, Dexter Canoy, and Kazem Rahimi (2020) Untangling the complexity of multimorbidity with machine learning, *Mechanisms of Ageing and Development*, Volume 190, September 2020, 111325; https://doi.org/10.1016/j.mad.2020.111325

[854] https://www.labmedica.com/molecular-diagnostics/articles/294793279/index.php

[855] https://www.labmedica.com/hematology/articles/294791085/blood-test-combines-ai-and-machine-learning-to-detect-cancer-before-it-becomes-visible-or-symptomatic.html

- Researchers at the US National Cancer Institute have created an AI tool that uses a patient's blood to predict if the patient's cancer will respond to immune checkpoint inhibitors. The ML model, named Logistic Regression-Based Immunotherapy-Response Score (LORIS), assists doctors in determining the efficacy of immunotherapy drugs for the patient's cancer treatment.[856]
- The use of digital technologies, such as predictive analytics, by life companies for product innovation.[857] Predictive analytics makes use of data mining, predictive modelling and ML to analyze current and historical data in order to make predictions about the future. An example is a joint venture between Longevitytech.fund and Vesttoo to harness the power of AI and ML to forecast and price long-tail risks such as longevity, excess mortality, lapse, as well as Value-in-Force (VIF) monetization and excess mortality Industry Loss Warranties (ILW) and transfer them to the capital markets.[858]
- IntelliGenes software developed by Rutgers Health combines conventional statistical methods with ML algorithms to generate personalized patient predictions and provide a visual representation of the biomarkers significant to disease prediction.[859]
- The development of a blood test, called ClarityDX Prostate, to improve the detection of prostate cancer – which affects one-in-six men – and reduces invasive biopsies. The test uses the ClarityDX ML algorithm which takes account of multiple factors, including PSA (prostate-specific antigen) levels to provide a more accurate risk score for aggressive prostate cancer. The test results can then be used to decide if a biopsy is needed.[860]
- The use of an AI-based method to improve the diagnosis of drug-resistant infections, particularly those caused by deadly bacteria like tuberculosis and staphylococcus. The method more accurately detects genetic markers of antibiotic resistance in *Mycobacterium tuberculosis* and *Staphylococcus aureus*, which could facilitate faster and more effective treatment. Scientists at Tulane University (in New Orleans) have developed a Group Association Model (GAM) which builds on machine learning to identify genetic mutations associated with drug resistance; it operates without relying on prior knowledge of resistance mechanisms, making it more adaptable and capable of identifying previously undetected genetic alterations.[861]
- The application of 'wellbeing technology' to improve the quality of people's lives across four dimensions:

[856] https://www.labmedica.com/immunology/articles/294801415/index.php
[857] Demand for predictive analytics rises among life insurers, *The Actuary*, 26 November 2020.
[858] PRNewswire, 7 January 2021.
[859] https://www.labmedica.com/molecular-diagnostics/articles/294799996/first-of-its-kind-software-uses-ai-and-ml-for-personalized-disease-prediction.html
[860] https://www.labmedica.com/molecular-diagnostics/articles/294798810/innovative-blood-test-to-revolutionize-prostate-cancer-detection-and-reduce-invasive-biopsies.html
[861] https://www.labmedica.com/microbiology/articles/294804598/new-ai-based-method-improves-diagnosis-of-drug-resistant-infections.html

    - Maintaining and improving mental health, via stress-relief technology utilizing biometric data, e.g., heart and respiration rate; and applications and services to alleviate stress and anxiety
    - Maintaining and improving physical health, via fitness tracking on mobile apps and wearable devices; rehabilitation using virtual reality and augmented reality; and telehealth that provides online healthcare services
    - Enhancing social wellbeing, via social networks that prevent loneliness and isolation; and technology that reinvigorates local communities
    - Supporting people to be financially secure, via apps for managing spending and savings goals, and robo-advisors utilizing AI to select investment strategies.[862]
- Scientists at ETH Zurich and the University of Zurich have combined biomedical technology and mechanical engineering to create a robotic system to give more accurate cancer diagnoses by analyzing tissue samples in their entirety, an improvement over the traditional approach of slicing tissue samples, examining them for abnormalities under a microscope, and then staining suspect cells. The new approach automates these processes and finally analyzes the tissue using 3D imaging software and training algorithms.[863]
- Robotic-assisted surgery can reduce the human risk and lead to faster recovery times for patients.[864]
- Quantum computing is still in the early stage of development, but is likely to revolutionize a number of industries. Whereas classical computers use binary bits of 0s and 1s stored on silicon chips, quantum computers use quantum bits or qubits and subatomic particles like electrons and photons. A qubit can represent 0, 1, or a superposition state of both 0 and 1 simultaneously, where the probability of observing a 0 or 1 depends on the wave functions of the qubit. The advantage of qubits is vastly increased storage capacity compared with bits. To illustrate, 2-bits can store at any one time only one of 00, 01, 10 and 11, while 2-qubits can simultaneously store both 00, 01, 10 and 11 and 00, 01, 10 and 11. Similarly n-bits can only store one value at a time between 0 and 2^n total possible values, while n-qubits can simultaneously store any value at a time between 0 and 2^n total possible values and *every* value 0 and 2^n total possible values. IBM's quantum computer, Eagle, has 127-qubits. To match the storage capacity of this computer, a classical computer would have to have more bits than there are atoms in the human race. IBM's Summit, the world's fastest supercomputer, is around 158 million times slower than Google's quantum computer. In December 2024, in another step towards generating reliable, scalable quantum computers, Google announced that a new chip, named Willow, had significantly improved how long qubits can maintain their quantum states (qubits easily lose their quantum properties when interacting with their environment) and also reduced

[862] https://www.pensionpolicyinternational.com/the-future-of-a-hyper-aging-society-navigated-by-well-being-technology/
[863] https://www.labmedica.com/pathology/articles/294799080/index.php
[864] PI Magazine: ESG Club, April 2024.

computational errors while increasing the number of qubits (even under controlled conditions, quantum operations are prone to errors).[865]

Quantum computers also use the entanglement property whereby two subatomic particles interact so the state of one impacts the state of the other. This is needed to overcome the 'Schrödinger Cat' paradox of quantum superposition whereby a cat in a sealed box is simultaneously alive and dead until the box is opened and the true state of the cat is observed. By analogy, once an attempt is made to read a qubit, the superposition of multiple states collapses and its computing power is lost. Quantum entanglement is used to observe the qubit indirectly by reading its entangled partner and inferring the state of the original qubit without it collapsing from superposition. Quantum computer are designed to process large complex data sets. They can used in biochemistry to create models of proteins and in medicine to create new drugs without having to go through long trial periods.[866]

A related development is AgeTech which has been described as the application of technologies, such as e-health, robotics, artificial intelligence and mobile devices to support the health and independence of older people.[867] Recent examples include:

- Combining AI and robotics to improve healthcare for the elderly. For example, Taiwan has created an AI robot which can interact with and accompany elderly when they are outside the hospital. This robot analyzes the elderly's medical records, reminds them to take their medication, and measures their blood sugar levels. The robot also helps doctors give more timely diagnosis and monitor patients. It is able to combine the physiological data of patients and upload it to the cloud, where doctors can view it remotely. This allows them to detect any abnormalities and immediately give a diagnosis. AI also helps doctors better communicate with their elderly patients. Most of the elderly in Taiwan speak only Hokkien. But an AI program has been developed that automatically translates Mandarin to Hokkien, and vice versa, to assist doctor-patient communication.[868]

[865] https://blog.google/technology/research/google-willow-quantum-chip
[866] Congressional Research Service (2023) *Quantum Computing*, Report R47685, 7 September, https://crsreports.congress.gov/product/pdf/R/R47685; Martin Giles (2019) Explainer: What is a quantum computer?, MIT Technology Review, 29 January, https://www.technologyreview.com/2019/01/29/66141/what-is-quantum-computing; Vidar (2021) Google's Quantum Computer Is About 158 Million Times Faster Than the World's Fastest Supercomputer, 28 February, https://medium.com/predict/googles-quantum-computer-is-about-158-million-times-faster-than-the-world-s-fastest-supercomputer-36df56747f7f
[867] Alan Gow (2024) How to approach the use of AgeTech, 26 November, Global Research Institute in Health and Care Technologies, Heriot-Watt University; https://www.hw.ac.uk/uk/research/long-read/how-to-approach-the-use-of-agetech.htm
[868] https://govinsider.asia/health/how-ai-and-robots-are-caring-for-the-elderly-in-taiwans-ageing-society-dr-jenny-su-ncku/

China has developed similar robots to provide personalized support, companionship and ensure the safety of the elderly.[869]

- South Korea also has an aging problem, and, as a consequence of having the world's lowest birth rate at 0.7 children per woman, it will become a super-aging society – where more than 20% of the total population is above 65 and older – in 2025. In 2020, in response to the acute shortage of healthcare workers during the pandemic, the internet provider Naver Corporation created the CareCall system, an AI call robot designed to assist public health centres check and report Covid-19 symptoms. This has now developed into CareCall partnerships with local authorities, whereby the robot will call people weekly at the same time to help manage disease and medication, advise on diet and exercise, detect emotional problems, and help prevent lonely deaths. The calls are personalized, last only a few minutes, and the robot is trained to sound as natural as possible and recall details from previous discussions to increase the level of emotional care. At the end of the call, a report is sent to the local authority, with any points of concern followed up by human healthcare professionals. Users report an overall 90% satisfaction rate: some feel comforted by the calls, while others have made lifestyle changes following discussions about eating and exercising. The national government is planning to use AI to monitor high-risk groups by analyzing power and water usage patterns to identify any signs of unusual behaviour.[870]

Clearly these developments are going to have a significant effect on diagnosing illnesses and improving health care and, in turn, on projections of future life expectancy.

Despite this, ethical concerns have been raised. For example, a study by Padhan et al. (2023) in the *Cureus Journal of Medical Science on AI and Robotics* recognised the potential benefits of AI algorithms in monitoring the health of the elderly, but argued that there should be robust security measures and clear consent procedures in place to address privacy concerns over the collection and use of personal health data: 'Cloud technologies that allow for real-time data analytics from numerous sources across integrated organizations and data sharing need to be carefully evaluated, information security needs to be maintained, and the threat of cyberattacks needs to be minimised. …In addition, the issue of autonomy arises when older adults rely heavily on AI and robotic systems, raising questions about decision-making and the potential loss of human connection. …The employment of robots by older persons may increase the danger of dishonesty, infantilization, and confusion among them as to why their human caretakers are using technology rather than face-to-face consultations'. The study called for guidelines and regulations to ensure responsible use of the technology.[871]

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[869] https://www.pensionpolicyinternational.com/robot-caregivers-chinas-solution-for-aging-population/

[870] https://www.telegraph.co.uk/global-health/climate-and-people/south-korea-elderly-care-robots-artificial-intelligence

[871] Srikanta Padhan, Avilash Mohapatra, Senthil Kumar Ramasamy, and Sanjana Agrawal (2023) Artificial Intelligence (AI) and Robotics in Elderly Healthcare: Enabling Independence and Quality of Life, *Cureus*

Further, AI and robotic systems are likely to have a significant impact on labour employment. Acemoglu and Restrepo (2020), for example, estimated that, between 1990 and 2007, each additional robot added in manufacturing in the US replaced about 3.3 workers nationally and lowered wages by around 0.4%. Generative AI is now leading to lay-offs (which could be as high as 30%) in the very tech companies that invented it, such as Microsoft, Meta, eBay, SAP and PayPal. Machines are now much better at programming than humans. Some studies predict that 40% of all jobs are at risk from AI. Many of the remaining jobs will be enhanced by AI, however.[872]

Finally, there have also been growing concerns by industry insiders about the risks of AI becoming smarter than humans. For example, Eliezer Yudkowsky, head of research at the Machine Intelligence Research Institute, gives this stark warning: 'Many researchers steeped in these issues, including myself, expect that the most likely result of building a superhumanly smart AI, under anything remotely like the current circumstances, is that literally everyone on Earth will die. … To visualize a hostile superhuman AI, don't imagine a lifeless book-smart thinker dwelling inside the internet and sending ill-intentioned emails. Visualize an entire alien civilization, thinking at millions of times human speeds, initially confined to computers – in a world of creatures that are, from its perspective, very stupid and very slow. A sufficiently intelligent AI won't stay confined to computers for long. In today's world you can email DNA strings to laboratories that will produce proteins on demand, allowing an AI initially confined to the internet to build artificial life forms or bootstrap straight to postbiological molecular manufacturing'. While some, including Elon Musk, have called for 'all AI labs to immediately pause for at least 6 months the training of AI systems more powerful than GPT-4' since AI presents 'profound risks to society and humanity',[873] Yudkowsky argues that pausing is not enough and instead we must 'Shut it all down'.[874]

Implications of global aging for financial markets and economic growth

Aging populations – as a consequence of both declining fertility and mortality – could have a big influence on the future returns and the volatility of returns on the assets in which pension funds and PRT providers invest, in addition to their impact on government spending on pensions and the sustainability of pension systems, as well as on the rate of economic growth.

15(8): e42905; doi:10.7759/cureus.42905. Similar concerns have been raised in a presentation entitled 'The double-edged sword conundrum', by Professor Andrew Sixsmith, Director of the Science and Technology for Aging Research (STAR) Institute at Simon Fraser University in Canada and Co-founder of AGE-WELL, Canada's AgeTech network; https://www.hw.ac.uk/uk/research/long-read/how-to-approach-the-use-of-agetech.htm

[872] Jeremy Warner (2024) The AI jobs slaughter is coming for tech first, *Daily Telegraph*, 13 February.

[873] Billy Perrigo (2023) Elon Musk Signs Open Letter Urging AI Labs to Pump the Brakes, *Time,* 29 March; https://time.com/6266679/musk-ai-open-letter/

[874] Eliezer Yudkowsky (2023) Pausing AI Developments Isn't Enough. We Need to Shut it All Down, *Time*, 29 March; https://time.com/6266923/ai-eliezer-yudkowsky-open-letter-not-enough/

Long-term real interest rates in developed countries have been falling since the mid-1980s. Before that they averaged around 3% back to the 1950s. They reached 0% in around 2012 and fell to as low as -2% in some European countries. The European Systemic Risk Board (2021) explains this new low interest rate environment (LIRE) in terms of:

- demographic developments including rising life expectancy and falling population growth rates (Acemoglu and Johnson (2007), Backus et al. (2014), Aksoy et al. (2019), Ferrero et al. (2019));
- a falling (relative) price of investment goods and a rising share of intangible investment (Karabarbounis and Neiman (2014), Thwaites (2015));
- slowing pace of technological innovation (Gordon (2016));
- falling marginal product of capital (related to demography and technical progress) (Cochrane (2021));
- rising wealth and income inequality (Summers (2014), Rachel and Summers (2019))
- rising savings rates in developing countries and the consequent increasing demand for assets issued by advanced economies (Bernanke (2005)); and
- declines in the consumption/wealth ratio which predict depressed real rates for an extended period of time (Gourinchas and Rey (2019)).

Summers (2013) describes the LIRE as 'secular stagnation' and some expect it to last for an extended period of time (e.g., Blanchard et al. (2014), Gourinchas and Rey (2019) and Kiley (2020)). The European Systemic Risk Board (2021) identifies four key areas of concern in the LIRE:

- the profitability and resilience of banks: as net interest margins have trended downwards, banks have responded by increasing interest-earning assets and shifting the composition of their assets towards riskier market segments – including towards commercial real estate, consumer lending and small and medium-sized enterprises (SMEs);
- the indebtedness and viability of borrowers, as the LIRE facilitates higher leverage and encourages search-for-yield behaviour;
- systemic liquidity risk, as the LIRE have made the financial system more sensitive to market shocks;
- the sustainability of the business models of insurers and pension funds offering longer-term return guarantees, as they experience increasing pressures in the LIRE.[875]

Focusing on the demographic developments, Jen (2007)[876] argued that there are four important economic and financial implications:

[875] See also John Fell, Tuomas Peltonen and Richard Portes (2021) Lower for longer – macroprudential policy issues arising from the low interest rate environment, 2 June; https://voxeu.org/article/macroprudential-policy-issues-arising-low-interest-rate-environment

[876] Drawn from Jen (2007) – with updated data. See also Bohl et al. (2016).

- The level of real long-term interest rates will be affected by the changing fiscal outlook of countries. Potential economic growth rates vary with these demographic trends. Potential economic growth in countries with high dependency ratios will likely slow.[877] Not only will the growth of labour supply slow, but justifications for capital accumulation will be less compelling in an aging country. Further, as the population of a country ages, ceteris paribus, the aggregate wage bill may shrink, reducing tax receipts. At the same time, medical expenditures and other healthcare-related spending may crowd out the education expenses needed to enhance the productivity of the shrinking work force.[878] The end result is a shrinking tax base and rising budgetary demands. Without changes in the retirement age or female participation in the labour force, what this means is that the levels of real interest rates in countries with aging populations may rise above what could be justified by their potential growth rates, as public borrowing needs grow and the private sector starts to dis-save during retirement, both of which drive up interest rates.

  Aksoy et al. (2019) provide empirical evidence from OECD countries which confirm that population aging leads to subdued output growth,[879] higher net savings and lower interest rates. In particular, an increase in the share of the dependent population and a decline in the share of the working age population lead to a statistically significant decline in real interest rates. However, these rates would be even lower without the impact of increased public borrowing and retiree dissaving.

- Yield curves should flatten in countries with aging populations and steepen in countries with younger populations. The shapes of the yield curves may change as well. With the monetary policy of most central banks driven by formal or informal inflation targeting, demographic trends could distort the shapes of the yield curves.

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[877] One study estimated that in Europe, a 1% increase in the old age dependency ratio (of those aged 65+ to those in work) decreased real per capita GDP by 0.4% (A 'back of the envelope' evidence on aging and growth in Europe, www.reforming.it, 30 March 2018). Key European countries are attracting headlines like this: 'Aging Germany Is Running Out of Workers, Putting Europe's Largest Economy at Risk'; https://www.pensionpolicyinternational.com/aging-germany-is-running-out-of-workers-putting-europes-largest-economy-at-risk/. In 2022, the German government announced that it wanted to attract 400,000 qualified workers from abroad each year to tackle both the demographic imbalance and labour shortages in key sectors that risk undermining the recovery from the coronavirus pandemic; https://www.pensionpolicyinternational.com/germany-wants-to-attract-400000-skilled-workers-from-abroad-each-year/

[878] In theory, investment to enhance total factor productivity could keep output growth high, even with a shrinking population.

[879] Farouki Majeed, chief investment officer of the $19bn School Employees Retirement System of Ohio Fund, put it this way: 'forecasts of GDP growth …have an implied demographic element. It's incorporated in GDP in the sense that if you look at GDP as a two-factor model, it's population times productivity growth', implying that population aging slows down both working population and productivity growth, and hence GDP growth (quoted in Simon Hoyle (2024) The long and the short of harnessing demographics for better returns, 4 September; https://www.top1000funds.com/2024/09/the-long-and-the-short-of-it-harnessing-demographics-for-better-returns/

In a country with an aging population (such as the US), in the short term, the Fed would need to have higher policy rates to stabilize inflation as potential growth decelerates. In other words, it should be more sensitive to lingering inflationary pressures at every given level of growth rate of aggregate demand. However, the long-term interest rate should be commensurate with the new, lower, potential growth rate and therefore should be lower, notwithstanding the possibility of a rise in the borrowing cost and retiree dissaving. This implies a flatter yield curve in the US and similar countries with aging populations.

Similar logic suggests that the accelerating potential growth rates in younger countries would tend to steepen their yield curves.

- Aging may affect the preferred structure of financial portfolios. Different generations have different risk preferences. There are two competing theories. On the one hand, it is thought that global aging may raise the equity premium, as aging households become less willing to warehouse risk. As a result, aging could benefit bond markets relative to equity markets. Most academics would agree with this.[880]

  However, recent experience in Japan suggests an interesting alternative hypothesis. A fixed retirement age, coupled with ever improving life expectancy, has created a 'longevity risk', whereby retirees can no longer be confident of their ability to defend their lifestyle if they end up living much longer than they expect at the time of their retirement. In the case of Japan, this has led to more risk-taking, not less, as retirees try to enhance their expected investment returns by diversifying away from assets with low credit risk. In contrast to the first hypothesis, this alternative hypothesis suggests that retirees should have a bigger appetite for equities.[881]

- Asynchronous aging patterns in different parts of the world have implications for current account (C/A) imbalances. C/A imbalances are essentially savings-investment gaps.[882] If demographic trends drive the savings patterns in countries,

[880] So would some practitioners. For example, Pictet Asset Management (Picket AM)'s chief strategist Luca Paolini has said: 'An aging society tends to be…more conservative. More conservative means less risky. [The elderly] tend to stick with the status quo, normally' (quoted in Simon Hoyle (2024) The long and the short of harnessing demographics for better returns, 4 September; https://www.top1000funds.com/2024/09/the-long-and-the-short-of-it-harnessing-demographics-for-better-returns/

[881] Picket AM's Luca Paolini also has some sympathy for this argument: 'On equity versus bonds, the theory until recently was if you live longer, obviously you are more risk-averse, so in theory you prefer bonds to equities. Then we see this big rise in inflation, [and] we say wait a second. If you are old and you have a pension, what is the best action, bonds or equities? Probably equities' (quoted in Simon Hoyle (2024) The long and the short of harnessing demographics for better returns, 4 September; https://www.top1000funds.com/2024/09/the-long-and-the-short-of-it-harnessing-demographics-for-better-returns/

[882] This follows from the national income accounting identity: savings – investment = exports – imports (if government expenditure = taxation). If savings are low relative to investment, this will be associated with a current account deficit.

> then C/A imbalances should also be affected. The permanent income (or life cycle) hypothesis suggests that very 'young' and very 'old' countries tend to dis-save, while those with low dependency ratios should be saving. However, the constellations of the C/A imbalances in the world are not consistent with this pattern.

Jen (2007) continues: 'What this may imply is that, as Japan ages, its savings rate should decline, as retirees start to draw down their savings. This may very well start to happen. With a high C/A surplus position [2.14% of GDP in 2022[883]], this prospective trend should not pose a problem for Japan. However, the same argument applies to the US, but with a high C/A deficit [3.8% of GDP in 2022[884]], the US does not seem to have a great deal of scope to dis-save further. [Two other countries with large C/A surpluses (Germany and China)] are themselves facing aging pressures, and therefore downward pressures on savings. The implications for the dollar will be a function of how fast the US savings rate changes relative to that of the rest of the world'.

More recently, Goodhart and Pradhan (2020) argue that 'the underlying forces of demography and globalization will shortly reverse three multi-decade global trends – it will raise inflation and interest rates. …Deflationary headwinds over the last three decades have been primarily due to an enormous surge in the world's available labour supply, owing to very favourable demographic trends and the entry of China and Eastern Europe into the world's trading system. …These demographic trends are on the point of reversing sharply, coinciding with a retreat from globalization. The result? Aging can be expected to raise inflation and interest rates, bringing a slew of problems for an over-indebted world economy, but is also anticipated to increase the share of labour [in national income], so that inequality falls'. However, while nominal interest rates might rise, this does not necessarily mean that real interest rates will rise.

There are differing views on whether population aging leads to price volatility in asset markets, which would be the case if, for example, a relatively large old generation attempted to sell its asset holding to a relatively smaller younger generation to finance its retirement. Mankiw and Weil (1989) argue that it does – at least in the housing market. However, Poterba (2001) could find no strong cohort effect. He estimated a flat financial asset profile in old age, indicating that there was little evidence of a mass disposal of assets in old age – at least in the US – and conjectured that this might be for precautionary or bequest motives. Similarly, Börsch-Supan (2006), using an open-economy model, predicts that capital outflows will restrict asset price reductions in the domestic economy, suggesting that open economies can avoid some of the demographic effects that depress saving rates and the rate of return on capital. On the other hand, it is possible that

[883] https://www.statista.com/statistics/1171474/japan-current-account-balance-as-share-of-gdp/; https://www.theglobaleconomy.com/Japan/current_account/
[884] https://data.worldbank.org/indicator/BN.CAB.XOKA.GD.ZS?locations=US

imperfections in international capital and traded goods markets could well contribute to international asset price volatility arising from differential aging across countries.[885]

The bottom line, according to Jen (2007) is that 'demographic trends have important economic and financial implications'.

This is confirmed by a 2024 study from the McKinsey Global Institute called *Dependency and Depopulation* which predicted that as birth rates decline, some of the world's most advanced economies would need to at least double their productivity growth rates to sustain historical improvements in living standards.[886] In the case of China, GDP per capita growth could slow by 0.4% annually on average from 2023 to 2050, unless productivity growth increases by two to four times or people work one to five hours more per week.

The study also predicted that 'consumers and workers will be older and increasingly in the developing world. Seniors will account for one-quarter of global consumption by 2050, double their share in 1997. Developing countries will provide a growing share of global labor supply and of consumption, making their productivity and prosperity vital for global growth. …In confronting the consequences of demographic change, societies enter uncharted waters. Absent action, younger people will inherit lower economic growth and shoulder the cost of more retirees, while the traditional flow of wealth between generations erodes. Long-standing work practices and the social contract must change. More fundamentally, countries will need to raise fertility rates to avert depopulation – a societal shift without precedent in modern history'.

What pension funds need is, as Ferrero et al. (2019, p275) point out: 'structural reforms and fiscal policies that encourage later retirement and promote innovation and investment in research and development. These policies would also reduce the negative impact of

[885] This is an implication of Borio and Disyatat's (2015), Ford and Horioka's (2016, 2017), and Horioka and Ford's (2017) explanation of two of the so-called macroeconomic puzzles identified by Obstfeld and Rogoff (2000), in particular, the Feldstein-Horioka puzzle and the purchasing power and exchange rate disconnect puzzle. The former puzzle, identified by Feldstein and Horioka (1980), is the high correlation between domestic savings and investment rates when there should be no correlation if capital mobility is perfect. The second puzzle, identified by Meese and Rogoff (1983), is that real exchange rates can deviate from purchasing power parity exchange rates for considerable periods which should not be possible if there was a high degree of mobility in internationally traded goods. However, Borio and Disyatat (2015), Ford and Horioka (2016, 2017) and Horioka and Ford (2017) argue that these are not real puzzles at all. Borio and Disyatat (2015) argue that the puzzles are a consequence of the 'failure to maintain a clear distinction between net resource flows [i.e, the gap between savings and investment] and financing flows'. Ford and Horioka (2016) make the same point in a different way: 'financial markets alone cannot achieve net transfers of financial capital and cannot equalize real interest rates across countries – [and this] also helps explain why previous attempts to connect changes in the exchange rate to economic fundamentals have not been successful'. It is clear that, given the slow response of the global economic and financial system to savings, investment and trade imbalances, then differential population aging will add an additional source of asset price volatility.

[886] McKinsey Global Institute (2024) *Dependency and Depopulation*; https://www.mckinsey.com/mgi/our-research/dependency-and-depopulation-confronting-the-consequences-of-a-new-demographic-reality

aging on potential output growth, although their effects would materialize only gradually. An acceleration in technological innovation (Brynjolfsson and McAfee, 2014), arising from the unfolding of the "the second machine age"[887] could offset the impact of adverse demographic developments and raise potential output growth'.

Indeed, Acemoglu and Restrepo (2022) have found evidence that aging, because it creates a shortage of middle-aged workers specializing in manual production tasks, leads to greater industrial automation. Aging is associated with the greater adoption of robots and other automation technologies and that more automation innovation occurs in countries undergoing faster aging. Further, productivity improves relatively in industries that are more amenable to automation.

At the same time, a report by the American Association of Retired Persons found that the 50-year-plus population accounts for a large portion of global GDP and recommends that policies should be implemented that enable older citizens to be as productive as possible. This would require governments and companies to abandon ageist stereotypes and make the kind of investments that harness the opportunities unleashed by increased longevity, such as policies to promote lifetime training and initiatives to boost late-life entrepreneurship. The report looked at the 50-plus population across 79 countries between 2020 and 2050, and predicts that their contribution to global GDP could increase between 2020 and 2050 from $45 trillion to $118 trillion. Much of that would be driven by people working longer and continuing to contribute in their 50s, their 60s, and even their 70s, depending on their health.[888]

Workers are also taking a more flexible attitude to retirement in some countries. For example, a survey by abrdn for its *Class of 2022* study of 2,000 UK workers due to retire in 2022 found that 66% planned to remain employed in some form compared to 56% in 2021 and 34% in 2020. The survey found that 24% will go part-time with either the same job or a new one, 15% will continue to work for their own business, and 12% plan to become entrepreneurs and start their own business. The main reasons cited for 'flexi-retirement' include needing the income (31%) and wanting to keep busy (32%).[889]

Climate change and sustainable development

The problem: climate change

The issue of climate change is clearly linked to population size and some scientists have begun to ask whether there are global limits to human habitability. For example, Dr Steven Running, emeritus professor of ecology at the University of Montana and a member of the

[887] 'The automation of a lot of cognitive tasks that make humans and software-driven machines substitutes, rather than complements'.
[888] https://www.pensionpolicyinternational.com/why-an-aging-population-doesnt-spell-economic-doom/
[889] https://www.professionaladviser.com/news/4047456/flexi-retirement-trend-emerges-thirds-plan-research

NASA Earth Observing System, argues that a population cannot grow indefinitely in a finite ecosystem, such as the Earth. He explains: 'Systems ecology theory predicts when resource limits are exceeded, a progressive system feedback of starvation, predation and disease limits uncontrolled population and consumption growth. The global human population has nearly tripled since 1950, and economic activity increased tenfold, leading many to suggest that humanity is heading toward a population and consumption overshoot and correction this century. The global population, currently at [8]bn people, is projected to rise beyond 10bn by 2100. Future limits become an urgent policy issue when one considers the expansion in living standards aspired to by the underdeveloped world. Is humanity smart enough to anticipate global overshoot, and shift to sustainable policies before these morally unacceptable systems feedbacks take over?'.

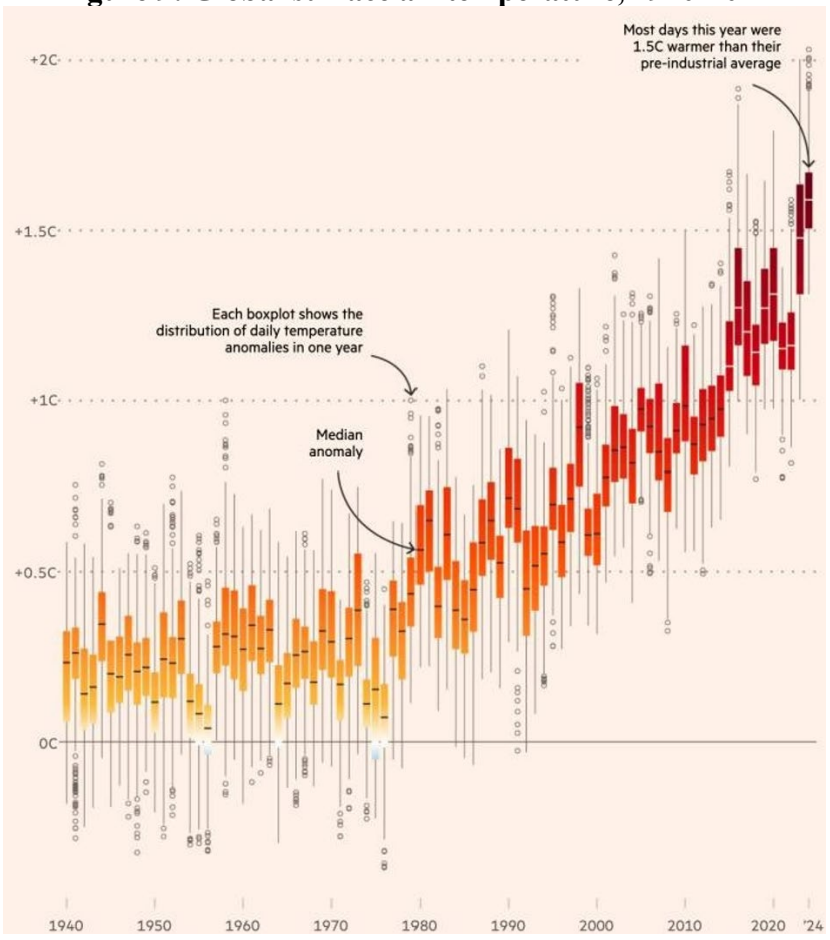
The core metric for quantifying total plant growth is net primary production (NPP), measured in kilograms per hectare of plant biomass. Land-based plants absorb around 30% of the carbon dioxide that human activity adds to the atmosphere. Increasing NPP slows down global warming. NASA has been monitoring global NPP for the last quarter century. Running points out that NPP depends on temperature and water availability: 'rising temperatures increase growing season length, but decrease water availability, and many of the NPP trends identified can be directly attributed to these effects. We showed how significant droughts between 2000 and 2009 caused the reduction in NPP in the Southern Hemisphere. Decreases in cloud cover increased sunlight over tropical areas causing the largest increases in NPP, particularly in the Amazon rainforest. It initially appeared that rising global temperatures were having a positive effect on the growth of plants, potentially increasing their ability to act as a sink for excess carbon dioxide produced by human activity. However, the reduction in NPP from 2000 to 2009 from drought effects raises serious issues. If rising global temperatures reduce plant growth, the ability of vegetation to act as a carbon sink will be reduced, accelerating climate change'. He concludes: 'As the Earth's population continues to increase, and climate continues to change, consistent monitoring of NPP will become an even more essential tool for understanding and mitigating damage caused to the biosphere. It is essential for humanity to not reach catastrophic planetary limits risking collapse. There is no better and available global dataset than NPP, the foundation of food, fibre, biofuel and climate stabilization, for this essential monitor of global habitability'.[890]

According to the World Meteorological Organization, hydrological cycles are 'spinning out of balance' and the world will experience an 'increasingly erratic' water cycle as climate change drives new patterns of both extreme flooding and drought. Droughts, extreme rainfall and melting snow and glaciers are threatening long-term water security. Petteri Taalas, WMO secretary-general, said that the overwhelming majority of disasters are water related: 'A warmer atmosphere holds more moisture. We are seeing much heavier precipitation episodes and flooding. And at the opposite extreme, more evaporation, dry

[890] Steven Running (2019) The biosphere: Global limits of human habitability, 30 October; https://www.openaccessgovernment.org/biosphere-human-habitability/75469/

soils and more intense droughts'.[891] Between June-August 2023, the Earth experienced the hottest three-month period on record with an average global temperature of 16.7ºC – see Figure 9. In September 2023, António Guterres, Secretary General of the United Nations, said that 'Climate breakdown has begun'. The UN forecasts that by 2050, more than 75% of the global population could be affected by drought and lack access to water, up from 1.1bn currently.[892]

Figure 9: Global surface air temperature, 1940-2024



Source: ERA5, C3S/ECMWF. Note: The figure shows the average daily surface temperature compared with the pre-industrial average (1850-1900). Blocks show the interquartile range.

[891] Quoted in Aime Williams (2023) Global water cycles are 'spinning out of balance', weather agency reports, *Financial Times*, 12 October; https://www.ft.com/content/a8c1b4cb-e7ec-4dd7-9eac-8adc2d874a96

[892] Quoted in Verity Bowman and Harriet Barber (2023) The world has experienced its hottest ever three-month period, *Daily Telegraph*, 13 September; https://www.telegraph.co.uk/global-health/climate-and-people/climate-change-global-warming-wildfires-drought-floods/

The World Economic Forum's *Global Risks Report 2019* warned of increasing naturally emerging infectious disease pandemics and risks posed by revolutionary new biotechnologies, claiming that these could be as big a threat as climate change.[893] And within a year this came to pass.

A study by Carlson et al (2022) asserts that at least 10,000 virus species have the capacity to infect humans, but, at present, the vast majority are circulating silently in wild mammals. However, climate and land use change will produce novel opportunities for viral sharing among previously geographically-isolated species of wildlife. In some cases, this will facilitate zoonotic spillover between species – a mechanistic link between global environmental change and disease emergence. The study uses a phylogeographic model of the mammal-virus network to simulate potential hotspots of future viral sharing and to make projections of geographic range shifts for 3,139 mammal species under climate change and land use scenarios for the year 2070. The model predicts that species will aggregate in new combinations at high elevations, in biodiversity[894] hotspots, and in areas of high human population density in Asia and Africa, driving the novel cross-species transmission of their viruses an estimated 4,000 times. Because of their unique dispersal capacity, bats account for the majority of novel viral sharing, and are likely to share viruses along evolutionary pathways that will facilitate future emergence in humans. The study also conjectures that this ecological transition may already be under way, and holding warming under 2°C within the century will not reduce future viral sharing. The authors conclude that 'Our findings highlight an urgent need to pair viral surveillance and discovery efforts with biodiversity surveys tracking species' range shifts, especially in tropical regions that harbor the most zoonoses and are experiencing rapid warming'. Vector-borne diseases (which are caused by the bite of infected insects, such as mosquitoes, ticks, and sandflies, which act as carriers or 'vectors') account for more than 17% of all infectious diseases, leading to more than 700,000 deaths annually.[895] In March 2024, the first mammal-to-human H5N1 (bird flu) virus transmission took place between a cow and a Texan dairy worker; all previous transmissions to humans came from infected birds.[896] Live traces of H5N1 were found in batches of raw or unpasteurized milk sold at retail stores in California in November 2024.[897] The first reported human death from H5N1 occurred in Louisiana on 6 January 2915.[898]

Some scientists predict a new 'pandemic age'. Professor Eddie Holmes, an evolutionary biologist and virologist at the University of Sydney, said: 'Climate change and pandemics

[893] https://cirmagazine.com/cir/epidemic-risks-pose-as-big-a-business-threat-as-climate-change.php
[894] Biodiversity refers to the 8.7m varieties of life forms on Earth, such as plants, bacteria, animals and humans; https://education.nationalgeographic.org/resource/biodiversity/
[895] Nicola Oliver (2023) The Impacts of Climate Change on Mortality, *Life Risk News*, 8 March;https://liferisk.news/the-impacts-of-climate-change-on-mortality/
[896] https://www.telegraph.co.uk/global-health/science-and-disease/first-mammal-to-human-transmission-h5n1-bird-flu-confirmed
[897] https://www.telegraph.co.uk/global-health/science-and-disease/h5n1-bird-flu-raw-milk-california-united-states-of-america/
[898] https://www.cdc.gov/media/releases/2025/m0106-h5-birdflu-death.html

go hand-in-hand….The more animals are forced to mix, the more viruses will jump species'.[899] One current example is the spread of dengue – or 'breakbone fever' because of the intense joint and muscle pain it causes – by mosquitos. It affected nine countries in the 1970s, but has spread to more than 100 and affects around 400 million people a year. The main causes are climate change and rapid urbanisation.[900] Another example is mpox (monkeypox) which causes miscarriage, has a fatality rate of up to 10%, and is spreading rapidly in central Africa and could spread to Europe.[901] In August 2024, the World Health Organization declared mpox a global health emergency.[902] In October 2024, an outbreak of Marburg – related to Ebola and with a fatality rate of up to 88% – occurred in Rwanda, killing more than a dozen people.

Also in October 2024, the Global Preparedness Monitoring Board (GPMB) – an independent body convened by the Director-General of the World Health Organisation and the President of the World Bank – warned that the next pandemic will probably 'catch the world napping', despite all the advances made during Covid-19: 'Changing patterns of life and the ongoing encroachment of human activities into natural environments [are] altering the global risk landscape and making the emergence of new pathogens more likely'. The GPMB made three critical recommendations to governments focusing on pandemic planning: prioritise risk profiles and assessments that account for a broad range of factors, including those like conflict or climate change that drive up the risk of new epidemics emerging, or those that will impact the world's ability to respond, such as digital connectivity and biomedical innovation; prioritise equity in their preparedness plans, making sure they 'address the specific and basic needs of vulnerable populations', and, in particular, access to 'medical countermeasures', like vaccines or treatments; and for collaboration between different sectors to be strengthened. The GPMB also identified 15 risk drivers, with four having the greatest impact: the movement of people around the world 'is at a record high and is likely to continue to increase in the coming years'; a dramatic increase in global livestock numbers is driving the spread of H5N1; the rise of social media means people are increasingly being exposed to misinformation, and 'public health organisations and governments are struggling to keep up'; and a 'decline in trust in many countries, distrust in institutions is growing and trust in the multilateral system is at risk. This is impacting our collective capacity both to tackle health emergencies and to find multilateral solutions to protect the world'.[903]

Bowman and Barber (2023) point out that: 'Many [existing] infectious diseases are climate sensitive and global warming is giving them the opportunity to expand their reach,

[899] https://www.telegraph.co.uk/global-health/science-and-disease/hotter-sicker-climate-crisis-will-trigger-surge-spillover-events
[900] https://www.telegraph.co.uk/global-health/science-and-disease/why-singapore-alert-record-breaking-year-disease
[901] https://www.telegraph.co.uk/global-health/science-and-disease/new-strain-of-mpox-causing-miscarriages-spreading-rapidly
[902] https://www.nytimes.com/2024/08/14/health/mpox-who-emergency-africa.html
[903] https://www.telegraph.co.uk/global-health/science-and-disease/why-the-next-pandemic-may-catch-us-napping-despite-all-weve/

threatening the lives of millions. With flooding, population displacement and overcrowding caused by storms and extreme flooding, waterborne infections – such as cholera, typhoid and hepatitis – are on the rise. Milder winters, warmer summers, and fewer days of frost are also making it easier for disease-carrying mosquitoes to roam beyond their habitats, bringing infections like malaria[904] [and] Zika …fever closer to countries previously out of their reach'.

Similarly with fungi. The high body temperature of humans has traditionally protected them against fungi, but fungi are beginning to adapt to higher temperatures, making transmission easier. An example is Candida auris, a fungus that first appeared in humans in 2009.[905] A study by Denning (2024) found that four million people have been dying annually from fungal infections, including chronic pulmonary aspergillosis, pneumocystis pneumonia and cryptococcal meningitis. This is nearly double the previous global estimate and means that fungal infections are killing six times more people than malaria and nearly three times as many as tuberculosis.[906]

A report on climate change and health published in December 2020 by *The Lancet*[907] estimates that global warming has already caused a 50% increase in heat-related deaths of people older than 65, especially in Japan, China, India and parts of Europe. The main reasons for this are heat stroke, kidney failure (caused by kidneys overworking due to dehydration), and heart failure (caused by an excessive heart rate as the heart pumps more blood to the skin, with a corresponding reduction of blood flow to the brain).[908] In the US, the report argues that rising temperatures, combined with pollution and wildfires, are endangering the health of Americans, with fatal consequences for many older people. The solution, according to the reports' authors is to aggressively curb planet-warming gases in the next five years: 'Climate action is a prescription for health'. In February 2024, a study from the Yale School of Public Health, published in *Nature Communications*, estimated that at 1.5°C, 2°C, and 3°C increases in global warming, heat-related deaths will increase by 0.5%, 1.0%, and 2.5%, respectively. Of these, 20-25% can be attributed to population aging.[909] In May 2024, an article also published in *Nature Communications* by scientists from the CMCC Foundation–Euro-Mediterranean Center on Climate Change and Boston

[904] The parasite that causes malaria has a complicated life cycle and is able to avoid detection by the immune system. However, two malaria vaccines for children – one developed by GSK and the other by Oxford University – have recently been approved by the World Health Organization; *Telegraph World*, 3 October 2023.
[905] Verity Bowman and Harriet Barber (2023) The world has experienced its hottest ever three-month period, *Daily Telegraph*, 13 September; https://www.telegraph.co.uk/global-health/climate-and-people/climate-change-global-warming-wildfires-drought-floods/
[906] David W. Denning (2024) Global incidence and mortality of severe fungal disease, *The Lancet Infectious Diseases*; https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(23)00692-8/fulltext
[907] Reported in the *New York Times*, 3 December 2020.
[908] https://www.telegraph.co.uk/global-health/climate-and-people/climate-change-global-warming-wildfires-drought-floods
[909] https://medicine.yale.edu/news-article/aging-population-to-be-major-driver-of-future-climate-related-deaths/; https://www.nature.com/articles/s41467-024-45901-z

University predicted that 246 million people around the world may be at risk of heat exposure by 2050 due to global warming and an aging population.[910] Also in May 2024, the World Heart Federation (WHF) warned that air pollution was now the 'greatest single environmental health risk', responsible for annual global deaths of 7 million people, around half of which are due to cardiovascular conditions such as heart attacks and strokes. However, it also warned that measures to make homes better insulated and eco-friendly could actually increase the number of deaths by making them airtight and increasing the build-up of air pollutants.[911] In August 2024, an Air Quality Life Index (AQLI) study published by the Energy Policy Institute (EPIC) at the University of Chicago estimated that permanently cutting fine particulate matter (known as PM2.5) which gets into the lungs and bloodstream would add around two years to life expectancy.[912]

In 2022, the UK Longevity Science Panel published a report (*The Effects of Climate Change on Health in the UK*) assessing the impact of climate change on the UK's health.[913] The report suggests that climate change will be experienced unevenly across different sections of the UK population, and may deepen health inequalities in physical and mental health in the UK. The most economically deprived and those who are already frail through age or having long-term health conditions will be the most vulnerable to high temperatures and shocks induced by adverse weather events. Compared with many other countries, the report found that the direct impacts of climate change such as heat waves, flooding and the increased spread of vector-borne diseases, are likely to be relatively modest. This is because of the UK's geographic location in the Northern hemisphere and its economic power to adapt houses, workplaces and infrastructure to reduce the negative impact of climate change.

In March 2025, a study from the USC Leonard Davis School of Gerontology indicated that greater exposure to extreme heat may accelerate biological aging in older adults. The evidence was that people living in areas experiencing more days of high heat showed greater average biological aging than residents in cooler areas. The study was based on 3,600 Health and Retirement Study (HRS) participants aged 56 and older. Blood samples taken during the six-year study period were analyzed for epigenetic changes via a process called DNA methylation. The researchers used epigenetic clocks to analyze methylation patterns and estimate biological ages at each point a blood sample was taken. They then compared participants' changes in biological age to their location's heat index history and number of heat days reported by the National Weather Service from 2010 to 2016. The analysis revealed a significant correlation between areas with more days of extreme heat

[910] https://www.pensionpolicyinternational.com/up-to-246-million-older-people-may-be-exposed-to-heat-risk-by-2050-due-to-global-warming/
[911] https://www.telegraph.co.uk/news/2024/05/24/net-zero-efforts-could-cause-rise-in-air-pollution-deaths/
[912] https://www.telegraph.co.uk/global-health/climate-and-people/cutting-pollution-may-add-two-years-to-average-persons-life/
[913] https://www.pensionpolicyinternational.com/climate-change-poses-a-threat-to-health-equality-in-the-uk-the-longevity-science-panel-report/

and individuals experiencing greater increases in biological age. This correlation persisted even after controlling for socioeconomic and other demographic differences, as well as lifestyle factors such as physical activity, alcohol consumption and smoking.[914]

However, the indirect impacts could worsen existing inequalities in health for the following reasons:

- Socio-economic. When economies are stressed the health of the most disadvantaged is disproportionately affected.
- Climate change-related disruptions to global food production and supply chains will reduce food security, particularly for low-income families. Lower socio-economic households are more likely to be exposed to the damage caused by extreme weather events as poverty tends to force people to live in higher risk areas, but they often lack the disposable income to adequately prepare for the hazards associated with climate change. The build quality of certain lower income and private rental homes can make them more vulnerable to severe damage during adverse weather events.
- Gender inequalities. Women are likely to be impacted more by climate effects than men. They are more often the primary caregivers, and these responsibilities can be considered an additional source of stress in times of adversity, particularly when infants and children in their care are threatened directly by displacement or food insecurity.
- Age inequalities. The young and the old are disproportionately affected by climate change compared to working age adults. This is due to differences in physiology, impacts on education, development, exposure, vulnerability to illness, lack of social support, declining health, and disruption to daily activities.
- Mental health. Climate change can negatively impact mental health in two main ways: by causing actual harm to people, family members, homes, livelihoods or culture, or by acting as a threat of harm and source of uncertainty.
- Disruptions to the UK economy, in part caused by climate-induced global economic stresses, are a key indirect pathway through which climate change may adversely impact on population health in the UK.

Climate change can also have a major economic impact on companies and financial markets in the form of supply chain disruptions, reduced worker productivity, damage to corporate infrastructure and the communities in which businesses operate. In the US, weather-related disasters, such as wildfires, flooding and drought, cost $150bn annually, and are happening with increasing frequency, from an annual average of three in the 1980s to 18 in the 2020s.[915] A study reported in *S&P Global Sustainability Quarterly* in November 2023 analyzed the S&P Global Sustainable1 Physical Risk Exposure Scores and Financial Impact dataset. It examined seven physical climate hazards: extreme heat, water

[914] https://www.pensionpolicyinternational.com/climate-change-may-drive-premature-aging/
[915] https://www.pensionpolicyinternational.com/the-largest-u-s-pension-fund-just-rolled-out-a-climate-transition-plan-focused-on-risk-and-opportunity/

stress, coastal flood, fluvial flood, tropical cyclone, drought and wildfire. It predicted that without adaptation and resilience measures, by the 2050s, the costs to companies exposed to these hazards will average 3.3% p.a. – and up to 28% – of the value of their real assets. The average rises to 6.0% p.a. by the 2090s. Extreme heat was the biggest single hazard: 'If it is too hot, employee health and safety and company operations can suffer. Energy grids can come under pressure as the general population cranks up air conditioning use. Transportation links can be damaged, leading to delays in supply chains'. Particularly badly affected would be datacenters: 'Datacenters are sensitive to extreme temperatures and restricted access to water due to their dependency on heating, ventilating and air conditioning (HVAC) and cooling'.[916]

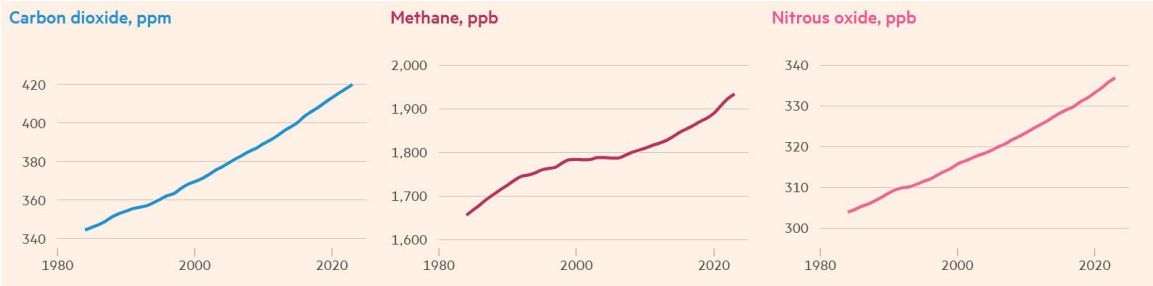
Open interest in the Chicago Mercantile Exchange's weather derivatives (i.e., futures and options) contracts, which was below 20,000 contracts in 2019, rose to 200,000 contracts in 2023. The contracts allow speculators to take a position on temperature swings. They also act as a form of insurance by allowing organizations to hedge extreme weather events. They track an index and their value depends on how far the temperature deviates from the monthly average. The CME said: 'They're more popular now because the market has determined that [extreme weather] events are becoming more impactful and more frequent'.[917]

In March 2024, ICE (the Intercontinental Exchange) released a report called 'The link between physical climate risk and sovereign default'.[918] The report assigned scores to around 200 Sovereigns based on their vulnerability to climate-related deaths, water stress, changes in productivity and temperature. It predicted that Sovereign issuers with the highest exposure to climate risk (with a score of 5) were 18.5% more likely to default than those with no physical climate risk exposure (with a score of 0). Each unit increase in the score increases sovereign default probability by 3.7%. The report said that 'under realistic emissions scenarios', the impacts of climate change were likely to have a 'profound' effect on sovereign nations' fiscal stability and economic security. To illustrate, wildfires in 2019 and 2020 cost Australia $100bn.

In March 2025, the UN World Meteorological Organization reported that the concentration of carbon dioxide in the atmosphere was at its highest level in 800,000 years – see Figure 10.[919]

[916] https://www.spglobal.com/esg/insights/featured/special-editorial/quantifying-the-financial-costs-of-climate-change-physical-risks
[917] https://www.fnlondon.com/articles/traders-flock-to-weather-derivatives-amid-climate-fears-20240403
[918] https://www.ice.com/insights/sustainable-finance/the-link-between-physical-climate-risk-and-sovereign-default
[919] https://www.ft.com/content/36916c9f-377b-4a3a-91d2-62d111faacc8

Figure 10: Atmospheric concentration by greenhouse gas, 1980-2024



Source: WDCGG

The solution: sustainable development

In 2015, the United Nations adopted 17 global Sustainable Development Goals (SDGs), including ending poverty, fighting inequality and addressing climate change.[920,921]

According to Schroders' 2020 *Global Investment Survey*, 'increasingly clients are using the Sustainable Development Goals as a common language' and estimated global ESG (environmental, social, and governance) assets under management in excess of $1trn.[922] Investment strategies consistent with SDG include: negative screening (excluding companies based on controversial business practices), socially responsible investing (SRI), thematic (pursuing specific sustainable themes based on a company's operations or sources of revenue) and impact investing (investing in a measurable sustainable outcome in addition to financial returns).[923]

The UK's response

The UK was the first major country to publish a Green Finance Strategy in 2019.[924] It agreed to fund a new Green Finance Institute[925] with the City of London 'to foster greater

[920] The UN-commissioned Brundtland Report (*Our Common Future*, Oxford University Press, October 1987) defined sustainable development as meeting the present needs without compromising the ability of future generations to meet their own needs.
[921] The Global Goals for Sustainable Development: Goal 1: No Poverty; Goal 2: Zero Hunger; Goal 3: Good Health and Wellbeing; Goal 4: Quality Education; Goal 5: Gender Equality; Goal 6: Clean Water and Sanitation; Goal 7: Affordable and Clean Energy; Goal 8: Decent Work and Economic Growth; Goal 9: Industry, Innovation and Infrastructure; Goal 10: Reduced Inequality; Goal 11: Sustainable Cities and Communities; Goal 12: Responsible Consumption and Production; Goal 13: Climate Action; Goal 14: Life Below Water; Goal 15: Life on Land; Goal 16: Peace and Justice Strong Institutions; Goal 17: Partnerships to achieve the Goal; https://www.globalgoals.org.
[922] The power of measurement: Schroders approach to sustainability, *funds-europe*, November 2020.
[923] Five reasons to choose indexing for sustainable, *portfolio institutional*, November 2020.
[924] https://assets.publishing.service.gov.uk/media/643583fb877741001368d815/mobilising-green-investment-2023-green-finance-strategy.pdf
[925] https://www.greenfinanceinstitute.com/

cooperation between the public and private sectors, create new opportunities for investors, and strengthen the UK's reputation as a global hub for green finance' and a new Centre for Greening Finance and Investment (CGFI) 'to advise lenders, investors and insurers [in order to] enable them to make environmentally sustainable decisions, and support a greener global economy'.[926] In September 2021, the UK government issued its first 'green gilt' to investors in order to finance projects with clearly defined environmental benefits, thereby helping the UK achieve net-zero carbon emissions by 2050. The bond satisfies the International Capital Market Association (ICMA) Green Bond Principles,[927] a voluntary framework for issuers to follow and which promotes transparency and disclosure to reduce the risk of 'greenwashing' (where investors are misled about how sustainable an investment is).

The UK government set out 6 categories of expenditure or investment that will be financed by these gilts. Each category is also mapped to appropriate UN Sustainable SDGs:

1. Clean transportation, e.g., zero-emission buses (consistent with the SDG: sustainable cities and communities)
2. Renewable energy, e.g., wind, solar and hydrogen (affordable and clean energy)
3. Energy efficiency, e.g., support schemes for energy efficiency programs for the public, commercial, industrial and residential sectors (including heating, retrofit and insulation) and research and development for new energy efficiency technologies (affordable and clean energy, industry, innovation and infrastructure)
4. Pollution prevention and control, e.g., reduction of air emissions and greenhouse gas control (responsible consumption and production)
5. Living and natural resources, e.g., protection and enhancement of terrestrial and marine biodiversity, ecosystems and natural capital;[928] sustainable land use and protection, including environmentally sustainable agriculture; environmentally sustainable clean water, water storage and wastewater management initiatives (zero hunger, clean water and sanitation, life below water, and life on land)[929]
6. Climate change adaptation, e.g., flood protection, resilience and other risk mitigation programs (climate action).

[926] https://www.ukri.org/news/10m-research-centre-to-spur-a-greener-global-financial-system/
[927] https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/
[928] Discussed in more detail below.
[929] Bonds that invest in activities relating to SDG 6 (Clean Water and Sanitation) and SDG 14 (Life Below Water) are known as 'blue bonds'. The market in blue bonds is currently small, with only 26 blue bonds issued between 2018 and 2024 worldwide; https://professionals.fidelity.co.uk/articles/expert-opinions/2024-04-05-blue-bonds-whats-all-comm-ocean-1712297104759; https://www.investmentweek.co.uk/news/4321170/fidelitys-atkinson-blue-bonds-growing-popularity-challenges-remain

In March 2023, the UK government published its 2023 Green Finance Strategy, *Mobilising Green Investment*,[930] aimed at strengthening the rapidly growing global green finance market, while encouraging private investment to deliver its energy security, net-zero and environmental objectives.[931] One example is direct air carbon capture and storage (DACCS) systems which strip CO_2 from the atmosphere and pumps it into disused oil and gas reservoirs under the North Sea which have a total capacity of 78 billion tonnes. In order to meet the UK's net zero commitment, these systems would need to collect 38-48 million tonnes of CO_2 annually by 2050. The total cost is estimated at £30bn; the high cost is due to the low concentration of CO_2 in the atmosphere, around 426 parts per million, or 0.0426%. The UK is currently responsible for about 800 million tonnes of CO_2 annually, half from domestic production and half from imported goods. Globally, around 37bn tonnes of CO_2 is produced annually, mainly from using fossil fuels such as coal, gas and oil. Around 40% is absorbed by the sea, while the rest remains in the atmosphere.[932] In April 2024, JPMorgan released a global energy strategy report which recommended that the short-term focus of the pathway to clean energy should be on the coal to natural gas switch, which could save up to 17% of global emissions compared to a 2022 baseline. Coal made up 44% of global fuel emissions while providing 33% of global fossil fuel energy in 2022.[933]

The European Union's response

In December 2019, the EU introduced the European Green Deal[934] with the aim of greening both the real economy, especially in agriculture, industry and transport, and its financing through the use of sustainable finance. One of key features of the deal is the Sustainable Finance Action Plan which aims to achieve net zero by 2050.[935] Another is the Sustainable Finance Disclosures Regulation (SFDR) which requires asset managers to publish disclosure statements about which of their products fall into three distinct categories:

- Article 9 funds: those funds that specifically have sustainable goals as their objective, e.g., investing in companies whose goal is to reduce carbon emissions (known as 'dark green' funds).

[930] This is the first update since 2019; https://www.gov.uk/government/publications/green-finance-strategy
[931] *XPS Investment Briefing*, September 2021. In September 2021, the European Commission introduced a 'gold standard' for EU 'green bonds' where the proceeds are spent on environmentally friendly activities. The standard came into force in December 2023. European green bonds are aligned with the 'European taxonomy' which specifies the types of green projects that can be funded, making it more difficult for companies to engage in greenwashing; https://www.ipe.com/news/eu-green-bond-standard-rules-to-enter-into-force-after-council-ok/10069660.article.
[932] https://www.telegraph.co.uk/business/2024/04/28/britain-30bn-strip-co2-atmosphere-hit-net-zero
[933] https://www.esgdive.com/news/jpmorgan-warns-clean-energy-transition-could-take-decades-or-generations/714180/
[934] https://www.consilium.europa.eu/en/policies/green-deal/
[935] https://www.pensionpolicyinternational.com/how-sustainability-disclosures-and-regulations-benefit-investors/

- Article 8 funds: those funds that promote E or S characteristics, but do not have them as the overarching objective (known as 'light green' funds).
- Article 6 funds: funds that are not promoted as having ESG factors or objectives (known as 'non-ESG' funds).

A survey by Morningstar (*SFDR – The First 20 Days*) found that Article 8 and 9 funds accounted for around 21% of total European funds and 25% of total European fund assets.[936]

The main ESG asset classes – which according to S&P Global account for 5% of the total global market – are sustainable investment funds ($500bn) and 'green'[937] or 'social'[938] bonds ($500bn). Many of these bonds are issued by inter-governmental organizations (e.g., the EU's SURE[939] bonds) or local authorities with high credit ratings and they offer higher yields than conventional sovereign bonds. The bonds are used for socio-economic enhancement (30%), housing (21%), education (20%), essential infrastructure (13%) and healthcare (11%).[940] Europe is the leading region for issuing ESG bonds, with 20% of all European bonds now green, social and/or sustainable. In 2023, 3,184 green social sustainable (GSS) bonds, valued at $930bn, were brought to market.[941]

Another key feature is the EU's Corporate Sustainability Reporting Directive (CSRD) which requires companies to include sustainability-related information in their annual reports from 2026[942] that must meet European Sustainability Reporting Standards (ESRS). This will generate considerable amounts of standardised sustainability data in future years, with digital tagging and online repositories aiming to make the data more usable and discoverable. Maurits Heldring, senior adviser for responsible investment at PGGM, said: 'We're looking forward to this data, not just for compliance reasons but also because we

[936] https://esgclarity.com/sfdr-which-groups-have-the-most-article-8-9-funds/

[937] Green bonds (also known as climate bonds or sustainable bonds) are designated fixed-income bonds intended to encourage sustainability and to support climate-related or other types of special environmental projects. More specifically, they finance projects aimed at energy efficiency, pollution prevention, sustainable agriculture, fishery and forestry, the protection of aquatic and terrestrial ecosystems, clean transportation, clean water, and sustainable water management. They also finance the cultivation of environmentally friendly technologies and the mitigation of climate change; https://www.investopedia.com/terms/g/green-bond.asp

[938] Social bonds are used to fund projects with positive social outcomes, such as economic development by financing small businesses, affordable housing and transportation, promoting access to education and healthcare in low-income areas, and food supply protection. Traditionally, they have been issued by supranationals and governments. But corporate social bonds are also now being issued by companies wishing to demonstrate their corporate social responsibility to their employees, customers and local communities; https://inews.co.uk/inews-lifestyle/money/ethical-money/social-bonds-what-how-work-available-who-invest-explained-1012606

[939] Support to mitigate Unemployment Risks in an Emergency (SURE); https://commission.europa.eu/strategy-and-policy/eu-budget/eu-borrower-investor-relations/sure_en

[940] ESG News, *portfolio institutional*, November 2020 (p26).

[941] https://www.investmentweek.co.uk/news/4172932/green-social-sustainable-bonds-hit-record-issuance-2023

[942] https://www.ipe.com/news/eu-parliament-writes-two-year-delay-into-esg-reporting-rules/10071260.article

are starting what we call 3D investing, covering risk, return and sustainability, and to be able to steer on the third element we need good and consistent data'.[943] Investment funds are also required to make disclosures under SFDR which will allow investors to compare investment funds and their sustainability performance. An additional key feature is the European Taxonomy Regulation which requires companies to report on the percentage of their economic activities that are environmentally sustainable.[944] On 31 July 2023, the European Commission released an initial batch of 12 European Sustainability Reporting Standards (ESRSs) developed by the European Financial Reporting Advisory Group (EFRAG). The EU has adopted a double 'materiality approach', implying companies must consider both the impact of a sustainability topic, such as climate, on their activities and the impact of their activities on that topic.[945] In April 2024, the EU Corporate Sustainability Due Diligence Directive (CS3D) came into effect, requiring firms to undertake environmental and social due diligence on businesses within their value chains, and to mitigate any harms they identify during that process; they also have to develop and implement climate transition plans.[946]

In December 2023, the European Securities and Markets Authority (ESMA), the EU financial regulator, issued guidelines for funds claiming to contribute to sustainability objectives, including the climate transition. Funds with 'ESG'-related names should allocate at least 80% of their assets in line with their stated strategy, consistent with sustainable investments definitions in Article 2(17) SFDR, and reflecting the expectation investors may have based on the fund's name. The funds must also abide by exclusions developed for Paris-aligned Benchmarks (PABs), screening out companies involved in controversial weapons and tobacco, as well as those deemed to have breached the UN Global Compact or the OECD Guidelines for Multinational Enterprises. In particular, PABs ban investments in companies that generate more than 1% of revenues from coal and lignite, 10% from oil, or 50% from gas, and in companies that generate more than 50% of their revenues from carbon-intensive electricity. At the same time, ESMA has made allowance for funds marketed as contributing to the climate transition, as well as those pursuing social or governance-related objectives. For funds with 'transition'-related names, there is a new category with exclusions based on the EU's Climate Transition Benchmarks, which are less strict than PABs, and allow investments in fossil fuels. ESMA requires such funds, as well as funds with 'impact'-related names, to demonstrate that their investments 'are made with the intention to generate positive, measurable social or

[943] https://www.ipe.com/special-reports/investors-await-influx-of-standardised-corporate-sustainability-data/10076570.article
[944] https://www.sustainable-investment.com/opinion/4077463/european-green-deals-framework
[945] https://www.ipe.com/news/eu-sustainability-board-under-pressure-to-finalise-materiality-guidance/10068505.article
[946] https://www.ipe.com/news/corporate-sustainability-due-diligence-directive-final-text-gets-green-light/10072891.article

environmental impact alongside a financial return or are on a clear and measurable path to social or environmental transition'.[947]

Dai et al. (2023) found that, using a broad sample of international investment funds, the introduction of SFDR was followed by a significant decarbonization (around 10%) of investment portfolios of EU-marketed funds claiming to invest based on sustainability criteria. The lower level of emissions was mainly due to changes in funds' investment decisions, but a substantial part of the effect (roughly one third) was due to changes in firm-level emissions. Overall, the findings suggest that regulating investor disclosure induces asset managers to decarbonize their portfolios not only by shifting capital flows away from high-emission firms, but also by increasing pressure on portfolio firms to achieve emissions reductions at the firm level.[948]

In February 2024, ESMA warned that investment funds claiming to support the 17 UN Sustainable Development Goals could be mis-selling in the form of greenwashing or impact-washing.[949] It examined 187 funds, with total assets under management of €74bn, which claimed – via their names, investment strategies or Key Information Documents – to contribute to the goals. It then compared the assets against a number of benchmarks, including an SDG Index developed by the UN. It found that, regardless of the different frameworks used for measurement, the 187 funds do not, on average, hold significantly more SDG-aligned issuers. ESMA said 'This raises questions as to whether funds claiming to contribute to the SDGs are actually fulfilling their promise to investors… and that further monitoring was necessary'.[950] In the same month, the EU announced that ESG rating providers would be authorized and supervised by the ESMA. They would be required to adhere to transparency requirements regarding methodologies and information sources. The new rules also require the detailed disclosure of ESG rating methodologies by financial advisers using ESG ratings in marketing.[951] Also in February, a survey conducted by MainStreet Partners, a subsidiary of AllFunds, found that 24% of Article 8 funds carried a risk of greenwashing.[952] In July 2024, ESMA published Guidelines on Enforcement of Sustainability Information (GLESI) which lists its guidelines for promoting convergent and

[947] https://www.ipe.com/news/eu-watchdog-spells-out-rules-for-transition-labelled-funds/10070714.article
[948] Jiyuan Dai, Gaizka Ormazabal, Fernando Penalva, and Robert A. Raney (2023) 'Imposing Disclosure on Investors that Choose to Promote Sustainability: Does it Lead to Portfolio Decarbonization?', European Corporate Governance Institute: Finance Working Paper 945/2023 and IESE Business School Working Paper No. 4564890; https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4564890
[949] Impact-washing occurs where bonds are labelled as 'impact', but there is little evidence that the issuer uses the proceeds for any demonstratable impact; https://www.funds-europe.com/impact-washing-is-a-reality-amid-growing-issuance-study-finds/
[950] https://www.ipe.com/news/esma-study-finds-sdg-labelled-investment-funds-risk-impact-washing/10071466.article
[951] https://www.funds-europe.com/eu-legislators-reach-consensus-on-overseeing-esg-ratings-providers
[952] https://www.funds-europe.com/quarter-of-article-8-funds-at-risk-of-greenwashing

consistent supervision and enforcement by national competent authorities of sustainability information.[953]

In February 2024, the EU introduced the world's first carbon removal certification scheme. This allows the trading of carbon removal units (equal to one tonne of CO_2 removed from the atmosphere). Four types of carbon removal will be permitted:

- Permanent carbon removals, such as direct air capture and storage and bioenergy with carbon capture and storage (CCS), which can store CO_2 for several centuries.
- Temporary carbon storage in long-lasting products such as wood-based construction, for at least 35 years.
- Temporary carbon storage from carbon farming, such as restoring forests and soil, wetland management, seagrass meadows (minimum five years).
- Soil emission reduction obtained from carbon farming, such as wetland management, no tilling and cover crop practises (minimum five years). [954]

COP26 – November 2021

In November 2021, COP26, the 26th United Nations Climate Change Conference, took place in Glasgow, Scotland.[955] The outcome was the Glasgow Climate Pact which:

- Reaffirmed the 2015 Paris Agreement to limit global warming to below 2°C, preferably to 1.5°C, compared with pre-industrial levels and to achieve a climate-neutral ('net-zero') world by 2050.[956] However, it went further and expressed 'alarm and utmost concern that human activities have caused around 1.1°C of warming to date, that impacts are already being felt in every region, and that carbon budgets consistent with achieving the Paris Agreement temperature goal are now small and being rapidly depleted'.
- Seeks accelerated action to reduce carbon dioxide emissions by 45% in the 2020s**,** with countries producing stronger national action plans by 2022.
- Agreed to a provision calling for a phase-down of coal power and a phase-out of fossil fuel subsidies.
- Reaffirmed the pledge by developed countries to deliver $100bn a year for developing countries.
- Called for a doubling of finance to support developing countries in adapting to the impacts of climate change and building resilience.
- Agreed to complete the Paris rulebook, the operational details for the practical implementation of the Paris Agreement. An example is the norms relating to carbon

[953] https://www.esma.europa.eu/sites/default/files/2024-07/ESMA32-992851010-1600_Final_Report_on_Guidelines_on_Enforcement_of_Sustainability_Information_GLESI.pdf
[954] https://www.euractiv.com/section/climate-environment/news/eu-reaches-deal-on-worlds-first-carbon-removal-certification-scheme/
[955] https://www.un.org/en/climatechange/cop26
[956] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

markets, which will allow countries struggling to meet their emissions targets to purchase emissions reductions from other nations that have already exceeded their targets.

- Agreed to strengthen the Santiago Network that connects vulnerable countries with providers of technical assistance, knowledge and resources to address climate risks.
- Agreed new deals on:
    - Halting and reversing forest loss and land degradation by 2030.
    - Limiting methane emissions – one of the most potent greenhouse gases and responsible for a third of current warming from human activities – by 30% by 2030, compared with 2020 levels.
    - Restricting all new car and van sales to be zero-emission vehicles by 2040 globally and 2035 in leading markets, thereby accelerating the decarbonization of road transport, which currently accounts for about 12% of global greenhouse gas emissions.
    - Private financial institutions and central banks realigning $130trn towards achieving global net zero emissions, via the Glasgow Financial Alliance for Net Zero (GFANZ).

GFANZ was established in April 2021 by UN Special Envoy on Climate Action and Finance Mark Carney and the COP26 presidency to accelerate the transition to a net-zero global economy, bringing together CEOs and leaders from the financial services sector.[957] It supports the UN's Race to Zero campaign and has become an umbrella organisation of eight sub-groups, including the Net Zero Asset Owner Alliance, the Net Zero Asset Managers Initiative, and the Net-Zero Banking Alliance.

The International Financial Reporting Standards (IFRS) Foundation announced the formation of the International Sustainability Standards Board (ISSB) at COP26.[958,959] It was set up to counter the problem that ESG disclosure was being hindered by differing sets of rules, leading to confusion amongst investors and companies, and hence inaction. It has four key objectives:

- To develop standards for a global baseline of sustainability disclosures.
- To meet the information needs of investors.
- To enable companies to provide comprehensive sustainability information to global capital markets.

[957] https://www.gfanzero.com/

[958] The ISSB focuses on investors and the financial markets. The standards published by the ISSB currently only include climate and sustainability, but the board is considering expanding the disclosures to include human capital and rights; https://www.ifrs.org/groups/international-sustainability-standards-board/; https://www.ifrs.org/groups/international-sustainability-standards-board

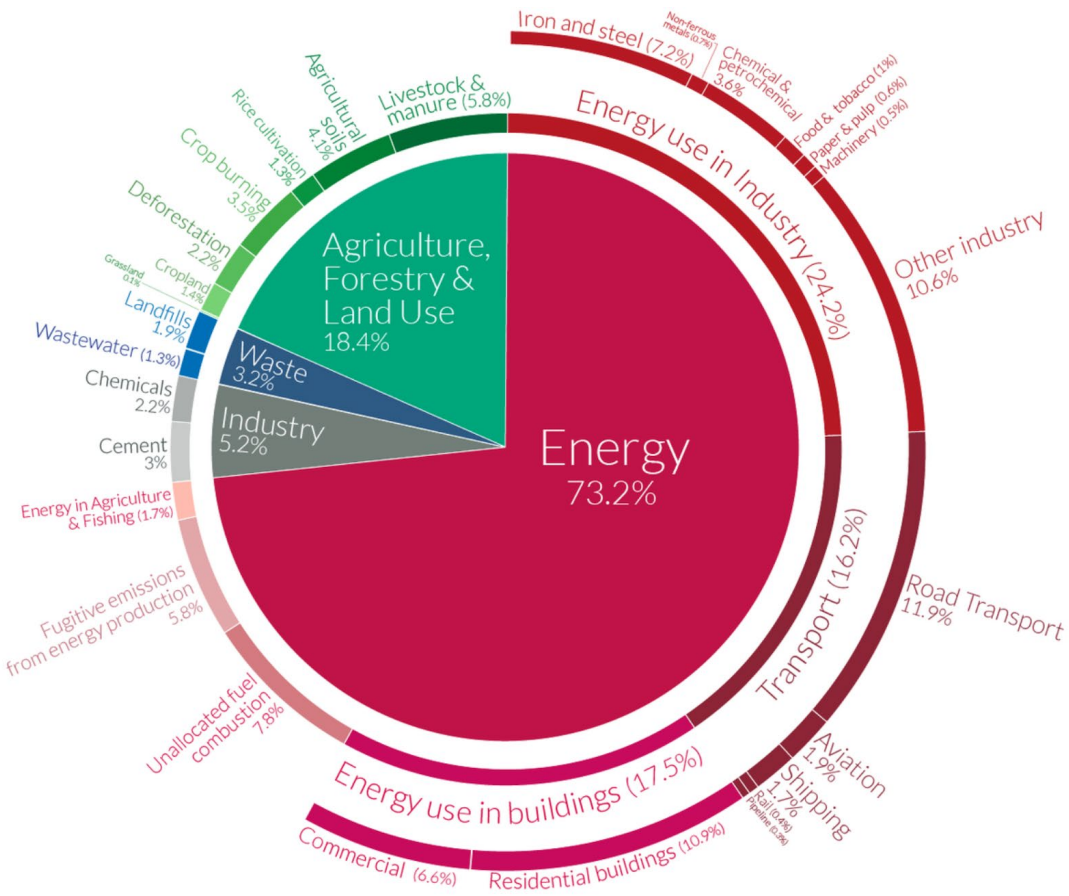
[959] In 2022, the ISSB took over responsibility for the SASB (Sustainability Accounting Standards Board) Standards for companies reporting on sustainability; https://sasb.ifrs.org/standards/

- To facilitate interoperability with disclosures that are jurisdiction-specific and/or aimed at broader stakeholder groups.

In June 2023, the ISSB published two global corporate sustainability reporting standards: International Financial Reporting Standard S1, the General Requirements for Disclosure of Sustainability-related Financial Information; and IFRS S2, Climate-related Disclosures. The latter requires greenhouse gas (GHG) emissions to be measured in accordance with the GHG Protocol Corporate Standard (2004), for example.[960]

Figure 11 shows the sectoral breakdown of global greenhouse gases in 2016.

Figure 11: Global greenhouse gas emissions by sector, 2016



Sources: OurWorldinData.org, Climate Watch, World Resources Institute (2020), https://www.visualcapitalist.com/a-global-breakdown-of-greenhouse-gas-emissions-by-sector/

[960] https://www.ipe.com/issb-releases-robust-inaugural-sustainability-reporting-standards/10067384.article

Transition planning

In April 2022, the Transition Plan Taskforce (TPT) was launched by the UK Treasury to develop the 'gold standard for private sector climate transition plans'. The TPT Framework applies three guiding principles: ambition, action (involving implementation and engagement strategies) and accountability (covering metrics, targets and governance). TPT has engaged globally with financial institutions, real economy corporates, policymakers, regulators and civil society to develop its materials. In April 2024, TPT published finalised guidance to help asset owners develop credible climate transition plans. It also published guidance on how entities should approach climate adaptation, nature and the 'just transition' in their climate plans.[961] TPT said: 'The primary responsibility of asset owners is to secure the financial futures…of their beneficiaries in line with their fiduciary duty (where applicable), contractual obligations and duties imposed by financial regulators. …In order to do this, an asset owner should explain how it integrates climate into its investment decisions, manager selection and contracts, and engagement activities. …Taking a strategic and rounded approach helps asset owners consider a wide range of decarbonization levers available to them and, where possible, avoid a strategy of "paper decarbonization", which is characterized by actions that decarbonize an entity's portfolio in ways that may not necessarily contribute to the actual decarbonization of the economy'.[962] In June 2024, the IFRS Foundation took over responsibility for transition plan disclosure resources developed by TPT, marking 'an important milestone in the creation of global norms for transition plan disclosure'. The TPT's remaining role was to support the UK's Transition Finance Market Review.[963]

Transition finance has been defined as 'investments meant to decarbonize high-emitting and hard-to-abate industries such as steel, aviation and shipping. This capital is also aimed at addressing potential social impacts associated with decarbonization, including unemployment and loss of tax revenue for local governments'.[964] Frédéric Ducoulombier, Research Programme Director at the EDHEC Climate Institute shows that transition finance is one of the three types of investments needed for achieving net-zero:[965]

- Climate solutions: Investments in activities central to a net-zero economy, including low-emissions energy, clean transportation, energy efficiency and waste management.
- Transition investments: Support for decarbonizing high-emission sectors lacking low-emission substitutes, such as adopting low-carbon processes, retrofitting

[961] A just transition would involve fairness and equity in the transition to a net zero sustainable economy; https://impact-investor.com/special-report-pension-funds-grapple-with-the-just-transition
[962] https://transitiontaskforce.net; https://transitiontaskforce.net/wp-content/uploads/2023/10/TPT_Disclosure-framework-2023.pdf; https://www.ipe.com/latest/uk-launches-climate-transition-plan-guidance-for-asset-owners/10072621.article
[963] https://www.ipe.com/news/ifrs-foundation-takes-over-tpts-transition-plan-disclosure-resources/10074144.article
[964] https://trellis.net/article/what-transition-finance-and-why-it-matters/
[965] https://climateimpact.edhec.edu/charting-pathway-transition-finance-lessons-eu-framework

industrial facilities in hard-to-abate sectors….or decommissioning unsustainable fossil fuel power plants and other carbon-intensive facilities.

- Carbon sinks: Investments to offset unavoidable emissions through nature-based or technological solutions, such as restoring ecosystems, enhancing soil and ocean carbon absorption, and advancing carbon capture technologies.

In October 2024, the UK government launched the British Infrastructure Taskforce (BIT) 'as part of a new approach that involves government working with business to design policy that will unlock private investment, including by building business confidence in UK infrastructure investments'.[966] BIT will offer insights that deliver long-term solutions for job creation, growth, and environmental goals. Members of BIT include PIC, Phoenix Group, M&G, Blackrock, abrdn, the National Wealth Fund (NWF), and IFM Investors.[967]

IFM Investors has helped to accelerate pension fund investment in Australia's energy transition and wants to do the same in the UK via BIT. It has put forward a number of recommendations that will help enable the right policy settings to drive investment. A key recommendation is resolving the backlog in grid connection requests from renewable power providers, particularly from remote sites as more renewables come online; it is now holding back clean energy development and wider economic growth. Nadeem Hussain, Co-CIO at the £30bn local authority pool LGPS Central, said he would be willing to invest in renewable power providers and data centres, but 'Investors must often bid for grid connectivity years in advance of building the wind or solar development. We ask our managers to ensure the grid connection is secure before we invest because the last thing you want is to cancel a project because there is no grid connectivity. We are [also] open to investing more in data centres but the rapid growth in the sector means many are now securing whatever energy source they can which might not be renewable. We think this is a short-term solution'. Another recommendation is faster planning approvals 'which are essential to nurturing clearer project pipelines and making UK infrastructure more competitive on the global stage', according to Jonathan Ord, head of investments, GLIL Infrastructure. Another recommendation is regulatory certainty. Hussain says 'Infrastructure investors don't want to see a regulatory change that materially impacts the economics of a project during their ownership'. A further recommendation relates to risky investment in large capex projects and early-stage investment in new construction. Luba Nikulina, chief strategy officer at IFM, says: 'Investors require mid-to-long-term power purchase agreements and/or extension of Contracts for Difference terms beyond 15 years to reflect longer project lives. The sharper risks in the next phase of the energy transition in carbon capture, low carbon fuels and floating offshore wind will also require much greater revenue certainty mechanisms. First-of-a-kind projects carry a unique combination of risks, including permitting sites for new technologies, technology maturity and scale,

[966] https://www.gov.uk/government/news/government-launches-british-infrastructure-taskforce

[967] IFM Investors is a Melbourne-based investment manager which invests on behalf of institutions worldwide, including pension, superannuation and sovereign wealth funds, universities, insurers, endowment funds and foundations; https://www.ifminvestors.com/en-gb/about-us/

construction and supply chain risks, revenue uncertainty and risks associated with changes to policy and regulation'.

Nikulina hopes to use her seat on BIT to persuade the government to adopt these recommendations: 'successful engagement rests on understanding the government's priorities and finding common ground to crystalise mutual benefits. Open lines of communication and a preparedness for the long haul are key, as well as an understanding that policy makers can't solve risks like inflation and supply chain constraints. I believe we can achieve the best outcomes when we work together and signalling our investment objectives can drive policy change'.[968]

In January 2022, the McKinsey Global Institute published a report called *The net-zero transition: What it would cost, what it could bring*.[969] It estimated that capital spending on physical assets for energy and land-use systems in the net-zero transition between 2021 and 2050 would amount to about $275trn or $9.2trn per year. The required spending would be front-loaded, rising from 6.8% of GDP in 2021 to as much as 8.8% of GDP between 2026 and 2030 before falling. The report points out that 'While these spending requirements are large and financing has yet to be established, many investments have positive return profiles (even independent of their role in avoiding rising physical risks) and should not be seen as merely costs. Technological innovation could reduce capital costs for net-zero technologies faster than expected'.

Pension scheme responses

The UK

Pension schemes

While climate change has been in the news for around 30 years, only in the last few years has it begun to impact the pensions industry. For example, UK listed companies and asset managers, such as pension funds, were required to report on climate change risk by 2022, in line with recommendations made by the Financial Stability Board's Taskforce on Climate-related Financial Disclosures (TCFD).[970] The UK Pensions Regulator and

[968] https://www.top1000funds.com/2025/01/meet-the-investors-trying-to-de-risk-uk-transition-infrastructure/

[969] https://www.mckinsey.com/capabilities/sustainability/our-insights/the-net-zero-transition-what-it-would-cost-what-it-could-bring

[970] The corporate disclosure recommendations are based on a framework of:

- Governance: the organization's governance around climate-related risks and opportunities.
- Strategy: the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy and financial planning.
- Risk management: the processes used by the organization to identify, assess and manage climate-related risks.

- Metrics and targets: which metrics and targets are used to assess and manage relevant climate-related risks and opportunities.

Pension scheme trustees face similar obligations:

- Governance
  - Trustees must establish and maintain oversight of the climate-related risks and opportunities relevant to the scheme.
  - Trustees must establish and maintain processes to satisfy themselves that any person responsible for the scheme's governance activities takes adequate steps to identify, assess and manage climate-related risks and opportunities.
- Strategy
  - Trustees must, on an ongoing basis, identify climate-related risks and opportunities which they consider will have an effect over the short-, medium- and long-term on the scheme's investment and funding strategy.
  - Assess the impact of the above risks and opportunities.
  - As far as they are able, trustees must undertake scenario analysis, considering the impact on assets and liabilities of two scenarios under which global temperatures rise.
  - One scenario to be consistent with 1.5-2 degrees warming.
  - Analysis is to be carried out in the first year in which the regulations apply, and then every three years thereafter.
- Risk management
  - Trustees must establish and maintain processes for the purpose of enabling them to identify, assess and effectively manage climate-related risks.
- Metrics and targets
  - Trustees must select a minimum of three metrics, two of which are prescribed; one giving total greenhouse gas emissions of the scheme's assets ('absolute emissions metric'), and one giving total carbon dioxide emissions per pound of assets invested ('emissions intensity metric').
  - As far as they are able, trustees must obtain Scope 1, Scope 2 and Scope 3* greenhouse gas emissions data for the scheme's assets, to calculate their metrics and to identify and assess climate related risks and opportunities. (In the first scheme year in which the requirements apply, trustees are not required to collect and report on scope 3 emissions).
  - Trustees must set a target for at least one of the metrics, and subsequently measure performance relative to that target on an annual basis.

*Scope 1: all direct emissions from the activities of an organization or under its control (e.g., business operations).
Scope 2: indirect emissions created from the production of electricity/energy purchased and used by the organization.
Scope 3: all other indirect emissions from activities of the organization (from sources the organization does not directly control, e.g., supply chain or customer emissions when using a company's product).
Sources: https://www.fsb-tcfd.org/; https://www.willistowerswatson.com/en-GB/Insights/2021/09/reporting-pension-scheme-climate-risks-what-how-when

The World Resources Institute has now introduced Scope 4 emissions to refer to the emission reductions that occur outside of a value chain or the life cycle of a product, sometimes called avoided emissions, e.g., the energy or emissions that have been saved as a result of the new climate or energy-saving technology associated with a product or service. Scope 4 emissions also include homeworking emissions, e.g., the

Department for Work and Pensions have established the Pensions Climate Risk Industry Group (PCRIG) to produce guidance for pension schemes on 'climate-related practices', to ensure they are effectively governed in respect of the effects of climate change. Further, asset managers and other financial services firms are required to report publicly on how they manage climate risks.

Speaking at COP26, Thérèse Coffey, the UK secretary of state for work and pensions, said that 'pensions can be a superpower that delivers prosperity for people and the planet in our race to net zero'. Her department launched a consultation on proposals to require occupational pension schemes that already fall within the scope of climate disclosure regulations to publish a 'Paris alignment' metric to show the extent to which their investment portfolio is aligned with the 1.5°C Paris Agreement. The UK government also published *Greening Finance: A Roadmap to Sustainable Investing* which includes a new economy-wide Sustainability Disclosure Requirement (SDR) which would apply to occupational schemes. This aims to tackle greenwashing via the implementation of a Green Taxonomy', which will set out clear criteria for economic activities to meet in order to be considered sustainable. The Pension Schemes Act 2021 introduced new climate reporting obligations on UK schemes, together with annual implementation statements in respect of scheme assets.

The UK Pensions and Lifetime Savings Association (PLSA) which represents pension funds in the UK also supports the TCFD recommendations as well as measures to increase climate reporting and regulatory obligations throughout the investment chain, together with clarifying definitions of climate-aware investment. Related to this is ESG which are the three central factors in measuring the sustainability and societal impact of an investment in a company or business. In the UK, this is implemented via the Stewardship Code. The PLSA wants to work with the investment industry and regulators to develop principles for ESG asset management funds to adhere to on ESG generally, or specifically with regard to climate.[971]

Sustainability reporting (or sustainability disclosure) of non-financial performance data relating to ESG was first developed by the Global Reporting Initiative (GRI) in 2000. The Global Sustainability Standards Board (GSSB), set up in 2016, is responsible for setting globally accepted standards for sustainability reporting. The GSSB operates to oversee the development of the GRI Standards 'according to a formally defined due process'. The GRI Standards allow third parties to assess the environmental impact from the activities of a company and its supply chain. The Universal Standards for reporting came into effect in January 2023.[972]

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emissions created to keep utilities on, laptops running, and to maintain central air conditioning or heating systems; https://greenly.earth/en-gb/blog/company-guide/what-are-scope-4-emissions.

[971] Richard Butcher (2020) The PLSA is here to help overcome barriers as industry embraces climate-aware investment, *portfolio institutional*, November.

[972] https://www.globalreporting.org/about-gri/governance/global-sustainability-standards-board/

In November 2021, the UK Pensions Regulator published a climate adaptation report into the climate risks most relevant to occupational pension schemes which found that too few schemes were giving enough consideration to climate-related risks and opportunities. Only 43% of defined contribution schemes surveyed took account of climate change when devising their investment strategy, while 51% of defined benefit schemes had not spent any time or resources assessing financial risks and opportunities associated with climate change.[973]

In 2022, a pension consultant offered this advice to trustees considering a net-zero target:[974]

- Define your beliefs and priorities
- Set your overall net-zero objective
- Review your current portfolio
- Engage with your investment managers and define a net-zero pathway
- Consider sustainable funds
- Establish ongoing engagement and monitoring.

Charles Counsell, TPR's chief executive, said: 'Climate change is a risk to long-term sustainability [that] pension trustees need to consider when setting and implementing investment strategy, while many schemes are also supported by employers whose financial positions and prospects for growth are dependent on current and future policies and developments in relation to climate change'.[975] In February 2024, the Financial Markets Law Committee, which advises the UK markets on financial law, said pension trustees may consider climate change when making investment decisions, alleviating long-standing concerns that incorporating key ESG factors could be a breach of fiduciary duty – which is to act in the best financial interests of scheme members.[976]

Ashley Hamilton Claxton, head of responsible investment at Royal London Asset Management, argues that 'ESG is here to stay. Covid-19 has accelerated the trend towards greater awareness of sustainability and the interconnectedness between our economy, environment and society'. However, standards differ in different parts of the world. In the EU, for example, ESG is part of the fiduciary duty of fund managers, whereas in the US, the fiduciary duty is purely a financial duty.[977]

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[973] Further climate change disclosures in the offing as world leaders meet at COP26, *XPS Insights*, November 2021.
[974] Carbon Reduction Pathways: How your pension scheme investments can become Net Zero aligned now, *XPS*, July 2022.
[975] Susanna Rust (2019) UK to explore mandatory climate reporting for pension funds, companies, *IPE*, 2 July; https://www.ipe.com/uk-to-explore-mandatory-climate-reporting-for-pension-funds-companies/10032058.article. Susanna Rust (2020) UK pension trustees presented with guide to climate-related risks, *IPE*, 12 March; https://www.ipe.com/news/uk-pension-trustees-presented-with-guide-to-climate-related-risks/10044243.article
[976] https://www.pensionpolicyinternational.com/u-k-pension-funds-may-consider-climate-change-financial-markets-law-committee/
[977] Romil Patel (2020) Spinning on a sustainable axis, *funds-europe*, November 2020.

In February 2022, the UK Employer Covenant Practitioners Association (ECPA) published a report which argued that climate change is 'progressively impacting' the covenant of a range of employers sponsoring DB schemes, from affecting future cashflows to representing a 'fundamental risk' to scheme longevity. The report said that DB schemes should consider the impacts of climate change through sectoral analysis, including technological evolution, in order to identify 'red flags for their sponsor'. It added that covenant practitioners sit in the middle of the impact on the sponsor and the impact on other aspects of the scheme such as funding and investment. They will need to work with an increasing number of stakeholders and face a 'steep' regulatory trajectory.[978]

In June 2022, the UK Department for Work and Pensions, in collaboration with the Behavioural Insights Team, Aviva, Smart Pension and Hargreaves Lansdown, launched a 'green nudge' trial, designed to encourage pension scheme members to learn more about making greener pension choices. The trial would test the impact of behavioural nudges and messages on increasing saver engagement with the sustainability of pension investments and how it could translate into greener pension decision-making. Around 160,000 pension scheme members were involved. The DWP said: 'Through the productive long term investment power of pensions, we can help the UK get to net zero and deliver both investment returns and a sustainable planet'.[979] The findings were published in October 2024: general engagement with pensions is low; scheme members were more engaged with the financial performance of their pensions than the environmental performance of the investments and that light-touch communication-based nudges are not a promising avenue to shift pension investments towards more environmentally sustainable funds; and given the low consumer engagement with the sustainability of their pensions, in order to make meaningful progress towards aligning pension investments with environmental sustainability, interventions further upstream would be needed; this will require further research to understand the role of key players including employers, pension providers, trustees and government, in increasing the environmental sustainability of investment funds, with a focus on default arrangements.[980]

In May 2023, UK consultancy LCP introduced a new tool – LCP Beacon – to help pension scheme stakeholders improve their understanding and engagement with sponsor-related climate risks and opportunities to ensure DB pensions are protected. The tool enables trustees to analyze company business plans and forecasts, linking what was promised to a sponsor's stakeholders around net zero and climate risk mitigation goals and the cost of implementation.[981] In March 2024, Aon introduced RI-360i, a tool to help institutional

[978] https://www.professionalpensions.com/news/4044614/climate-change-fundamental-risk-scheme-longevity
[979] https://www.pensionpolicyinternational.com/new-uk-trial-seeks-to-nudge-people-into-making-greener-pension-choices/
[980] *Applying Behavioural Insights to Green Pensions*; https://assets.publishing.service.gov.uk/media/66fbf73de84ae1fd8592ec18/Applying-Behavioural-Insights-to-Green-Pensions.pdf
[981] https://www.ipe.com/news/lcp-sets-up-climate-risk-tool-for-pension-scheme-stakeholders/10066769.article

investors understand and manage risks, and build responsible investment portfolios. It can help to identify, understand, and effectively manage sustainability issues, such as climate risk, and their impact on investment portfolios. It can also evaluate alternative managers who may align more closely with the investor's objectives on responsible investment.[982]

In December 2023, UK consultancy XPS reported that UK pension schemes were still holding assets that were misaligned with the climate transition. It reviewed the Taskforce on Climate-related Financial Disclosures of 35 pension large schemes, with total assets of £344bn. It said that that progress has been made among schemes to manage climate risk, since most schemes had changed their investment mandates to include climate-aware objectives and to finance climate solutions more directly. However, it also said that there was 'room for improvement', since most schemes had focused specifically on carbon emissions reduction, leaving other aspects of climate transition underrepresented. XPS estimates that UK pension schemes' asset holdings have a weighted average of reported Implied Temperature Rise of 2.8°C, whereas the Paris Agreement limits the temperature rise to 1.5°C, explaining XPS's conclusion that UK pension schemes are currently misaligned with the climate transition. The TCFD also requires schemes to stress test the financial impacts of physical risks in a high global warming scenario every three years. The XPS analysis found that 56% of £5bn+ schemes did not conduct the test in 2023 and many that did said that they did not find meaningful conclusions. In the light of these findings, XPS recommends that: scheme trustees undertake ongoing training to understand the latest TCFD developments, speak to their pension consultants on enhancing their climate strategy, assess the transition alignments across their portfolios, and consider increasing range of funds with embedded climate objectives.[983] In February 2024, a study by sustainability research organization Profundo of the top 20 UK DC workplace pension scheme providers, with combined assets of £500bn, found that 85% had 'inadequate' or 'poor' climate plans in place. Further, despite almost all having publicly set net zero targets, not one provider was deemed to be taking a leadership role on climate action. The main failures related to fossil fuels (coal, oil and gas) and deforestation and land use.[984]

Pension risk transfer providers

SDG/ESG considerations have begun to impact the investments held by PRT providers in the UK. For example, they are investing in social housing. Not only does this meet one of the SDGs, it also provides a regular income stream to pay pension annuitants from an investment that generates higher returns than UK government bonds. Similarly, in March 2022, the Aon MasterTrust and Aon's Group Personal Pension Plan seeded the UBS Global Equity Climate Transition Fund with £700m. The fund offers cost-efficient and broad-based exposure to global equity markets, providing investors with the ability to mitigate

[982] https://www.ipe.com/news/aon-launches-enhanced-responsible-investment-solution/10072350.article
[983] https://www.ipe.com/news/uk-schemes-misaligned-with-climate-transition-says-xps-study/10070610.article
[984] https://www.ipe.com/news/majority-of-uk-pension-providers-found-to-have-inadequate-or-poor-climate-plans/10071725.article

climate-related investment risks while aiming to have a positive effect on society.[985] As another example, in July 2022, Railpen, the UK railways pension scheme, and the Alberta Investment Management Corporation (AIMCo) bought a grid-scale battery energy storage platform in the UK from investment firm Constantine for £400m. Railpen said: 'This acquisition marks Railpen's first direct investment into battery storage and reflects our ambition to drive positive change through our portfolio, working with management to develop the critical infrastructure needed to support the UK's transition to net zero'.[986]

The European Union

In December 2020, the European Insurance and Occupational Pensions Authority (EIOPA) published a discussion paper on a methodology for including climate change in the Solvency II standard formula when calculating natural catastrophe underwriting risk.[987] The frequency and severity of natural catastrophes and extreme weather, such as heat waves, heavy precipitation, droughts, top wind speeds and storm surges, is expected to increase due to climate change. EIOPA wants to ensure the financial resilience of (re)insurers covering natural catastrophes, implying that the solvency capital requirements for natural catastrophe underwriting risk need to be appropriate in light of climate change.[988]

In April 2022, EIOPA launched its first stress test of the impact of climate change on European pension scheme investments. It included not only an assessment of the effects of a rise in inflation, but also a climate risk stress which will test schemes' resilience against a climate change scenario developed with the European Systemic Risk Board and the European Central Bank. The scenario involves a disorderly transition to climate neutrality due to delayed policy action, specifically, that new climate policies are not introduced until 2030 and this leads to an abrupt carbon price increase which affects the entire economy. The stress test will focus on both the impact on pension fund investments and the financial situation of scheme sponsors.[989]

In December 2022, EIOPA reported the findings from this stress test. The test covered 187 pension funds from 18 EU member states with €2trn of assets (65% of total assets in DB and DC schemes). The funds were tested for resilience to a sharp rise in carbon prices caused by a sudden disorderly transition to carbon neutrality resulting from delayed policy actions. The funds held 6% of their share and 10% of their corporate bond investments in

[985] https://www.ipe.com/news/aon-mastertrust-pension-plan-seed-ubs-climate-fund/10058957.article
[986] https://realassets.ipe.com/news/railpen-aimco-to-pump-400m-into-uk-battery-energy-storage-projects/10061353.article
[987] EIOPA launches discussion paper on a methodology for integrating climate change in the standard formula, *Pensions Policy International*, 4 December 2020; https://pensionpolicyinternational.com/eiopa-launches-discussion-paper-on-a-methodology-for-integrating-climate-change-in-the-standard-formula
[988] For more details about the impact on insurance of climate risk, see Garrido et al. (2024).
[989] https://www.ipe.com/news/eiopa-launches-climate-risk-focussed-2022-pension-fund-stress-test/10059031.article

carbon intensive industries such as mining, electricity, gas and land transport. The stress test resulted in a fall in asset values of 12.9%. EIOPA concluded that the funds were 'materially exposed' to transition risks.[990]

In February 2024, EIOPA set out four principles that should be observed when insurers and pension entities make sustainability claims:[991]

- Principle 1 states that sustainability claims 'should be accurate, precise, and consistent with the provider's overall profile and business model, or the profile of its products'. To ensure the accuracy of sustainability claims, all relevant information should be disclosed without omission.
- Principle 2 states that sustainability claims should be kept up to date, and any changes should be disclosed in a timely manner and with a clear rationale.
- Principle 3 states that sustainability claims should be substantiated with clear reasoning and facts. In line with Principle 2, any change to the sustainability profile of a product must be adequately substantiated.
- Principle 4 states that sustainability claims and their substantiation should be accessible and understandable.

In October 2023, the EU adopted the 'Fit-for-55' package which aims to reduce greenhouse gas emissions by 55% by 2030. In November 2024, the EU conducted a 'Fit-for-55' stress test on banks, insurers, investment funds and pension funds, and found that, in the worst-case scenario, the pension funds experienced losses of 21.5%, considerably more than the other three institutions. In this scenario, transition risks manifest themselves in the form of a 'run-on-brown' shocks, whereby investors sell off the securities of carbon-intensive firms, combined with 'other standard macro-financial stress factors'. This results in significant decreases in market values, especially of corporate and sovereign bonds, which constitute around half of insurers' and pension funds' investments. However, the increase in yields reduces pension fund liabilities which helps to ameliorate the negative impact.[992]

In April 2025, EIOPA launched its fifth stress test of occupational pension funds, assessing the impact of two adverse economic scenarios on the liquidity position of pension funds, in the one case, sharp increases and, in the other case, sharp declines in interest rates. EIOPA said: 'In the "yield curve up" scenario, EU interest rates increase sharply as market participants anticipate economic developments related to the abrupt escalation of geopolitical tensions. These geopolitical tensions cause disruptions in trade and a sharp rise in commodity prices, leading to a large upward revision in inflation expectations. In this context, the scenario assumes EU's vulnerability to trade restrictions that cause the euro to

[990] https://www.pensionpolicyinternational.com/climate-change-could-cost-pension-funds-billions-eu-watchdog-says/
[991] https://www.pensionpolicyinternational.com/eu-sustainability-and-greenwashing-in-insurance-eiopa-publishes-draft-opinion
[992] https://www.ipe.com/news/pension-funds-assets-down-by-up-to-215-in-climate-stress-scenario/10126438.article

depreciate. In the second, "yield curve down" scenario, EU interest rates plummet as market participants internalise an unexpected prolongation of geopolitical tensions, triggering a loss of confidence in financial markets'.[993]

The US

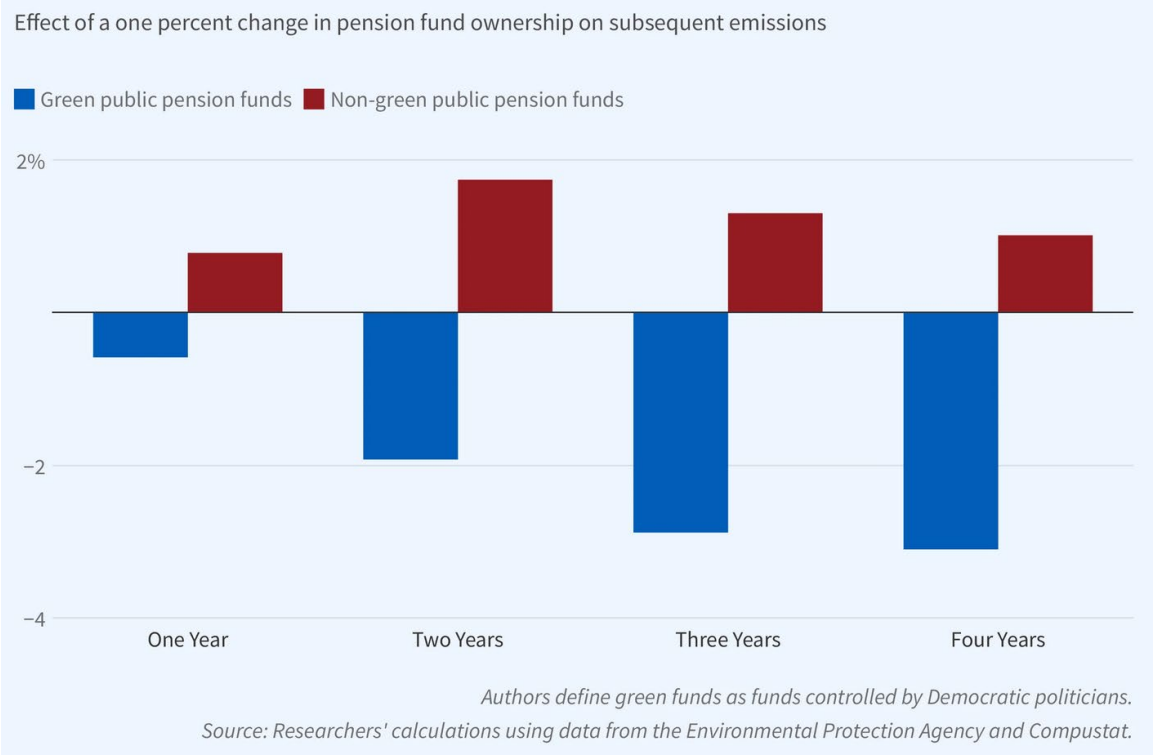
In January 2024, Matthew E. Kahn, John Matsusaka, and Chong Shu published a study entitled *In Divestment and Engagement: The Effect of Green Investors on Corporate Carbon Emissions* (NBER Working Paper 31791).[994] The study analyzed whether US public pension funds affect the level of greenhouse gas emissions at the companies they own. It categorized public pension funds based on the political affiliation of the leaders who control them through governance or board trusteeship. Those under Democratic control were labeled 'green', while those under Republican control were labeled 'non-green'. The study's hypothesis was that that Democrats generally favor carbon emission reductions more than Republicans. It analyzed emissions data from 2010–21 for 5,241 facilities across 685 publicly traded companies, along with data on pension fund stock holdings for 24 of the US's 50 largest public funds. These funds collectively managed over 88% of total public pension assets in the US. Companies reduced their greenhouse gas emissions as the ownership stake of green pension funds rose. A 1 percentage point rise in shares owned by green pension funds was associated with a 3.1% decline in carbon emissions over four years, and a 5.2 percentage point increase in the probability of some carbon emission reduction over this period. Increased ownership by non-green funds was not associated with any decline, and may be associated with an increase in emissions. See Figure 12.

The study considered three ways in which increased green ownership could potentially affect emissions: managerial reactions to investor ownership, pressure exerted by investors through shareholder proposals, and persuasion of managers by pension shareholders. It found that emission cutbacks depend in part on the proactive engagement of green funds, suggesting that managers do not respond without some shareholder involvement. It rejected the shareholder proposal channel since it found no increase in shareholder environmental proposals calling for companies to scrutinize and report on environmental concerns after a surge in green ownership. The study concluded that persuasion carries more weight than confrontational pressure in driving emission reduction.

993

994 https://www.nber.org/digest/202401/role-green-investors-reducing-corporate-carbon-emissions; https://www.nber.org/papers/w31791

Figure 12: Pension fund ownership and corporate greenhouse gas emissions



Global

In November 2024, Ortec Finance published its first global pension fund climate risk report, *Climate Risks Facing the Pension Industry Worldwide*,[995] which analyzed publicly available data from around 140 pension funds in the US, Canada, the UK, the Netherlands and Switzerland using its climate scenario modelling framework. It considered seven climate scenarios, including the climate tipping into high-warming states (involving a global average rise in temperature of 3.7°C). It found that North American pension fund returns could decline up to 50% by 2040 under a high-warming scenario, UK funds by less than 30% by 2040, and Dutch and Swiss funds by much less due to their lower geographical exposure to extreme climate events and substantial allocations to less vulnerable assets. Transition risks are expected to be the dominant climate risk driver compared to physical risks during the 2025–2030 period for pension funds worldwide. A 'disorderly' transition ('drastic and uncoordinated policy changes' designed to reach net zero quickly) would result in average losses of 14% over the next five years. Doruk Onal, climate risk specialist at Ortec Finance, warned that the decline in investment returns has serious implications: 'For pensioners, reduced returns could lead to lower retirement benefits and financial insecurity. Sponsors, including corporations and government bodies, might face increased

[995] https://www.ortecfinance.com/en/insights/whitepaper-and-report/climate-risks-facing-the-pension-industry-worldwide

contributions to cover shortfalls, impacting their financial health. Employees could also be affected by lower pension fund performance, leading to potential adjustments in retirement planning and expectations'.[996]

Large pension schemes

We consider examples of some large pension schemes' climate change considerations that have been publicly reported.

In March 2023, TPT Retirement Solutions, one of the UK's largest workplace pension plans, announced that it had introduced climate change considerations into its investment decisions. Cliff Speed, TPT's chief investment officer, said: 'Climate change has the potential to reduce the security of our members' retirement benefits and represents a systemic risk to the long-term value of our investment portfolio. At the same time, the investment required to transition to a net-zero economy presents an opportunity to support the expansion of climate solutions. For us, this means taking an approach to managing our investment risks and opportunities on behalf of our members in line with our fiduciary duty'. In 2016, TPT made its first allocation to renewable energy generation and renewable supporting technologies. It also invested in two additional renewable energy strategies in 2021. It is on the global steering group of the Paris Aligned Investment Initiative, a global forum representing investors (known as Paris Aligned Asset Owners (PAAO)[997]) with $34trn in assets aligning their portfolios and activities to the goals of the Paris Agreement.[998]

In March 2024, the People's Pension, a £26bn UK multiemployer DC scheme, announced that it had moved £15bn from developed markets equities to a strategy based on the EU's Climate Transition Benchmark (CTB) methodology and would now follow regional MSCI Climate Change Indexes. The methodology involves an immediate 30% reduction in financed emissions, additional portfolio decarbonization by 7% each year, and divestment from companies that produce thermal coal within the assets covered by the new strategy. It said the primary aim was 'to manage the long-term risks posed to members' investments by climate change and a green transition, that aren't currently being priced by the market' which in turn meant 'members can be confident their investments are working toward the goals of the Paris Agreement'.[999] In April, the People's Pension introduced a new responsible investment policy that required fund managers to have a commitment to net

[996] https://www.ipe.com/news/pension-fund-returns-could-suffer-with-climate-change-impact/10126581.article; https://www.pensionpolicyinternational.com/how-climate-change-will-impact-pension-fund-investment-portfolios/
[997] https://www.parisalignedassetowners.org/
[998] https://www.ipe.com/news/uk-workplace-pension-scheme-plans-investment-in-climate-solutions/10065832.article
[999] https://www.ipe.com/news/peoples-pension-shifts-15bn-to-eu-climate-transition-benchmark-strategy/10071987.article

zero and adequate resources committed to stewardship; failure to do so could trigger a review and possible transfer of assets to other managers.[1000]

A 2024 survey of UK pension funds by AlphaReal, a real assets manager, found that a majority (90%) of pension funds planned to increase their allocation to renewable energy in the next year: 28% reported they would increase their allocations to 21% or more of the portfolios they manage, while 39% said they would increase their allocations to between 16% and 20%.[1001]

In August 2023, a study by Columbia University, the World Bank and the Sustainable Finance Institute examined the portfolios of five of the world's largest pension funds: the Japan Government Pension Investment Fund (GPIF, assets of $1.5trn), the Norway Government Pension Fund Global (GPFG, $1.4trn), the Netherlands' Stichting Pensioenfonds (ABP, the Dutch civil service pension scheme), $465bn), the Canada Pension Plan Investment Board (CPPIB, $420bn), and the New York State Common Retirement Fund (NYSCRF, $242bn). All invest in renewable energy and all assess the environmental sensitivity of any new investments. GPIF, the world's largest public pension fund, is reducing its holdings of carbon-based companies, invests in two low-carbon-oriented stock indexes, and issues green bonds to raise capital to invest in renewable energy and low-carbon companies. GPFG's revenues come from North Sea oil and gas wells, but it has divested from companies that do not meet its climate or ethical standards. ABP planned to reduce its portfolio's carbon footprint by 40% by 2025. CPPIB is heavily invested in real estate and infrastructure (which includes the ownership of 295 'green-certified' buildings in 25 countries) and has issued $109bn in euro-denominated green bonds. NYSCRF has divested from investments in shale oil and gas and has pledged to have a net-zero portfolio by 2040 by investing in its own low-carbon index. With the exceptions of ABP and GPIF, the report noted that the other funds 'fail to define their objectives in numeric terms'.[1002]

In December 2023, the California Public Employees' Retirement System (CalPERS), the largest US public pension fund, announced plans to invest $100bn in climate solutions by 2030 (the CalPERS Sustainable Investments 2030 strategy), as part of its aim of cutting emissions from its portfolio investments to net zero by 2050, while securing long-term financial returns for its members. CalPERS said it wanted to address the major risks that financial markets and companies face as a result of the changing climate, such as business interruptions and damage to assets as a result of hurricanes or flooding It also wanted to participate in the 'booming new clean economy, creating new markets, and investing in the next batch of winners as this shift continues to accelerate exponentially – and avoiding being left behind with dwindling markets, outmoded business models, and stranded assets'.

[1000] https://www.pensionpolicyinternational.com/uk-peoples-pension-ramps-up-esg-expectations-of-asset-managers
[1001] https://www.pensionpolicyinternational.com/uk-pension-funds-turn-to-renewable-energy-investment/
[1002] https://www.pensionpolicyinternational.com/how-5-of-the-worlds-largest-pensions-funds-invest-to-combat-climate-change/

According to the International Energy Agency, a record $1.8trn was invested in clean energy in 2023, more than was invested in fossil fuel energy.[1003] In January 2025, CalPERS, with $502.9 billion in assets, revealed that it was more than halfway towards its $100bn goal, with around $53bn committed to climate adaptation, transition, and mitigation efforts.[1004] In March 2025, CalPERS called for a shift in climate disclosure narratives, emphasizing that companies need to highlight opportunities alongside risks. It noted that the past decade has focused heavily on risk disclosure, and companies should be more vocal about their positive climate initiatives, particularly in areas such as green revenues.[1005]

However, a survey of 24 US public pension funds conducted for a report called *The Hidden Risk in State Pensions: Analyzing State Pensions' Responses to the Climate Crisis in Proxy Voting* found that 'too few state pensions are taking adequate steps to address climate-related financial risks and protect their members' hard-earned savings, raising serious concerns about their execution of fiduciary duty'.[1006] On the other hand, a study by Kahn et al. (2024) found that ownership and active constructive engagement from US public pension funds were more effective than confrontational tactics, such as voting or shareholder proposals. In particular, they found that companies reduced their greenhouse gas emissions when stock ownership by 'green' funds (where the majority of trustees were Democrats or were located in states with a Democratic governor) increased, and did not alter their emissions when ownership by 'non-green' funds (e.g., those in Florida or Texas) changed. The authors concluded that widespread disinvestment from companies currently in the fossil fuel business could be misguided and lead to unintended consequences.[1007]

In December 2023, the Dutch pension fund Pensioenfonds Metaal & Techniek (PMT) announced it had divested from 40 oil and gas companies, but remained invested in nine European companies (Shell, Aker BP ASA, BP, Enbridge, Eni, Equinor, Galp Energia, Neste and OMV) with 'sufficiently convincing plans' for the energy transition and carbon reduction. The 40 companies sold did not have sufficiently ambitious and substantiated CO_2 reduction targets to commit to the Paris Agreement goals. Although the retained companies were not currently operating in line with the goals – which applies to the entire global economy – they made progress during the two-year engagement program with the fund and will be continuously monitored to confirm sufficient progress. PMT insists the companies must stop developing new oil fields by 2025, but can continue to develop new gas fields due to the global scarcity of natural gas. PMT's strategy is to keep

[1003] https://www.pensionpolicyinternational.com/the-largest-u-s-pension-fund-just-rolled-out-a-climate-transition-plan-focused-on-risk-and-opportunity/
[1004] https://www.top1000funds.com/2025/01/calpers-goes-big-on-the-green-transition
[1005] pionline, 12 March 2025
[1006] https://www.pensionpolicyinternational.com/us-too-few-public-pension-funds-address-climate-in-proxy-voting-report/
[1007] Matthew E. Kahn, John G. Matsusaka and Chong Shu (2024) Measuring the unintended consequences of public pension fund disinvestment from fossil fuel companies, CEPR, 26 January; https://cepr.org/voxeu/columns/measuring-unintended-consequences-public-pension-fund-disinvestment-fossil-fuel

talking to polluters and 'not simply exclude companies or a sector'. This contrast with two other large Dutch pension funds, ABP and PME, which have divested from the entire fossil sector.[1008]

In March 2024, ABP announced that it would invest a total of €30bn in energy transition and non-listed impact investments targeted at biodiversity solutions, innovation and affordable housing. It said that it had identified climate and biodiversity 'as the key themes influencing societal and economic changes, presenting risks and opportunities in the investment portfolio'. It also said that it would stop investing in companies 'where climate or biodiversity damage is inherently linked to their business activities, with no realistic prospect of improvement' which potentially included companies involved in the meat, cacao, coffee, palm oil, animal feed or paper and wood industries.[1009]

In February 2025, PGGM,[1010] the investment manager that invests on behalf of five Dutch pension funds (in particular, the healthcare pension scheme PFWZ), announced it had taken a 49% stake in Carbon Collectors, a Dutch company involved in carbon capture. This was part of a €1bn investment that will be allocated to climate-related start-ups.[1011]

In March 2025, the £78bn Universities Superannuation Scheme (USS), the UK's largest pension fund, announced that was going to spend more time on engagement with government and corporates than producing emissions reports. Between 2019 and 2023, it reduced the carbon emissions of its asset portfolio by 35%. It did this by tilting to climate-friendly assets, reducing its exposure to companies poorly positioned to adapt, and investing directly in renewables. Despite this, global emissions have continued to increase. USS argues that the carbon reporting burden was distracting from more useful strategies like engagement to encourage others to act as long-term players. It added that policy change was a precursor to meaningful corporate change and it wanted to help create a landscape and economic framework within which corporates and consumers can choose lower carbon options.[1012]

In March 2025, a survey by consultant XPS of 48 pension schemes' task force on climate-related financial disclosure (TCFD) reports found that 75% of schemes had adopted net-zero targets in 2024, an increase from 60% in 2023. In addition, 69% had made asset allocation changes to address climate risks, while 42% had some direct investment in climate solutions. In total, the schemes surveyed had £400bn in assets.[1013]

[1008] https://www.pensionpolicyinternational.com/dutch-pension-fund-pmt-sells-most-fossil-fuel-holdings/
[1009] https://www.ipe.com/news/abp-pledges-30bn-for-new-impact-investments/10071989.article
[1010] https://www.pggm.nl/en/about-us/about-pggm/
[1011] https://impact-investor.com/pggm-buys-stake-in-dutch-carbon-capture-company/
[1012] https://www.top1000funds.com/2025/03/uss-calls-time-on-emissions-reporting
[1013] https://www.pensionpolicyinternational.com/uk-three-quarters-of-pension-schemes-have-now-adopted-net-zero-targets/; https://xps-13503-s3.s3.eu-west-2.amazonaws.com/files/1717/4306/7339/XPS_Group_TCFD_in_Review_Year_3_002.pdf

In April 2025, Local Pensions Partnership Investments (LPPI), the £27bn investment pool for three funds in the UK Local Government Pension Scheme – Lancashire County Pension Fund, the London Pensions Fund Authority and the Royal County of Berkshire Pension Fund – launched a £500m LPPI Environmental Opportunities Fund, a private markets fund focused on decarbonisation investment opportunities, in particular, climate mitigation, climate adaptation, and the protection, restoration, and sustainable management of nature.[1014]

In April 2025, Border to Coast Pensions Partnership agreed to invest £40m in a UK life science fund managed by UBS Asset Management's Real Estate & Private Markets and £40m in a renewables impact fund managed by Quinbrook Infrastructure Partners (the Quinbrook Renewables Impact Fund (QRIF) II fund). The former fund has assets in the 'golden triangle' region encompassing Cambridge, Oxford and London. The latter fund will invest in projects, such as the 2,000-acre Mallard Pass solar farm on the Rutland/Lincolnshire border, which will generate sufficient energy to power 92,000 UK homes, and battery storage facilities aimed at decarbonising commercial vehicles.[1015]

In April 2025, Pensioenfonds ING, the pension fund of Dutch bank ING, appointed Achmea Investment Management as a strategic advisor for impact investing, with an emphasis on investments in climate, health and nature themes in private markets. This aligns with a call from the Netherlands Advisory Board on impact investing for the country's pension funds, asset managers, insurance companies and banks to allocate at least 10% of their assets under management to impact investments by 2025.[1016]

Smaller pension schemes

In August 2024, a study by The Pensions Regulator in the UK of 3,500 schemes found that many smaller schemes only had minimum compliance with ESG aspects of statements of investment principles (SIPs) and implementation statements (ISs). Trustees often failed to demonstrate ownership of their policies or key activities in respect of ESG and where they delegated activities to managers, they often failed to explain or demonstrate oversight of ESG activities. Further, where schemes are invested in pooled funds, a number of trustees highlighted they had limited ability to influence underlying managers on decisions related to ESG. TPR said scheme trustees should aim to fully demonstrate their engagement with material ESG considerations whether climate impact, nature loss or social factors and invite challenge in the interest of protecting outcomes for savers.[1017] In the same month, a study by Climate Safe Pensions found that, with $46trn in assets worldwide, pension funds were

[1014] https://www.ipe.com/news/local-pensions-partnership-launches-climate-solutions-fund/10129778.article
[1015] https://realassets.ipe.com/news/border-to-coast-invests-80m-in-uk-life-science-real-estate-and-renewables/10129920.article
[1016] https://impact-investor.com/achmea-im-to-advise-ings-pension-fund-on-impact-investing
[1017] https://www.ipe.com/news/tpr-report-missed-opportunity-as-trustees-focus-on-minimum-esg-compliance/10074997.article

still amongst the largest institutional investors in fossil fuels, holding nearly 30% of fossil fuel industry shares.[1018]

In March 2025, Scottish Widows *Responsibly Invested Pensions* survey revealed that 69% of employers in the UK offered a responsibly invested company pension, but only 44% have it as their default fund option for their DC scheme. This put the burden on employees to take action if they want to switch; however 61% of employees reported that had 'no idea' how to change their default, highlighting a need for employers and advisers to educate workers on this issue. The survey also found that more employees have become interested in how environmental, social and governance 'friendly' their company pension scheme is: 17% employees class their pension's environmental or social impact as a top priority, rising to 25% for those aged 18-34. The survey said employers were taking a range of approaches to embedding responsible investment into their pensions: 53% were allocating pensions to specific sustainable funds, 46% were invested in impact strategies, and 45% were focused on investing in companies cutting carbon emissions.[1019]

UN-supported initiatives relating to asset owners, asset managers, insurers and banks

We now consider some UN-supported initiatives relating to asset owners, asset managers, insurers and banks.

Principles for Responsible Investment

One of the earliest, established in 2005, was the Principles for Responsible Investment (UNPRI or PRI),[1020] an international network of financial institutions whose aim is to implement six 'Principles':

- Principle 1: We will incorporate ESG issues into investment analysis and decision-making processes.
- Principle 2: We will be active owners and incorporate ESG issues into our ownership policies and practices.
- Principle 3: We will seek appropriate disclosure on ESG issues by the entities in which we invest.
- Principle 4: We will promote acceptance and implementation of the Principles within the investment industry.
- Principle 5: We will work together to enhance our effectiveness in implementing the Principles.

[1018] https://www.pensionpolicyinternational.com/pension-funds-should-protect-our-future-not-destroy-it/
[1019] https://www.pensionpolicyinternational.com/uk-two-thirds-of-employers-embrace-responsible-pensions-less-than-half-have-it-as-their-default/
[1020] https://www.unpri.org/

- Principle 6: We will each report on our activities and progress towards implementing the Principles.

In April 2024, UNPRI issued ten priorities for embedding sustainability in pension systems:[1021]

1. The policy framework is comprehensive and consistent

   Policy makers develop a comprehensive, consistent and supportive policy framework that provides clarity for pension funds as they seek to address sustainability risks and opportunities, including system-level risks, when they pose a threat to achieving their financial objectives. Policy and regulatory frameworks ensure that:

   (i) There is clarity regarding the duties and obligations of pension funds to incorporate ESG factors into investment decisions and stewardship activity, and to consider taking action to pursue sustainability outcomes that are instrumental to fulfilling financial objectives in line with members' and beneficiaries' preferences.
   (ii) The long-term investment horizon and fiduciary duties of pension funds are recognized, incentivized and protected through appropriate parameters in investment decision-making, product choice and the tenure of pension fund trustees and senior executives, leading to decision-making that prioritises long-term goals.

2. Policy and regulation distinguish between addressing exposure to sustainability-related risks, tackling underlying drivers of such risks and pursuing sustainability outcomes in parallel with financial objectives

   Pension funds are enabled to move beyond ESG integration at a risk-return level and pursue sustainability outcomes. Standards and guidance should clarify when pension funds may be required to consider addressing system-level risks relevant to financial objectives, as well as when and how they might pursue sustainability objectives in the best interest of members and beneficiaries.

3. Pension funds, investment managers and intermediaries produce standardized reporting on sustainability objectives

   Standardized reporting provides information about the extent to which pension funds have met stated sustainability objectives and taken action to achieve those objectives. Similarly, investment managers and relevant intermediaries in the

[1021] Progress and priorities: reviewing sustainability in key pension systems; https://www.unpri.org/private-retirement-systems-and-sustainability/progress-and-priorities-reviewing-sustainability-in-key-pension-systems/12285.article

investment value chain align their reporting to support pension funds. Reporting by pension funds is in a format that is accessible to members and beneficiaries.

4. There is appropriate guidance on the sustainability claims of pension funds

   Regulators provide guidance to pension funds on how to demonstrate the sustainability claims of their offerings and ensure that their disclosures indicate the types of strategies that facilitate these claims. This is a key factor in ensuring that members and beneficiaries have confidence in the sustainability characteristics of their products. Such guidance should not create unnecessary restrictions on the types of strategy that can be considered sustainable, providing adequate incentives to innovate.

Market structure

5. Pension funds have scale or can otherwise access the benefits of scale

   Policy makers and regulators encourage fund consolidation where there are benefits to the market within which the funds are operating. However, the impacts of consolidation on sustainability objectives and strategies should be properly considered. In the absence of consolidation, policy makers and regulators encourage pooling of investments or resources, including encouraging sharing of resources on stewardship activities.

6. Suitable, sustainable investment products are available and accessible

   Pension funds can access investment products with their desired sustainability characteristics, at appropriate cost and scale, to achieve their sustainable investment objectives.

Investment practices

7. Members and beneficiaries are educated about and engaged with regarding their sustainability objectives

   Pension fund members and beneficiaries are appropriately educated about and regularly and systematically engaged with regarding their sustainability objectives. Where appropriate, the views of members and beneficiaries are reflected in pension fund sustainability strategies.

8. Trustees and fiduciaries are capable and skilled, with sustainability knowledge

   Trustees and fiduciaries are equipped to meet high professional standards and receive sustainability-related training.

9. Trustees and fiduciaries are willing to move beyond traditional pension fund investment strategies and identify, implement and support the development of appropriate benchmarks to take action to pursue sustainability outcomes in keeping with their fiduciary duties

   This includes provision of adequate incentives and market settings for moving, where appropriate, from traditional benchmarks focused on short-term, portfolio-level risks, towards benchmarks that allow the measurement of a scheme's impact on system-level risks and the impacts of system-level risks on funds over longer time frames.

10. Service providers are adequately incentivized to support the pursuit of pension funds' sustainability objectives

    Service providers (notably investment managers and consultants) are adequately incentivized, able and willing to provide products and services that support pension funds' sustainability objectives. This includes protecting against the adverse impacts of market concentration, such as the potential for conflicts of interest or impacts on the principal-agent relationship due to the size of intermediaries relative to the pension fund clients they serve.

In March 2025, figures from the PRI – based on the reports of more than 3,000 of its signatories which represent nearly $90trn in assets under management – indicated that between 2023 and 2024, there was an increase in the proportion of asset owners, from 14% to 19%, that did not include any responsible investment clauses in their contracts with managers. In addition, fewer asset owners required their managers to adopt their exclusion criteria, incorporate material ESG factors into investment and stewardship activities, or report on their responsible actions over the period. More than 50% of respondents are based in Europe, 23% in North America and 10% in Asia.[1022]

Net-Zero Asset Owner Alliance

The UN-convened Net-Zero Asset Owner Alliance (NZAOA)[1023] was established in 2019 by Allianz, Caisse des Dépôts, La Caisse de dépôt et placement du Québec (CDPQ), Folksam Group, PensionDanmark and Swiss Re – with Alecta, AMF, CalPERS, Nordea Life and Pension, Storebrand, and Zurich Insurance joining shortly after. Members commit to transitioning investment portfolios to net-zero greenhouse gas emissions by 2050. In May 2021, four UK pension asset owners joined the Alliance – Phoenix Group, L&G, Rothesay and Prudential (UK) – bringing the total membership to 42 and combined assets

[1022] https://www.ipe.com/news/drop-in-asset-owners-including-responsible-investment-clauses-manager-contracts/10129674.article
[1023] https://www.unepfi.org/net-zero-alliance/

of $6.6trn.[1024] By October 2023, assets had grown to $9.5trn[1025] and there were 88 members, of which around 60 were European pension funds and insurers, with new joiners such as Danica Pension, the BT Pension Scheme and AXA.

In November 2023, NZAOA published its engagement expectations for investment managers wanting to win and retain mandates from its members: 'asset managers must adopt a consistent, transparent, and outcomes-oriented climate engagement strategy, which recognises that climate change poses systemic risks to asset owner portfolio returns. [Such an approach would be] critical for asset managers' continued ability to win mandates of clients committed to net zero'. Managers were recommended to get climate engagement processes and standards verified or assured. In addition, asset managers would be expected to explain their approach, objectives and deadlines for securing real-world change for each engagement they undertake, as well as 'transparently share their expectations of issuers and, importantly, their successes and learnings from engagement'.[1026] In February 2024, NZAOA launched a call for action by investment managers by sending a clear message that serving asset owner clients was only possible through climate stewardship. Investment managers needed to ensure their net-zero pledges were being taken up by senior leadership or they would start losing out on mandates.[1027]

In April 2024, NZAOA released the fourth edition of the Target-Setting Protocol, covering all private assets, requiring the halving emissions by 2030 and ensuring 20% of AUM are in green investments by 2030.[1028] In September 2024, NZAOA announced that that there had been a 6% annual reduction in greenhouse gas emissions registered by its 88 members (90% of which are either insurers (62%) or pension funds (28%)) since 2018 which meant that the group was on target for achieving net zero emissions by 2050. Eighty members have set targets for investments in 'climate solutions' which contribute to real-world decarbonization.[1029] Mark Lyon, deputy CIO of the UK's Border to Coast pension pool, explains how this annual reduction is being achieved: '[It requires some annual rebalancing of the portfolio]. Many of the new managers we're choosing tend not to invest in high-emitting, old-economy stocks like energy and materials because they're more focused on growth. The rest has been achieved by the companies themselves. We own more than 1,000 companies, and the top 60 or 70 account for more than half our emissions. So, if we get those companies to transition, we can see big changes almost immediately. And that's what's happened'. Ravien Sewtahal, senior investment manager at the Dutch pension fund

[1024] https://www.pensionpolicyinternational.com/uk-pension-asset-owners-join-net-zero-asset-owner-alliance/
[1025] *Insurance Asset Management*, 19 October 2023.
[10261026] https://www.ipe.com/news/net-zero-engagement-asset-owners-publish-rules-for-managers/10070072.article
[1027] https://www.ipe.com/news/asset-owners-warn-managers-to-take-climate-pledges-seriously/10071464.article
[1028] *Insurance Asset Management*, 18 April 2024.
[1029] https://www.pensionpolicyinternational.com/net-zero-asset-owner-alliance-unveils-milestone-emissions-cuts/; https://www.ipe.com/news/net-zero-asset-owners-have-successfully-decarbonised-in-line-with-15c/10076517.article

PFZW, said 'some of the decarbonisation has come from the scheme's decision to sell almost all its oil and gas stocks, which it believes will reduce financial risks over the longer term. The board has an intrinsic motivation to change things in the real world because we know it will be much easier to make returns for our participants if the planet is not on fire or under water. …[PFZW] recently launched a strategy to make direct investments into European companies providing solutions to the climate crisis and supporting the transition to a low-carbon economy through things like new heating and cooling systems. That was a really big step in telling our participants that we're contributing to real-world change not just by encouraging big companies to decarbonise, but by financing good investment ideas that will help make it possible. …Now we have the flexibility to invest in more climate solutions, as long as they create real-world impact, stay close to our overall investment beliefs and fit within our risk management constraints. The new model also creates synergies and awareness within our broader organisation around climate transition investing'.[1030]

Also in September 2024, the London Stock Exchange Group (LSEG) published a Decarbonization in Portfolio Benchmarks report in association with NZAOA. It found that between 2016 and 2022, the weighted average carbon intensity of the FTSE All-World equity index had declined by 4.1% annually on a revenue basis (Weighted Average Carbon Intensity (WACI)) and 5.1% on an ownership basis (Enterprise Value Including Cash (EVIC), the sum of market capitalization plus total debt). Similar rates occurred in corporate fixed income, with the FTSE WorldBIG Corp index decarbonizing at 3.9% (WACI) or 1.4% (EVIC) p.a. over the same period. At a benchmark level, 90% of the equity benchmark by index weight and 85% of the corporate fixed income universe now disclose their Scope 1 and 2. Scope 3 disclosure remains more limited due to poor data quality.[1031]

In January 2025, NZAOA requested information about asset managers' carbon dioxide removal investments. It said that phasing in investments in carbon removal solutions, both nature-based and technology-based, 'cannot wait', particularly 'if decarbonisation falters': 'That is why the Alliance is publishing this request for information, seeking to contribute to capacity building and knowledge sharing, and ultimately investment scaling in this space', while recognizing there were limitations to carbon dioxide removal solutions with commercial viability and uncertainty about long-term demand.[1032]

[1030] https://www.ipe.com/special-reports/pension-funds-outline-progress-towards-net-zero/10076568.article
[1031] https://www.lseg.com/content/dam/lseg/en_us/documents/sustainability/lseg-decarbonisation-portfolio-benchmarks-report.pdf
[1032] https://www.ipe.com/news/net-zero-asset-owner-body-issues-carbon-dioxide-removal-info-request/10128439.article

Net Zero Asset Managers initiative

The Net Zero Asset Managers initiative (NZAM) was launched in December 2020 – as a formal partner of the UN's Race to Zero Campaign[1033] – and aims to galvanize the asset management industry to commit to a goal of net zero emissions.[1034] At the time of COP26, NZAM announced that 35% of their assets under management were being managed in line with net-zero emission targets.[1035] Morningstar reported that in 2021 there were 860 mutual funds and exchange-traded funds (ETFs) with a climate-focused mandate with total assets of $408bn, double the previous year.[1036] Climate Impact Consistent (CIC) Indices have been introduced for net-zero investors. They weight each company in proportion to its net-zero alignment, as measured through its carbon emissions intensity, its emissions disclosure/quality, its forward-looking emissions targets and their credibility, and its revenues from climate solutions.[1037] By mid-2024, NZAM had around 325 members with $57.5trn in assets under management.[1038]

At the COP26 meeting, BlackRock, then a NZAM member, announced that it had raised $673m in public and private sector money for a new infrastructure fund which would invest in climate-related projects in emerging markets.[1039] The International Energy Agency estimates that investment in energy transition in emerging markets needs to rise to $1trn a year by 2030 if the world is to reach the net-zero target by 2050.[1040] In 2023, British International Investment (BII), the UK's development finance institution, signed an agreement with ILX, an Amsterdam-based manager of an emerging market private debt fund, to co-finance up to $500m of debt to support long-term sustainable development in developing and low-income countries in Africa, Asia, and the Caribbean, through investing in sectors, such as renewable energy, infrastructure, financial services, manufacturing and agribusiness.[1041] In 2023, there were around 400 private debt impact funds and more than two-thirds were lending to emerging markets. Although the total was only 3% of private credit globally, there was growing recognition of the potential for financial returns that create positive social and environmental outcomes, according to Vincent Lemaitre, head of ESG for private debt at Tikehau Capital.[1042]

However, in December 2022, Vanguard, the world's second largest fund manager and the world's largest manager of index funds, announced: 'After a considerable period of review,

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[1033] https://unfccc.int/climate-action/race-to-zero-campaign
[1034] https://www.netzeroassetmanagers.org/
[1035] https://www.ipe.com/news/average-35-of-assets-initially-in-scope-for-net-zero-manager-targets/10056078.article
[1036] https://www.investmentweek.co.uk/news/4048291/assets-climate-focused-funds-soar-usd408bn-2021
[1037] *IPE*, 17 May 2021.
[1038] *Insurance Asset Management*, 24 July 2024.
[1039] *Financial News*, 7 March 2022.
[1040] *Financial News*, 7 March 2022.
[1041] Lauren Mills (2024) Bridging the SDG funding gap with private debt impact funds, *Impact Investor Guide 2024.*
[1042] https://impact-investor.com/bridging-the-sdg-funding-gap-with-private-debt-impact-funds

we have decided to withdraw from NZAM so that we can provide the clarity our investors desire about the role of index funds and about how we think about material risks, including climate-related risks – and to make clear that Vanguard speaks independently on matters of importance to our investors. [The move] will not affect our commitment to helping our investors navigate the risks that climate change can pose to their long-term returns'.[1043] The move followed pressure from some investors and Republican politicians in the US to decrease reliance on ESG criteria when making investments, on the grounds that this negatively impacts the ability of companies such as Vanguard to maximise returns for shareholders, requires disinvestment from fossil fuel at a time when energy security is paramount, and violates anti-trust rules. Index funds face a particular issue since they, by definition, invest in all securities in proportion to their market value and do not discriminate on the basis of the economic activities of the companies issuing those securities. Further, there are no commonly agreed sustainable investment benchmark indices in which index funds could invest. As a result, Vanguard has committed less than 5% of its assets under management with net-zero goals.[1044]

Larry Fink, the CEO of BlackRock, the world's largest fund manager, said he has stopped using the term ESG because it had become too politicized and 'entirely weaponized… by the far Left and by the far Right'. Former DWS[1045] Group Sustainability Officer Desiree Fixler has said: 'Beyond politics, there are plenty of other factors fuelling the anti-ESG movement. Lacklustre fund performance, too much red tape and greenwashing have left a sour taste. There's been pervasive greenwashing in the market, and people are fed up with having to pay more for green products which it turns out aren't very green'.[1046] In 2022, Texas blocked state entities, such as pension funds, from investing with BlackRock on account of its 'boycotting' of the oil and gas sector; in 2021, BlackRock had reduced its exposure to oil and gas stocks by around 15% to $552bn. However, BlackRock said it continued to invest in fossil fuels and promised to invest even more in Texas: in February 2024, it announced a $10bn private investment in Texas' power grid, enabling the construction of new power plants, including natural gas plants.[1047] Despite this, in March, the Texas Permanent School Fund announced that it would divest $8.5bn from BlackRock over what that State Board of Education's chairman termed BlackRock's ESG-oriented commitment to harm Texas' oil and gas industry.[1048]

In January 2024, the responsible investment campaign group Share Action[1049] accused larger asset management companies of failing to vote on environmental resolutions. Its research showed that on environmental resolutions assessed, only 3% passed in 2023

[1043] https://www.investmentweek.co.uk/news/4061376/vanguard-quits-net-zero-asset-managers-initiative
[1044] https://impact-investor.com/vanguard-exit-unlikely-to-trigger-mass-defections-from-net-zero-initiative/
[1045] DWS is a fund manager which is 80% owned by Deutsche Bank.
[1046] https://www.fnlondon.com/articles/its-time-to-dismantle-this-circus-esg-has-served-its-purpose-say-blackrocks-tariq-fancy-and-dwss-desiree-fixler-20230821
[1047] https://www.ai-cio.com/news/blackrocks-fink-strikes-truce-with-texas
[1048] https://www.ai-cio.com/news/truce-is-over-texas-school-fund-to-ax-8-5-billion-in-blackrock-investments
[1049] https://shareaction.org/

compared with 32% in 2021; on social resolutions, majority support fell from 15% to 4%. Voting behaviour was also different in different jurisdictions. European asset managers supported 88% of shareholder proposals on environmental and social issues, while support in the UK and US averaged 64% and 25%, respectively. In terms of the so-called 'big four' asset managers, Blackrock, Fidelity, Vanguard and State Street, their average support for environmental resolutions fell from 39% to 14% between 2021 and 2023, while their support for social resolutions fell from 29% to 13%. Blackrock, supported only 8% of resolutions. Share Action also said that asset managers which have signed up to Climate Action 100+[1050] with a mandate to protect the environment 'are at the same time voting down resolutions at AGMs that would improve environmental protections in what can only be described as greenwashing'.[1051] There was also evidence of a growing backlash to ESG investing amongst investors. According to data from Morningstar, sustainable funds in Europe collected $76bn in new money in 2023, about half the sum of $149bn they collected in 2022. ESG bond funds collected 36% more in management fees during 2023, generating $216.8m for fund groups, compared with a 380% increase in fee income for 2022. ESG equity funds experienced an increase in management fees of 18% in 2023 to just over $1bn, down from 290% in 2022.[1052] In February 2024, JP Morgan Asset Management, PIMCO and State Street Global Advisors (SSGA) left Climate Action 100+, while BlackRock transferred its participation to its international arm. BlackRock said: 'The new Phase 2 approach of CA100+ will require signatories to make an overarching commitment to use client assets to pursue emissions reductions in investee companies through stewardship engagement. In our judgment, making this new commitment across our assets under management would raise legal considerations, particularly in the US'. Phase 2, which began in June 2023, involved 'enhanced investor engagement' and a '[marked shifting of] the focus from corporate climate-related disclosure [Phase 1] to the implementation of climate transition plans'.[1053]

In March 2024, Reclaim Finance released a report which analyzed 430 funds labelled as sustainable by five of the world's largest passive investors: BlackRock, DWS, Legal & General Investment Management, UBS Asset Management and Amundi. It found that 70% of the funds were exposed to companies that continued to expand their fossil fuel production. Collectively, the investors had holdings of $227bn in fossil fuel developers in 2023, with more than 50% of this in their passive funds. Reclaim Finance said it wanted regulators to introduce minimum standardized mandatory criteria for funds making

[1050] Climate Action 100+ is an investor-led initiative to ensure the world's largest corporate greenhouse gas emitters take appropriate action on climate change in order to mitigate financial risk and to maximize the long-term value of assets. Members of Climate Action 100+ are expected to ask their portfolio companies to 'take action to reduce greenhouse gas emissions across the value chain' and 'implement transition plans to deliver on robust targets'; https://www.climateaction100.org/

[1051] https://www.portfolio-institutional.co.uk/esg-hub/asset-managers-under-fire-for-not-voting-on-esg-resolutions/

[1052] https://www.fnlondon.com/articles/esg-fees-stall-as-managers-battle-sustainable-fund-slowdown-20240201

[1053] https://www.ipe.com/news/climate-action-100-reacts-to-us-asset-manager-exits/10071828.article

sustainability claims and a ban on passive funds holding fossil fuel firms being marketed as sustainable.[1054]

Also in March 2024, a report by PitchBook entitled *The State of Private Market ESG and Impact Investing in 2024* noted that some asset managers were engaged in 'greenhushing', i.e., retreating from their public ESG commitments. These managers were de-prioritizing some of their ESG and impact investing programs due to concerns about potential backlashes from opponents of green and sustainable investment strategies and because of possible reputational damage in the face of claims of greenwashing. The report also found that there was no evidence that ESG strategies meant lower returns. Further, fundraising was lower in 2023 compared with 2023.[1055] Other asset managers have been accused of 'engagement washing', i.e., not delivering meaningful change due to poor quality engagement or, alternatively, exaggerating the impact of their ESG engagement with the companies in which they invest.[1056]

To counteract the politicization of ESG, Blackrock announced that it was switching from ESG investing to 'transition investing' which supports 'strategies that focus on preparing for, being aligned to, benefitting from and/or contributing to the transition to a low-carbon economy'. Larry Fink said: 'We believe the next 10 years is going to be a lot about infrastructure. There is a high demand for capital to fund the world's transition to clean energy. If we are going to decarbonize the world ... capital and infrastructure is going to be very necessary and supply/demand imbalance creates compelling investment opportunities for our clients'.[1057]

In January 2025, a BlackRock investment stewardship note announced that the fund manager would not use its stewardship and voting power to achieve specific real-economy decarbonisation goals: 'its team cannot – and does not try to – direct a company's strategy or its implementation [when it comes to climate change]. It is not our role to engineer a specific decarbonisation outcome in the real economy. [Its duty was solely to] advance our clients' long-term financial interests. …The money we manage is not our own – it belongs to our clients, many of whom make their own asset allocation and portfolio construction decisions'.[1058] In the same month, BlackRock announced its withdrawal from NZAM, saying that its membership 'caused confusion regarding BlackRock's practices and

[1054] https://www.fnlondon.com/articles/blackrock-lgim-and-dws-sustainable-passive-funds-exposed-to-fossil-fuels-20240320
[1055] https://www.funds-europe.com/greenhushing-impacting-private-markets-esg-activity; https://www.fnlondon.com/articles/greenhushing-esg-fund-marketing-names-20240325
[1056] *Insurance Asset Management*, 12 April 2024; https://www.impactive.pro/blog/what-is-engagement-washing-and-how-to-avoid-it
[1057] https://www.blackrock.com/sg/en/investment-strategies/sustainable-transition-investing; https://www.portfolio-institutional.co.uk/esg-hub/blackrock-transition-investing-a-primer-on-the-what-the-why-and-the-how-2/; https://raoglobal.org/blog/blackrocks-shift-from-esg-investing-to-transition-a-bold-move-towards-sustainable-transformation
[1058] https://www.ipe.com/news/blackrock-distances-itself-from-real-economy-decarbonisation-efforts/10128091.article

subjected us to legal inquiries from various public officials'.[1059] Shortly after this, NZAM announced it had suspended activities: 'Recent developments in the US and different regulatory and client expectations in investors' respective jurisdictions have led to NZAM launching a review of the initiative to ensure NZAM remains fit for purpose in the new global context'. NZAM signatories will be consulted while the initiative tracks signatory implementation and reporting. In the meantime, NZAM has removed from its web site the list of signatories and commitment statements, which also include signatories' net-zero targets and case studies. At the time, NZAM reported that 325 signatories with $57.5trn in assets under management that had made a commitment to achieving net-zero portfolios by 2050.[1060] In the same month, Northern Trust Asset Management (with $1.6trn under management) announced its withdrawal from NZAM and Climate Action 100+ (of which it was a founding signatory), citing confidence in its ability to independently manage material risks and engage with portfolio companies.[1061]

In April 2025, German prosecutors fined DWS Group €25m for 'negligent infringement' relating to ESG statements made between mid-2020 and January 2023, following a previous $19m SEC penalty. The fund manager's claims of being a 'leader' in ESG and 'ESG is an integral part of our DNA' 'did not correspond to reality', according to the prosecutors. DWS admitted that its past marketing was 'sometimes exuberant, but has subsequently improved internal documentation and control processes. The prosecution was triggered by Desiree Fixler's 2021 allegations of greenwashing. It resulted in significant organizational changes including the resignation of the CEO.[1062]

Net-Zero Insurance Alliance

The Net-Zero Insurance Alliance (NZIA), also convened by the UN Environment Programme (UNEP), was launched in 2021 and has developed the foundational concepts and frameworks to support its members as they work towards decarbonizing their insurance and reinsurance underwriting portfolios.[1063] However, in 2023, a number of major insurers pulled out of NZIA, including Munich Re, Zurich, Hannover Re, Swiss Re, SCOR, Allianz, AXA and Lloyd's of London. Political pressure from some US states and the threat of anti-trust claims have persuaded these companies to leave. Prior to leaving, John Neal, CEO of Lloyd's of London, called on NZIA to make its membership rules less prescriptive or risk falling apart. AXA said it would focus on its own sustainability goals. The remaining

[1059] https://www.ft.com/content/f0fb9841-db1d-442e-a757-1a1327497fb1. In 2024, 11 Republican-led states filed a case against BlackRock, Vanguard and State Street, alleging they had conspired to constrain coal supplies and further a 'destructive, politicised environmental agenda'; https://www.ft.com/content/dc34dffe-c92f-4743-8991-f0ec173d083b

[1060] https://www.ai-cio.com/news/net-zero-asset-managers-initiative-pauses-activities-following-blackrock-exit

[1061] https://www.pionline.com/esg/northern-trust-am-leaves-climate-action-100-and-net-zero-asset-managers-initiative

[1062] https://www.reuters.com/sustainability/german-asset-manager-dws-fined-25-mln-eur-greenwashing-case-2025-04-02/

[1063] https://www.unepfi.org/net-zero-insurance/

members, which include Aviva, Generali and NN, are trying to overhaul NZIA, while remaining 'fully committed to the net-zero transition and [are] engaging with a broader community of stakeholders on the evolution of the NZIA'. A report by Insure our Future found that European insurers, including Lloyd's of London, Zurich and Swiss Re, underwrote more around a third of US coal production. Lloyd's of London is the world's biggest fossil fuel underwriter, earning an between $1.6bn and $2.2bn in annual premiums in 2022. Hortense Bioy, global director of sustainability research at Morningstar, said 'Some insurers have taken steps to align their business with the goals of the Paris Agreement and commit to becoming net zero by 2050, but many haven't. Underwriters face mostly physical risks, and their job is to price and manage these risks. Modelling weather events and physical hazards is their core expertise, and supposedly something they can do better than banks or asset managers. They are already factoring in the fact that as temperatures rise and physical risks increase as a result, more assets will become increasingly difficult, if not impossible, to insure'.[1064]

Net-Zero Banking Alliance

The Net-Zero Banking Alliance (NZBA) was also launched in 2021 under the UNEP.[1065] Participating banks commit to:

- Transition the operational and attributable greenhouse gas (GHG) emissions from their lending and investment portfolios to align with pathways to net-zero by 2050 or sooner.
- Within 18 months of joining, set targets for 2030 or sooner and a 2050 target, with intermediary targets to be set every 5 years from 2030 onwards.
- Banks' first 2030 targets will focus on priority sectors where the bank can have the most significant impact, i.e., the most GHG-intensive sectors within their portfolios, with further sector targets to be set within 36 months.
- Annually publish absolute emissions and emissions intensity in line with best practice and within a year of setting targets, disclose progress against a board-level reviewed transition strategy setting out proposed actions and climate-related sectoral policies.
- Take a robust approach to the role of offsets in transition plans.

However, in April 2024, the European Central Bank released a White Paper (*Business as Usual: Bank Climate Commitments, Lending, and Engagement*) which indicated that global banks with climate-related targets had done little to change their business practices to meet their goals: 'Climate-aligned banks do not change their lending or loan pricing differentially compared to banks without climate commitments, suggesting they are not

[1064] https://www.reinsurancene.ws/axa-and-allianz-have-announced-their-exit-from-the-nzia/; https://www.fnlondon.com/articles/major-insurers-risk-falling-behind-on-climate-change-as-net-zero-coalition-fights-for-survival-20240201

[1065] https://www.unepfi.org/net-zero-banking/

actively divesting. …Further, we find no evidence of a change in interest rates charged by climate-aligned banks to high-emission firms'. The White Paper concluded: 'Our results cast doubt on the efficacy of voluntary climate commitments for reducing financed emissions, whether through divestment or engagement. More broadly, it suggests that voluntary private-sector initiatives may have relatively little impact on decarbonization'.[1066]

In January 2025, Morgan Stanley withdrew from the Net Zero Banking Alliance, saying that its 'commitment to net zero remains unchanged. We aim to real-economy decarbonisation by providing our clients with the advice and capital required to transform business models and reduce carbon intensity. We will continue to report on our progress as we work towards our 2030 interim financed emissions target'. It follows recent withdrawals by other top US investment banks, including JP Moragn, Goldman Sachs, Citigroup, Wells Fargo and Bank of America.[1067] In response to these withdrawals, GFANZ (the Glasgow Financial Alliance for Net Zero) has lowered its requirements for membership, saying it will now focus on green investment opportunities instead of decarbonisation: 'GFANZ going forward will allow any financial institution working to mobilise capital and lower the barriers to financing energy transition to participate' and become an 'independent principals group, led by CEOs and leaders from financial institutions'. Prior to this, GFANZ expected its members to align their financial activities with the goals of the Paris Agreement which, according to the Intergovernmental Panel on Climate Change, would require them to stop financing oil and gas projects in the US. This was not be acceptable to the new Republican government under Donald Trump who has promised to 'drill, baby, drill'. According to Bob Eccles, visiting professor at the University of Oxford's Saïd Business School, said: 'This new pressure from Trump has given a lot of these guys a reason to leave GFANZ. Some of them were just looking for an excuse. They all signed up too quickly, and didn't think through what this would actually mean for them. This whole finance-centric theory of change is flawed. It's not the role of banks and investors to get rid of fossil fuel companies'.[1068] In April 2025, the NZBA announced a series of changes to its framework and principles, including removing a mandatory requirement for banks to align lending and capital markets activities with the goal of limiting global warming to 1.5°C. At its height in 2024, the NZBA had 140 banks representing $74trn of assets.[1069]

Multi-national and multi-industry initiatives

There are also some multi-national and multi-industry initiatives outside the UN's remit.

[1066] https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2921~603e225101.de.pdf; https://www.ai-cio.com/news/ecb-research-finds-climate-aligned-banks-all-talk-no-action/
[1067] https://www.investmentweek.co.uk/news/4392139/morgan-stanley-leaves-net-zero-banking-alliance
[1068] https://www.pensionpolicyinternational.com/sustainable-finance-is-braced-for-its-toughest-year-yet/
[1069] https://www.esgtoday.com/net-zero-banking-alliance-drops-requirement-to-align-financing-with-1-5c/

Carbon Disclosure Project and the Science Based Targets initiative

First is CDP (Carbon Disclosure Project) which was established in 2000 as an international non-profit organization based in the UK, Japan, India, China, Germany, Brazil and the US to help companies, cities, states, regions and public authorities disclose their environmental impact. It aims to make environmental reporting and risk management a business norm, driving disclosure, insight, and action towards a sustainable economy.[1070]

The Science Based Targets initiative (SBTi) was established in 2015 as a collaboration between CDP, the UN Global Compact, the World Resources Institute (WRI) and the World Wide Fund for Nature (WWF). It aims to help companies set emission reduction targets in line with climate sciences and Paris Agreement goals. It is funded by IKEA Foundation, Amazon, Bezos Earth Fund, We Mean Business coalition, Rockefeller Brothers Fund and UPS Foundation. In 2021, it launched the world's first net zero standard, together with a framework and tools for companies to set science-based net zero targets.[1071] According to SBTi, by 2024, net zero pledges covered 92% of global GDP and 88% of global emissions.[1072] In April 2024, it proposed using 'environmental attribute certificates'[1073] (which include emission reduction credits) for offsetting certain emissions. This was criticized by those who said SBTi should be prioritising emissions reductions. Others, such as Varma, the Finnish mutual pensions insurance company, said: 'the inclusion of carbon credits in the SBTi framework introduces a new component that, if managed with rigorous oversight and strict criteria, could serve as an additional tool, …while ensuring that the emphasis on direct reductions remains at the forefront of our sustainability efforts'.[1074]

Institutional Investors Group on Climate Change

Second is the Institutional Investors Group on Climate Change (IIGCC) which was established in 2001 as a forum for collaboration between pension funds and asset managers on issues related to climate change.[1075] In 2005, it and the Carbon Trust worked with Mercer to develop a guide for pension trustees to support them in understanding and

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[1070] https://www.cdp.net
[1071] https://sciencebasedtargets.org/
[1072] https://impact-investor.com/special-report-pension-funds-grapple-with-the-just-transition
[1073] The SBTi defines environmental attribute certificates as 'instruments used to quantify, verify and track the environmental benefits associated with climate mitigation activities or projects. Environmental attribute certificates are used in different chains of custody models with varying traceability, e.g., from models where the activity issuing the certificate is traceable throughout the value chain to models where the certificate is traded separately from the underlying activity, not allowing traceability of the activity issuing the certificate to the value chain. Trading of these certificates may allow buyers to make claims, while also providing financial incentives to interventions that reduce greenhouse gas emissions, promote renewable energy or achieve other sustainability objectives'; https://sciencebasedtargets.org/resources/files/call-for-evidence-environmental-attribute-certificates.pdf
[1074] https://www.ipe.com/news/time-for-sbti-to-stand-aside-says-allianz-si-head-amid-offsets-fallout/10072848.article
[1075] https://www.iigcc.org/

addressing climate risk. In 2012, IIGCC established the Global Investor Coalition (GIC) to collaborate on joint international projects focused on climate policy, corporate engagement and investment practices. In May 2019, IIGCC helped to establish the Paris Aligned Investment Initiative (PAII), an investor-led forum to support investors in aligning their portfolios and investment activities to the goals of the Paris Agreement.

In April 2021, IIGCC published the Net Zero Investment Framework (NZIF) for decarbonizing institutional investors' assets. In November 2023, it published a 'users guide' to defining, measuring and investing in climate solutions, building on the NZIF. It estimated that $120trn of investment will be required by 2050 in order to keep the world below 1.5°C. Danielle Boyd, head of climate strategy implementation at IIGCC, said that: 'Without a concerted effort to increase investment into climate solutions, the decarbonization part of that approach is unlikely to happen. But there's a big gap in what this actually means for investors, so this guidance tries to help investors understand how to identify climate solutions, how to measure their impacts, and how to engage with data providers and companies on these issues'. The guidance discussed climate solutions in public equities and corporate fixed income portfolios (together with emissions performance criteria) and their role in corporate transition plans.[1076] In February 2024, IIGCC introduced the Cumulative Benchmark Divergence (CBD) which measures the difference between the decarbonization trajectory implied by a company's emissions target and a climate benchmark over the whole pathway to net zero. This is designed to help investors better identify transition risk in their assets and portfolios.[1077]

In June 2024, IIGCC released NZIF 2.0.[1078] This introduced a Portfolio Decarbonization Reference Target to aid portfolio alignment and investment in climate solutions. It also included guidance for other asset classes, such as sovereign bonds, private equity, and real estate infrastructure. Suggested actions included investor engagement with issuers and other actors in the investment value chain to advance the global decarbonization agenda, such as pressing data providers to increase the quality and consistency of consumption emissions disclosures, 'land use, land-use change, and forestry' (LULUCF), methane emissions reporting, and to develop indicators to better assess criteria set out by the guidance.[1079]

In September 2024, IIGCC finalized materiality-based guidance for investors about addressing Scope 3 emissions in investments, including checking their portfolios' exposure to key 'hotspots', such as particular categories of value chain emissions related to the energy sector, industrials and materials, banking, consumer products and services, and food

[1076] https://www.ipe.com/news/iigcc-publishes-investor-guidance-on-climate-solutions/10070079.article
[1077] https://www.ipe.com/news/iigcc-unveils-new-corporate-climate-target-assessment-tool/10071691.article
[1078] https://www.iigcc.org/hubfs/2024%20resources%20uploads/IIGCC_NZIF%202.0_consultation_2024.pdf
[1079] https://www.ipe.com/news/iigcc-finalises-update-to-key-net-zero-guidance-for-investors/10074138.article

producers. It pointed out that an asset's value chain emissions, e.g., from the use of a company's products, are material to the mitigation of financial risks associated with climate change and should be taken into consideration by investors. It said investors should develop a bespoke strategy to approaching Scope 3 emissions in the context of what is material to their individual portfolios and this should be communicated transparently.[1080]

In March 2025, IIGCC launched a consultation on the Climate Resilience Investment Framework (CRIF) which is intended to encourage more investors to factor climate risk into their investment strategies by outlining the benefits of managing physical climate risks from a financial materiality perspective: 'Reducing physical climate risks across value-chains and encouraging investment in adaptation solutions is part of this framework promotion of systemic resilience as part of the overall objective of climate resilience goals'. The CRIF is designed to complement the Net Zero Investment Framework (NZIF), but also has differences: including target setting as process-based, not outcome-based, reflecting the nuances of climate resilience; encouraging a shift in focus from merely assessing environmental impacts to actively incorporating climate resilience into investment strategies; and integrating the Physical Climate Risk Assessment Methodology (PCRAM)[1081] into existing investor processes.[1082]

In August 2024, the €59bn Danish pension fund PKA withdrew from NZAOA (which it joined in March 2021), citing resource strain. It said that instead it would 'focus on the Institutional Investors Group on Climate Change and its Paris Aligned Asset Owners (PAAO) initiative, to maximize the impact of our resources and collective efforts in climate and biodiversity'. NZAOA and PAAO are Glasgow Financial Alliance for Net Zero (GFANZ) asset owner initiatives that are co-ordinated by IIGCC. This was the fourth departure from NZAOA. The Australian super fund CBUS left in September 2022, the German insurer HanseMerkur left in May 2023, and the Church of England Pensions Board left in June 2023. All said they wanted to concentrate on one asset owner initiative.[1083]

Global Impact Investing Network and Catalytic Capital Consortium

Third is the Global Impact Investing Network (GIIN) which was established in 2009. It is 'dedicated to increasing the scale and effectiveness of impact investing. [It] builds critical infrastructure and supports activities, education, and research that help accelerate the development of a coherent impact investing industry'. Its members (around 4,000) from 60 countries included asset owners, asset managers, and service providers (with total AUM of $1.5trn in 2024).[1084] Related to this is the Catalytic Capital Consortium (C3). 'Catalytic

[1080] https://www.ipe.com/news/iigcc-finalises-materiality-based-scope-3-guidance-for-investors/10075466.article
[1081] https://www.mottmac.com/en/insights/topics/pcram-the-industry-methodology-for-climate-resilient-infrastructure-investment/
[1082] https://www.ipe.com/news/iigcc-launches-climate-resilience-framework-consultation/10129263.article
[1083] https://www.pensionpolicyinternational.com/danish-pension-fund-leaves-net-zero-asset-owner-alliance/
[1084] https://thegiin.org/

capital' is defined as 'investment capital that is patient, risk-tolerant, concessionary, and flexible. It is an essential tool to support impact-driven enterprises and organizations that lack access to capital on suitable terms through the conventional marketplace. The aim of catalytic capital is to unlock impact and additional investment that would not otherwise be possible, strengthening communities, expanding opportunity and economic growth, and fueling innovation that advances the wellbeing of people and the planet, while laying the groundwork for mainstream investors to participate in transformative investments'. C3 seeks to address the annual funding shortfall of $2.5trn in developing countries that is preventing the world from reaching the UN Sustainable Development Goals.[1085] According to Mónica Vásquez del Solar, head of strategy and impact at Social Nest Foundation, 'These investments are made by investors willing to take on greater risk, those capable of investing in for example early-stage startups, more transformative business models, or early-stage investment vehicles that face challenges in securing their first round of funding. Without these investors, entrepreneurs and impact fund managers would find it impossible to build a track record that might allow them to scale their models and maximize impact'.[1086]

Network for Greening the Financial System and Climate Financial Risk Forum

Fourth is the Network for Greening the Financial System (NGFS) set up in 2017.[1087] This is a network of 114 central banks and financial supervisors which aims 'to help strengthen the global response required to meet the goals of the Paris Agreement and to enhance the role of the financial system to manage risks and to mobilize capital for green and low-carbon investments in the broader context of environmentally sustainable development. To this end, the Network defines and promotes best practices to be implemented within and outside of the Membership of the NGFS and conducts or commissions analytical work on green finance'.[1088] [1089] Related to this is the Climate Financial Risk Forum (CFRF), an industry forum jointly convened by the UK Prudential Regulation Authority and Financial Conduct Authority.[1090] On 17 January 2025, three days before the inauguration of Donald Trump as the 47th President of the United States, the US Federal Reserve Board announced its withdrawal from the NGFS, on the grounds that 'the work of the NGFS has increasingly broadened in scope, covering a wider range of issues that are outside of the Board's statutory mandate'. [1091]

[1085] https://www.macfound.org/programs/field-support/impact-investments/catalytic-capital-consortium/; https://catalyticcapitalconsortium.org/

[1086] https://impact-investor.com/viewpoint-the-transformative-power-of-catalytic-capital

[1087] https://www.ngfs.net/en

[1088] https://www.ngfs.net/en

[1089] NGFS identifies seven different transition scenarios: Current Policies, Nationally Determined Contributions, Fragmented World, Delayed Transitions, Low Demand, Below 2°C, and Net-Zero 2050. Of these, only the Low Demand and the Net-Zero 2050 scenarios are compatible with the 1.5°C global warming goal.

[1090] https://www.bankofengland.co.uk/climate-change/climate-financial-risk-forum

[1091] https://www.federalreserve.gov/newsevents/pressreleases/bcreg20250117a.htm

Climate Finance Leadership Initiative

Fifth is the Climate Finance Leadership Initiative (CFLI) formed in 2019 by Michael R. Bloomberg in his role as UN Special Envoy on Climate Ambition and Solutions, at the request of the UN Secretary General, António Guterres, to 'support a global mobilization of private finance in response to the challenge of climate change' both in industrialized countries and the Global South. It brings together leading private sector institutions (including corporates, commercial and investment banks, insurers, asset managers, and asset owners), policymakers and development finance institutions. Founding members included Allianz Global Investors, AXA, Bloomberg, Enel, Goldman Sachs, Japan's Government Pension Investment Fund (GPIF), HSBC, and Macquarie. [1092]

Mirova and Robeco fund manager-led initiative to standardize the calculation of avoided emissions

Sixth is a fund manager initiative to establish a standardized method for calculating avoided emissions in commercial environmental projects, such as electric car manufacturing. The initiative is led by Mirova and Robeco, and includes Edmond de Rothschild, Natixis CIB, Lombard Odier, Comgest, Man Group, Sienna IM and Caisse des Dépôts. It aims to develop a standardized toolkit to calculate avoided emissions and then to encourage data providers to introduce avoided-emissions (i.e., low-carbon) solutions based on the metrics. The toolkit will also be used by fund managers with exposure to asset classes, such as infrastructure and project financing. Two consultancies, I Care by Bearing Point and Quantis, were appointed in January 2024 to build the database and toolkit. The database will initially consider 80 low-carbon solutions, such as biomass energy, recycled plastic and low-carbon concrete. As an example, the group said that if it is relevant to take into account all the resources and the recyclability of components that come into play in the production of an electric vehicle, it is also relevant to understand and measure the carbon emissions that can be avoided by an electric vehicle in a transport sector still very dependent on thermal engines. Lucian Peppelenbos, climate and biodiversity strategist at Robeco, said: 'Avoided emissions are the missing piece of the puzzle when it comes to facilitating transition finance. At a global level, much more capital needs to go into climate solutions. This metric can help to direct capital flows towards companies that provide the most effective climate solutions'. Fees will be 'reasonable' to encourage widespread market use. [1093]

[1092] https://www.bloomberg.com/cfli/about/

[1093] https://www.funds-europe.com/news/fund-managers-select-consultants-to-create-missing-piece-of-climate-finance-puzzle; https://www.responsible-investor.com/investor-backed-avoided-emissions-data-project-kicks-off/

Allianz's dashboard to track the transition pathway to net zero

Seventh is SAMEpath, a dashboard released by Allianz in January 2024 to track the transition pathway to net zero by 2050 across more than 50 industries. The tool outlines the emissions reductions required to hit targets, as set out in the 2015 Paris Agreement. It has a number of functions, including customized searches on climate scenarios, the identification of climate transition risks across sectors and the economy, and the carbon price required to achieve a reduction in emissions. The tool can form the basis for business, investment and underwriting decisions worldwide.[1094]

International Organization of Securities Commissions' initiative for companies world-wide to adopt sustainability-related financial disclosure standards

Eighth is the International Organization of Securities Commissions (IOSCO) which cover 95% of the world's securities markets. In December 2023, it announced that around 130,000 companies world-wide would adopt the sustainability-related financial disclosure standards, across both trading and capital raising, developed by the International Sustainability Standards Board. Erkki Liikanen, chair of the IFRS trustee board, said: 'By endorsing the ISSB standards, securities regulators around the world are working to achieve the consistency and comparability of information that capital markets demand'.[1095] However, in contrast to the double materiality approach of the EU, the ISSB has adopted a single materiality approach, where companies report only on the impact of a sustainability topic on their business. There are also differences between securities commissions at the national level. For example, in March 2024, the Securities and Exchange Commission (SEC) released the first climate disclosure rules for US corporates to 'provide investors with consistent, comparable, and decision-useful information, and issuers with clear reporting requirements'.[1096] The disclosures are less onerous than the original proposals, e.g., only large public companies are required to calculate and report certain greenhouse gas emissions, and then only if they are considered 'material'; value chain greenhouse gas emissions are excluded; and the climate expertise of the board of directors does not have to be reported. This differs from both EU requirements and the new IFRS S2 rules.[1097]

Accounting for Sustainability

Ninth is Accounting for Sustainability (A4S)'s 2024 Sustainability Principles Charter for the UK bulk annuity process which establishes guiding principles for the bulk annuity process focusing on transparency, decision making, reporting and engagement, and

[1094] https://www.investmentweek.co.uk/news/4168121/allianz-unveils-dashboard-track-transition-net-zero
[1095] https://www.fnlondon.com/articles/more-than-100000-firms-to-use-new-sustainability-disclosure-standards-says-global-securities-chair-issb-iosco-20230725
[1096] https://www.pensionpolicyinternational.com/how-sustainability-disclosures-and-regulations-benefit-investors/
[1097] https://www.theguardian.com/business/2024/mar/06/us-sec-climate-change-emissions-disclosure

collaboration.[1098] This is an initiative that has brought together schemes, insurers and advisers. Founding signatories include pension schemes (Cancer Research Pension Scheme, Church of England Pensions Board, HSBC Bank Pensions Scheme, Railpen, and Railways Pension Scheme), insurers (Aviva, Just Group, Legal & General, Pensions Insurance Corporation, Standard Life, and Rothesay), and advisers and trade bodies (Cardano, Aon, Hymans Robertson, LCP, Mercer, Redington, the Pensions and Lifetime Savings Association and the Pi Partnership Group). The motivation for the charter was concern over whether bulk annuity transactions would maintain the sustainability strategies established by pension schemes. and how they would then be transferred over in a bulk annuity process.[1099]

In February 2025, signatories of the Sustainability Principles Charter agreed to adopt the Bulk Annuity Sustainability Survey (BASS), reducing the number of surveys used by different advisers to assess insurers' sustainability credentials for the bulk annuity process from 10 to 1. The aim is to improve the efficiency of the process and the range of information available for comparing insurers' responses on sustainability.[1100]

Net Zero Engagement Initiative

Tenth is the Net Zero Engagement Initiative (NZEI) which launched in March 2023. NZEI's aim is to 'build on and extend the reach of investor engagement beyond the Climate Action 100+ focus list, including more companies that are heavy users of fossil fuels, contributing to demand for its products. The objective is to help investors align more of their portfolio with the goals of the Paris Agreement, as set out by their net zero commitments. …Under the [IIGCC's] Net Zero Investment Framework (NZIF)…investors should engage, or classify as aligned, assets that account for 70% of financed emissions in material sectors. ...The central ask of investor engagement via NZEI is a corporate net zero

[1098] There are four key principles:

1. Transparency: Transparency of values, principles and investment beliefs in relation to sustainability, as well as ongoing commitments that may guide future policy and practice affecting sustainability approaches.
2. Decision making: Evidence and understanding of how sustainability considerations are incorporated into investment analysis and decision-making processes, and investment stewardship activity.
3. Reporting and Engagement: Ongoing reporting and engagement to key stakeholders on sustainability commitments beyond the point of transaction.
4. Collaboration: Commitment to ongoing engagement across the pension sector as responsible investment best practice evolves.

Source: https://www.accountingforsustainability.org/en/about-us/our-networks/asset-owners-network/bulk-annuity-sustainability-principles-charter.html.

[1099] https://www.ipe.com/news/pension-insurers-charter-commits-to-sustainable-pension-risk-transfers/10071329.article; https://www.accountingforsustainability.org/

[1100] https://www.ipe.com/news/sustainability-principles-charter-signatories-adopt-bulk-annuity-sustainability-survey/10128685.article

transition plan'.[1101] In May 2024, IIGCC released guidance (*Net Zero Investment Framework for the Private Debt Industry*) to the private debt industry (involved in direct lending, venture/growth debt, opportunistic credit, structured credit, fund financing and private placements) on establishing a cohesive framework for setting and delivering net zero commitments. The guidance includes a 'three-way engagement model' between lenders, portfolio companies (PCs) and private equity (PE) sponsors, includes climate disclosures in loan documentation, and encourages the consistent sharing of standardized climate/ESG data.[1102]

Just transition networks

Eleventh are a number of just transition networks. For example, in 2022, a dozen UK pension funds, led by the Church of England Pensions Board, established the Emerging Markets Just Transition Investment Initiative to support climate transition in emerging markets. Similarly, in 2023, the Impact Investing Institute established the Just Transition Criteria in collaboration with 21 global financial institutions.[1103] At the UK Impact Investor Forum 2024, pension funds emphasized the importance of taking into account the just transition in their investment strategies, given the risks to members' future health and economic wellbeing associated with global warming and the energy transition. This meant looking beyond maximizing investment returns to consider the long-term interests of members.[1104] Another example is Pensions for Purpose which was established in 2017 and is part of 'the global movement for an inclusive, equitable, and regenerative economy'.[1105] It is a public B Corp[1106] and meets B Lab's standards for social and environmental impact. In January 2025, it published *Integrating Nature & Biodiversity into Investment – An Asset Owner Perspective*.[1107] This found that 65% of asset owners were incorporating nature and biodiversity into their sustainability strategies, while a further 20% plan to do so. Bruna Bauer, research manager at Pensions for Purpose, said: 'One key issue is that nature and biodiversity are still primarily viewed through the lens of risk mitigation rather than opportunity. It's essential to highlight the financial value of preserving and restoring ecosystems'.[1108]

[1101] https://www.iigcc.org/net-zero-engagement-initiative
[1102] https://www.iigcc.org/resources/nzif-private-debt-industry; https://www.portfolio-institutional.co.uk/esg-hub/climate-change-investor-group-sets-out-private-debt-framework/
[1103] https://impact-investor.com/special-report-pension-funds-grapple-with-the-just-transition
[1104] https://impact-investor.com/impact-investor-forum-leading-pension-funds-on-managing-a-just-transition/
[1105] https://www.pensionsforpurpose.com/; https://www.pensionsforpurpose.com/knowledge-centre/press/2018/09/01/a-history-of-pensions-for-purpose-so-far/
[1106] https://www.bcorporation.net/en-us/certification/
[1107] https://www.pensionsforpurpose.com/assets/uploads/2025-01-30-Impact-Lens-Biodiversity.pdf
[1108] https://www.pensionpolicyinternational.com/asset-owners-increasingly-aware-of-risks-of-biodiversity-loss-report-says/

International collaboration between pension funds

Twelfth, pension funds have begun to collaborate internationally to deliver net zero. An example is 'Mobilising pension capital for net zero: A policy blueprint for the UK'. This is a joint venture by a around a dozen large UK and Australian funds, pension-fund-owned investors, and the Pensions and Lifetime Savings Association (PLSA). It was set up in October 2024 in response to a new UK government which has plans to rapidly increase clean power. The government wants to work with the private sector to double onshore wind, triple solar power, and quadruple offshore wind by 2030. It also wants to expand new net zero technologies, such as hydrogen and carbon capture and storage. This will require tens of billions of pounds of investment annually. The signatories to the blueprint collectively represent £1.7trn in pension savings from around 30 and 10 million workers in the UK and Australia, respectively. Many are already major investors in the infrastructure of each country. The blueprint's 20-point plan seeks an active and coordinated approach by government, investors and industries across planning, climate, energy, fiscal and industrial decarbonization policy. This would help unlock further investment in the UK's net zero transition, drive economic growth and deliver appropriate risk-adjusted returns on workers' retirement savings. The objective is a pipeline of investable projects in which pension fund capital can participate in line with their fiduciary duty to members. Gregg McClymont, executive director for public affairs Europe at IFM Investors, one of the signatories to the blueprint, said: 'Our recommendations are led by the call for the government to take a long-term approach with respect to energy transition investments. … Such an approach will encourage the co-investments which will be an important part of energy transition finance. … [T]he blueprint's broader aim is to deepen dialogue between government and pension capital on the financing of the energy transition. After all net zero will be reached project-by-project, sector-by-sector over the next 25 years'.[1109]

Industrial Transition Accelerator

Thirteenth is the Industrial Transition Accelerator (ITA), whose aim is to 'galvanize leaders from across industry, finance, and governments to scale the decarbonization of heavy-emitting industries. Backed by a vast network of climate innovators, industry leaders and technical experts, the ITA seeks to unlock investment and drive solutions across six critical sectors that account for roughly 30% of global emissions: aluminum, cement, chemicals, steel, shipping, and aviation'.[1110] It wants governments to implement measures that stimulate the demand for green products. It estimates that such measures could unlock up to $1trn in green investments by 2030 and drive the development of over 500 sustainable

[1109] https://www.ipe.com/analysis/viewpoint-pension-funds-must-be-at-the-centre-of-the-uk-investment-debate/10076163.article
[1110] https://ita.missionpossiblepartnership.org/

industrial facilities in sectors, such as steel, aluminium, and aviation.[1111] The ITA was launched at COP28 in December 2023.

The OECD's Climate Adaptation Investment Framework

Fourteenth is the OECD's Climate Adaptation Investment Framework (CAIF) which 'aims to support governments' efforts to unlock investment in adaptation to build resilience to climate change. Building upon the foundation of the OECD's Policy Framework for Investment and the Foreign Direct Investment (FDI) Qualities Policy Toolkit, it identifies the key domestic policies that are particularly relevant for enabling climate change adaptation investment. The scope of the CAIF includes both public and private investment, given that both sources will be critical for climate adaptation. …Increased public and private investment will be needed in activities that help to reduce harms or realise any potential opportunities due to the impacts of climate change ('adaptation investments'), such as the development of climate-resilient infrastructure, food systems and supply chains. Adaptation investments are economically and socially worthwhile. The benefits will be context specific, but there is a large volume of economically worthwhile investment opportunities: one study identified USD 1.8 trillion of adaptation investments, with benefit-cost ratios ranging from 2:1 to 10:1'.[1112]

University-based research programs on climate change and solutions

Finally, a number of universities have begun programs of research on climate change and solutions. Examples are Princeton University's Net-Zero America Project,[1113] MIT's Climate Pathways Project,[1114] with its En-ROADS online climate solutions simulator,[1115] and the London School of Economics and Political Science (LSE)'s Grantham Research Institute on Climate Change and the Environment.[1116] In 2017, the Global Research Alliance for Sustainable Finance and Investment (GRASFI) was established by a network of global research universities 'in order to promote rigorous and highly impactful academic research on sustainable finance and investment'.[1117]

COP28 – December 2023

In December 2023, COP28, the 28th United Nations Climate Change Conference, took place in Dubai, United Arab Emirates. The outcome is the UAE Agreement or Consensus, a key component of which is the Global Stocktake, a progress report on climate change

[1111] https://funds-europe.com/cop29-uk-launches-carbon-market-integrity-priciples
[1112] https://www.oecd.org/en/publications/climate-adaptation-investment-framework_8686fc27-en.html
[1113] https://netzeroamerica.princeton.edu/
[1114] https://mitsloan.mit.edu/centers-initiatives/sustainability-initiative/mit-climate-pathways-project
[1115] https://www.climateinteractive.org/en-roads/; https://en-roads.climateinteractive.org/scenario.html?v=24.1.0
[1116] https://www.lse.ac.uk/granthaminstitute/
[1117] https://sustainablefinancealliance.org/

measures since the signing of the Paris Agreement in 2015 and what measures are needed to fill the gaps. The UAE Agreement has the following key components:[1118]

- The pathway to 1.5°C

The agreement recognizes that to avoid breaching 1.5°C by 2050 requires global greenhouse gas emissions to peak before 2025, followed by deep, rapid and sustained reductions in emissions of 43% (relative to 2019 levels) by the end of 2030, by 60% by 2035, before reaching net-zero carbon dioxide emissions by 2050. Developed nations are expected to take a lead in the 'transition away' from fossil fuels and provide technological and financial support to help developing nations follow them. All countries are expected to develop updated national climate plans (called Nationally Determined Contributions (NDCs)) by 2025, taking account of different national circumstances, pathways and approaches.

- The future of fossil fuels

For the first time in a UN climate declaration, the agreement specifically references the need to reduce global reliance on all fossil fuels – coal, gas, and oil – in order to combat climate change, and, in particular, accelerate moves to 'phase-down unabated coal power'. This is in line with the 'ratchet' mechanism in the Paris Agreement which requires countries individually and collectively to continuously increase their efforts to transition away from fossil fuels in order to achieve the 2050 target. There are caveats, however. For example, the final text of the agreement 'recognises that transitional fuels can play a role in facilitating the energy transition, while ensuring energy security', which is seen as a concession to fossil fuel-dependent countries and new gas-fired power generation projects. There are also potential loopholes. For example, the call to transition away from fossil fuels exclusively refers to 'energy systems', thereby excluding any mention of non-energy uses of fossil fuels, such as plastics and transport.

- Fossil fuel subsidies

The agreement calls for 'phasing out inefficient fossil fuel subsidies that do not address energy poverty or just transitions, as soon as possible'. This follows on from COP26's recognition of the urgent need to transition public funds away from supporting carbon-intensive industries and towards clean energy solutions. The challenge is significant, however, since global subsidies for fossil fuel consumption exceeded $1trn in 2022, a record high according to the International Energy Agency. The term 'inefficient' has been criticised for being a potential loophole, given its ambiguity.

[1118] This section is drawn from: https://www.investmentweek.co.uk/news-analysis/4156897/cop28-agreed-climate-summit-dubai; https://impact-investor.com/cop28-pledges-aplenty-now-for-the-action

- Carbon capture, removal, and abatement

The agreement calls on countries to support global efforts to develop carbon capture and storage, carbon removals and abatement technologies 'particularly in hard-to-abate sectors' – although these are not defined.

- Renewables and clean technologies

The agreement calls for support for new targets to triple renewable energy capacity and double the annual rate of energy efficiency improvements by 2030.[1119] These are accepted as challenging targets, but are believed to be achievable if supported by strong policy, investment and planning reforms. It also calls for the accelerated use of 'zero and low emission technologies, including inter alia, renewables, nuclear… and low carbon hydrogen production' to help reduce greenhouse gas emissions, and for the accelerated reduction in road transport emissions 'including through development of infrastructure and rapid deployment of zero and low emission vehicles'. There is also strong support for wind, solar, and energy storage systems that aid the transition away from fossil fuels, with the added bonus that their costs 'have fallen continuously'.

- Methane and non-CO_2 emissions

Methane has a far greater impact on global warming than CO_2. The agreement calls on countries to support global efforts to accelerate and 'substantially' reduce non-CO_2 emissions 'including in particular methane emissions' by 2030. This implicitly targets oil and gas producing countries and companies whose pipeline leaks and flaring are a key source of global methane emissions. It also calls on agriculture, another major contributor, to reduce methane emissions. Major global dairy companies, such as Danone, Kraft Heinz and Nestle, have committed to reporting on their success in reducing their own methane emissions. The Global Cooling Pledge was agreed by 63 countries at the conference with the aim of reducing other key greenhouse gases, such as hydrofluorocarbons (HFCs) and other F-gases which are used in air conditioning and refrigeration.

- Nature, agriculture, and food systems

The agreement also includes text explicitly linking climate and nature, and offered support for the international goals set out in the Kunming-Montreal Global Biodiversity Framework (KMGBF),[1120] adopted by 188 countries at the UN Biodiversity Conference COP15 in Montreal, Canada, in December 2022. The KMGBF commits the 196 countries that are signatories to the Convention on Biological Diversity (CBD) to develop National Biodiversity Strategies and Action Plans (NBSAPs) for achieving the 23 targets set by the

[1119] The International Renewable Energy Association estimates that an average of 1,000 gigawatts of renewable power capacity needs to be built globally every year until 2030; https://www.ft.com/content/6873d96e-3e40-45c6-9d84-8ce27b7b23e1

[1120] https://www.cbd.int/gbf/. Biodiversity is discussed in more detail below.

KMGBF, which included protecting 30% of the land and oceans and recover 30% of the planet's degraded ecosystems by 2030 (the 30x30 target).[1121] The text recognises the importance of 'conserving, protecting and restoring nature and ecosystems towards achieving the Paris Agreement goal, including through enhanced efforts towards halting and reversing deforestation and forest degradation by 2030'. It also emphasises the importance of 'ensuring social and environmental safeguards' for nature-based climate solution projects, and invites countries to 'preserve and restore oceans and coastal ecosystems' as a key climate mitigation action. However, while recognizing the vulnerability of food production to the negative impacts of climate change and the need to protect, conserve and preserve water systems, there is little reference in the text about how to transform food systems to reduce emissions and end deforestation.

- International trade

The text says that 'measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade'. The conference was concerned to avoid countries introducing protectionist measures in the name of climate change mitigation. One potential example of this is the 2022 US Inflation Reduction Act (IRA) which promised $370bn in energy infrastructure investment related tax credits over 10 years, although these would mainly benefit US businesses and tax-exempt organizations, like pension funds, which could take advantage of the tax credits from these investments.[1122] Similarly, the EU's introduction of a Carbon Border Adjustment Mechanism (CBAM) in 2026 is concerning developing economies because it could involve import levies on their goods and services if they fail to meet EU climate regulations and standards. While the agreement did not explicitly oppose CBAMs, it did call for greater 'transboundary cooperation' to meet the Paris goals and for a recognition that developing economies 'have significant capacity constraints' when trying to decarbonize.

- Circular economy and sustainable lifestyles

The text notes 'the importance of transitioning to sustainable lifestyles and sustainable patterns of consumption and production in efforts to address climate change, including through circular economy[1123] approaches, and encourages efforts in this regard'.

- Carbon markets and offsetting

A carbon market trades carbon credits, in which the owners of projects delivering reductions in CO_2 from the atmosphere can sell credits for this which can then be purchased

[1121] https://www.unep.org/un-biodiversity-conference-cop-15, https://www.cbd.int/conferences/2021-2022
[1122] https://www.pensionpolicyinternational.com/how-sustainability-disclosures-and-regulations-benefit-investors/
[1123] The circular economy is discussed in more detail below.

by CO_2 emitters and hence used to offset (i.e., compensate for) those emissions.[1124] Article 6 of the Paris Agreement covered carbon credit trading between nations and organizations, but the terms have not been formally agreed, and hence the market is still largely an informal one. Indeed, COP28 deferred discussions again until COP29 in Azerbaijan. The main concerns relate to verification and transparency, i.e., ensuring that projects are delivering the promised emission reductions and preventing the issuance of unjustified credits. An example of a current practice that needs to end is 'double-counting', where both the selling and purchasing country or organization claim emissions reductions from the same credits. The absence of formally regulated markets reduces to some extent the incentive to invest in carbon offset[1125] projects.

- Climate adaptation

The agreement established a new Global Goal on Adaptation, requiring countries to establish climate adaptation plans by 2025 and implement them by 2030, via their updated NDCs. The goals cover issues such as poverty eradication, gender equality, nature-based solutions, climate resilient agriculture and food systems, water security, and reducing climate impacts on health, ecosystems, biodiversity, and human infrastructure. However, there was lack of detail on how this was going to be financed.

- Climate finance, and loss and damage

COP28 agreed to set up a global Loss and Damage Fund, through which vulnerable countries facing climate impact costs could apply for financial support. At the conference,

[1124] One carbon credit constitutes the reduction, avoidance or removal of one tonne of carbon dioxide or its carbon dioxide-equivalent (CO_2e). The reduction, avoidance or removal must be permanent, additional to that which was going to happen in any case, and be verifiable. Carbon pricing mechanisms covered around 20% of global emissions in 2023 (*Financial News*, 27 November 2023, Issue 1359, p9).

[1125] The carbon offset market is believed to originate with US power company Applied Energy Services (AES) which had the idea of planting a forest to absorb the CO_2 produced by its Connecticut-based coal-fired power plant. Due to the cost of land in Connecticut, in 1989, it paid 40,000 farmers to plant trees in Guatemala. Carbon offsetting was sanctioned by the 1997 Kyoto Protocol and the UN Clean Development Mechanism. In 2020 – based on a proposal by former Bank of England governor, Mark Carney – the Taskforce on Scaling Voluntary Carbon Markets established to create a formal market for offsets. Today most carbon credits are bought from developers using brokers. Oil companies (e.g., BP and Shell) and the Saudi government have carbon trading desks. McKinsey has predicted that the value of voluntary offsets could rise from $2bn to $50bn in 2030. There is, however, concern that aggressive tactics might be used to relocate local and indigenous people in order to plant trees and create credits. Further, REDD ('reducing emissions from deforestation and forest degradation') projects have to demonstrate that they genuinely conserve forests by 'proving' that the forests would otherwise have been cut down. This is achieved by measuring forest loss in an unguarded reference area. A newspaper investigation in 2023 claimed that more than 90% of rainforest offsets certified by Verra, the world's largest certifier, did not involve genuine carbon reductions and that two-thirds of the carbon credits generated over a decade did not offset any significant pollution; https://www.telegraph.co.uk/environment/2024/04/21/carbon-offsetting-greenwashing-private-jet-celebrity/

richer countries committed $792m to the fund. However, the annual cost of losses and damages from climate impacts for developing nations is estimated to be $400bn.

The agreement also lacked a clear financial program to support countries engaged in energy transition and climate adaptation activities. Many developing countries, including the Alliance of Small Island States (AOSIS), were concerned about the limited progress on climate finance, adaptation, and loss and damage. However, the text of the agreement only requires developed countries to 'provide such support voluntarily', although they 'should take the lead in mobilizing climate finance from a wide variety of sources' and that this 'should represent a progression beyond previous efforts'.

The COP27 global climate agreement signed in Egypt in November 2022[1126] had estimated that the global transition to a low-carbon economy would require annual investments of $4-6trn, or approximately 4-6% of 2022 global GDP of $95trn.[1127] Yet developed countries are still failing to reach an agreed goal to jointly raise $100bn in climate finance annually.[1128]

Kieron Boyle, CEO of the Impact Investing Institute, who attended the summit said that key themes discussed by financial services industry leaders, regulators, and policymakers included the need for more effective capital, greater collaboration among financial market actors, governments and civil society, as well as improved risk-sharing mechanisms between the public and private sectors. Much of the heavy lifting in capital mobilization will need to be via mechanisms such as blended finance and catalytic capital. Funding and guarantees from developed world governments and multilateral development finance institutions to leverage much larger flows of private finance into climate change investments is seen as crucial, especially in low-income countries, where perceptions of high investment risk are blocking private capital flows.

On the opening day of COP28, the UAE announced that it would create a $30bn climate-related investment fund called Alterra,[1129] with the aim of attracting $250bn of investment in carbon emissions reductions and climate resilience projects by 2030. The fund is seeking to make profits from these climate projects, rather than being a development initiative. Launch partners include BlackRock, Brookfield and TPG. The UAE hoped its presence as an investor would be catalytic, giving others the confidence to invest too. A $5bn component of the total will be used to provide risk mitigation capital to incentivize investment flows into developing countries. One of the first projects will be the development of 6 gigawatts of clean energy capacity in India.

[1126] https://unfccc.int/cop27
[1127] https://www.statista.com/statistics/268173/countries-with-the-largest-gross-domestic-product-gdp/
[1128] The International Energy Agency estimates that the public sector will have to contribute 30% of the total global climate finance needed, with the rest coming from the private sector; https://www.ft.com/content/6873d96e-3e40-45c6-9d84-8ce27b7b23e1
[1129] https://www.alterra.ae/

Existing funds received additional funding commitments: the Green Climate Fund[1130] has pledges totalling $12.8bn from 31 countries; the Least Developed Countries Fund[1131] and Special Climate Change Fund[1132] have combined pledges of $174m; and the Adaptation Fund[1133] has pledges of $188m.

2024 developments in sustainability

In January 2024, the Institut Rousseau published a report entitled *Road to Net Zero* which estimated that the EU needed to invest €1.5trn per year (around 10% of GDP) in order to reach net zero by 2050. The main categories are transport (c€700bn), buildings, (c€425bn), energy production (c€180bn), and agriculture (c€160bn).[1134] In February 2024, the Institute for Climate Economics (I4CE) estimated that, in order to meet its target of cutting emissions by 55% of 1990 levels by 2030, the EU must invest €813bn annually (or 5.1% of GDP) between 2024 and 2030; spending in 2022 was €407bn.[1135] Also in February 2024, Bloomberg New Energy Finance (BNEF) estimated that global investment in clean energy was $1.2 trillion in 2021, $1.5 trillion in 2022, and $1.8 trillion in 2023. This was around three times as much as investment in oil and gas. Investment in clean energy in 2023 was $670bn in China, $300bn in the US, $341bn in the EU and $74bn in the UK. The increase in renewable energy at around 800 gigawatts (GW) annually was greater than the 700 GW annual increase in power consumption. The International Energy Agency forecasts that fossil use in electricity generation will decline in 2024 in absolute terms and this will continue in future years. The introduction of sodium-ion batteries is estimated to reduce grid storage costs by two thirds to $40 kWh by 2026. Goldman Sachs has estimated that the 2022 US Inflation Reduction Act (IRA) prompted $282bn clean-tech projects in the first year and will ultimately total $3trn.[1136] Yet in the midst of this positive news, a study in *Science Advances* warns that the 'Atlantic meridional overturning circulation' (AMOC)[1137] could be close to a tipping point as a result of Greenland ice melt diluting seawater salinity and weakening the Gulf Stream which brings warm wet weather to North West Europe. A collapse in AMOC could reduce precipitation and lower average temperatures in NW European cities by 5 to 15°C. There could also be a global chain-reaction which destabilizes rainforests.[1138]

[1130] https://www.greenclimate.fund/
[1131] https://www.thegef.org/what-we-do/topics/least-developed-countries-fund-ldcf
[1132] https://www.thegef.org/what-we-do/topics/special-climate-change-fund-sccf
[1133] https://www.adaptation-fund.org/
[1134] https://www.greens-efa.eu/en/article/study/road-to-net-zero; http://extranet.greens-efa.eu/public/media/file/1/8692; http://extranet.greens-efa.eu/public/media/file/1/8693
[1135] *Financial Times Newsletters*, 21 February 2024.
[1136] Ambrose Evans-Pritchard (2024) 2024 is the year when the world's green juggernaut becomes unstoppable, *Daily Telegraph*, 13 February.
[1137] AMOC or Gulf Stream comprises the northward surface-level flow of warm salty water and the deep-level southward flow of colder water.
[1138] René M. van Westen, Michael Kliphuis, and Henk A. Dijkstra (2024) 'Physics-based Early Warning Signal Shows that AMOC is on Tipping Course', *Science Advances*, 10(6);10.1126/sciadv.adk1189

The activities and pressures on institutional investors and banks is beginning to impact corporates themselves according to the 2024 ESG Risk & ROI Survey of chief financial officers released by accountants BDO. Of 600 CFOs questioned, 53% had embedded or were actively integrating sustainability into their core business strategy. BDO said CFOs 'have embedded sustainability and ESG factors into their overall operating and growth plans – to the benefit of their businesses, workers, stakeholders, and the environment. Driving sustainable value is a long-term game, but companies are also seeing immediate impact on their talent pipeline and workplace culture'.[1139]

In 2024, the Just Transition Finance Lab was established at the LSE's Grantham Institute. Its executive director, Nick Robins, believes that institutional investors have a vital role to play: 'They remain key actors in signalling to the rest of the financial system the importance of climate action delivered through a just transition. More than this, pension funds are also pools of workers' capital, often with union and employee representation in their governance, bringing a direct link to the just transition agenda. …[However, there are] four main barriers – the lack of traction in financial decision-making, uncertainty about what good looks like, a lack of rules and incentives and insufficient leadership. The Lab's four objectives are designed to respond to each of these pain points, and our focus on financial instruments is starting with the bond and fixed income markets. [We have] partnered with the Climate Bonds Initiative to drive a more inclusive transition to net zero. The bond market has been one of the most impressive arenas for sustainable finance – green, social, sustainable and sustainably-linked – and Climate Bonds are a very effective market player with high integrity. …A transformation of the nearly $500trn global financial system is needed to bring the just transition to life'.[1140]

According to Sandor Steverink, senior investment consultant at WTW in the Netherlands, Dutch pension funds have been analyzing the just transition in the context of the UN SDGs: '[They] have embraced the Sustainable Development Goals. These are part of the Paris Agreement on climate change which includes just transition as an important principle. ….[However], the pension funds are becoming more selective in the SDGs that they are focused on. …Only a limited number of these SDGs are investable, of which SDG 7 'affordable and clean energy' and SDG 10 'sustainable cities and communities' are the most concrete with the highest probability to meet the risk/return targets'.[1141]

In April 2024, the UK Financial Conduct Authority published a consultation paper on extending the Sustainability Disclosure Requirements regime to the UK fund management industry which covers around 400 firms with £1.4trn of assets under management. They would be required to use four SDR investment labels for the portfolios they manage: Sustainability Focus, Sustainability Improvers, Sustainability Impact, and Sustainability Mixed Goals.[1142] This will mainly impact DC pension plan members who choose their own

[1139] https://www.pensionpolicyinternational.com/esg-increasingly-part-of-core-business-cfo-survey-finds/
[1140] https://impact-investor.com/special-report-pension-funds-grapple-with-the-just-transition
[1141] https://impact-investor.com/special-report-pension-funds-grapple-with-the-just-transition
[1142] https://www.professionaladviser.com/opinion/4205980/extending-sdr-regime-portfolio-management

investments. Fund managers were required to decide whether to adopt one of four sustainability labels by April 2025. However, only 80 funds (with £34.5bn in assets) had chosen a label by this date, whereas 325 funds (with £280bn in assets) had not selected a label. More than 50% of labelled funds have chosen Focus, followed by Impact, Improvers, and Mixed Goals. Further, all labelled funds are actively managed, with global large-cap equity strategies dominating.[1143]

However, fund managers must meet strict guidelines to receive a label. For example, a focus fund can only invest in companies that support sustainability, such as solar, wind or hydrogen companies. As a result, many funds have revised their investment policy statements and dropped any mention of 'sustainable'. For example, Schroder British Opportunities Trust chose not to apply for a label and removed any mention of ESG from its investment policy. Fewer funds than expected applied for a label. Morningstar said the low take-up had 'surprised everyone', adding 'There's lower investment demand and also the environment and the anti-ESG sentiment coming from the US mean there is less appetite, despite the surveys saying that investors are interested in sustainability'. The FCA has acknowledged the slow uptake of labels under the Sustainability Disclosure Requirements (SDR) arguing that it is 'still early days for the regime. We recognise that changes to fund managers' investment approaches require significant effort and will take time to phase in. … We are now seeing more and more funds adopting the labels. We have always acknowledged that some firms might not want to use sustainability labels'. Nevertheless, withdrawals from ESG equity funds exceeded inflows for the first time in 2024, with around $48bn of net outflows. European ESG equity funds, which include UK funds, saw $1.6bn of net outflows in November in reaction to Donald Trump's pro-fossil fuel views.[1144]

In May 2024, the UK Sustainable Investment and Finance Association (UKSIF)[1145] released a report which called for 'supportive policies and regulation' that could lead to a £100bn increase in sustainable investment. The UK's sustainable finance sector needed strengthening in three key areas: a 'clear and world-leading sustainability disclosure regime', which would include the adoption of International Sustainability Standards Board standards, the introduction of mandatory corporate transition plans and a UK Green Taxonomy, specifying the criteria for investments to be considered sustainable; clarifying the fiduciary duties of pension scheme trustees to enable them to factor in financially

[1143] https://corporate-adviser.com/sdr-fund-labelling-incomplete-as-deadline-passes/

[1144] https://www.telegraph.co.uk/business/2025/01/05/why-the-city-is-turning-its-back-on-green-investing-trump

[1145] UKSIF's mission is: empowering the financial services industry to move further and faster to ensure a sustainable and responsible financial system; supporting members in the transition to a sustainable future, as exemplified by Net Zero and UN Sustainable Development Goals; and advancing the UK and our members in their leadership on sustainable and responsible finance and the integration of sustainability into all strategies and decision-making; https://uksif.org/

material ESG issues and manage associated risks and impact; and embed biodiversity into the regulatory framework.[1146]

Portfolio managers have been responding to proposals like this to design climate-aware multi-asset portfolios. One example is Wellington Management which has developed a framework for integrating climate change and its capital-market effects into multi-asset portfolios, thereby enabling asset owners to incorporate climate objectives into their portfolios via the strategic asset allocation (SAA).[1147] The framework consists of three pillars. The first focuses on incorporating climate-related inputs (including transition risks and physical risks) into the capital market assumptions (CMAs) underlying SAA decisions. The second is a climate-aware SAA approach, which adds relevant climate metrics to the asset allocation optimization process. The third pillar is implementation which involves selecting the specific climate-aware building blocks and strategies to meet the desired asset allocation.

In July 2024, the Investment Delivery Forum (ID Forum), representing the UK's long-term saving industry, released an action plan to generate more private investment in support of public infrastructure spending from the UK's new National Wealth Fund (set up by the Labour Government elected on 4 July 2024). Insurance and pensions companies wanted the new government to make greater use of blended finance to attract the long-term private investment needed to help fund costly low carbon and other green infrastructure, such as electric vehicle charging networks, nuclear power development, floating offshore wind, carbon capture technology, and green hydrogen. In particular, they wanted public support from the National Wealth Fund to help mitigate the early-stage risks of investment in new infrastructure that private investors are currently unable to make due to regulatory rules designed to protect policyholders. Over the next 10 years, the UK's long-term savings industry has committed to channelling £100bn into 'productive assets', defined as those contributing to the real economy, expanding productive capacity, speeding up the energy transition or furthering sustainable growth. The plan would also track and report on investments made under the Solvency UK regulatory regime from January 2025. The ID Forum comprises seven insurance and long-term savings companies with an interest in large-scale infrastructure investment: Aviva, Just, Lloyds Banking Group, M&G, Phoenix, Rothesay and Royal London.[1148]

In October 2024, the cumulative issuance of Green, Social, and Sustainability (GSS) bonds exceeded $5trn, according to ESG data provider MainStreet Partners.[1149] In the same month, Italian insurer Generali announced that it would no longer provide insurance for

[1146] https://www.portfolio-institutional.co.uk/esg-hub/uksif-unveils-proposals-for-regulators-to-boost-sustainable-investment/
[1147] A blueprint for building climate-aware multi-asset portfolios, Wellington Management, March 2024; https://www.wellington.com/en/insights/climate-aware-multi-asset-portfolios
[1148] https://impact-investor.com/insurers-outline-blended-finance-plan-for-uk-infrastructure/
[1149] https://funds-europe.com/green-bonds-drive-gss-bond-issuance-past-5tn

risks associated with oil and gas expansion, including new liquified natural gas (LNG) terminals and gas-fired power plants.[1150]

In September 2024, a study from the University of Zurich and Dutch asset manager Robeco found that companies with a higher alignment to the United Nations Sustainable Development Goals were less likely to become embroiled in scandals. The study argued that 'This is imperative for investors: corporate scandals adversely affect market value and often have negative societal and environmental impacts. Aligning investments with the SDGs thus enables investors to enhance their financial and sustainability objectives'.[1151]

In November 2024, in a speech at the Mansion House in London, the UK finance minister, Rachel Reeves, announced the creation of a Transition Finance Council as recommended by the Transition Finance Market Review.[1152] She also gave the Bank of England a mandate to support sustainable finance and updated the remit letters of key regulators and supervisory committees to refer to the need for investment in the green transition. In addition, there were proposals for strengthening the voluntary markets for carbon and nature credits. Pension funds will be expected to show how their assets are being aligned with net zero, in addition to protecting the fund's financial returns from climate change.[1153]

In December, the UK Land, Nature and Adapted Systems (LNAS) Advisory Group (a spin off from the Green Technical Advisory Group (GTAG)) published a report (Framework to Develop a UK Green Taxonomy for Adaptation and Resilience) which provides guidance on how to define a taxonomy to help the UK economy adapt to climate change. It outlined a five-step framework to define adaptation and resilience, and to encourage the mobilisation of capital into adaptation investments. The report stated: 'As climate change impacts intensify, the UK faces escalating risks across all sectors of its economy. While building a net-zero economy remains crucial, adaptation and resilience must be elevated to be a parallel priority. Yet, adaptation investment continues to lag and current financial frameworks are not mobilising capital at the scale needed. …Green taxonomies have become useful tools for directing capital towards environmentally sustainable economic activities. However, their primary focus on mitigation to date has left the adaptation opportunity underdeveloped'. LNAS had previously published a report in October outlining how disclosures in relation to sustainable agriculture, fisheries, and aquaculture could be structured in a UK Green Taxonomy.[1154]

Concern was being expressed about the energy and water cooling usage by data centres. With the massive growth of artificial intelligence, the International Energy Agency has estimated that data centres' total electricity consumption could double from 2022 levels to

[1150] *Insurance Asset Management*, 23 October 2024.
[1151] https://impact-investor.com/report-sdg-alignment-reduces-risk-of-future-scandals/
[1152] https://www.gov.uk/government/publications/transition-finance-market-review
[1153] https://www.ipe.com/analysis/what-the-mansion-house-speech-means-for-green-finance-in-the-uk/10126456.article
[1154] https://www.ipe.com/news/uk-government-advised-on-climate-adaptation-taxonomy/10127948.article

1,000TWh in 2026, equal to Japan's 2024 total level of electricity demand. Google became the first tech company to commission new nuclear power plants for its data centres. Data centres have been trying to reduce their power usage effectiveness (PUE) factor by investing in closed-loop water consumption and recycling systems.[1155]

Also in December, the Trustee Sustainability Working Group (TSWG) was launched with the aims of accelerating the implementation of good sustainability investment practice across the pensions industry and encouraging consultants and investment managers to consider the global financial risks from not transiting to a net-zero world quickly enough. The TSWG said that, while it believes pension regulation has helped to increase awareness of sustainability and climate change, there was now an 'over-emphasis on low level reporting' which had direct implications for the use of trustees' limited resources, especially for small and medium-size schemes. It also believed that much of the climate scenario modelling across the industry was not decision-useful, with the output often 'at variance with the science' and it wanted to encourage further work in this area.[1156] In addition, it suggested that innovation was needed to ensure the assets schemes are investing in, such as global index tracking funds, remain resilient.[1157]

In 2024, $910bn of green, social, and sustainability (GSS) bonds were issued globally, the highest volume in three years.[1158] However, 88 global climate-themed funds (which cover low carbon, climate transition, green bond, climate solutions and clean energy/tech mandates) closed in 2024, up from 52 in 2023 and 18 in 2022. Hortense Bioy, head of sustainable investing research at Morningstar Sustainalytics, said that the main reasons for these closures were poor performance of renewable energy stocks and 'greenwashing concerns, political uncertainty and a growing anti-ESG sentiment' which lowered investor appetite for climate-based products: 'Clean energy stocks have had a volatile ride over the past six years. There was a boom followed by a four-year burst. So, I would not say they are a safe investment bet'.[1159]

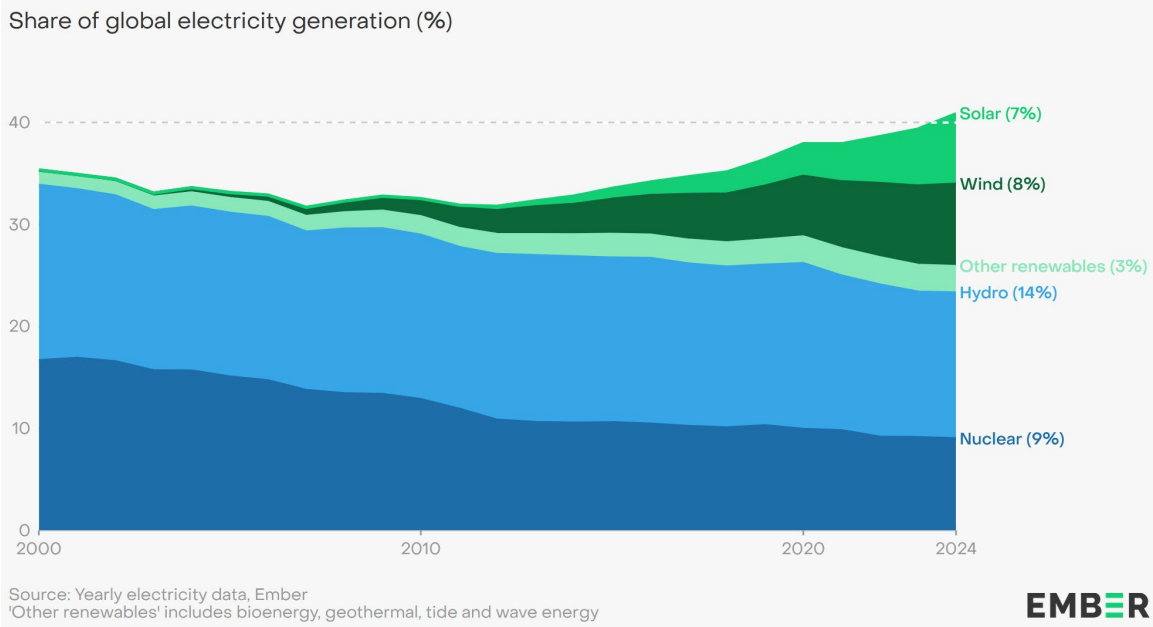
Article 9 (dark green) funds experienced net outflows in 2024, highlighting growing investor hesitation and sparking calls for a more accessible sustainable finance framework, according to European Fund and Asset Management Association (Efama) research. By contrast, Article 8 (light green) funds experienced net inflows in 2024, particularly in the

[1155] https://hub.ipe.com/asset-manager/pgim/greening-the-grid-data-centres-address-their-footprint/10076603.supplierarticle
[1156] https://www.professionalpensions.com/news/4387713/trustee-sustainability-group-launched-bid-accelerate-change
[1157] https://www.pensionpolicyinternational.com/uk-pension-trustees-urged-not-to-lose-sight-of-urgency-of-climate-issues/
[1158] MainStreet Partners, *Insurance Asset Management*, 6 February 2025.
[1159] https://www.investmentweek.co.uk/news-analysis/4409034/green-investors-ditch-worst-case-scenario-trump-amid-rising-climate-fund-closures

money market and bond fund segments. Overall, their net assets held steady at around 51% of the total UCITS[1160] and alternative investment funds market.[1161]

In 2024, for the first time, more than 40% (40.9%) of global electricity generation was from clean sources, in particular from renewables and especially solar (which increased by 29% over 2023). However, heatwaves in 2024 caused an overall increase in electricity demand (by 4%) which resulted in a small increase in fossil generation, driving up power sector emissions to an all-time high – see Figure 13.[1162]

Figure 13: Share of global electricity generation from clean sources, 2000-2024



The World Economic Forum's *Top 10 Emerging Technologies of 2024* report identified a number of technologies that could provide solutions for overcoming climate change. One example is elastocalorics which aims to power heat systems to work like muscles, leading to more sustainable ways of keeping cool. Modern heat pumps use elastocaloric materials, such as nickel and titanium – which emit heat when mechanical stress is applied and cool down when the stress is relaxed – and are more energy-efficient than traditional heating and cooling systems and also avoid using environmentally harmful refrigerant gases. Another technology uses microorganisms which can capture greenhouse gases from air or

[1160] UCITS stands for 'Undertakings for Collective Investment in Transferable Securities'. These funds can be sold to EU retail investors and are subject to EU regulations.
[1161] https://funds-europe.com/article-9-funds-saw-net-outflows-in-2024-efama
[1162] https://ember-energy.org/latest-insights/global-electricity-review-2025/

exhaust gases and convert them into biofuels and protein-rich animal feed, which have the potential to reduce global warming.[1163]

COP29 – November 2024

In November 2024, COP29, the 29th United Nations Climate Change Conference, took place in Baku, Azerbaijan. The conference highlighted growing doubts about limiting global warming to 1.5°C, with 2024 set to breach 1.5°C for the first time and with the United Nations Environment Programme (UNEP) Emissions Gap Report, reflecting the slow progress in global climate action.[1164] A new deal was agreed for developed nations to provide $300bn annually by 2035 to help developing nations prepare for the impacts of climate change and transition away from fossil fuels, but this is less than the $1.3trn annually the UN estimates is required for a successful transition, implying that the private sector has to make up the shortfall.[1165] There was no progress on the commitment to reduce fossil fuel use, with discussions delayed until 2025; the 22-nation Arab Group would not accept any text in the deal which targeted specific sectors, including fossil fuels. There was a new agreement on a consistent mechanism for trading carbon credits internationally, with an accounting system for how a country selling a credit can deduct it from its national carbon inventory to prevent the same credit from being used twice. There was limited progress with the Loss and Damage Fund, established at COP27 to assist developing countries address emergencies such as sea-level rise, migration, reconstruction and recovery, such as the appointment of an Executive Director; to date, the total pledged financial support for the Fund exceeds $730m and is expected to start financing projects from 2025.[1166] There was the launch of the Harmoniya Climate Initiative for Farmers which aims to streamline the implementation of climate-agriculture projects, building climate-resilient agri-food systems through innovation and technology; there was particular focus on areas such as regenerative farming practices, precision strip-till farming, enhanced-efficiency fertilisers, and water-saving technologies. Around 30 nations, including 8 of the top 10 methane emitters, endorsed the Global Methane Pledge to reduce global methane emissions by 30% by 2030.[1167]

At COP29, the UN's Independent High Level Expert Group (IHLEG) on Climate Finance called for the direction of private finance towards emerging markets and developing countries (EMDCs) to meet net zero goals. It was set up at COP26 to assess net zero pledges from the private sector and other non-state entities. Its third report (*Raising Ambition and Accelerating Delivery of Climate Finance*) stated that: 'The transition to clean, low-carbon energy, urgently building resilience to the impacts of climate change, and protecting nature

[1163] https://www.weforum.org/stories/2024/06/top-10-emerging-technologies-of-2024-impact-world/
[1164] https://www.unep.org/resources/emissions-gap-report-2024.
[1165] Some commentators have argued that this financing deal is 'too little, too late', see, e.g., Martin Wolf (2024) Climate change is a global problem – it requires a global solution, *Financial Times*, 27 November; https://www.ft.com/content/a0cfcf55-6b4d-4aeb-a3ec-b3db33575047
[1166] COP29_Investment_Briefing, XPS Group, November 2024.
[1167] https://funds-europe.com/cop29-climate-action-methane-pledge-agricultural-innovation

and biodiversity, requires a rapid step-up of investment in all countries. …This investment push will give a major boost to growth and development, and will lead to large, avoided costs and very substantial savings. But this new growth story can only be realized through a major transformation of the climate finance system based on concerted efforts to unlock investment opportunities and ramp up all pools of finance'. The report also highlighted the need to tackle supply-side regulatory and incentive barriers to remove both legal and organisational constraints to investing in EMDCs, especially for clean energy and green industrialisation: 'While supply-side regulation like the prudential regime for insurance and reinsurance undertakings in the EU, Solvency II, is still a critical barrier to insurers, pension funds arguably do not have the same legal or fiduciary constraints'.[1168]

Also at COP29, the UK strengthened its climate commitments, by announcing a target 81% reduction in emissions by 2035. It also unveiled its 'Principles for Voluntary Carbon and Nature Market Integrity', establishing a framework to support high-integrity voluntary carbon markets (VCMs). The principles focus on using carbon credits to complement internal emission reductions, ensuring credit quality, transparent reporting, proactive planning, accurate environmental claims, and collaboration to build a trustworthy, efficient market. The principles aim to enhance market integrity by providing clear guidelines on claims transparency, biodiversity integration, and reporting standards. Mark Kenber, executive director of the Voluntary Carbon Markets Integrity Initiative (VCMI) said: 'The UK Government's principles align closely with the VCMI Claims Code, creating a robust framework for transparent and impactful carbon market participation… While these guidelines are essential, additional incentives will be crucial to encourage the private sector to confidently engage in carbon credits during this decisive decade'.[1169]

In December 2024, the Finnish-based Upright Project launched an impact database quantifying the impact of around 1,000 private equity and venture capital funds and 20,000 portfolio companies, having previously introduced a similar data base for 35,000 mutual funds and ETFs in September 2024. Upright used natural language processing technology to investigate 300 million scientific articles, databases from the World Health Organisation and the Organisation for Economic Co-operation and Development, and company disclosures in order to assess funds' environmental, social, health, and knowledge impacts globally. For general partners at PE/VC firms, the databases provide tools to benchmark impact performance, enhance portfolio management, communicate effectively with stakeholders, and future-proof value creation strategies. Mikael Homanen, head of scientific research, innovation and partnerships at Upright, said: 'It has [previously] been

[1168] https://www.ipe.com/news/un-expert-group-calls-for-major-financial-transformation-to-meet-climate-goals/10076864.article
[1169] https://funds-europe.com/cop29-uk-launches-carbon-market-integrity-priciples

thought to be impossible to measure the impact of private equity because unlisted companies disclose little about their sustainability'.[1170]

Also in December 2024, the UK's Sustainability Disclosure Technical Advisory Committee (TAC) published recommendations on how global sustainability reporting standards should be incorporated into UK national law. TAC recommended adopting the International Sustainability Standards Board's first two standards, subject to amendments about reporting timeframes: International Financial Reporting Standard S1 (which explains how an entity should prepare and report its sustainability-related financial disclosures) and International Financial Reporting Standard S2 (which explains how climate-related disclosures should be reported). The ISSB wanted entities to disclose their Scope 1 and 2 emissions in the first year of adoption, with Scope 3 emissions and all other sustainability metrics to follow in the second year. TAC has recommended that sustainability metrics should wait until the third year. The ISSB also wanted investors and banks to use the Global Industry Classification Standard (GICS) for reporting sectoral categories, but TAC said any classification system should be permitted under UK law. The UK was one of the first countries to publicly declare support for the ISSB when it was set up in 2021.[1171]

Three key sustainability issues: biodiversity, natural capital and the circular economy

We now turn to three key sustainability issues attracting the attention of pension schemes: biodiversity, natural capital and the circular economy.

Biodiversity

Mark Thompson (2023),[1172] a pension scheme trustee, argues that pension funds should consider biodiversity on their investment strategy:

> *Biodiversity is the variety of animals, plants, fungi and micro-organisms that make up the natural world. These species and organisms work together in ecosystems to maintain balance and support life. The planet's biodiversity is being seriously depleted, threating the viability of human existence. Since 1970, the Earth's wildlife populations have fallen by almost 70% – a result of deforestation, excessive human consumption and industrial scale pollution.*[1173] *Mother Nature's cupboard cannot be raided forever without serious consequences. …It is estimated that around half of the world's GDP is dependent on nature.*

[1170] https://funds-europe.com/worlds-first-private-equity-impact-database-goes-live
[1171] https://www.ipe.com/news/uk-receives-official-advice-on-national-sustainability-reporting-standards/10127864.article
[1172] Mark Thompson (2023) Biodiversity: What trustees need to know, *portfolio institutional*, 17 January; https://www.portfolio-institutional.co.uk/opinion/biodiversity-what-trustees-need-to-know/
[1173] If the global average temperature rises above 1.5°C, this could constitute a threat to 20-30% of all remaining species.

Against this background, there are four possible risks supporting why trustees should incorporate biodiversity considerations into their investment processes:

- *Companies that rely on threatened ecosystems will suffer from increased financial risk, with negative effects on their share prices and credit ratings.*
- *Like climate change, there is transition risk, as governments legislate to mitigate the systemic risk of biodiversity loss.*
- *Companies that exploit unpriced biodiversity externalities run the risk of reputational risk as media and public opinion turns against them with the resultant impacts on shareholder value.*
- *Finally, schemes are unlikely to reach their climate net-zero objective without significant improvements in biodiversity loss. This is because marine and terrestrial ecosystems are the sole sinks of anthropogenic carbon emissions.*

In December 2022, almost 200 countries signed up to the UN Biodiversity accord.[1174] *The accord commits to halting and reversing biodiversity loss by 2030. Implementation will be key to the accord's success and that will need increased legislation around the globe.*

However, in doing this, unlike climate change (which is essentially a case of controlling carbon emissions), biodiversity has many facets, and they are location-specific. This makes constructing a framework to manage biodiversity risks, and develop disclosure requirements, more complicated. This is the challenge the Taskforce on Nature-related Financial Disclosures (TNFD) has taken up. It is sensibly adopting the framework pioneered by the TCFD to build on.

Assets managed by funds focused on biodiversity increased from $525m to $1.3bn between 2020 and 2022. However, the Convention on Biological Diversity estimates that to reverse biodiversity losses would require global investment in conservation of $536bn annually by 2050, while current expenditure is only $133bn per year.[1175] In January 2024, 320 organizations across more than 46 countries and representing US$14trn in assets under management committed to making nature-related disclosures based on TNFD recommendations. These included PwC, EY Global, Candriam, Cardano, Robeco, Van Lanschot Kempen, the UK Local Government Pension Scheme pools Brunel Pensions Partnership and London CIV, UK asset managers such as Fidelity International and Schroders, and the London Stock Exchange Group.[1176]

[1174] The COP15 Kunming-Montreal Global Biodiversity Framework discussed above.
[1175] CAMRADATA (2023) Biodiversity; https://s42854.pcdn.co/wp-content/uploads/2023/12/Biodiversity-whitepaper.pdf
[1176] https://www.pensionpolicyinternational.com/uk-pension-funds-to-begin-tnfd-reporting/

The UN's COP 16 Biodiversity Conference took place in Cali, Colombia in October-November 2024. A key aim was to assess progress on the Kunming-Montreal Global Biodiversity Framework agreed at COP15. However, only 44 of 196 countries submitted their National Biodiversity Strategies and Action Plans at COP16. Another aim was to check progress on the Global Biodiversity Framework Fund (GBFF) which was set up at COP15.[1177] The GBFF aims to help countries achieve the Kunming-Montreal Global Biodiversity Framework goals and targets with a strategic focus on strengthening national-level biodiversity management, planning, policy, governance, and finance approaches. At COP16, a total of $396mn was pledged to the GBFF by Austria, Canada, Denmark, France, Germany, Japan, Luxembourg, New Zealand, Norway, Province of Québec, Spain, the UK and others. Yet another aim was to persuade developed nations to commit at least $20bn annually by 2025 and and at least $30 billion a year by 2030 to support conservation efforts in the Global South.[1178]

Some fund managers are integrating biodiversity into their listed equity strategies. For example, AXA IM's 'biodiversity strategy aims to achieve long-term investment returns by investing in innovative companies that can deliver a positive and measurable outcomes'. It applies both the Kunming-Montreal Global Biodiversity Framework and the Global Impact Investing Network (GIIN)'s framework. It is focusing on three solutions that will contribute to stopping biodiversity loss by 2030 and have a net positive impact on biodiversity by 2050:

- Sustainable food and agriculture - reducing the use of water, fertilisers, pesticides, and pollution while increasing food production helped by shifting consumption to meat and dairy alternatives.
- Responsible production and consumption – increasing resource efficiency and reducing pollution through recycling, sustainable materials, and recirculation.
- Resilient infrastructure – modernising ageing water networks to reduce water consumption and pollution, and using the latest science and technology to build next generation sustainable infrastructure designed with biodiversity in mind.[1179]

Natural capital

Natural capital is a new asset class in which land is used to generate an investment return. There are three sub-categories: food production (the traditional use of land), afforestation (for carbon sequestration), and timber (as an alternative to steel and concrete in real estate

[1177] https://www.thegef.org/what-we-do/topics/global-biodiversity-framework-fund
[1178] https://en.wikipedia.org/wiki/2024_United_Nations_Biodiversity_Conference; https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/biodiversity-global-conference/
[1179] https://core.axa-im.com/responsible-investing/insights/why-and-how-integrating-biodiversity-listed-equity-strategies

construction). But with total productive land in scarce supply, there is an increasing competition over these uses.

The outcome in any particular country will depend on the price of carbon generated by the country's emission trading scheme. If demand from companies for carbon offsets increases the price of carbon credits, this makes carbon farming more attractive.

For example, in New Zealand, which is one of the world's highest per-capita carbon emitters (because of its red meat industry), carbon credits are above US$50 per tonne. This has resulted in prime farmland being sold to forestry investors for NZ$20,000 per hectare, up from NZ$4,000 per hectare, reflecting the higher net present value of the cash flows that can now be generated from it. This, in turn, has led to criticism from the red meat industry (Beef + Lamb New Zealand) which is forecasting significant economic damage to the sector and its rural communities.

The University of Melbourne's *Land Gap Report*, published in November 2022, has the following warning: 'Governments' over-reliance on carbon removal could push ecosystems, land rights and food security to the brink – with new land area equivalent to 50% of the world's croplands currently being required to meet [climate pledge] targets. Climate pledges should focus on protecting and restoring existing ecosystems with carbon benefits'.

Asset manager Gresham House has produced a Forest Charter, outlining six core pillars for investment managers, which include biodiversity and integration with the community.[1180] It argues that a long-term sustainable supply of timber is 'enabling the world to transition to a lower carbon, sustainable model, through the continued replacement of concrete and steel as building materials'.[1181]

According to Florence Chong (2023): 'Global asset managers now see as a central tenet of their management practices an ability to deliver benefits to surrounding communities in the first instance, then to the wider community. An ongoing emphasis on sustainability, preservation, biodiversity and rehabilitation of degraded land is seen as paramount. They point out that, in the first instance, they are accountable to their investors as to how both carbon credits are generated and the timber products produced. Increasingly, too, they are under no illusion that land is finite, and that their ongoing viability as businesses depends on co-existing with other forms of land use, especially farmland'.[1182] Further, investors in natural capital assets will have to take into account both climate mitigation and climate adaptation and understand the physical risks to their portfolios.

[1180] https://greshamhouse.com/forest-charter/
[1181] https://greshamhouse.com/news-media/global-timber-outlook/
[1182] Florence Chong (2023) Natural capital: food, timber or carbon?, *IPE Real Assets*, January/ February; https://realassets.ipe.com/forestry-agri/natural-capital-food-timber-or-carbon/10064740.article

In February 2024, it was reported that most of the 50 largest natural capital investors are from North America. The largest is Canada's Public Sector Pension Investment Board (PSP Investments) with €8.4bn in assets. This is followed by the US TIAA (General Account) with €5bn and Canada's BCI with €3.5bn. US public pension plans have been investors in timberland and farmland for a considerable time. The largest investor outside the US is the Dutch ABP pension fund with €2.9bn in assets.[1183] In total, the 50 largest institutional natural capital investors owned €70.6bn at the end of 2014, equal to over 1% of their total assets.[1184]

An example of the social benefits of protecting natural capital is the US reforestation program which began in the 1920s. Since then, 15m hectares have be reforested in the eastern US. This has created a 'warming hole' over the areas covered where temperatures have flatlined or even fallen, despite a warming trend elsewhere in the US.[1185]

In January 2025, the First Sentier MUFG Sustainable Investment Institute commissioned a report from Pensions for Purpose which found that 65% of asset owners in the UK were incorporating nature and biodiversity into their sustainability strategies, while a further 20% planned to do so. The report emphasized the need for the financial sector to tackle biodiversity risks, with asset owners increasingly aware of the dangers of biodiversity loss. Pensions for Purpose research manager, Bruna Bauer, said that it was financial materiality, rather than regulatory pressure, that had emerged as the primary reason for asset owners to act: 'Biodiversity loss poses tangible risks to investments, including supply chain vulnerabilities and ecosystem fragility, prompting schemes to proactively protect their portfolios. Asset owner respondents have realized ignoring nature-related risks is not just a sustainability issue but has financial consequences too, leading to the integration of nature into sustainable strategies before more regulation mandates it'.[1186]

The risks of ignoring nature-related risks could lead to 'planetary insolvency' according to a report by the UK Institute and Faculty of Actuaries entitled *Planetary Solvency – Finding our Balance with Nature*.[1187] The report defines 'planetary solvency' as 'managing human activity to minimise the risk of societal disruption from the loss of critical support services from nature'. The report concludes that there is an increasing risk of 'planetary insolvency', i.e., 'an increasing risk of severe societal and economic disruption caused by a breakdown in critical ecosystem services. This could include the provision of food and water and

[1183] https://realassets.ipe.com/special-reports/top-50-natural-capital-investors/10071197.article
[1184] https://realassets.ipe.com/special-reports/holistic-natural-capital-strategies-take-shape-in-investors-minds/10128328.article
[1185] https://www.theguardian.com/environment/2024/feb/17/us-east-trees-warming-hole-study-climate-crisis
[1186] https://www.pensionpolicyinternational.com/uk-financial-materiality-forcing-nature-and-biodiversity-into-sustainability-strategies/
[1187] https://actuaries.org.uk/document-library/thought-leadership/thought-leadership-campaigns/climate-papers/planetary-solvency-finding-our-balance-with-nature/

regulation of the climate. Therefore, catastrophic or extreme impacts are plausible unless decisive action is taken to mitigate climate and nature risks'.

The report has five recommendations to mitigate the risk of 'planetary insolvency':

1. Implement planetary solvency assessments to provide clear global systemic risk information for realistic and effective global risk management
2. Set planetary solvency limits that respect planetary boundaries, including revisiting climate goals and developing metrics to monitor planetary health
3. Enhance governance structures to formalize planetary solvency and provide transparent, easy-to-digest assessments for relevant bodies and the public
4. Build policymaker capacity on systemic risk management, enhancing understanding of the risks and interdependencies, and embedding risk outputs within current risk management processes
5. Take action to mitigate risk through incentives and policy design, as well as exploring options to limit global warming

The report introduces illustrative outputs for planetary solvency risk assessments in the type of format that might be provided to a risk committee. This includes an assessment of risk appetite alongside a risk dashboard. It sets out the current risk position and trajectory across the different dimensions of: climate, nature, society and the economy.

In March 2025, natural capital investment manager New Forests launched a fund to help Japanese paper-products manufacturer Oji Holdings meet its 2030 environmental goals. Oji Holdings will invest US$300m to establish Future Forests Innovations Fund which will invest in forestry plantations in Southeast Asia, North America, Latin America and Africa. It is targeting an additional 1.5m tCO_2e p.a. of net sequestration by 2030 from the forestry assets it acquires. It already owns 635,000 hectares of plantations globally and will invest in an additional 70,000 hectares, including greenfield and brownfield assets.[1188]

In March 2025, the British Standards Institution (BSI) released a government-backed green finance standard – as part of the Nature Investment Standards Programme – to encourage investment in nature restoration and prevent greenwashing. The standard will promote investment in projects such as wetland restoration, water quality improvement, flood resilience, and habitat creation. The BSI is also launching a consultation on the first version of a Natural Carbon Standard which will gather market views on high-integrity principles for projects selling nature-based carbon credits in UK markets. These credits will consist of habitats which store carbon, such as woodlands or peatlands.[1189]

[1188] https://realassets.ipe.com/news/new-forests-launches-300m-fund-to-help-japanese-corporate-meet-2030-goals/10129587.article

[1189] https://www.bsigroup.com/en-GB/products-and-services/standards-services/the-nature-investment-standards-programme/; https://www.ipe.com/news/uk-launches-nature-finance-standards-to-prevent-greenwashing/10129677.article

In March 2025, a report entitled *Balancing Act: Aligning Climate And Nature* was released by Savvy Investor and Nuveen.[1190] The report investigated the intersection between net-zero investing and nature conservation and highlighted the unintended risks of focusing solely on emissions reduction. It considered how climate-driven investment strategies can inadvertently harm biodiversity and outlined a framework for integrating nature considerations into investment decision-making for investors seeking to balance decarbonization with ecosystem preservation. The report suggested that to bring nature-positive investing into financial decision-making most effectively, investors should consider a whole-portfolio approach that encompasses both systemic- and event-based risks. This implies looking at how nature-related impacts occur across different asset classes and identifying opportunities to support ecosystem restoration and resource efficiency. The report proposes some key investment strategies:

- Prioritizing high-impact themes: Focus on sectors and activities with the greatest environmental footprint, such as land use change, resource consumption, and pollution generation. Identifying material risks within corporate value chains can help direct capital toward the most impactful areas.
- Using science-based assessment frameworks: Metrics such as the Science Based Targets Network (SBTN) provide structured methods for evaluating corporate sustainability commitments. Investors can use these frameworks to measure progress toward nature-positive outcomes.
- Exploring fixed-income solutions: A specific example is a $225m Amazon reforestation bond issued by the World Bank, which ties financial returns to measurable carbon removal outcomes. This type of innovative financial instrument can channel capital toward conservation efforts while generating returns.

Further, the report said it was of critical importance to address nature risks across different asset classes, such as equities, corporate debt, and structured financial products. Given that nature risks are embedded across multiple industries, creating and using a holistic strategy that incorporates biodiversity and natural capital considerations is necessary for investors who wish to manage long-term financial risks.

In April, the IFRS Foundation and the Taskforce on Nature-related Financial Disclosures (TNFD) agreed to create better guidelines for improving nature-related financial disclosures, building on the TNFD recommendations in the ongoing work of the International Sustainability Standards Board (ISSB). The ISSB said: ‘Our collaboration with the TNFD is a clear signal to the market that we are committed to reducing fragmentation in sustainability disclosure while meeting the need for relevant and high-quality information for capital markets’. The TNFD said: ‘Nature is essential to our economies and our future. Our collaboration with the ISSB is a major step toward making

1190 https://www.savvyinvestor.net/sites/default/files/node/paper/file/savvyreport_nuveen_mar2025_final.pdf

nature visible in businesses reporting and how capital is allocated. Climate-related standards have already moved markets, and we are pleased to continue to support ISSB efforts that bring the rest of nature into global reporting practice. Stronger standards mean stronger businesses, and a healthier, more resilient planet for all of us'.[1191]

Circular economy

A key feature of a sustainable future is the Circular Economy. This has been defined, by Amundi Asset Management, as an economy which 'allows [the production of] sustainable consumer goods, while protecting nature – by giving it time to regenerate – and ensuring the wellbeing of individuals. There is an urgent need to promote a society in which natural resources are protected, in which nature has the time to regenerate, where consumption is reasoned, where the life of goods is extended to the maximum and where waste is treated to be recycled in new products… We therefore need to move from a linear economic model to a circular economic model that will limit the damage to the environment, giving it time to regenerate by promoting the extension of the life span of produced goods – notably through eco-design, reparability, durability, and the second-hand market. It must also include better treatment of waste allowing raw materials to be reused to create new goods... thus closing the loop'.[1192]

Speaking at the Fiduciary Investors Symposium at Oxford University in November 2024, Gabriel Micheli, senior investment manager at Pictet Asset Management, pointed out that the planet had lost around three quarters of its species over the past 50 years and that biodiversity regeneration and restoration were essential for the planet's resilience. He said that regenerative agriculture is more resilient, reduces tilling and uses less pesticides and more nature-based solutions to ensure yields. Although circularity accounts for just 7% of the global economy, he predicted that the circular economy and recycling offer investors a huge opportunity.[1193] Speaking at the same Symposium, Ingrid Kukuljan, head of impact and sustainable investment at Federated Hermes Limited, also agreed that 'you can make money by investing in solutions. [But] if you don't start investing now there won't be any returns in ten years because the degradation will be so high. Take it seriously from a fiduciary duty point of view'. She also reminded delegates of the potential risks from not stemming biodiversity losses: 'plants alone are responsible for around 40% of the medicine in the western world'.[1194]

[1191] https://www.ipe.com/news/ifrs-joins-forces-with-tnfd-to-improve-nature-related-financial-disclosures/10129953.article
[1192] The wheels of a Circular Economy go round and round, Amundi Asset Management, 26 January 2022; https://research-center.amundi.com/article/wheels-circular-economy-go-round-and-round
[1193] https://www.top1000funds.com/2024/12/biodiversity-regeneration-set-to-become-big-investment-theme-in-future
[1194] https://www.top1000funds.com/2024/12/why-investing-in-biodiversity-champions-pays

Investment and sustainability

Here we discuss how investors are responding to the climate change challenge.

Integrating biodiversity into finance

Emmanuelle Sée, Head Equity Management, Swiss Life Asset Managers France, discusses the importance of integrating biodiversity into finance:

> *By integrating biodiversity into decision-making and investment practices, financial institutions can help protect the planet's natural resources while generating sustainable returns for investors and society. The economy's dependence on nature makes biodiversity loss a significant risk for companies, especially as regulations tighten.*
>
> ***Nature-related risk: a critical challenge for businesses.*** *Financial institutions must anticipate and incorporate both climate-related and nature-related risks into their business activities and investment portfolios. The degradation of biodiversity and ecosystems presents substantial threats to financial stability, including physical, transition, and systemic risks. Recent estimates suggest that annual cost of losing ecosystem services range from USD 4 trillion to USD 20 trillion (OECD).*
>
> ***Physical risks*** *result from the degradation of nature, which impacts economic activities – ranging from acute crises like natural disasters to chronic issues such as ecosystem decline. Sectors dependent on specific ecosystems are particularly vulnerable. For instance, the decline of pollinators can reduce agricultural yields, while large-scale pollution events, such as oil spills, can disrupt business operations.*
>
> ***Transition risks*** *include reputational and regulatory challenges as governments enforce stricter environmental regulations or as consumers become more environmentally conscious. Companies that fail to adapt to these demands risk being left behind as sustainable alternatives gain traction.*
>
> ***Systemic risks*** *refer to the broader implications of biodiversity loss on the global economy's resilience. Ongoing ecosystem degradation can undermine natural infrastructures, such as coastal wetlands that protect against storms, posing risks to both communities and businesses.*
>
> *Addressing these risks is not just about compliance; it is essential for safeguarding the long-term viability of economic activity and ensuring the resilience of financial systems.*

A nature-positive approach. *Companies and investors are increasingly adopting a 'nature-positive' approach, complementing their carbon neutrality efforts. This shift is influenced by international agreements like the Paris Accord, alongside rising governmental regulations aimed at enhancing environmental sustainability. The approach recognises biodiversity's essential role in ecosystem health and strengthening the resilience of global economies amid climate challenges.*

This broader focus extends beyond climate to include biological diversity, encapsulated by the equation: Nature = Climate + Biodiversity. Nature is shaped not only by climate but also by the diversity and interactions among species. Integrating biodiversity into corporate strategies is key to meeting stakeholders' growing expectations regarding sustainability and environmental responsibility.

By pursuing a 'nature-positive' approach, businesses can minimize their environmental impact and actively contribute to preserving and restoring vital ecosystems. This involves strategies that protect biodiversity, restore degraded ecosystems, and align business models with the needs of the planet and its inhabitants.[1195]

The drivers of investment funds' allocation to sustainable investments

Annamaria de Crescenzio and Etienne Lepers (2024) consider the key drivers of investment funds' allocation to sustainable investments, particularly in emerging markets (EMs).[1196] Using a unique micro-level dataset on a detailed portfolio-level sample of the 37,000 largest investment funds globally and a unique classification of 'green' companies based on revenues in carbon solutions (renewable energy, green transport, and infrastructure), the authors find that:

- A key role is played by benchmarks. Inclusion in major indices, such as the MSCI EM equity index, was the single most important factor influencing global investment fund choices. For example, major EMs like China and Brazil, with substantial representation in these global benchmarks, were able to attract significant shares of green investments, 'reflecting the appeal of their green companies'.
- Developing robust green sectors can position countries as prime destinations for capital. Countries with high renewable energy generation and strong green exports were able to attract more capital. Conversely, structural barriers, such as

[1195] Emmanuelle Sée (2024) The new nature of business: integrating biodiversity into finance, Swiss Life Asset Managers, November; https://hub.ipe.com/asset-manager/swiss-life-asset-managers/the-new-nature-of-business-integrating-biodiversity-into-finance/10076605.supplierarticle

[1196] Annamaria de Crescenzio and Etienne Lepers (2024) What Drives Capital to Green Companies in Emerging Markets: Evidence from Investment Funds, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4822081; https://cepr.org/voxeu/columns/drivers-investment-funds-allocation-green-companies

concentrated ownership of listed companies, deter investment by limiting the availability of tradable shares. So maintaining openness and a favourable investment climate remains critical.

- There was no robust statistical evidence for a role of climate policies in influencing green investment shares in country portfolio allocations.

Building sustainable investment strategies

How can investors build sustainable investment strategies? Bouchet and Shahyar (2024) offer a framework for achieving this which begins with certain building blocks (themes, levers and data) and ends with four categories of sustainable investment strategies (sustainable, transition, solutions, and ethical).[1197]

The themes range from local 'ESG' to global 'SDG'. There are three key types of lever: exclusion, allocation and engagement. Exclusion removes certain stocks from the portfolio; it is used as a response to non-sustainable activities, as a last resort when engagement fails, and to align with trustees' ethical considerations or resource constraints. Allocation applies a weighting scheme to the selected stocks, with the objective of either (1) maximizing sustainable metrics like ESG scores, carbon intensity, or average sustainable revenues or (2) ensuring a minimum allocation to certain market segments, e.g., companies offering climate solutions. Engagement builds relationships with companies and stakeholders. It begins with 'field building', the establishment of direct relationships with companies and with the fellow investors and regulators who can also influence a company's behaviour. This, in turn, leads to specific actions, such as 'Say on Climate' resolutions (e.g., ESG votes at AGMs) and collective investor initiatives like Climate Action 100+. The aim is to change corporate behaviour, particularly in transitioning non-sustainable activities to sustainable ones. Since this involves significant time and resources, investors are recommended to focus on specific themes and companies. The effectiveness of engagement is increased if exclusion by a group of investors remains a genuine possibility.

Data can be distinguished between primary and secondary. Primary data for sustainable investing reveals a company's state and activities. This is increasingly standardized, with metrics aligned with reporting requirements which emphasize climate mitigation. There is also more public data available, such as Urgewald's global coal exit list and the Finance Exclusion Tracker Initiative's aggregated exclusion list. Further, technological developments in web scraping and text analysis allow the generation of alternative ESG data. This has led to more reliable ESG primary data, making it easier to set exclusion and sustainable investment criteria. Secondary data are derived from primary data and are used to create ESG ratings. However, there are currently significant differences between ESG rating providers at both company and fund levels, mainly due to differences in the measurement of ESG attributes, rather than differences in scope or weight. There are also

[1197] Vincent Bouchet and Shahyar Safaee (2024) Institutional equity portfolios: how can asset owners build coherent sustainable strategies?, *EDHEC Research Insights*, Summer 2024, 7-11.

secondary metrics, chiefly related to climate change mitigation, but again there are big differences in measurement methodologies; nevertheless they can provide a useful basis for discussions with companies.

The themes, levers and data can be used to construct the four types of sustainable investment strategies. A sustainable investment satisfies one or more of the three ESG criteria of avoiding harm to environmental or social goals, contributing positively to these goals, and adhering to good governance standards. 'Harm' as a result of both activities (what a company produces) and behaviour (how the company produces) have to be defined, and an investor could assess them in terms of, say, the EU's 'do no significant harm' (DNSH) criteria or the UN's SDG framework, using primary data on, e.g., revenue distribution, consumption and production. A company can be considered to make a 'positive contribution' if its core activities meet one or more SDGs at a minimum threshold and the company also manages negative impacts from all activities and behaviour, consistent with 'do no harm'. Some organizations have set criteria for defining such investments, e.g., the Sustainable Development Investment (SDI) Asset Owner Platform.[1198] Again, primary data on revenues and production tend to be preferred for screening positive companies, since they focus directly on company activities; by contrast, secondary metrics such as ESG scores, tend to focus more on behaviour and often net off positive and negative contributions.

Investment strategies can range from 'alignment', where holdings align with values but no specific change is expected, to 'impact', where explicit improvements in activities or behaviour are targeted. Targets should ideally be derived from science-based or global standards, such as the Paris Agreement or the Net-Zero Asset Owner Alliance's Target-Setting Protocol.

Bouchet and Shahyar argue that the above analysis leads naturally to four categories of investment strategies with the following aims and principal levers (see Figure 14):

- *Sustainable*. Aim: to align the portfolio's constituents with one or more sustainable development goals, focusing on companies that 'do no harm' to environmental and social issues. Principal lever: exclusion, based on primary data.
- *Transition*. Aim: to transform companies with negative impacts into sustainable ones, using engagement on specific themes. Principal levers: exclusion thresholds and science-based transition plans, using both primary and secondary data.
- *Solutions*. Aim: to align a significant portion of the portfolio with specific theme solutions addressing environmental or social issues. Principal levers: dialogue with companies to reinforce and develop these solutions, and exclusion to ensure alignment with do-no-harm criteria.

[1198] https://www.sdi-aop.org/about/. SDIs are defined as those solutions that contribute to the UN Sustainable Goals.

- *Ethical*. Unlike the three preceding strategies, this category allows subjective preferences, such as religious or personal values, to influence investment criteria and targets.[1199]

Figure 14: Classification of sustainable investment strategies

		Portfolio initial allocation			Portfolio management		
Strategy	**Themes**	**Targeted companies**	**Negative screening**	**Weighting scheme**	**Shareholder engagement**	**Field building**	**'Output' metrics**
Sustainable	All	Companies whose behaviour and activities 'do no harm' to any SDGs	Covering all SDGs, based on revenues, physical metrics, controversies	Optimising risk and return under sustainability constraints: ● Negative screening		Publication of exclusion list	Alignment with 'do no harm' criteria, dynamic review of controversies
Transition	Specific	Companies whose behaviour and activities 'do harm' to certain SDGs, but where change is possible	Companies not prioritised for engagement + Companies where engagement has failed	Optimising risk and return under sustainability constraints: ● Negative screening ● Min/max share of 'targeted transition companies' (sustainability segment)	Systematically engaging on issues relating to the specific theme chosen	Publication of targets, engagement outputs and exclusion list	Engagement results
Solutions	Specific	Companies whose activities contribute positively to specific SDGs	Covering all SDGs, based on revenues, physical metrics, controversies	Optimising risk and return under sustainability constraints: ● Negative screening ● Min/max share of 'positive contribution companies' (sustainability segment)	Focusing on engagement related to activities (strategy, investments)		Share of 'positive contribution' investment
Ethical	All	Companies whose behaviour and activities are in line with ethical choices	Based on subjective preferences	Optimising risk and return under sustainability constraints: ● Negative screening			Respect of exclusion criteria

Source: Vincent Bouchet and Shahyar Safaee (2024) Institutional equity portfolios: how can asset owners build coherent sustainable strategies?, *EDHEC Research Insights*, Summer 2024, p11.

Nick Stansbury, Carl Fredrik Pollack, and Emma Henningsson (2024) take a contrarian view: 'We believe the negative framing of the climate question and the slow transition progress of many companies have created a significant opportunity for investors'. They argue that 'the greatest climate impact – and potentially also some of the greatest returns – can be sought by investing in those companies with high emissions or whose products have the greatest impact on other companies' emissions. Central to this approach is pro-active and profound company engagement; we believe in encouraging the companies to pull the

[1199] There are other approaches to building sustainable portfolios. For example, Lazanas et al (2025) select a portfolio that minimizes the return variance, subject to a standard no-leverage constraint and an emission budget constraint that requires the weighted average carbon intensity (WACI) of companies included in the optimal portfolio not to exceed the net-zero compliant emissions budget (or target). The companies included from each sector of the economy will be selected from the peer group of companies in that sector. The optimal portfolio weight for a particular company is the standard minimum variance weight plus a term involving the product of the normalized target intensity change for the company's peer group (the excess of the net-zero compliant emissions of the peer group over the risk-weighted intensity average of the peer group, divided by the risk-weighted standard deviation of the intensity of companies in the peer group) and the emission intensity weighted z-score for the particular company (the excess of the emission intensity of each company included in the portfolio over the risk-weighted intensity average of the company's peer group, divided by the risk-weighted standard deviation of the intensity of companies in the peer group). If this product is positive, the optimal portfolio weight for a particular company will be higher than the standard minimum variance weight. See Equation (9) of Antonios Lazanas, Zarvan Khambatta, Yingjin Gan, Lingjuan Ma, and Niall Smith (2025) Building 'Net-Zero-Aligned' Portfolios, CFA Institute, 8 January; https://rpc.cfainstitute.org/research/reports/2025/building-net-zero-aligned-portfolios

levers necessary to target improved aggregate climate outcomes. The goal is to allocate more capital to drive the business opportunities the transition creates, while simultaneously driving down emissions over time'.[1200]

Another warning comes from a study by Samuel M. Hartzmark and Kelly Shue published in December 2023 called 'Counterproductive Impact Investing: The Impact Elasticity of Brown and Green Firms'.[1201] The authors argue that the dominant sustainable investing strategy in recent years involves directing capital towards green firms and away from brown firms, with the goal of facilitating a green economic transition by influencing the firms' costs of capital. However, this may be counterproductive, as it makes brown firms more brown without making green firms more green. The authors introduce a new measure called impact elasticity, which quantifies how a firm's emissions intensity responds to a change in its cost of capital. They examine the impact elasticities along with other financial and emissions data of US public companies from 2002 to 2020. Firms are then sorted into quintiles based on their emissions intensity, with the lowest representing brown firms and the highest representing green firms. With this data, the authors examine: the level and variability of firm emissions, the impact elasticities of brown and green firms, and the incentive effects of the dominant sustainable investing strategy.

The key finding from the study are:

- The average brown firm releases 261 times more emissions per unit of revenue than the average green firm. Additionally, the annual variability of emissions intensity for a brown firm is equal to the average level of emissions from 35 green firms combined.
- The impact elasticity of green firms is close to zero, whereas the impact elasticity of brown firms is large and negative. This means that brown firms substantially increase their emissions following an increase in their cost of capital, while green firms' emissions remain largely unchanged.
- Brown firms have different impact elasticities than green firms because they have the choice to invest in green projects, such as new pollution abatement technology, or brown projects, such as expanding existing high-emitting production. Green firms do not have such choice, as their projects all have relatively low emissions.
- Since green projects have higher up-front costs and relatively more backloaded cash flows than brown projects, an increase in a brown firm's cost of capital will make brown projects more attractive. Therefore, following an increase in their cost of capital, brown firms deprioritize the green transition and emissions reductions, contrary to the goals of sustainable investing.

[1200] Nick Stansbury, Carl Fredrik Pollack, and Emma Henningsson (2024) Climate change:Inaction is not an option: Seeking to deliver an active approach to engagement and investing, LGIM and AP7; https://www.lgim.com/landg-assets/lgim/_document-library/climate-change-inaction-is-not-an-option-whitepaper-final.pdf

[1201] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4359282

- Changes in environmental impact are often measured in the wrong units. Many green funds and ESG ratings mistakenly reward firms for a large percentage reduction of emissions rather than a large reduction in the level of emissions. For example, a green firm reducing its emissions by 100% is much less economically meaningful than a brown firm reducing its emissions by only 1% since the initial level of the brown firm's emissions intensity is substantially higher than the green firm's.
- Rather than avoiding brown industries, as many do not have suitable alternatives, sustainable investors should instead direct capital towards these brown industries and reward the relatively green or transitioning brown companies within these industries.

In short, the study finds that brown firms have a large and negative impact elasticity: they respond to increases in their cost of capital by increasing their emissions. In contrast, green firms have an impact elasticity of around zero: their emissions do not meaningfully change following a change in cost of capital.

A number of studies from asset managers seek to address some misconceptions about net-zero investing.

Valeria Dinershteyn and Guido Baltussen (2024), for example, argue that investors can achieve alignment with their net-zero commitment without significant active risk and without compromising their return objectives. They accept that many net-zero strategies have high levels of tracking error, but they explain this in terms of sub-optimal portfolio construction. Many climate-focused indexes are substantially underweight in sectors such as energy and utilities, but if sector volatility is high (e.g, due to sensitivity to economic events), the tracking error may also be elevated. They analyzed the impact of a carbon intensity reduction on a portfolio's active risk in the MSCI World Index universe. They calculated carbon intensity by dividing a company's carbon emissions by enterprise value including cash. Their research shows that investors can achieve significant reductions in carbon intensity with very little active risk. Specifically, just 0.5% of active risk in a portfolio is required to achieve an 80% reduction in carbon intensity. They point out that this scale of reduction is well ahead of the existing pathway for global carbon emission targets. Forward-looking measures of carbon risk, such as the MSCI Low Carbon Transition Score or the ISS Carbon Risk Rating, have a more material impact on active risk. For example, 1.0% of active risk allows for a 17% improvement in the MSCI Low Carbon Transition Score and a 27% improvement in the ISS Carbon Risk Rating.

Dinershteyn and Baltussen also counter a second misconception, namely that investors cannot gain meaningful exposure to factors such as value in a net zero portfolio. They found that it is possible to maintain the vast majority of targeted factor content while achieving carbon intensity reduction levels above 70%. Integration of forward looking measures have a bigger impact on factor content. They applied their representative set of climate change criteria to the MSCI World Index to see how it would impact a multi-factor

approach while allowing for up to 2% of active risk. They found that it is possible to retain over 85% of factor content while meeting significant sustainability goals.[1202]

Mathias Talmant (2024) also argues that it is possible to reconcile alpha with sustainability in impact investing. He says that 'Impact investing sits at the intersection of the Venn diagram. It is the only investment philosophy where the interests of all stakeholders (People, Planet, Prosperity) are aligned, in harmony and without compromise. The concept of Triple Bottom Line (or Triple P) challenges the perennial dilemma of impact versus return and implies that impact investing is not a zero-sum game. In other words, caring about sustainability does not mean ignoring fundamentals, but it does indeed limit the size of the investment universe as only the heart of the Venn diagram exhibits purity'. Using total returns by SFDR (Sustainable Finance Disclosure Regulation) classification as compiled by J.P. Morgan with Morningstar data in March 2024 and using Article 9 funds as a proxy for impact, Article 9 funds outperformed both Article 6 and Article 8 funds over a 5-year horizon, although they underperformed over shorter horizons. However, a high demand for impact funds leads to a price premium which can reduce returns, although Talmant concludes that this 'overlooks the nuanced landscape of sustainable investing, where untapped opportunities abound'. [1203]

Constructing climate-risk hedge portfolios

Alekseev, Giglio, Maingi, Selgrad and Stroebel (2022) have proposed a quantity-based approach to constructing climate risk hedge portfolios.[1204] Climate-risk hedging strategies are becoming increasingly important for investors, but there are few financial instruments available that can directly hedge against these risks and historical stock prices may not contain enough information to estimate climate risk exposures. Accordingly, the authors introduce a new method to hedge climate risks by analyzing the trading patterns of mutual fund managers following a change in their beliefs on climate change. These patterns can be used to determine the most relevant industries to buy and sell to hedge against negative climate news shocks.

The authors identify two primary triggers for a climate belief shift: an extreme heat event in the manager's region or changes in climate-related discussions in the fund's disclosure reports. Since these events are localized and only apply to a small subset of investors, they do not move stock prices. However, the quantity of stocks bought or sold by fund managers

[1202] Valeria Dinershteyn and Guido Baltussen (2024) Addressing misconceptions with net-zero investing, Northern Trust Asset Management, November; https://hub.ipe.com/asset-manager/northern-trust-asset-management/addressing-misconceptions-with-net-zero-investing/10076602.supplierarticle
[1203] Mathias Talmant (2024) Reconciling Alpha with Sustainability in Impact Investing, Degroof Petercam Asset Management (DPAM), November; https://hub.ipe.com/asset-manager/degroof-petercam-asset-management/reconciling-alpha-with-sustainability-in-impact-investing/10076598.supplierarticle
[1204] Georgij Alekseev, Stefano Giglio, Quinn Maingi, Julia Selgrad and Johannes Stroebel (2022) A Quantity-Based Approach to Constructing Climate Risk Hedge Portfolios, Working Paper 30703, National Bureau Of Economic Research, December 2022; http://www.nber.org/papers/w30703

following these events contains information on how investor demand for assets in certain industries at the aggregate level shifts in response to heightened perceived climate risks. The authors quantify how fund managers respond to these events by analyzing the quarterly trading data of nearly 2,500 actively managed non-sector mutual funds in the US between 2010 and 2019.

The study finds that:

- Traditional climate hedging strategies based either on historical time-series data or economic reasoning, such as shorting companies vulnerable to stranded asset risks, are generally not correlated with negative climate news events, suggesting that climate risks are complex and difficult to hedge.
- The long-short quantity-based climate hedge portfolios constructed by the authors outperform the traditional approaches to hedging climate risks.
- This 'wisdom of the crowd' approach uncovers new insights about sector exposures to climate risks. The long-short hedge portfolio is long stocks in the automotive, semiconductor, insurance, and energy sectors and short stocks in the commercial and professional services, real estate, and retail sectors.
- Insurance stocks can surprisingly serve as a hedge to negative climate news, potentially due to expected increases in demand for insurance when climate risks are higher and the ability of insurers to reprice premiums annually.
- Similarly, auto stocks can serve as a hedge to negative climate news, potentially due to increase in demand for electric vehicles from households and firms hoping to reduce their carbon footprints.

Another way to hedge climate risk is through insurance. Wenjun Zhu, Jinggong Zhang, Lysa Porth, and Ken Seng Tan (2025) explain how index insurance can be used to hedge climate and weather risk: 'Index insurance is a special type of financial contract whose payout is based exclusively on some pre-specified indices. For example, weather index insurance determines the claim payments based on future realizations of weather events determined from certain weather indices. The primary distinction between index insurance and traditional indemnity-based insurance lies in their payout mechanisms. In traditional insurance, payouts are directly tied to the actual losses experienced by policyholders. In contrast, index insurance bases its payouts on predefined indices, which should be built upon data that is both transparent and representative. This structure theoretically reduces information asymmetry issues, such as adverse selection and moral hazard, because the payout is not influenced by the specific losses of an individual policyholder but by the performance of the index. This attribute makes index insurance particularly appealing, as it addresses many of the limitations associated with conventional insurance models. …Furthermore, the adoption of advanced technologies, including satellite measurements

and digitalization, has significantly reduced the costs associated with index insurance'. While index insurance has shown some growth in sectors like agriculture that are highly susceptible to weather-related risks, growth is still limited due to basis risk, the risk that the underlying indices and actual losses are mismatched. The authors argue that: 'While challenging to completely eliminate, basis risk can be mitigated through careful contract design. …Besides basis risk, ambiguity aversion, farmers' past insurance payout experiences, and insurance literacy, among others, are also influencing factors for index insurance demand'.[1205]

The performance of ESG portfolios

Alves, Krüger and van Dijk (2025) analyzed the relationship between ESG ratings and stock returns over the period 2001-2020, across 16,000+ stocks in 48 countries and seven different ESG-rating providers.[1206] They found that ESG investing did not systematically affect investment performance during this period. They also found that: incorporating ESG ratings into investment strategies did not systematically come at the expense of financial returns; the prices of stocks with high ESG ratings were not consistently driven up by demand effects; and firms' cost of capital was not affected by ESG ratings. The authors argue that further research is needed to determine whether the lack of a relationship between ESG ratings and stock returns is due to: the poor quality of ESG ratings, the less than pervasive prevalence of ESG preferences among investors, the challenges in distinguishing between short-term demand effects and long-term equilibrium effects, and/or other reasons.

Bruno and Goltz (2024) also find that sustainable investing did not yield higher returns than standard index funds over the period 2012-22.[1207]

A number of authors have investigated the performance of ESG portfolios using a common-factor asset pricing model[1208] which incorporates an ESG common factor. Pástor et al (2021)[1209] add ESG to a single-factor model, while Dobrick et al. (2025)[1210] add ESG to a

[1205] Wenjun Zhu, Jinggong Zhang, Lysa Porth, and Ken Seng Tan (2025) Index-based Insurance Design for Climate and Weather Risk Management: A Review, in Hirbod Assa, Peng Liu and Simon Wang (eds.), *Quantitative Risk Management in Agricultural Business*, Springer Actuarial (chapter 2); https://doi.org/10.1007/978-3-031-80574-5_2

[1206] Rómulo Alves, Philipp Krüger, and Mathijs van Dijk (2025) 'Drawing Up the Bill: Are ESG Ratings Related to Stock Returns Around the World?', Working Paper, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4674146

[1207] Giovanni Bruno and Felix Goltz (2024) Sustainability alpha in the real world, *Scientific Beta, EDHEC Research Insights*, Winter.

[1208] This model tries to identify the factors that explain the common variation in stock returns over time.

[1209] Ľuboš Pástor, Robert F. Stambaugh, and Lucian A. Taylor (2021) Sustainable Investing in Equilibrium. *Journal of Financial Economics,* 142(2): 550–571; https://doi.org/10.1016/j.jfineco.2020.12.011

[1210] Juris Dobrick, Christian Klein and Bernhard Zwergel (2025) 'ESG as Risk Factor', *Journal of Asset Management*; https://doi.org/10.1057/s41260-024-00382-z

Fama-French-Carhart four-factor model.[1211] The ESG factor in Dobrick et al. (op cit.) is defined as UMS (unsustainable minus sustainable), i.e., is long in 'unsustainable (brown)' stocks and short in 'sustainable (green) stocks'. In long-run equilibrium, the expected return on UMS is positive, since the expected return on unsustainable stocks should be larger than those of sustainable stocks. This is because investors are assumed to have a preference for green stocks, green stocks can be used to hedge climate risk, and green stocks have a resilience to ESG-related shocks, such as unexpected changes to climate-change-related regulation. This drives up the long-run equilibrium price of green stocks relative to brown stocks and drives down their long-run relative returns.[1212] However, during the transition period to equilibrium, when investor preferences are changing or when climate-related concerns are increasing, early investors in green stocks will capture the higher returns from the increase in their prices. The risk premium (or factor loading) on the ESG factor is therefore expected to be positive in equilibrium, but may be negative during the transition.

Dobrick et al. (op cit.) examined the ESG factor of three ESG-rating providers (ASSET4, LSE Refinitiv and Moody's Vigeo Eiris). Their data set consists of 4500 companies that have ESG ratings from all three providers over a sample period July 2007 - June 2020 for European companies and July 2012 - June 2020 for North American companies. For each provider, they construct ten decile portfolios with ascending scores for the UMS risk factor. If there are systematic risk components related to ESG, the risk premium is expected to be positive (negative) for the lowest (highest) scores and insignificant in between. This is what they find for each of the ESG-rating providers, suggesting that ESG should be incorporated into common-factor asset pricing models. However, the authors find the average ESG-factor risk premium is not significantly different from zero over the sample period, indicating that the average investor's return from holding green stocks was no different from the average investor's return from holding brown stocks. This is consistent with the findings of both Alves et al. (op cit.) and Bruno and Goltz (op cit.) above.

The Sustainability Dividend

The Sustainability Dividend of a company is measured by it Sustainability ROI, the return on investment of its sustainability efforts.[1213] It is a key measure to attract investors in the company.

Sustainability ROI 'reflects the measurable benefits derived from corporate sustainable practices, including economic, environmental, and social gains. …[The] goal is to evaluate the full value (i.e., the overall worth or benefit) generated from these investments.

[1211] The four factors are market risk, size, book-to-market value, and momentum.
[1212] See and Pástor et al. (op cit.), Dobrick et al. (op cit.) and Bradford Cornell (2021) 'ESG Preferences, Risk and Return', *European Financial Management*, 27:12–19; DOI: 10.1111/eufm.12295
[1213] The Sustainability Dividend: A Primer on Sustainability ROI; https://corpgov.law.harvard.edu/2025/01/04/the-sustainability-dividend-a-primer-on-sustainability-roi/

Sustainability ROI differs from traditional ROI, which emphasizes measurable, short-term returns tied to monetary gains, by adopting a longer-term view and factoring in broader environmental, social and governance outcomes'.

Accurately measuring sustainability ROI can be challenging due to its multidimensional nature and intangible benefits: 'For example, a manufacturing company might reduce costs by improving energy efficiency and waste reduction, while a retail business could enhance its brand reputation by prioritizing ethical sourcing and reducing carbon emissions. Both approaches contribute to Sustainability ROI, but the value created may vary. Some factors, like energy costs, can be easily quantified, whereas others, such as positive brand association, might be more challenging to calculate and attribute. …To fully capture sustainability ROI, companies should account for both tangible (easily quantifiable) and intangible (non-physical, with harder-to-quantify monetary value) benefits, including those that may not be immediately obvious (hidden benefits)'. Currently, few companies are reporting their sustainability ROI.

Sustainable investing and the growth in artificial intelligence

Generative artificial intelligence will revolutionize knowledge work, potentially enhancing the productivity of those who are able to embrace the technology, while leading to job losses where the technology replaces specific types of jobs.[1214]

AI is heavily dependent on data centres – the physical infrastructure behind processes such as transmission, hosting, data processing and manipulation. These data centres use a massive amount of energy (and water), contributing to increasing power demands at a time when grids are already under strain.[1215] According to a report in *Nature*, AI-driven applications require 23-30 times the energy of standard digital processes. In Virginia, for example, data centres account for more than 25% of the state's electricity usage; similarly for financial hubs like London and Dublin.[1216] Miranda Beacham, head of UK responsible investment at Aegon Asset Management argues that these energy costs pose a significant challenge for responsible investing: 'With responsible investing becoming more nuanced, advisers must assess not just a company's ESG credentials, but also its exposure to rising energy costs. Advisers are urged to look beyond traditional ESG funds and consider funds focused on the energy transition. Renewable energy, grid infrastructure, and nuclear innovation are areas that could see long-term growth as AI's power needs expand. Advisers

[1214] One UK-based research organization estimates that under a worst-case scenario, 8 million jobs could be lost in the UK; https://www.ippr.org/media-office/up-to-8-million-uk-jobs-at-risk-from-ai-unless-government-acts-finds-ippr

[1215] Data centres account for around 1% of global electricity consumption, and annual electricity consumption from data centres globally is about half of the electricity consumption from household IT appliances, like computers, phones and TVs; https://www.iea.org/commentaries/what-the-data-centre-and-ai-boom-could-mean-for-the-energy-sector

[1216] https://www.nature.com/articles/d41586-025-00616-z

must also be prepared to explain the evolving regulatory environment and ensure that client investments align with their financial goals and ethical values'. [1217] The UK government has introduced the AI Opportunities Action Plan, which aims to balance AI growth with sustainability. The plan includes measures to enhance energy efficiency in data centres and promote the use of renewable energy sources to mitigate the environmental impact of AI expansion.[1218]

Implications

The findings in this subsection have implications for life expectancy (including that of pension scheme members), the assets in which pension funds invest, and the risk and return on those assets (including the risk of investing in what become stranded assets). These factors affect both the asset and liability side of pension fund balance sheets and also of insurers buying out pension fund assets and liabilities. There are other global developments that could affect life expectancy – some positively, others negatively.

It is clear from this look into the future that longevity risk is likely to increase going forward – even the direction of the trend change in life expectancy will be more uncertain than it has been in recent decades. In addition, there is likely to be increasing uncertainty about the real level and volatility of the returns on the assets which pension funds and PRT providers need to hold to achieve their objectives. Technological developments and changing retirement patterns will also influence outcomes.

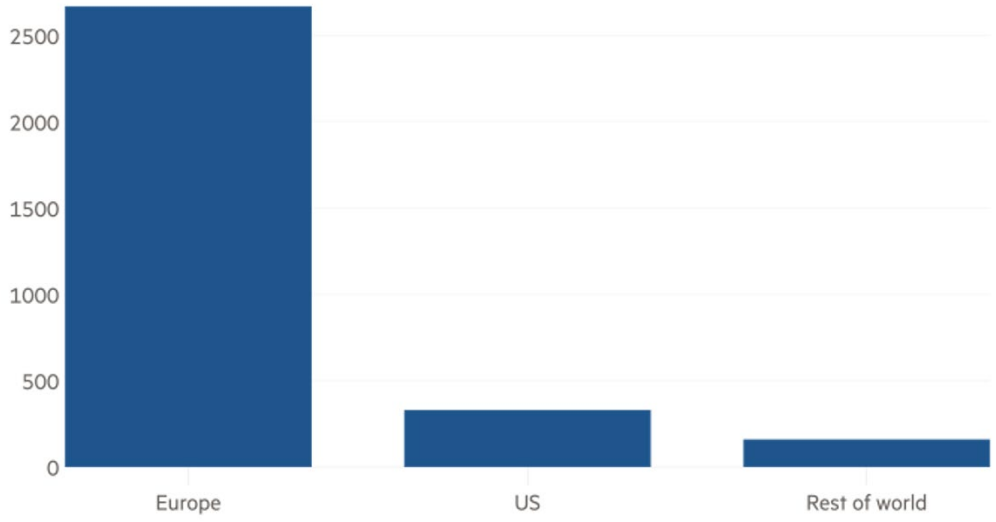
In addition, and despite all these initiatives, a report from the Oxford Sustainable Law Programme by Wetzer et al. (2024) argues that investors are 'flying blind' to the risk of 'increasingly impactful climate litigation and regulatory enforcement actions' that could hit companies with trillions of dollars in damages. The report counted 2,485 climate lawsuits filed globally against large corporate carbon emitters, with Chevron alone liable for up to $8.5trn if the climate lawsuits it faces are successful. The report recommends five ways for investors and regulators to assess climate-related legal risks: market-impact analysis; analysis using the social cost of carbon; attribution of climate change damages; estimating costs of accelerated climate mitigation, and qualitative analysis of legal, financial and scientific variables to predict legal action and its financial impact.[1219] Further, according to Will Martindale, former head of policy and research at the UN Principles for Responsible Investment, asset owners, such as pension funds, do not have the budget to

[1217] https://www.professionaladviser.com/news/4410533/ais-energy-demands-pose-responsible-investing-challenge
[1218] https://www.gov.uk/government/publications/ai-opportunities-action-plan/ai-opportunities-action-plan
[1219]Thom Wetzer , Rupert Stuart-Smith, and Arjuna Dibley (2024) Climate risk assessments must engage with the law: Legal actions determine the allocation and magnitude of climate-related financial risk exposures, *Science*, 383(6679): 152-154; 10.1126/science.adj0598

meaningfully contribute to asset managers' stewardship efforts, such as policy engagement, in respect of sustainability challenges.[1220]

Finally, Figure 15 shows that the majority of sustainable funds are based in Europe.[1221]

Figure 15: Assets under management by sustainable funds, March 2025 ($bn)



Source: Morningstar; https://www.ft.com/content/142eb9ee-7b20-4308-9d13-38613af58ea1

Longevity 18

As with the previous conferences, *Longevity 18 (L18)* consisted of both academic papers and more practical and policy-oriented presentations. There were four plenary sessions and the following keynote speakers and panellists contributed to these sessions:

- Plenary Session 1: Aging and health
    - Professor Richard Faragher (Brighton University) opened the conference with a presentation entitled 'The dam has broken: What does the new science of aging mean for the pension risk transfer market'. As a professor of biogerontology, Richard identified the key diseases of aging: Alzheimer's, cancer, cardiovascular, Parkinson's, macular degeneration,

[1220] Will Martindale (2024) *Responsible Investment: An Insider's Account of What's Working, What's Not and Where Next*, London: Palgrave Macmillan.
[1221] The Morningstar data comprises funds that claim to focus on sustainability, impact or environmental, social and governance factors.

type II diabetes, and osteoporosis. The evolution of aging is shaped by two mechanisms: antagonistic pleiotropy[1222] and mutation accumulation.[1223] Aging is similar between species and the mechanisms and genetic pathways that maintain health are also shared between species. So anything that reduces cancer incidence or severity in mice, for example, will also benefit humans; further, targeting one hallmark of aging also positively affects the others.

The Interventions Testing Program (ITP) at the US National Institute on Aging[1224] is a peer-reviewed program designed to identify agents that extend lifespan and healthspan in mice. The following interventions have been found to extend longevity (the percentage increase in brackets): glycine (4-6% males and females), nordihydroguaiaretic acid (males, 10%), α-Estradiol – non-feminizing (males, 10%), aspirin (males, 10%), Protandim®-Nrf2 activator (males 7%), canagliflozin (14% males), acarbose – glucosidase inhibitor (males, 22%), and rapamycin (males and females, 10-25%) which also improves health and may be useful in early Alzheimer's detection.

Removing senescent cells in mice increases exercise capacity. For example, old mice with senescent cells removed can travel 175% further than old mice with senescent cells. Rapid progress is being made in senolytics, with more than 60 ongoing senolytic trials. For example, one trial has shown a 48%-67% lifespan increase depending on sex in Ames dwarf mice.

If humans experienced similar increases in life expectancy, then this could have the following significant impacts on the value of immediate annuities:

[1222] Antagonistic Pleiotropy (AP) is 'the best-accepted theory for the evolutionary origin of aging. According to AP theory, aging is a side effect of genes that are selected for their contribution to fertility and other essential components of individual fitness. In this standard view, aging exists because the benefits of enhanced fertility early in life are linked logically or physically to the long-term deterioration of the body, and evolution has been compelled to accept the latter as a cost of the former' (Josh Mitteldorf (2019) 'What is antagonistic pleiotropy?' *Biochemistry (Mosc)*, 84(12):1458-1468).

[1223] Mutation accumulation is 'a process which involves both natural selection and mutation which can lead to senescence. This process assumes there exist deleterious mutations that act in an age-specific fashion and that the strength of natural selection weakens as the age of onset of the mutation increases' (Laurence D. Mueller (2021) 'Mutation accumulation aging theory', *Encyclopedia of Gerontology and Population Aging*, Springer, Cham).

[1224] https://www.nia.nih.gov/research/dab/interventions-testing-program-itp

Scenario	Assumed increase in life expectancy of women aged 65 by 2040	Increase in value of immediate annuities
A. Compounds in clinical trials made available immediately (Dasatinib and Quercetin)	2 years	8%
B. Increased understanding of the biology of ultra-long-lived mice, leading to interventions that reduce mortality rates by 55% in 10 years	6 years	16%
C. Scenario B would happen twice – now and from 2050	10 years	25%
Note: Life expectancies are calculated based on U.S. Social Security life tables and mortality improvements, for illustration.		

Richard concluded that there is significant potential for developments in geroscience to impact life expectancy over the time frame considered by the pensions industry. Further, there is a real need for collaboration between basic scientists, actuaries and economists to better model future scenarios.

- Baroness Professor Susan Greenfield, CBE (Founder and CEO of Neuro-Bio Ltd) gave a presentation called 'A disruptive approach to Alzheimer's disease'.

  She began by pointing out that Alzheimer's Disease (AD) was the 'biggest unmet need of our time', with 44mn globally diagnosed with it. Mild cognitive impairment (MCI) was experienced by 12-18% of those over the age of 60, and by 15% over the age of 80 or by around 12mn people. She asked why it has taken so long to develop a treatment for AD. Her answer was that (1) too much focus had been given to anti-amyloid drugs, when there was no amyloid in early-stage pathology and so it could therefore not be the primary target; and (2) all 'theories' to date mistakenly regard brain cells as generic, whereas neurodegeneration is a highly selective process which is only apparent in certain cell groups and it is these that need to be targeted specifically, before the symptoms of cognitive decline appear.

Having understood the pivotal mechanism driving neurodegeneration, it became possible to design both a biomarker reflecting the degenerative process as well as a drug for intercepting it and halting further cell loss. The primarily vulnerable neurons are the cortical nuclei of the isodentritic core. They are special because they have a different embryological provenance. While most neurons experience loss of plasticity and are insensitive to developmental factors, the vulnerable neurons have robust plasticity and retain sensitivity to developmental factors. A common feature of the vulnerable cells is the enzyme Acetylcholinesterase (AChe). Derived from this is T14, a 14-mer peptide.[1225] T14 is present in all the vulnerable cells, irrespective of their transmitter, it has a partial homology[1226] with amyloid, and it promotes cell growth. But excessive levels of T14 are toxic and can lead to neurodegeneration. This can happen, for example, because vulnerable cells are damaged (e.g., by a stroke or injury) and the T14 mechanism is mobilised to 'compensate', but this then causes more cells to die, leading to further cognitive decline. Aberrant activation of T14 can also lead to cancer and skin disorders. T14 also increases both amyloid and tau proteins.

Neuro-Bio has developed the first ever pre-symptomatic AD test. This is based on the idea that tau is the cardinal marker, reflecting stages of Alzheimer's even before symptoms appear, with supporting evidence from both *post mortems* and living brains. The T14:tau ratio is a biomarker for pre-symptomatic AD. However, even in the early pre-symptomatic stage, the relationship can be disrupted. Further, it would be better to avoid extracting bodily fluids using lumbar punctures if possible.

Neuro-Bio has discovered that 50% of the components of nasal secretions are derived from cerebrospinal fluid (CSF) that is taken in lumbar punctures. It has therefore developed a lateral-flow/antigen nasal test together with saliva sampling for detecting T14 before any symptoms. It is now developing a treatment for AD called NBP14 which inactivates toxic T14 by cyclization.[1227] Experiments on 5xFAD mice with AD that have been treated with intranasal NBP14 twice weekly for 14 weeks show better weight gain and the ability to remember and distinguish familiar from novel objects (compared with a control group). In addition, brain amyloid is significantly lower in the hippocampus. IND-enabling studies[1228] are in progress. The potential benefits from therapeutic NBP14 are: bulk production (the purity is 97% and the yield is four times greater than expected); safety (due to intranasal delivery and no adverse effects at doses

[1225] 14-mer refers to the number of amino acids in the peptide.
[1226] Similarity of the structure.
[1227] Formation rings in a chemical compound.
[1228] These are needed to gain approval to conduct human clinical trials of a new drug.

tested); and recognition from UK regulator body (MHRA) as a truly innovative drug).

Susan concluded that Neuro-Bio had found a new approach to treating AD, by combining a liver function test (LFT) for T14 levels with NBP14 (T14 blocker therapy) to provide permanent prevention of symptom onset.

- Professor Les Mayhew (Bayes Business School) presented on 'Longevity and the economic value of healthy ageing'. He is the research director at ILC(UK) and discussed ILC(UK)'s Healthy Ageing and Prevention Index.[1229] This ranks 121 countries against six indicators: life span, health span, work span, income, environmental performance, and happiness. It allows users to compare how sustainable different countries are, both in terms of longer lives and the extent to which their governments are investing in efforts to prevent ill health and support healthy aging. There are significant inequalities between countries based on rank. For example, between the top 10 and bottom 10 countries, there is a 24-year gap in life span (life expectancy), a 21-year gap in health span (healthy life expectancy, and a 23-year gap in work span (working life expectancy). The top 10 countries in the index are Switzerland, Iceland, Norway, Sweden, Singapore, Australia, Luxembourg, Netherlands, Denmark and Ireland – but these account for only 1.1% of the world's population. Around 50% of the global population are in the top half of the index and 50% on the bottom half. Further, the high ranking countries are aging the most and low-ranking countries the least and so the gap is set to widen. The highest ranked countries also have the fewest inequalities as measured by income. However, both the level of inequality and the gap between countries remains broadly unchanged since 2000.

  Access to health care is massively unequal and inversely correlated with the index. Health outcomes are better in high-ranking countries with fewer deaths from communicable disease and lower infant mortality. Spend on prevention is proportionately higher in low ranked countries but nominally less than in those higher ranked. Transitioning countries are following in the footsteps of richer countries by adopting unhealthy lifestyles. Obesity is overtaking smoking as the number one health threat high to middle ranked countries. Undernourishment persists in the rest.

  Les summed up as follows. For greater prosperity, increases in life expectancy need to be balanced by improvements in health and working life expectancy. Higher productivity is an antidote to population aging but as older workers are less productive this cannot be guaranteed. Whilst a

[1229] https://ilcuk.org.uk/preventionindex/

growing population increases GDP it may not translate into improved GDP per capita, and so living standards can fall. Health improvement as well as technical progress is a great enabler. However, while there is theoretical scope to increase health expectancy it will be challenging, and it could easily go into reverse.

- Professor S. Jay Olshansky (University of Illinois at Chicago) spoke about 'The plausibility of radical life extension in humans'. Jay began by pointing out that there is entropy in human longevity and this equivalent to the transition from order to disorder – in accordance with the second law of thermodynamics. Entropy in human longevity means:

    - The longer we live, the more difficult it becomes to live longer
    - The metric of period life expectancy at birth should become less sensitive to mortality change over time
    - The rise in period life expectancy at birth should decelerate
    - Internal organs operate with declining efficiency as we age
    - Body parts wear out, such as muscles, joints, cardiovascular system (CVS), cellular maintenance and repair mechanisms, etc.
    - As the currently immutable force of biological aging becomes a more dominant risk factor, the effect of medicine on life extension will experience diminishing returns.

There is a remarkable consistency to the timing of death across species. Duration of life is calibrated to the onset and length of a species' reproductive window. For humans, the maximum length of life is 45,000 days, while the average is 29,000 days.

The evolutionary theory of senescence takes account of:

- Mutation accumulation genetic dustbins. Alleles[1230] with detrimental effects are 'pushed' by natural selection to either side of the reproductive window.
- Antagonistic pleiotropy. Genes that are harmful late in life are selected if they are favorable early in the lifespan.
- Disposable soma theory of aging.[1231] In a world with limited physiological resources, selection favors investment in reproduction at the expense of immortality.

[1230] An allele is one of two or more versions of a DNA sequence at a given genomic location. An individual inherits two alleles, one from each parent, for any given genomic location where such variation exists; https://www.genome.gov/genetics-glossary/Allele

[1231] Organisms age due to an evolutionary trade-off between growth, reproduction, and DNA repair maintenance; https://en.wikipedia.org/wiki/Disposable_soma_theory_of_aging

The human body is a miraculous machine that works with near artistic perfection – for a while. However, time reveals the 'flaws' in a body design that was not intended for long-term use. The key point to remember is not that we have the capacity to re-design our bodies better than they already are, but that unless we 'rethink aging' instead of just treating diseases, we are going to have to live with what we have.

Jay concluded by quoting from an article he co-authored in *The Scientist* called 'Re-engineering humans':[1232] 'Here, we imagine how the inner workings of the human body might have been designed differently, had a healthier and longer life been the motivating force that shaped life. Our goal is not to create new methods of combating disease, but rather, to spark an idea, trigger a thought, and inspire others to think outside the box by first imagining a new future of human health that is better than the present – and then working to make it so'.

- Plenary Session 2 Panel: Longevity 2.0 – Bringing the longevity risk market into its next phase

  The longevity risk market is now in its fifth decade of meaningful activity, with pension buyout transactions first being introduced in the 1980s. Buyout activity gained pace through the 2000s, and, with the implementation of Solvency II in the EU and UK, the need for insurers to manage their own longevity risk and capital emerged. As a result, over a decade ago, longevity swaps started being used to hedge pure longevity risk, which brought reinsurers into the value chain.

  Since then, efforts have been underway to incorporate capital markets investors into the longevity risk taker universe (often using index-based structures), but this has been slow to materialize. This panel explored the forces that are changing the dynamics in the longevity risk market: How are the business models of insurers and reinsurers changing? Are capital markets investors prepared to provide meaningful capacity to this market? What elements remain essential to this market achieving its long-term potential? What will happen if it does not? What are the catalysts for change that have occurred or may occur soon which will pressure the status quo? Essentially, what does it take for the Longevity Market to reach its next phase – Longevity 2.0?

  The panel was chaired by Avery Michaelson, Founder and CEO, Longitude Exchange, who gave a brief presentation about the efforts being expended by the Index Longevity Market Action Committee (ILMAC) to work with insurance regulators on a framework for capital relief from index-based hedging structures. The session also featured presentations by Jérôme Grenier, Portfolio

[1232] S. Jay Olshansky, Robert N. Butler, and Bruse A. Carnes (2007) 'Re-engineering humans', *The Scientist*, 1 March.

Manager, Securis Investment Partners and Khurram Khan, former Head of Longevity Risk at Pension Insurance Corporation. Following the presentations, Avery, Jérôme and Khurram were joined in a panel discussion by Eugene Dimitriou, Founding Partner, Farsight Partners and Robert Kairis, Head of Reinsurance Strategy, The Phoenix Group.

- Plenary Session 3: Longevity Issues

  - Eve Elisabeth Titon and Amal Elfassihi (Milliman) gave a presentation entitled 'Modeling the impact of climate risk on mortality'. Eve and Amal introduced the 'adapted climatic Lee-Carter model':

    $$ln(\mu_{x,t}) = \alpha_x + \beta_x^0 \kappa_t^0 + \delta_x^c CI_t$$

    where:
    $\mu_{x,t}$ is total mortality
    α_x describes average age specific pattern by age of mortality
    κ_t^0 is the time-varying index for general mortality
    CI_t is a climate index, and
    β_x^0 and δ_x^c are age-related sensitivity factors

    and the notation o refers to other causes of death than the climatic cause denoted by c.

    The model was calibrated using data from 1990 from: the Human Mortality Database (HMD); Global Health Data (GHD) which contains numbers of deaths classified by different parameters (age, territory, years, etc.) and particularly by cause of death; and Météo France, a climate database containing, for example, the number of days above a certain temperature (30°C (T_t^{30}), 35°C (T_t^{35}), 40°C (T_t^{40})), rainfall levels, wind speed, sunshine time or minimum, maximum or average temperatures.

    The climate index is estimated using a linear regression between the climate cause death rates and the climate variables T_t^{35} and T_t^{40}:

    $$CI_t = a + \alpha(bT_t^{35} + cT_t^{40}) + \beta(bT_{t-1}^{35} + cT_{t-1}^{40})$$

    This allows for a catch-up (or harvest) effect, whereby weaker people are mainly affected by an extreme weather event that causes excess mortality in the general population. Without the event, these people would have died within days or weeks that followed. Therefore, the event is followed by a period of under-mortality.

Projections are made using an autoregressive model:

$(T_t^{35}, T_t^{40}, \kappa_t) = (T_{t-1}^{35}, T_{t-1}^{40}, \kappa_{t-1}) + (\mu_1, \mu_2, \mu_3) + C(\epsilon_{t1}, \epsilon_{t2}, \epsilon_{t3})$

The age-shock to life expectancy is defined according to (EIOPA):

$$e_x^h(t) = \frac{1}{2} + \sum_{k=1}^{\infty} \prod_{s=0}^{k-1} (1 - (1-h) q_{x+s}(t+s))$$

where

$$h_{\inf}(x) = \underset{h \in]-1,1[}{\operatorname{argmin}} (e_x^h(t) - e_x^{0.5\%}(t))^2$$

On the basis of the model estimated, climate shocks are on average 6.12% more important than conventional shocks.

The next steps are to model the mortality due to each of the climatic causes identified, aggregate them by modeling the correlations between the different causes of death, and hence obtain a mortality model taking into account all the main climatic risks. Then the model can be integrated into an economic scenario generator. The resulting model cab used for information purposes, to project mortality, and to define climate stress tests for internal models

- Patrick Cheung and Jamie Campbell (RGA Re) talked about 'Funded reinsurance in the post-pandemic world'. Patrick and Jamie began by pointing out that, post-pandemic, alternative risk capital had entered the market to address a sharp increase in cedant desire to offload legacy blocks that consumed significant capital. They expected market needs and preferences to continue to evolve.

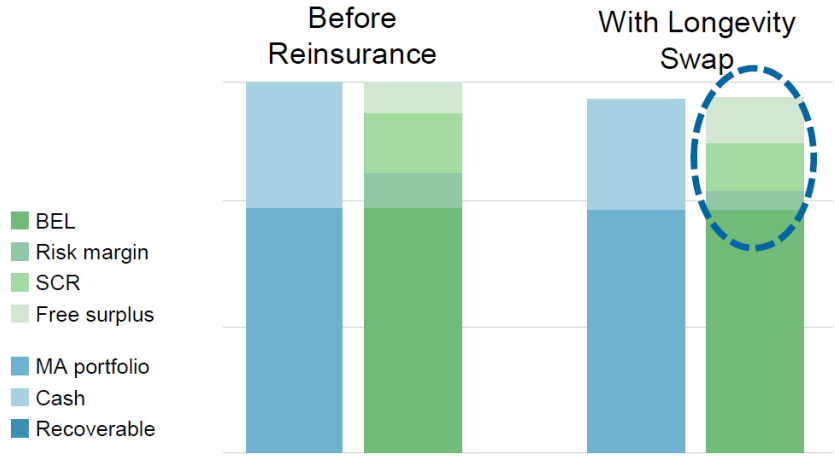
  They then considered the impact of a longevity swap. Under Solvency II, the trade-off between the embedded value sacrificed and the capital release achieved is typically viewed as favorable by most UK insurers. In terms of the balance sheet, implementing a longevity swap:

  - Reduces the Solvency capital requirement (a large decrease in longevity SCR and corresponding small increase in counterparty risk SCR)
  - Reduces the risk margin (as per changes in the SCR above)
  - Reduces total assets due to the reinsurance fee
  - Increases free surplus.

  In terms of key financial metrics, implementing a longevity swap leads to:

- Increase in Solvency Ratio due to higher free surplus
- Increase in Basic Own Funds (OF) due to risk margin release, offset to some extent by reduction of total assets driven by the reinsurance fee
- Decrease in PVFP due to risk margin release.

Capital efficiency improves significantly (i.e. increase in IRR) in return for a small decrease in embedded value.



1	Solvency ratio	**172%**	**237%**
2	Basic OF(*)	**32%**	**34%**
3	PVFP(*)	**16%**	**11%**
4	EV = (2) + (3)	**48%**	**45%**
5	IRR	**13%**	**18%**

Notes: Annuity writer on Standard Formula, taking out 50% QS longevity swap with AA rated reinsurer on new business, i.e. no Transitional Measures. PVFP is defined as present value of the unwind of (1) Risk margin and (2) margins in the BEL (e.g. earned yield above matching adjustment). BEL = Best estimate liabilities. EV = Embedded Value. IRR = Internal Rate of Return. (*) = percentage of BEL.

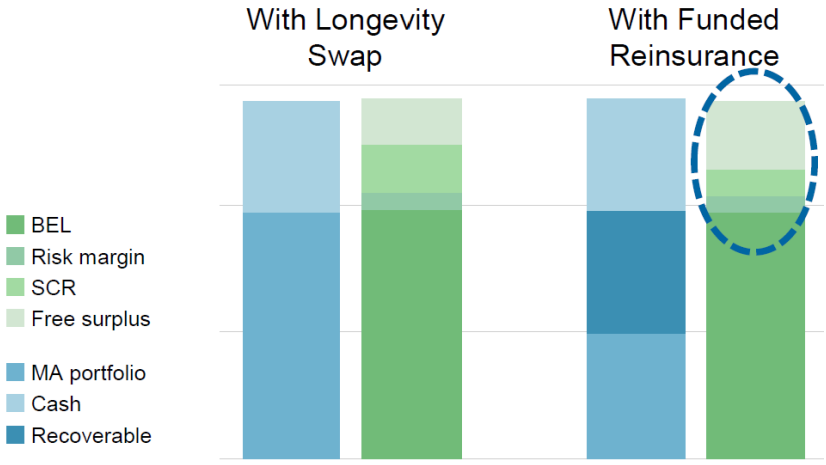
They then turned to the impact of a funded reinsurance. If insurers consider favorable the trade-off between the drop in embedded value and the increase in IRR after implementing a longevity swap, then funded reinsurance should be viewed as even more favorable. In terms of the balance sheet, implementing a longevity swap:

- Reduces the SCR (large decrease in asset SCR and small increase in counterparty risk SCR)
- Slightly increases the risk margin (due to small increase in counterparty risk SCR)
- Increases free surplus

In terms of key financial metrics, implementing funded reinsurance leads to:

- Further increase in the Solvency Ratio due to higher free surplus
- No change in Basic OF
- Further decrease in PVFP due to foregoing future unwind of margins in BEL

A full risk reinsurance solution brings further improvements in capital efficiency compared to a longevity swap.



		With Longevity Swap	With Funded Reinsurance
1	Solvency ratio	**237%**	**378%**
2	Basic OF(*)	**34%**	**34%**
3	PVFP(*)	**11%**	**9%**
4	EV = (2) + (3)	**45%**	**43%**
5	IRR	**18%**	**24%**

When it comes to funded reinsurance in the post-pandemic world, setting longevity assumptions a much trickier exercise. What is required is a significant degree of actuarial judgement and expertise in a wide range of areas, including epidemiological, political, economic factors etc:

- Progression of UK historical mortality rates. There was high improvement rates in the 2000's, followed by a slow-down in mortality trends in the 2010's, and then a discontinuity from 2020.
- The evolution of SARS-CoV-2. There has been a recent mutation (BA.2.86 or 'Pirola'), but only time will tell if this is important or a damp squib. We could be seeing the evolution of SARS-CoV-2 to an endemic state:
    - Expecting volatility in covid deaths along the way
    - Broad consensus on an endemic state

        - Precise nature of the future state remains uncertain
        - Range of outcomes: a common cold, a flu, a severe flu with pneumonia.
    - The UK National Health Service (NHS) faces challenges in controlling non-Covid excess deaths. The growth in health spending has stagnated when adjusted for changes in population. The planned increase in spending in 2024-25 is not sufficient to make up for lost ground since 2009. It is unclear how future increases will be funded, since the economy is still recovering from the pandemic, there has been high inflation, and some tax increases have been reversed (National Insurance).
    - There is political uncertainty about future government policy on health-care. A future Labour government, for example, has promised to: expand the workforce, double the number of medical school places to 15,000 a year, double district nurses qualifying each year, and train 5000 new health visitors.

Patrick and Jamie concluded by saying that funded reinsurance is one of the key tools in supporting the overall strength and security of the PRT market. The focus needs to be on continuing to collaborate to develop robust and bespoke solutions for the market.

- Cord-Roland Rinke (Hannover Re**)** spoke on 'Live and let marry: The importance of spousal assumptions'. Spousal benefits can have a significant effect on DB liabilities and it is important to estimate these as accurately as possible.

  The first question to ask is 'who can be eligible for spouse benefits – the named spouse or any spouse?'. In a DB pension context, the 'any spouse' definition is predominant. Benefits will be paid to the spouse legally married or in a civil partnership with the scheme member as at the date of death. Assumptions on the proportion married and the age difference (age of spouse) need to be made.

  Accuracy matters. There is a present value impact. For example, a 10% increase in the proportion married can increase the PV of liabilities by 0.9%–1.6%. Similarly, if the age difference of the female spouse is higher by 1 year, this can increase the PV of liabilities by 0.4%–1.4%. Underpricing impacts profitability, while over-pricing impacts competitiveness. Risks also matter, such as anti-selection and the impact of changes in portfolio composition over time.

  There are a number of data sources available on the proportion married and age difference, so there is a need to balance availability, accuracy, relevance and costs:

	Pros	Cons
Population data	Good history over time, biggest data pool	General data, not considering scheme specifics
Electronic tracing data	Fast and reliable	Requires assumptions around categories and accuracy
Experience data	Relevant experience of the scheme	Potential bias – not the lives being priced
Write-out/Survey data	Most accurate way to assess current spouse information	Response bias, time, costs

Available population data indicates that the proportion married reduces as the spouse's mortality increases. However, population data can vary over time. The proportion married also changes over time: there is a declining proportion married rates at younger ages and an increasing proportion of married rates at higher ages. Electronic tracing data is reasonably reliable for married or civil partnerships, but less so for other cohabiting categories, such as living as married, same sex cohabitee, with family, or multi-household. Write-out or survey data tends to be more accurate than other sources, but there is a non-respondent bias which needs to be corrected, since P(married | respondent) > P(married | non-respondent).

The next task is to set the proportion married and age difference assumptions. Portfolios can give reasonable estimates given sufficient portfolio size. The proportion married depends non-linearly on socioeconomics – with a higher proportion married in more affluent areas, according to post-code. The proportion married also increases with wealth (pension amount). There are very broad age differences across age groups, so computations based on representative agents or other standard approaches will not work.

The key takeaways are:

- Richer people are more likely to be married (70% vs 45%), but tend not to have younger spouses
- Pensioners in better neighbourhoods are more likely to have a spouse: there was a 10% to 15% point differential in subset of a selected DB pension portfolio in Hannover Re's data set
- Dependants age more slowly than pensioners: older people die with younger spouses
- Non-responders in a survey are less likely to be married than average: 42% vs 81% in a typical portfolio.

Cord-Roland summarised as follows:

- Accuracy of marital assumptions are increasingly important: underestimating negatively impacts profitability, while overestimating negatively impacts competitiveness
- Different sources for marital information are available to be used for any spouse benefits: the selection of data source involves a trade-off between availability, accuracy, relevance and costs
- The key risk factors are age, gender, socio-economics and wealth: socio-economics and wealth are important for the proportion married, but not for age difference.
- There are two modelling approaches: using the proportion married and the age difference at death, and using the proportion married and age difference at inception.

- Paul Kitson and Chris Anderson (Ernst & Young) gave a presentation entitled 'How might the changing attitudes to buy-out and buy-in in the UK change the shape of the longevity reinsurance market'. Two innovations were discussed. The first was the superfund model, such as Clara, where longevity protection over a 5-7 year period before buy-out might be considered. The second was the collective defined contribution model, such as the new Royal Mail CDC scheme, where the concept of collective pooling meant that longevity risk was shared, but there might be a role for some form of extreme risk cover.

- Plenary Session 4: Pension de-risking sets new records, while alternative capital finds its stride

  - Rohit Mathur (Prudential Financial) gave a presentation entitled 'Riding the swell: De-risking accelerates as the pension endgame comes into view'. Rohit pointed out that since 2007, there have been more than $800bn in pension risk transfer transactions in the UK, US, and Canada alone. Companies choose to de-risk their pension plans for a number of reasons: decrease or eliminate future contributions, redirect cash flow to R&D or M&A, increase focus on restructuring initiatives, improve investor returns compared to pension-heavy peers, or secure the pensions and financial wellness of employees or retirees.

    The UK market is entering a new paradigm, with an alignment of conditions which is driving the market into uncharted territory: the average funded status is 107.4%, although 66% of funds are holding illiquid assets; there are near-record market volumes of £40bn-50bn annually; there have been more than 10 transactions over £1bn; there are 14 insurers and 15 reinsurers in the market to support growth; regulatory changes in terms of revisions to Solvency II in the form of Solvency UK; and pandemic impacts on longevity and demands on the NHS. The implication of this is that although pricing is currently competitive, the market is running at near capacity. So insurers may refine deal criteria and

reinsurers may also become more selective. Pension schemes need to be well-prepared and smaller deals may fight for attention.

Certain factors are aligning: funded status is currently high, but not immune to volatility, while discount rates are the primary driver of the elevated funded status. Until discount rates fall significantly, pricing remains attractive. Transaction volumes are also high, and insurer capacity remains ample – for now. There is therefore the potential for rapid growth in the near-term. Projections forecast record-setting volumes in the next few years: 40% of pensions schemes plan to fully insure in the next five years, and 75% have a buy-out as their long-term target.

However, illiquid assets pose a challenge. As more plans move to terminate, how to handle illiquids can be a thorny question. There are a number of possible exit strategies: primary redemption, secondary market sale, run-off, transfer to sponsor, pass to a related scheme, and pass to insurer. In terms of the latter, there are a number of strategic options: deferred premium, third-party financing, corporate loan, and split or delay the transaction.

The market may face future capacity constraints. Insurers may help by raising capital themselves. However, while seeking new investors can help alleviate capital constraints, it will not necessarily help with asset and human resources capacity. However, reinsurance could ease these constraints. Reinsurance arrangements can offload longevity risk – and asset risk in the case of funded reinsurance – while also adding human capital in the form of reinsurer teams. In short, reinsurers can provide asset capacity, capital capacity and human resource capacity.

In terms of the US market, buy-in and buy-out market volume was the highest ever in 2022. The market remained strong in 2023, and continued growth is expected in 2024. Market pricing remains attractive. Schemes that are well-prepared can take advantage of market opportunities.

In the Netherlands, the shift from a DB to a DC-like framework has had companies considering what to do about their legacy pension obligations. The new law took effect on 1 July 2023. Many DB schemes are planning to enter run-off from 2025, with the transition completed by 2028. Further risk transfer opportunities are likely to arise after that.

- Kirsty Maclean (Willkie) presented on the 'UK regulatory environment - helping or hindering pension risk transfer'. She began by discussing the new UK solvency regime for insurers, Solvency UK.

First, the risk margin. The detailed changes to this are contained in the Insurance and Reinsurance Undertakings (Prudential Requirements) Regulations 2023. The risk margin was previously calculated using a cost of capital of 6%. This was criticised for being too sensitive to movements in interest rates. The new regulations reduce the capital rate from 6% to 4%. There is a new risk tapering factor. The changes will reduce the risk margin by 65% for long-term life insurers.

Second, the matching adjustment. The detailed changes to this are contained in the Insurance and Reinsurance Undertakings (Prudential Requirements) (No. 2) Regulations 2023. The PRA view was that it was not properly calibrated and was too high – insurers were benefitting from too much capital relief. The new regulations maintain the requirement for fixed cashflows but include some exceptions for some non-fixed cashflows subject to certain conditions, e.g., the risks to the quality of matching are not material.

Third, the fundamental spread. Changes involve increasing the risk sensitivity with notched allowances within major credit ratings and add-ons at the option of the insurer to apply a higher fundamental spread.

Fourth are new reporting and application processes, as outlined in the FCA's Consultation Paper (CP 12/23) 'Review of Solvency II: Adapting to the UK insurance market'. These involve a package of changes intended to increase flexibility, reduce the burden of regulation, promote competition and incentivize market entry:

- Easing the burden of reporting and administrating requirements by simplifying and reducing the frequency of certain reporting requirements
- Simplification and process improvements to the calculation of the transitional measure on technical provisions
- New, streamlined set of rules for internal models (reducing prescriptive requirements and introducing more supervisory judgement and principles-based requirements)
- Greater flexibility in the calculation of group solvency requirements
- The removal of certain requirements for branches and international insurers operating in the UK (to increase the attractiveness of the UK sector to inward investment)
- A new mobilization regime to facilitate entry and expansion for new insurers and facilitate competition
- Increase to the size thresholds at which small insurers are required to enter the Solvency II regime, so more small insurers fall outside the regime.

The PRA is also conducting a thematic review of funded reinsurance and asset-intensive reinsurance, whereby longevity risk and market risk is transferred from insurers to reinsurers. A large upfront premium is payable to the reinsurer (similar to a buy-in), while the insurer benefits from security. The PRA is concerned about credit-focussed new entrants and about 'same way' and recapture risks. Are firms entering into funded reinsurance transactions that they would not have entered into but for the surge in BPA demand? In particular, the PRA is looking at: the level of exposure; the suitability of the assets in the collateral pool and how well assets responds to market stress; and other transaction risks, e.g. counterparty risk, and how these are mitigated through contractual features.

TPR has recently issued new guidance on DB superfund consolidators. This is aimed at making it easier for schemes to transfer into a superfund, for example:

- Clarifying guidance on the assessment process and clarifying when it is the right time for a fund to consider transferring
- Extending the gateway period during which the ceding trustee is to assess whether a buy-out is affordable
- Updated position on profit extraction from the fund
- Changing funding expectations by amending the discount rate from gilts+0.5% to gilts+0.75% (but maintaining a fixed rate subject to future review, rather than a dynamic rate).

The DWP has also issued a consultation on DB superfund consolidators. It calls for evidence on how to increase investment by DB schemes into 'productive finance'. This follows the UK government's Mansion House Reforms – a package of measures that includes the creation of a permanent superfund regulatory regime. Proposals include consolidation models, including a 'public sector consolidator' in particular considering whether the Pension Protection Fund could fulfil this function.

The government is also concerned about insurers in financial distress and has made changes to the Financial Services and Markets Act (FSMA), in particular changes to insurer insolvency arrangements (Schedule 12 and 13 of FSMA 2023). The drivers for this were: protection of policyholders; continuity of coverage (avoiding actual insolvency) by allowing earlier intervention by regulatory authorities; and maintaining public confidence in the UK's insurance sector. There will also be an impact on counterparties to UK insurance companies in financial difficulty (i.e., reinsurers). The new rules: clarify and expand the existing statutory powers in s377 of FSMA to write-down an insurer's liabilities; ban counterparties exercising termination and other rights against the insurer (*ipso-facto* clauses); and put a stay on surrender options available to policyholder of a life insurance policies.

There will also be a new Insurer Resolution Regime (IRR) for insurers in financial distress. This will broadly follow the resolution regime for banks. There will be four new 'stabilisation options': transfer to a another private sector purchaser, transfer to a bridge institution, a bail-in, and temporary public ownership. There will be safeguards for creditors and counterparties. This will overlap with write-downs. The IRR likely to be used only with systemically important insurance companies. This will give comfort for pension schemes and reinsurers and increases the likelihood that arrangements will transfer to a solvent insurer.

- Amy Kessler (Prudential Financial) gave a presentation entitled 'From nascency to maturity – Rising interest rates and volatile markets show that alternative capital in the life and annuity sector may be here to stay'.

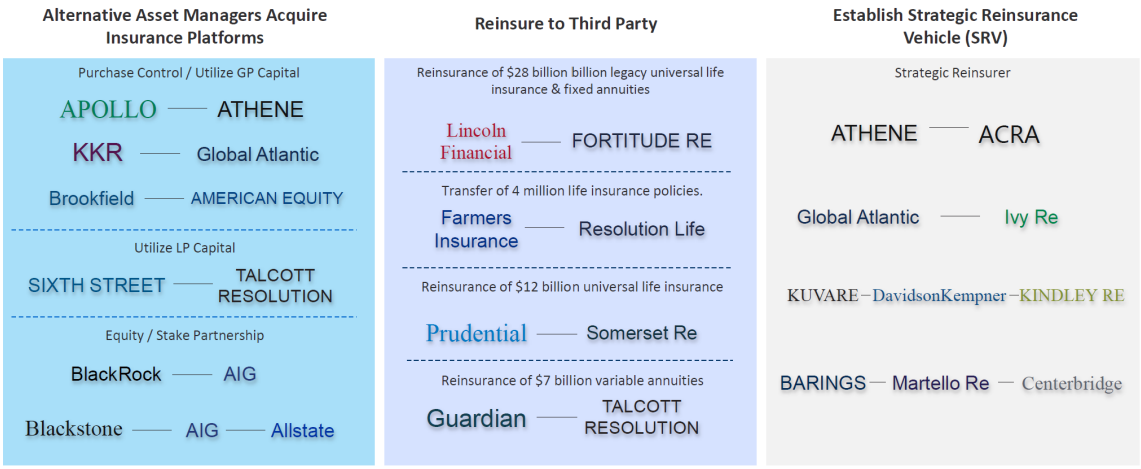
  Amy began by reviewing the role of third-party capital in the life and annuity sector. The sector emerged in 2016. Explosive growth came in 2020. Economic volatility has led to environmental shifts. Investors are a bit more selective today. Regulatory updates are bringing further evolution. An opportunity exists to broaden the investor base and advance the market further. She commented: 'A traditional traded market? No! A vibrant, traded market, nonetheless? YES!'.

  Persistent low rates drove the rise of reinsurance as an asset class. Investors found reliable return potential under 'lower for longer' market conditions. Fiscal and monetary policy stimulus during the pandemic led to high public equity valuations, low public fixed-income yields and historically tight credit spreads, suggesting low forward-looking returns. This drove increased investor demand for private markets and illiquid investments including life and annuity reinsurance which offers: reliable return potential, diversification, low correlation to mainstream public assets, access to illiquidity premia, and compelling risk-adjusted returns.

  Since the end of 2021, interest rates have risen faster than they have in 40 years. High inflation has pushed central banks worldwide to lift interest rates quickly. As a result, public equity valuations have decreased by 10% and credit spreads have returned to a more conventional baseline. Inflation remains persistent, and interest rates are unlikely to reverse course in the near future. Still, sophisticated investors see opportunity in reinsurance structures and capital continues to flow into the market. Despite headwinds, a traded market for reinsurance as an asset class appears to be durable.

  The continued alignment between asset managers and insurers is fundamental to attracting third-party capital. Asset managers have scaled their insurance

strategies, while insurers have partnered with asset managers and reinsurers to attract third-party capital and enhance their reinsurance capabilities:



Today, the market is maturing. Established players continue to grow, reaping the rewards of alignment. M&A, joint ventures, and similar arrangements drive growth for some, such as, Brookfield and BlackRock. Others find continued success writing new insurance and reinsurance business, e.g., Athene, Fortitude Re, and Talcott Resolution. These players built momentum during the rapid growth period of 2020 and 2021, when market expansion was fueled by the search equity-like alternatives to fixed income assets.

In the landscape today, newer market entrants are navigating longer roads to success. Higher rates open attractive alternatives in fixed income investing. Existing investors generally seek to avoid channel conflict and may only invest in one life and annuity vehicle. Inflation and market uncertainty have slowed some investors, while regulatory change has impacted others.

Clearing these hurdles requires a portfolio of capabilities in: insurance origination or reinsurance distribution, reinsurance capability, and asset management. The right capabilities open new possibilities. Further market growth may depend on attracting new investors to these private capital opportunities. Current participants include: sovereign wealth funds, top-tier pension funds, private equity and hedge funds, and asset managers. But there are opportunities for large pension funds with private equity capability, private endowments, family offices, and ultra-HNWIs. Bringing more investors from different investor types will be important in sustaining market growth.

A healthy cohort of reinsurers now consistently fund themselves with third-party capital: Talcott Resolution, Centerbridge, Skyridge Re, Martello Re, Athene/ACRA2, Resolution Life, Ivy Reinsurance. These reinsurers all have

these key capabilities in insurance origination or reinsurance distribution, reinsurance capability, and asset management.

Despite changing winds, Amy believes third-party capital is here to stay. In 2020, factors aligned for incredible growth. Today, activity has slowed, but not stopped. Investors are a bit more choosey and are proceeding with caution during this period of regulatory change. But new market entrants still have opportunity. And there is tremendous opportunity to expand the investor base, which today is an exclusive group of the world's largest institutions.

The academic papers that were selected by us as the editors of this Special Issue went through a refereeing process subject to the usual high standards of the European Actuarial Journal. We briefly discuss each of the five papers selected.

In 'Covid-19 mortality: the Proportionality Hypothesis', Andrew J. G. Cairns, David Blake, Amy Kessler, Marsha Kessler and Rohit Mathur introduce and provide evidence to support the Proportionality Hypothesis – which states that Covid-19 infection fatality rates are approximately proportional to all-cause death rates by age and subgroup (e.g., socio-economic class). They also show that vaccination played a very significant role in preventing people infected with Covid-19 from needing to be hospitalized, since it reduced the average severity of an infection. Death rates involving Covid-19 were very significantly lower for people in the fully vaccinated group compared to the unvaccinated group. During the pandemic, death rates from other causes were in some cases reduced (e.g., flu and pneumonia), in some cases unchanged (e.g., lung cancer) and in some cases elevated (e.g., heart disease). We discuss the implications of our findings both for potential adjustments to extrapolative mortality models which allow for future pandemics in a way that is consistent with the Proportionality Hypothesis and for insurance companies in terms of both modelling extreme scenarios and the design of mortality catastrophe bonds.

In 'Decomposing changes in life annuities', Cinzia Di Palo proposes a novel approach for assessing changes in the expected present value of life annuities by adapting decomposition techniques traditionally applied in demographic research. Building upon Vaupel and Canudas–Romo's method, a closed-form relationship is derived within the continuous framework to express changes in the expected present value of life annuities. By employing commutation functions, the concept of financially adjusted life-table entropy is introduced to capture the interplay between mortality and interest rate changes, offering a new and comprehensive measure for evaluating annuity price sensitivity. The approach is illustrated through a numerical application using life tables from Italy and the United Kingdom.

In 'An iterative least-squares Monte Carlo approach for the simulation of cohort-based biometric indices', Anna Rita Bacinello, Pietro Millossovich and Fabio tackle the problem of approximating the distribution of future biometric indices under a cohort-based perspective. Unlike period-based evaluations, cohort-based schemes require the computation of conditional expectations for which explicit solutions often do not exist. To

overcome this issue, we suggest the application of a well-established methodology, i.e., the Least-Squares Monte Carlo approach. The idea is to approximate conditional expectations by combining simulations and regression techniques, thus avoiding a straightforward but computationally demanding nested simulations method. To show the extreme flexibility and generality of the proposal, we provide extensive numerical results concerning two main longevity indices, life expectancy and lifespan disparity, obtained by adopting both single- and multi-population mortality models. Comparisons between period- and cohort-based results are made as well. Finally, the paper shows that the proposed methodology can be used to approximate other biometric indices at future dates for which cohort-based estimations are often replaced by period ones for computational simplicity.

In 'Individual health indices via register-based health records and machine learning', Nikolaj Udengaard Hansen, Yunus Emre Ergemen and Malene Kallestrup-Lamb argue that quantifying individual latent health has potential value in healthcare policy. Their paper constructs an individual-level health index using detailed population-wide registers for individuals at advanced ages. In the methodology, the authors use traditional and machine learning techniques. They provide importance rankings of health variables and evaluate their ability to form an accurate stratification of health states. The high dimensionality of the data allows the authors to derive a small subset of health measures that enables similar analysis in settings where individual health registers may not be available. Finally, the authors use the indices to forecast individual-level mortality.

Finally, in 'Fast estimation of the Renshaw-Haberman model and its variants', Yiping Guo and Johnny Siu-Hang Li argue that in mortality modelling, cohort effects are often taken into consideration as they add insights about variations in mortality across different generations. Statistically speaking, models such as the Renshaw-Haberman model may provide a better fit to historical data compared to their counterparts that incorporate no cohort effects. However, when such models are estimated using an iterative maximum likelihood method in which parameters are updated one at a time, convergence is typically slow and may not even be reached within a reasonably established maximum number of iterations. Among others, the slow convergence problem hinders the study of parameter uncertainty through bootstrapping methods. In this paper, the authors propose an intuitive estimation method that minimizes the sum of squared errors between actual and fitted log central death rates. The complications arising from the incorporation of cohort effects are overcome by formulating part of the optimization as a principal component analysis with missing values. Using mortality data from various populations, we demonstrate that our proposed method produces satisfactory estimation results and is significantly more efficient compared to the traditional likelihood-based approach.

Longevity 19 took place in Amsterdam on 16–17 September 2024; *Insurance: Mathematics & Economics* will publish a special issue. *Longevity 20* will take place in Singapore on 8–9 September 2025; the *Journal of Risk & Insurance* will publish a special issue. *Longevity 21* is planned for Rome in 2026.

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