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Longevity Risk and Capital Markets

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As populations in countries around the world age, governments, corporations, and individuals face increasing longevity risk. Pay-as-you-go state pensions and corporate pension plans are putting severe financial pressures on governments and companies; IBM and Verizon are just two of many recent corporate examples in the United States; British Airways and the Co-op are two current examples in the United Kingdom. Fertility rates have also fallen in many countries around the world and this, in conjunction with increased longevity, has caused the inversion of some countries' age distributions and so increased the severity of the longevity risk problem for pay-as-you-go government pension plans by both reducing the tax base and extending the payout period. Mortality improvements at older ages have also increased the severity and make it ever more likely that individuals with inadequate pension arrangements will require other tools to manage their longevity risk.

Longevity risk exists at an individual and aggregate level. For the individual, it is the risk of outliving one's accumulated wealth. In the aggregate, it is the risk that the average member of a birth cohort will live longer than expected. Tools have long existed for the management of individual longevity risk; some of the modern means include social security systems provided by governments, defined benefit plans provided by corporations through pension funds, and life annuities[1] provided to individuals by insurers.[2] The Law of Large Numbers would suffice to make longevity risk manageable for pension funds and insurers in the absence of the aggregate longevity risk

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[1] The life annuity is an instrument that provides a known cash flow for an individual until death. It differs from a fixed annuity because its maturity is stochastic.

[2] Other instruments contain embedded options that also provide the individual with protection against longevity risk. Some variable annuity contracts include guarantee minimum income benefits (GMIB) that allow the policyholder to annuitize a guaranteed amount at the contract maturity but with annuitization rates specified at the inception of the variable annuity contract. Hence, the GMIB is an option on a life annuity and so exposes the insurer to added aggregate longevity risk. See Bauer, Kling, and Russ (2006).

problem. The aggregate form of the problem, however, has made the provision of risk management tools for individuals an increasingly difficult task.

Capital markets do provide governments, corporations, and individuals with a means of transferring risks and resources across time as well as spreading risks across individuals. Similarly, individuals can transfer income forward via security purchases to fund their retirement years. Existing instruments, however, do not allow agencies or corporations to effectively hedge the aggregate longevity risk that they face.

The Second International Longevity Risk and Capital Market Solutions conference was held in Chicago on April 26, 2006.[3] It was convened to consider the scope of the aggregate longevity risk problem and the possible capital market solutions. The following were some of the questions considered: How significant and how large is the aggregate longevity risk problem and who currently holds that risk? How might that risk develop and what are the prospects for the allocation and pricing of that risk? Who should bear longevity risk? Alternatively, who should issue a capital market instrument to hedge longevity risk? Government? Individuals? Corporations? Is longevity a mathematically tractable risk or is it an inherent uncertainty?[4] If the former, then what methodological development is necessary to generate a single coherent forecasting model? What financial engineering is necessary at the individual and aggregate risk levels? If mortality-based instruments are financially engineered by corporations then how can they be priced in an incomplete market setting? A premium will have to be paid for some market participants to bear the longevity risk. How do we determine that risk premium in the incomplete market setting?

Given the continued demise of defined benefit company plans and the probable cuts in social security benefits, individuals in the future will face increasing personal exposure to longevity risk. They could respond to this by increasing their demand for life annuities and similar hedging instruments. In the absence of robust and sustainable capital market solutions to the aggregate longevity risk problem, however, the capacity of life annuity markets is likely to remain severely limited and, as a consequence, individuals will be forced to bear the longevity risk themselves. They are likely to respond to that increased risk by cutting consumption. Workers might well respond by increasing savings, but the retired might not dissave as much as one would normally expect. The net effect on savings is unclear but is unlikely to be similar to the drop in savings in the mid 1970s when the baby boomers pushed the ratio of worker cohorts to other cohorts to its minimum.[5] In the mid 1970s, young adults who are net borrowers and the retired who are dissavers dominated the economy, savings declined and interest rates rose. We might well see another local minimum for the ratio of worker cohorts to other cohorts, but the boomers entering retirement will be the dominant group in the other cohorts category, but will not have the same incentives due to the

[3] The First International Longevity Risk and Capital Market Solutions Conference was held at Cass Business School, London, on February 18, 2005.

[4] This is uncertainty as viewed by Frank Knight, i.e., risk is randomness with known probabilities while uncertainty is randomness with unknown probabilities. See Knight (1921). Also see http://cepa.newschool.edu/het/profiles/knight.htm.

[5] The worker cohorts are composed of those between 35 and 64 while the other cohorts include those under 24 and over 65. See Bond (2004).

growing longevity risk problem. We will therefore probably not see the same decline in savings and increase in interest rates. Rather we might see moderately growing savings, falling interest rates, and falling rates of consumption. While moderately falling interest rates might be a positive sign, the falling consumption would not prompt increased investment due to lower interest rates. Furthermore, the increase in aggregate longevity risk is likely to reduce risk taking: aging populations will demand less volatile income streams from their investment programs.

While there is considerable uncertainty about the consequences of inaction in managing longevity risk in the United States and abroad, the scope of the risk is less difficult to gauge. Turner (2006) and Blake et al. (2006) provided some observations on the scope of the longevity risk in the United Kingdom. Turner (2006) provided 2005 estimates of longevity risk in pension provision in the United Kingdom. Including insurer annuities, pension funds, unfunded public employee pensions and state pensions, he estimated liabilities at £2.46 trillion; of this, £1.13 trillion represented the government liability for state pensions. Since the government liability is a political promise, it could be changed but only with increasing difficulty as the median age of the population increases. The remaining £1.33 trillion, or with the 2006 revision, £1.38 trillion represent legally contracted liabilities. The longevity risk covered by insurers as annuity providers is only about 3 percent of the total. As the pay-as-you-go state retirement benefits become less generous and defined benefit plans are converted to defined contribution plans by employers, the longevity risk covered by insurers, reinsurers, and longevity security issuers must rise. The scope of the longevity risk, i.e., monetary amounts in the trillions in the United Kingdom and elsewhere, strongly suggests that much of that risk will be shifted, at an appropriate price for the risk bearing, to the capital market.

Another question addressed was: Who should bear the longevity risk? This question was addressed by two of the symposium speakers, Brown and Orszag (2006) and Turner (2006). Previously, Blake and Burrows (2001) raised the notion of survivor bonds and proposed that a government is best suited to issue the bonds given the size of the risk. The survivor bond is an annuity bond with a stochastic maturity and decreasing coupon payments linked to the realized mortality experience of a selected birth cohort. The bond could, for example, be issued for a 65-year-old cohort of men or women from the national population and pay a coupon proportional to the number of survivors each year and continue paying until the last survivor dies. A bond structured in this way would provide an instrument that insurers could use to hedge the aggregate longevity risk in their annuity books of business. Subsequent comments by Dowd (2003) and Blake (2003) were concerned with whether the financial instrument should be issued by government or by private enterprise and so bear on the question here. Dowd noted some of the classic justifications for government intervention, i.e., public goods, externalities, market failures, intergenerational issues, etc., could apply but argued that all are open to debate. Brown and Orszag have focused on adverse selection as a possible justification for government intervention. They analyze adverse selection because at its worst this asymmetric information problem can cause the market mechanism to break down. They review the adverse selection cost estimates that exist in the literature and observe that the costs are not sufficiently large to suggest market failure. Indeed they observe that the government need do no more than make life annuitization mandatory to eliminate the adverse selection problem

so the fix would be simple. Of course, they also appropriately observe that forcing annuitization would run counter to the progressive redistribution objectives of the government since lower-income individuals would have to annuitize, but income levels tend to be negatively correlated with longevity and so the low-income households would be partially subsidizing high-income households. Hence this government intervention is not without a social cost.

Dowd also critiques the notion that government should bear the longevity risk because the Blake and Burrows argument appealed to the Arrow-Lind Theorem. That theorem shows that the risk premium on a financial instrument issued by the government would be essentially zero because the risk would be dispersed across a sufficiently large population to make it so. Hence, if the analogy holds, the survivor bond would have a zero risk premium if issued by the government. Dowd counters that longevity risk is not diversifiable in this way and so a positive risk premium remains. Brown and Orszag gave an even more cogent argument by identifying nonsystematic and systematic components of longevity risk. The nonsystematic or equivalently idiosyncratic component can be diversified but the systematic or equivalently aggregate component cannot be. Hence the aggregate risk component would have to be borne and so priced.[6] Brown and Orszag emphasize the size of the risk premium associated with the aggregate risk; they note the size of the risk premium calculated in the literature and provide their own estimate. It is interesting to note that Dowd argued against the government bearing longevity risk because it would have to bear the risk premium while Brown and Orszag argue that government should not bear the risk because the risk premium would not be large enough to cause market failure and so motivate government action.

The remaining insights in addressing the question of who should bear longevity risk concern intergenerational issues. Governments have the unique ability to allocate risk across generations; financial markets can allocate risk across risk bearers and across time but not across born and unborn generations. An unexpected increase in longevity would have the greatest impact on the most elderly and that impact would decline with age; the next generations born would have the flexibility to fully adjust to the changed expectation about longevity throughout their lifecycle. Hence, as Brown and Orszag note, there is some potential for an improvement in social welfare if government spreads the aggregate risk across not only current generations but also future generations. Some difficulties arise by observing that if government issues the longevity instruments, such as survivor bonds, then the value of the survivor bonds increase at the same time that the government's other annuitized liabilities, e.g., social security, increase. Other concerns would include the political incentive to misallocate the longevity risk across generations. As the median age increases, there will be additional pressure to respond to the desires of the extant generations and so the potential for misallocation is growing. Turner (2006) made some arguments similar to Brown and Orszag with respect to the greater ability of younger generations to absorb and otherwise manage longevity risk; indeed he notes that the human capital of the younger generations provides them with a comparative advantage in managing longevity risk unlike the senior generations that have expended their human capital.

[6] Also see Milevsky, Promislow, and Young (2006). In a simple setting these authors demonstrate that a risk premium remains no matter how large the portfolio.

The weight of the political economy arguments in Brown and Orszag suggest that governments already long in longevity risk should not add to it by bearing more through the issue of survivor bonds. Turner also accepts governments' long position in longevity risk but takes a somewhat different view on the question of how it is allocated. Given the uncertainty in the long-term predictions of longevity, Turner sees a role for a longevity instrument issued by government to cover the uncertainty about mortality rates for the later retirement years, e.g., over 90, but only if government sheds preretirement longevity risk through reform of those programs, e.g., by indexing state pension age in line with increasing life expectancy. Hence, he provides arguments, not for increasing an already long government position in longevity risk, but rather a reallocation of that risk to those best suited to bear it.

The conclusions about who should bear longevity risk and whether a mortality-linked financial instrument should be issued to facilitate hedging that risk may well depend on whether longevity risk is viewed, at least in part, as a risk or an uncertainty. Both views were noted at the symposium and so yielded the following questions: Is longevity a mathematically tractable risk or is it an inherent uncertainty? If the former, then what methodological development is necessary to generate a single coherent forecasting model? While not directly addressing the first question, Stallard (2006) does in what he says suggest that longevity risk is quantifiable and so a risk rather than an uncertainty. Stallard notes that the necessary demographic data and mortality models exist but further methodological development is necessary to provide more precision in forecasting means and variances of the cohort survival functions.

Brown and Orszag (2006) commented on the life annuities and the market for them. We have known since Yaari (1965) that life annuities can increase expected utility, and more recently Davidoff, Brown, and Diamond (2005) have shown a stronger dominance result without the assumptions necessary in Yaari (1965). We know, however, that the life annuity market is quite small and that is a paradox which begs an answer. The next question considered at the symposium, while not a direct consideration of the paradox, does provide some insight: What financial engineering is necessary at the individual and aggregate longevity risk levels? Boardman (2006) provided some answers on the consumers' side of the life annuity market while Blake et al. (2006) provided some answers on the insurers' side. Boardman calculates the mortality cross-subsidy or equivalently the additional return that individuals annuitizing and surviving another year might obtain for a fixed investment and shows that this cross-subsidy grows exponentially, e.g., an annuity purchased at the age of 80 yields a cross subsidy 50 times that obtained with the same investment at the age of 60; the comparison is 150 times when annuitizing at 90 rather than 60. Hence, there is a sufficient excess return to allow the construction of an annuity with a money-back guarantee; such a structure provides an investment vehicle that avoids the consumer's fear of losing most of the capital investment if death occurs shortly after making the investment. This is an example of financial engineering that takes an important behavioral consideration into account which may, in turn, be driven by a bequest motivation that is missing from most expected utility models.[7] Next, Blake et al. (2006) considered financial engineering schemes that would provide insurers with capital market instruments

[7] See Davidoff, Brown, and Diamond (2005). These authors suggested that the lack of annuity demand could be due to behavioral considerations.

to hedge that portion of longevity risk that is not diversifiable. The nondiversifiable longevity risk must be reflected in a risk premium in the life annuities or it might be borne and priced in other capital market instruments; the advantage of the latter is that the population of risk bearers is potentially larger and more liquid for the other capital market instruments. If some capital market participants have a comparative advantage in bearing longevity risk, then the life annuity price will decrease. Alternatively, insurers may use the hedging instrument to reduce insolvency risk and make the life annuity with the same price more attractive to the consumer.

If mortality-linked instruments are financially engineered by corporations, then how can they be priced in an incomplete market setting? A premium will have to be paid for some market participants to bear the longevity risk. How do we determine that risk premium in the incomplete market setting? In a stylized setting, Milevsky, Promislow, and Young (2006) show that when the mortality distribution is unknown then the Law of Large Numbers does not suffice to show that the risk per policy goes to zero. Given the systematic or equivalently nondiversifiable risk, they use the Sharpe Ratio to develop a premium pricing method given aggregate mortality risk. In an incomplete market setting, Cox, Lin, and Wang (2006) use a normalized exponential tilting model to price brevity risk such as the December 2003 Swiss Re mortality linked security. Also, in an incomplete market setting, Cairns, Blake, and Dowd (2006) use a two factor model of stochastic mortality to price longevity risk such as the November 2004 European Investment Bank/BNP Paribas/Partner Re longevity bond.

The articles that follow explore the questions noted here. There was no consensus reached on key questions such as whether longevity is risk or uncertainty or on whether government should play a role in bearing longevity risk or facilitating the market for hedging that risk. Indeed it is too early in this vein of the literature to expect consensus. The articles do, however, frame some of the issues and provide guidance for progress in this literature. We hope you find them as thought provoking as we have.

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