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The Dynamics of the Gender Gap at Retirement in Italy: Evidence from SHARE

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The Dynamics of the Gender Gap at Retirement in Italy: Evidence from SHARE

Antonio Abatemarco* Maria Russolillo†

Abstract

We investigate the dynamics of the gender gap at retirement in Italy – by cohort and by year of retirement – for individuals retiring from 1980 to 2027 using data from SHARELIFE (Wave 7). Most importantly, we disentangle the opposite effects on the gender gap originating respectively from (i) improving labor market conditions for women from the sixties, and (ii) increasing actuarial fairness of the pension plan due to the progressive transition from a defined-benefit to a notional defined-contribution scheme. To capture the impact of these two driving forces, we implement a counterfactual analysis by which the gender gap at retirement – in terms of gender gap in pension (GGP) and between-group Generalized Entropy (GE) – is measured both in the actual and in the virtual distribution of pension benefits, with the latter being obtained under the hypothesis of an actuarially fair pension scheme. We observe a U-shaped pattern since the actual gender gap at retirement is found to be decreasing up to 2020 but increasing after this date. Specifically, the increasing pattern for the gender gap at retirement after 2020 is shown to be driven by (i) decreasing redistributive impact of the pension scheme, and (ii) women's penalization in the pro-rata mechanism due to lower contributions paid in the early working life.

Keywords: *gender gap, pension, redistribution, actuarial fairness*
JEL: *H55, J16, J26*

1 Introduction

Gender inequality at retirement is known to originate from the gender gap in the labor market – when pension savings are accumulated – and to be affected by the design of the pension scheme, by which the first pension benefit at retirement is determined. Both these determinants have sensibly changed in the last decades in Italy. On the one hand, labor market conditions of women have sensibly

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improved over time from the sixties to the early twenties at least. On the other hand, starting from the nineties, several pension reforms have been adopted in the attempt to keep pension expenditures under control. Most importantly, reforms in Italy have mostly reduced the generosity of the old pension system through the transition from a Defined-Benefit (DB) and *redistributive* pension scheme to a Defined-Contribution (DC) and *actuarially fair* scheme[1]. While the improvement of labor market conditions is expected to have sensibly reduced the gender gap at retirement, as far as women are penalized, on average, due to both career discontinuities and lower earnings, the transition from a redistributive to an actuarially fair scheme may clearly reduce, or even offset, the effect of bettering labor market conditions for women.

In this paper, we investigate the dynamics of gender inequality at retirement – by cohort and by year of retirement – from 1980 to 2027 in Italy, with particular emphasis on its determinants. We use SHARELIFE data (wave 7) on the real working life of individuals aged 50 years old at least in 2016. Cohorts from 1940 to 1970 – retiring from 1980 to 2027 – are considered to investigate the impact of the transition from the DB to the DC scheme. The time span of the analysis has been defined in such a way as to capture both driving forces which may have influenced the dynamics of gender inequality at retirement in recent times.

Our analysis is mostly but not entirely retrospective. We consider both the population of retirees from 1980 to 2016, as well as the population of still-in-job individuals in the 2016 (last chronological year in wave 7), who are expected to meet eligibility requirements for an old-age or a seniority pension within 2027. As for the prospective analysis, mortality rates used in the benefit formula – known as Transformation Coefficients in the Italian pension system – for workers retiring from the 2020 onward are projected according to the Lee-Carter model (Lee and Carter 1992) with data provided by the Human Mortality Database (HMD).

We wish to contribute to the existing literature by estimating the dynamics of gender inequality at retirement in Italy while emphasizing, from real data, the impact of both improving labor market conditions for women and progressive transition to a DC pension scheme. In this sense, we highlight how these two driving forces have been interacting to each other in a retrospective perspective, and how this interaction is expected to affect the future evolution of the gender gap at retirement.

With this purpose in mind, once the entire contribution career is reconstructed from real data, we adopt a counterfactual analysis by which the *actual* distribution of (yearly) pension benefits – for each cohort and year of retirement – is compared to the corresponding *virtual* distribution obtained under the hypothesis of a fully DC and actuarially fair scheme. Remarkably, in order to emphasize the effect of the changing scheme of pension, we focus on the *insurance mechanism* characterizing pension systems, i.e., the sole population of individuals satisfying eligibility requirements for an old-age or seniority pension (or blended criteria) are considered. Differently, first-tier pensions (e.g., basic, minimum and means-tested old-age social assistance payment) are excluded from our analysis, since these belongs to the sphere of *social assistance* whose objectives and rules go well beyond the definition of a pension annuity from a

[1] An actuarially fair scheme guarantees that, for each individual, the discounted amount of contributions paid during the working career is equal to the discounted amount of expected benefits received during retirement. For major details see Belloni and Maccheroni (2013).

contribution career.[2]

The counterfactual analysis we implement allows to disentangle the impact on gender inequality at retirement of both the Gender Pay Gap in the labor market (GPG) and the transition from the DB to the DC scheme in Italy. Specifically, we find a U-shaped dynamics of the Gender Gap in Pension (GGP) across cohorts, where the first and descendant part of the U-shape is characterized by both (i) improving labor market conditions for women and (ii) rich-to-poor redistribution due to the overwhelming application of the DB scheme. In the subsequent and ascendant part, we find that, even if the absolute gender gap in terms of mean pension benefits is almost unchanged[3], the same gap is increasing in relative terms (i.e. percentage points) because of the sensible reduction of mean pension benefits originating from the progressive application of the less generous DC scheme.

Unexpectedly, for workers retiring after 2020 with an old-age or seniority pension, we find that the gender gap at retirement is slightly higher than what would have been if a perfectly actuarially fair DC scheme were applied. Basically, since the DB and the DC scheme apply pro-rata during the transition to a fully DC system, women are found to be additionally penalized relative to males by (i) higher starting working age, and (ii) career discontinuities in the early working life, which reduce for women (more than for men in the same cohort retiring in the same year) the number of years of contribution falling in the more generous DB scheme.

Even if the GGP is a standard metric for the measurement of the gender gap at retirement, we also apply the decomposition of Generalized Entropy (GE) inequality indexes in terms of between-group (or, between-gender) and within-group (or, within-gender) inequality.[4] This approach, indeed, provides additional information on the dynamics of within-gender and overall inequality at retirement, which allows for a better understanding of the determinants of the observed dynamics of the gender gap at retirement. Most importantly, it allows to measure how the redistributive impact of the DB scheme, independently from gender differences, has changed across cohorts and years of retirement.

The results of the GE decomposition confirm both the U-shaped dynamics of the (relative) gender gap at retirement, and the penalization of women due to higher starting working age and career discontinuities in the early working life. In addition, the GE decomposition reveals that the share of overall inequalities originating from gender disparities is sensibly increasing after 2020 for retirees with an old-age or seniority pension.

The paper is organized as follows. In section 2, we discuss major pension reforms occurred in Italy from the nineties, with a special emphasis on the tran-

[2]Provided that adequate pension systems are expected to supply both insurance and assistance services (Abatemarco 2009), for some scholars, a clear separating line should be drawn between insurance and assistance tools, whereas interaction is required for some others. For major details on this debate, see Diamond (2004).

[3]The constant absolute gender gap observed in recent times is found to be the result of two driving forces offsetting each other; the advantage of a tiny improvement of women's labor market conditions after the eighties – which was definitely stronger during the sixties and the seventies – is compensated by the sensible reduction in the application of redistributive tools characterizing the old DB scheme.

[4]In this analysis, we strictly focus on the first pension benefit received after retirement. In a lifecycle perspective, instead, different indicators (net present-value ratio, internal rate of return, social security wealth) may be required in order to properly account for the dynamics of pension benefits after retirement (Belloni et al. 2020, Mazzaferro 2019).

sition from the DB to the DC pension scheme. In addition, existing evidences on the dynamics of the gender gap at retirement are reported with special emphasis on the Italian case. In section 3, we discuss the main characteristics of the SHARE database. The methodology of our analysis, as well as the results obtained from the application of the GGP analysis and of the GE inequality decomposition are illustrated. Section 4 concludes.

2 Gender Gap at Retirement in the Italian Pension System

In this section, we first discuss the main characteristics of the Italian pension system, with special attention to the reform process that has determined the ongoing transition from the old DB to the new Notional Defined Contribution (NDC) scheme.[5]

In the second part, we discuss the existing literature on the gender gap at retirement, which is based on both official reports and research papers. For our purposes, special emphasis is placed on recent papers discussing the recent and the expected evolution of the gender gap at retirement in Italy.

2.1 Pension reforms in Italy: from DB to NDC system

The Italian pension system is based on a Pay-As-You-Go (PAYGO) mechanism, where pension benefits paid to retirees are financed by pension savings (hereafter contributions) paid by the working age population. During the nineties, the Italian pension system underwent a major reform process, moving from a Defined Benefit (DB) to a Notional Defined Contribution (NDC) system, while maintaining the PAYGO financing mechanism.[6]

Up to 1992, pension benefits were calculated according to a Defined Benefit (DB) formula. The pension benefit was determined by *pensionable earnings*, defined as the average wage earned in the last years before retirement[7], the number of years of contribution at retirement, and the accrual rate of 2% for each year of contribution. Workers became eligible for retirement if they either paid at least 35 years of contributions (known as seniority pension), or they were 55/60 years old (women/male), with at least 15 years of paid contributions (known as old-age pension). In addition, an indexation mechanism to price inflation and real wages was implemented for the adjustment of the first pension benefit in the later life after retirement.

Most importantly, the DB scheme was characterized by several redistributive tools, like floors, ceilings, and redistributive accrual rates, which have been slightly amended over time starting from the eighties. *Floors* were established to raise pension benefits to a minimum amount if lower. On the other hand, *ceilings* were used to identify an upper bound for pensionable earnings to be

[5]For the purposes of our analysis, as well as for the lack of sufficient information, we do not consider small pension reforms whose impact on the population of retirees is marginal and, mostly, limited to specific work categories.

[6]For details on the Italian reform process, see Coda Moscarola and Fornero (2009), Belloni et al. (2013a), Brugiavini and Galasso (2004), Giuliani (2020).

[7]Specifically, 3 years until 1982; 5 and 10 years, respectively, for public and private sector employees after 1982.

accounted for the calculation of the first pension, even if workers were required to pay contributions for the part of earnings above this ceiling as well. The accrual rate was – and still is – *redistributive*, since the rate of return mentioned above (2%) is decreasing for higher wages according to earnings brackets updated year by year. E.g., for year 2020, the accrual rate is fixed at 2% for yearly earnings below 47,332 euros, 1.52% between 47,332 and 62,952 euros, 1.25% between 62,952 and 78,571 euros, and 1% for earnings above 78,571 euros.[8]

In 1992, the Amato Reform (Law 503/1992) modified the DB system by setting different – and more stringent – eligibility rules and by gradually increasing the number of years over which pensionable earnings are to be computed (from 5 to 10 for public sector employees). This reform also changed the indexation mechanism of the first pension by eliminating the adjustment to the dynamics of real wages, while preserving the link to price inflation. Actually, the Amato Reform represented a first attempt of reducing the tax burden of the pension system and of introducing a general discipline which, however, has been obtained with the subsequent reforms only.

The Dini reform (Law 335/1995) sensibly modified the structure of the Italian pension scheme by marking the gradual transition from a DB to a DC benefit formula. In order to allow for a progressive implementation of the DC scheme across cohorts, different eligibility rules and benefit formulas were established depending on the years of contribution achieved by each worker in 1995. Specifically, a separating line was introduced among elder, middle-aged and early workers, which is still in force nowadays.

For workers entering the labor market after 1995 (early workers), the sole NDC benefit formula applies, by which the first pension benefit is calculated from the total amount of contributions paid during the entire working life – notionally capitalized at the GDP nominal growth rate – and converted into an actuarially fair annuity through the application of an age-increasing[9] Transformation Coefficient (Daminato et al. 2020). Specifically, the conversion into a pension annuity is determined by the Expected Pension Period Duration (EPPD), i.e., by the expected number of years for which pension benefits must be paid (Coppola et al. 2020), provided that the life expectancy of both retirees and survivors is accounted for (see section A.1 in the appendix for major details). According to the current legislation, Transformation Coefficients must be updated every two years depending on demographic tables and long-term trend of GDP officially provided by the Italian National Institute of Statistics (ISTAT).

For workers with less than 18 years of contribution in 1995 (middle-aged workers), pension benefits are computed according to a pro-rata mechanism, by which the DB scheme is preserved for working years before 1995, whereas the NDC scheme applies for contributions paid afterwards. The DB quota, as for the pre-1992 system, is calculated by multiplying the pensionable earnings by the product of the number of years of contribution and the annual accrual rate. However, as far as pensionable earnings realized after 1992 are computed by averaging wages over a longer period (Riforma Amato), this is usually referred

[8]Even if the benefit formula of the Italian DB scheme is redistributive (Mazzaferro 2019), evidence of perverse redistribution has been reported in some cases (Abatemarco 2006, Borella 2004, Borella and Coda Moscarola 2006).

[9]The Transformation Coefficients vary from 57 to 71 years old according to the worker's retirement age.

to as the *modified* DB scheme.

Finally, for workers who achieved at least 18 years of contribution in 1995 (elder workers), the benefit formula is unchanged since the modified DB scheme from Amato reform applies for the entire working life. The decision to safeguard the interests of elder workers by preserving a very generous DB formula was mostly driven by political motivations.

After the Dini reform, several acts intervened to adopt more stringent rules with respect to both eligibility requirements and pensionable earnings. In 1997, to reduce once more the tax burden of the pension system, the Prodi government raised the retirement age, which was additionally increased a few years later by the Berlusconi government (Law 243/2004). A further step was taken in 2007, when the Prodi-Damiano Reform (Law 247/2007) modified the previous reform by introducing the use of quotas, i.e. age and contribution requirements for claiming pension, whose aim consisted of progressively increase the retirement age. As for the retirement age, the Sacconi reform (Law 102/2009) introduced for the first time an indexing mechanism by which the retirement age is automatically adjusted for changes in life expectancy.

In 2011, the Monti-Fornero Reform (Decree-Law 201/2011) has adopted several measures – fully applicable to labor market entrants from 1996 onward – promoting more stringent but more flexible eligibility requirements, as well as more inter-generational equity. As for the standard old-age pension, provided that (i) contributions have been paid for 20 years at least and (ii) the pension benefit is no lower than 1.5 times the old-age social assistance payment, under the new system the age of retirement has been gradually increased for men and women, until 2021, when no categories of workers are able to retire before the age of 67. Similarly, the years of contribution to be eligible for a seniority pension (early retirement) has increased gradually for men and women, until 2021, when eligibility is fixed at 41/42 (women/men) years and 10 months.[10] Moreover, in line with previous legislative actions, the Monti-Fornero reform establishes that age and seniority requirements must be both periodically adjusted according to life expectancy indexes published by ISTAT.

As for inter-generational equity, the Monti-Fornero reform also amended the modified DB scheme established by the Dini reform for workers with more than 18 years of contributions at 31 December 1995 (elder workers). To reduce the excessive generosity of the old DB pension scheme for these workers, the application of the NDC has been introduced starting from contributions accrued from 1 January 2012 onward. As such, for elder workers still in the labor force at 31 December 2011, a pro-rata mechanism applies as well, which is not to be confused with the pro-rata mechanism applied to middle-aged workers (Dini reform).

Finally, for our purposes it is worth mentioning the Decree-Law 4/2019 by which a more favourable early retirement scheme, namely "Quota 100", has been exceptionally introduced for workers retiring until 2021. Accordingly, workers are entitled to retire once the 100-year threshold is achieved by summing up 62 (or more) years old and 38 years of contribution at least.

[10] For workers achieving this threshold before 62 years old, a penalization with respect to the pre-2012 quota of the pension benefit applies.

2.2 Gender gap at retirement: existing evidence

In the existing literature, the gender gap at retirement is usually measured in terms of Gender Gap in Pensions (GGP), which is defined as the percentage by which women's average pension is lower than men's, and it is computed as one minus women's average pension income divided by men's average pension income.

In the EU-28, women's average pensions is 25% lower than the average pension for men in 2015 (OECD 2019). The gender gap stand at over 40% in Germany, Luxembourg and the Netherlands and below 10% in Denmark, Estonia and the Slovak Republic. In the United States, according to the Master Beneficiary Records of the Social Security Administration, the gender gap in terms of average monthly benefits among retirees is found to be 20% in 2019.

The GGP is almost never simply a question of pension system design, but it is due to a mix of factors. Current pensions are the result of long-term structural changes, short-term pressures related to recent economic developments and previous pension reforms (Bettio et al. 2013). The last aspect is particularly relevant in the recent times, since the ageing population has encouraged pension systems' revision, consisting mainly of raising retirement age and the introduction of a closer correspondence between lifetime earnings and pension levels, which may sensibly affect the GGP in the future (Chlon-Dominczak 2017).

As observed in Dessimirova and Bustamante (2019), the various factors determining the GGP can be grouped into two categories: (i) the design of the pension system, and (ii) the working career of individuals.

As regards the first category, pension systems are usually considered as gender neutral, as most of the rules and provisions are the same for men and women. However, it has been observed that, since the 1990s reforms in the pension systems have shifted towards contribution-based occupational schemes and the adoption of the actuarial principles, these changes are likely to increase the GGP, penalizing women more than men (Samek Lodovici 2016).

The main effect of these reforms indeed has been to toughen the dependence of retirement benefit on the period of employment and the amount of earnings. This has resulted in a negative impact on women's pensions as consequence of gender differences in the labour market. With their interrupted careers, women will be much more subject to basic, means-tested or minimum pensions, with the risk of a reappearance of old-age poverty due to their lower pension incomes.

In Europe, according to Chlon-Dominczak (2017), countries with the lowest exposure to risk of the future GGP are Denmark, Lithuania, Sweden, the Czech Republic and Finland, while those facing higher risk include Greece, Italy, Spain, Malta and the Netherlands. In Italy indeed, the old DB system has been gradually replaced by a regime inspired by principles of actuarial fairness.

With regard to the second aspect, i.e. the working career of individuals, there are different elements characterising individuals' working life. According to the European Institute for Gender Equality (EIGE 2018), women spend more years in unpaid employment than men, because they persist in the role of carers for children or aged parents. This report highlights that 15.0% of 15-to-64 years old inactive women are inactive for care reasons. Likewise, the average employment rate for mothers aged 20-49 with a young child (younger than 6 years old) is 65.4% in comparison to 91.5% of fathers. Thereby, women are more affected by gaps in contributions and discontinuous careers.

They differ from men also for the work intensity, as they work part-time or in fixed-term employment more often than men. Data shows that in the EU 31.3% of women work part-time, in comparison to 8.7% of men and also on average, 12.7% of women work in temporary contracts compared to 10.7% of men (EIGE 2018).

According to Eurostat (2020), the average Gender Pay Gap (GPG) in the EU, i.e. the difference in average gross hourly wage between men and women across the economy in 2017 was estimated to be 16.1%, slightly lower than in 2008 (17.3%). From the same report, the gap for Italy is found to be 5.0%, whereas the same metric is estimated to be 18 percent in 2019 for the U.S. (Barroso and Brown 2020). Notably, a lower gender pay gap does not necessarily indicate more gender equality. Rather, a lower gap can be a consequence of lower labour market participation of women (e.g. in Italy the employment rate for women is 53.1% compared with 72.9% for men).

In recent times, due to the increasing concern for the ongoing transition to the NDC scheme, several studies have explored how gender roles, changing over time, are expected to interact with the shifts in pension policies in Italy.

Zanier and Crespi (2015) provide an overview of the phenomenon of increasing gender inequalities that happen at old age regarding women's pension. Their paper is one of the first critical reviews of the effect of gender inequalities related to pension gaps in Italy. Throughout a European overview of pension gender gap, focusing in particular on Italy, the authors analyze the reasons behind gender-biased pension levels and how their cumulative effects result in significant gender gaps. Specifically, they conclude that welfare and social policies in Italy show a lack of awareness of family and women's needs, and are then unable to give appropriate answers to the growing concern for gender gap.

Leombruni and Mosca (2012), provide the first results on how the GPG evolves during the entire working career of individuals in Italy and how it translates into a further gap during retirement. Exploiting two different administrative databases (the Work Histories Italian Panel and the National Social Security Administration Contribution Accounts Archive) to reconstruct the entire working career of a sample of people who retired in the mid-2000s, the authors document how the pay gap constantly widens with age and how women tend to cumulate a lower number of eligible working years. They find that both these gaps have an impact on the pension calculation, so that gender differences become even higher at retirement. They show that the pension system partially counterbalances labour market effects, implying lower differences in lifetime incomes. Nevertheless, due to the current transition to an actuarially neutral system, the effect disappear, posing some concerns about the future prospects of gender income inequality.

Lorenti et al. (2019), by estimating the Working Life Expectancy (WLE), i.e. the expected years of life spent in employment, document large and increasing heterogeneity in the length of the working life. They analyze trends in working life expectancy in Italy and show that during the recent financial crisis the gender gap in WLE increased, with a difference of 3.5 years between men and women in 2012-2013. They find that discontinuous careers and the limited accumulation of contributions may result in inadequate pension benefits later in life. In a policy perspective, they conclude that it is crucial, for Italy, to increase employment levels at all ages, particularly among women, young people, and people who live in the South.

3 Analysis

3.1 Data

This paper uses data from SHARE (The Survey of Health, Aging and Retirement in Europe) Wave 7 (DOI: 10.6103/SHARE.w7.711), see Börsch-Supan et al. (2013) for methodological details.[11] The collection of data for this wave started in 2017 with variables updated to 2016. The sole population aged more than fifty is interviewed.[12]

SHARE-Wave 7 is the most recent wave (the other being SHARE-Wave 3) containing the SHARELIFE questionnaire which focuses on people's life histories including all of the important areas of respondents' lives, ranging from partners and children to housing and work history with detailed questions on health and health care. Most importantly, for each job position lasting six months at least, the set of retrospective employment questions includes data on employment spells (starting/ending year of each job position), employment status, job characteristics, income, retirement benefits, and employment after retirement. Data are also collected about the typology of contribution plans (public, occupational, private, individual), as well as about the type of public pension benefits (old-age or seniority-based, sickness, disability, survivor, social assistance,...). At present, this is the most important dataset for the reconstruction of the pension savings history of retired, or almost retired, workers in the EU (Alessie et al. 2013).[13]

After merging all of the SHARE files for the construction of the database, the initial number of observations for Italy is 4,571.

For our purposes, we only consider respondents who paid, or pay if still in job, contributions to a public pension plan, and receive old-age or seniority benefits if already retired. In addition, the sole population of workers achieving the minimum years of contributions for pension entitlement (20 years) are considered. The selection of the sole respondents receiving an old-age or seniority benefit from contributions to a public pension plan allows to focus on the sole impact of the insurance scheme (DB and/or DC), independently from social assistance at retirement usually pursued through first-tier benefits like survival pensions, minimum retirement benefits, etc.

We also restrict our sample to cohorts from 1940 onward, since these workers are immediately involved in the transition from the fully DB to the NDC pen-

[11] The SHARE data collection has been funded by the European Commission through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812), FP7 (SHARE-PREP: GA N.211909, SHARE-LEAP: GA N.227822, SHARE M4: GA N.261982, DASISH: GA N-283646) and Horizon 2020 (SHARE-DEV3: GA N.676536, SHARE-COHESION: GA N.870628, SERISS: GA N.654221, SSHOC: GA N.823782) and by DG Employment, Social Affairs & Inclusion. Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, HHSN271201300071C) and from various national funding sources is gratefully acknowledged (see www.share-project.org).

[12] The database exceptionally includes individuals younger than fifty when married/living with more than fifty years old respondents.

[13] Alternatively, the EU-SILC database may be considered for similar research purposes. Even if SHARE and EU-SILC differ from each other for the income definition and available information, it has been observed that these differences are not sufficient to jeopardize the compatibility of the 'big picture' emerging from the two databases (Tinios et al. 2015).

sion scheme. Still-in-job respondents are included if expected to meet minimal eligibility requirements for retirement no later than 2027 (old-age pension, or seniority pension, or 'Quota 100' within 31 December 2021). For these individuals, salaries in the 2016 (last chronological year in the survey) are assumed to grow at the constant average GDP growth rate observed from 2016 to 2020[14]. To avoid strong assumptions on the future dynamics of earnings, we cut off the simulated part of the analysis (prospective analysis) in 2027; hence, for a decade from 2017 to 2027 job positions are assumed to preserve the same characteristics held at the time of the interview (2016), and the pension system is assumed to retain the same eligibility requirements as in 2021 (except for 'Quota 100' ending in 2021).

After restricting the data set (i) to respondents with a public pension plan belonging to the 1940-cohort onward, and (ii) to retirees and still-in-job respondents expected to meet pension eligibility requirements no later that 2027, and (iii) after dropping observations reporting missing or refusal values for at least one among starting/ending period of the employment spell, salary in the employment spell, wage currency, and gender, the final data set consists of 760 observations, specifically 474 males and 286 females.

Due to the limited number of observations, we define groups of individuals through a disjoint and exhaustive partition of the population by (i) year of birth and (ii) year of retirement. More specifically, to preserve a sufficient number of observations in each group, we consider three consecutive intervals for the year of birth (cohort), respectively 1940-49, 1950-59, and 1960-69, and three consecutive intervals for the year of retirement, respectively 1980-09, 2010-19, and 2020-27. As a result, we obtain 9 cells, with only those on the main diagonal of Table 1 characterized by more than 50 observations for both males and females.

Table 1: absolute frequencies of year of birth and year of retirement by gender.

(Males)	**Year of Retirement**		
Cohort	1980-09	2010-19	2020-27
1940-49	*129*	*40*	*0*
1950-59	*29*	*137*	*64*
1960-69	*0*	*17*	*58*

(Females)	**Year of Retirement**		
Cohort	1980-09	2010-19	2020-27
1940-49	*80*	*13*	*0*
1950-59	*10*	*76*	*44*
1960-69	*0*	*5*	*58*

For this reason, we confine our analysis to the sole three cells on the main diagonal, namely Cell 1=(1940-49; 1980-09), Cell 2=(1950-59; 2010-19), and Cell 3=(1960-69; 2020-27).

Main descriptive statistics for Cell 1, Cell 2 and Cell 3 are reported in Table 2. On average, the population in each of the three cells consists of males and females born in 1944, 1954, 1962, whose working life started on average, respectively, in the early sixties, seventies and eighties. On average, males en-

[14]Methodological details are provided in the next section.

ter the labor market when younger than females with a slightly decreasing gap over time. We also report frequencies of self-employment[15] and civil servants, highlighting that the share of civil servants is higher among females, whereas self-employment is found to be more recurrent among males.[16]

Table 2: descriptive statistics of the population by gender.

	Groups birth/retirement		
Descriptive Statistics	Cell 1	Cell 2	Cell 3
Year of Birth			
Males	*1944.53*	*1954.95*	*1962.66*
Females	*1944.74*	*1954.59*	*1962.62*
Year of First Job			
Males	*1963.79*	*1973.21*	*1981.77*
Females	*1965.91*	*1973.28*	*1982.69*
Main Job Income			
Males	*1261.42*	*1693.46*	*1904.38*
Females	*825.68*	*1353.43*	*1692.16*
Self-Employment (%)*			
Males	*0.12*	*0.18*	*0.27*
Females	*0.13*	*0.05*	*0.08*
Civil Servant (%)*			
Males	*0.26*	*0.22*	*0.20*
Females	*0.36*	*0.29*	*0.32*
Married (%)**			
Males	*0.93*	*0.94*	*0.90*
Females	*0.90*	*0.94*	*0.85*
Children (%)			
Males	*0.83*	*0.86*	*0.89*
Females	*0.74*	*0.83*	*0.82*

* If self-employed and civil servant for one employment spell at least.
** If married at least once.

In Table 2, we also report the net monthly income from main job (identified as main by the respondent). This allows to calculate the Gender Pay Gap (GPG) for the sole main job, which is defined as the ratio between the absolute gender gap of average wages and the average wage of males.

Table 3: gender pay gap for main job.

	Groups birth/retirement		
Gender Gap	Cell 1	Cell 2	Cell 3
GPG(Main)	*0.345*	*0.200*	*0.111*

As reported in Table 3, the GPG has sensibly reduced across cells, at least for the main job. The GPG is found to be even lower for still-in-job respondents in the 2016, $GPG = 0.036$. This is consistent with existing evidence for Italy discussed in section 2.2.

[15] In the SHARE database, income from self-employment also includes those from small family entrepreneurship.
[16] Descriptive statistics on education are omitted due to excessive number of missing values.

For each respondent and employment spell, labor earnings are reported either as wages-in-job (for employees), or as incomes (for self-employment), by indicating the amount received at the beginning of each job. As far as job positions lasted less than six months are omitted in SHARE, the amount of accrued savings might be undervalued for some workers, especially for gig workers. Remarkably, respondents are required to indicate the net value of the starting earnings, implying that, as discussed in the next section, gross incomes must be simulated from net incomes in order to reconstruct the contributions paid by workers during their entire working life.

3.2 Methodology

According to pension reforms in Italy (section 2.1), for workers with at least 18 years of contributions in 1995, the transition from the DB to the NDC scheme applies pro-rata to contributions paid from 2012 onward (Monti-Fornero reform). Instead, for those workers who did not achieve at least 18 years of contributions in 1995, the NDC scheme applies pro-rata to contributions paid from 1995 onward (Dini reform). Hence, the NDC benefit formula is progressively implemented with time passing by from Cell 1 to Cell 2 and from Cell 2 to Cell 3, that is, across cohorts and years of retirement.

Most importantly, as far as the design of the Italian DB scheme is redistributive whereas the NDC is not, and provided that females accrue, on average, less contributions than males (due to lower labor earnings and career discontinuities), one may reasonably expect the transition from the DB to the NDC scheme to exacerbate *ceteris paribus* the GGP. On the other hand, the observed reduction of the GPG, especially during the sixties and the seventies, may push the GGP in the opposite direction, so as to offset the previous effect. In this sense, the evolution of the GGP in the near future is far from being straightforward in Italy (Leombruni and Mosca 2012, Zanier and Crespi 2015).

To capture the impact of the progressive replacement of the DB with the NDC scheme, we implement a counterfactual analysis by which the *actual* distribution of pension benefits reported by respondents is compared with the *virtual* distribution obtained by applying the sole NDC benefit formula to the entire working life of individuals in our population (Cells 1-2-3).

Let the GGP in the i^{th} Cell be defined as

$$GGP_i = 1 - \frac{\mu_i(F)}{\mu_i(M)} \tag{1}$$

with $\mu_i(F)$ and $\mu_i(M)$ indicating the average pension benefit in the i^{th} Cell of females and males respectively.

The dynamics of the actual GGP from Cell 1 to Cell 2 and from Cell 2 to Cell 3 reveals the overall effect determined altogether by the evolution of the GPG in the labor market and by the progressive replacement of the DB with the NDC scheme. Differently, as far as virtual GGPs across cells are computed by holding fixed the pension scheme, the dynamics of the virtual GGP captures the sole impact of the evolution of the GPG during the last decades.

Taken together, the difference between the actual and the virtual GGP measures the impact on the real population of the redistributive trait of the DB scheme in the absence of behavioral responses, i.e. holding fixed the working life of individuals. Reasonably, to the extent that the DB scheme is progressively replaced by the NDC scheme over time, the redistributive effect of the the DB scheme is expected to be greater in Cell 1, and then to decrease across cells (from Cell 1 to Cell 3).

The GGP-based counterfactual analysis discussed above allows to highlight the contribution of different driving forces to the observed trend of inequality (gap) between gender. However, for a more complete understanding of this trend, one may want to consider also the impact of these driving forces on the inequality within gender, i.e. among males or females only, as well as on overall inequality among the population of retirees by cohort and by year of retirement. To account for the dynamics of within-gender inequalities, we calculate Generalized Entropy (GE) measures of inequality, which is known to be additively decomposable in terms of within-group (within-gender) and between-group (between-gender) inequality (Shorrocks 1980).

Let b_{ij} be the pension benefit (actual or virtual) of the jth retiree in the ith Cell, the class of GE inequality measures is defined as

$$GE_i(\alpha) = \begin{cases} \dfrac{1}{n_i\alpha(\alpha-1)} \displaystyle\sum_{j=1}^{n_i} \left(\left(\frac{b_{ij}}{\mu(b_i)} \right)^{\alpha} - 1 \right) & \alpha \neq 0, \\ \dfrac{1}{n_i} \displaystyle\sum_{j=1}^{n_i} \frac{b_{ij}}{\mu(b_i)} \ln \frac{b_{ij}}{\mu(b_i)} & \alpha = 1, \\ -\dfrac{1}{n_i} \displaystyle\sum_{j=1}^{n_i} \ln \frac{b_{ij}}{\mu(b_i)} & \alpha = 0 \end{cases} \quad (2)$$

The parameter α regulates the weight given to distances between pension benefits at different parts of the income distribution; the greater is α the more the index is sensitive to pension benefits at the top of the distribution (e.g., GE increases more when a higher pension benefit increases). Vice versa, the lower is α the more the index is sensitive to pension benefits at the bottom of the distribution.

Several well known inequality metrics can be obtained from the class of GE measures by letting α change: e.g. $GE(0)$ is known to be the mean log deviation index; $GE(1)$ corresponds to the Theil index; $GE(2)$ is half the square coefficient of variation. Most importantly, each of the GE measures is additively decomposable, in that each of these indices can be reformulated in terms of within-group and between-group inequality as follows.

$$GE_i(\alpha) = GE_{\alpha}^{W} + GE_{\alpha}^{B} = \\ = \sum_{k=1}^{2} \frac{n_{ik}\mu_{ik}}{n_i\mu_i} \left(\frac{\mu_{ik}}{\mu_i} \right)^{\alpha} GE_i^k(\alpha) + \frac{1}{\alpha(\alpha+1)} \sum_{k=1}^{2} \frac{n_{ik}\mu_{ik}}{n_i\mu_i} \left(\left(\frac{\mu_{ik}}{\mu_i} \right)^{\alpha} - 1 \right) \quad (3)$$

with $k = (F, M)$ for female and males respectively, and $GE_i^k(\alpha)$ indicating inequality in group k of the ith Cell.

As compared to the GGP, the group-decomposition of inequality measures provides information on both the gender gap (between-group inequality) and the within-group (within-gender) inequality, as well as on the overall inequality. In a dynamic perspective, additional information on the evolution of within-group inequality may allow for a better identification of the contribution of generic (non gender-specific) rich-to-poor redistribution, independently from its impact on the dynamics of the gender gap.[17]

Also, it is worth observing that the dynamics of the two metrics (GGP and GE) may differ in size depending on what average pension benefit – the one of females or males – is changing more, since the GGP is more sensitive to variations of the average pension benefit of males. This is because the GGP is obtained by dividing the absolute (monetary) gender gap by the average pension benefit of males, whereas both males and females' average pension benefits are equally considered in GE measures.

3.2.1 Pension savings at retirement: main assumptions

The counterfactual analysis we propose, is based on the reconstruction of the working career of real individuals from their real working life. This allows to obtain a more realistic 'picture' of the current and expected evolution of the gender gap at retirement in the near future. However, as far as the reconstruction of the entire working career is a very information-demanding process, simplifications and generalizations are inevitably required. Some of them are almost natural and standard practice in the field of pension systems; some others originate from limited information on the working history of respondents, and are definitely more relevant. In what follows, we discuss the details of the assumptions adopted in our analysis.

First, in the SHARELIFE database, labor earnings for each employment spell are reported for the first year only. This is particularly insidious for long-lasting job positions. To account for earnings' progression in the same job, the first income in each spell is capitalized at the earnings growth rate – differentiated by macro sector – from official statistics of the Italian Institute of Statistics (ISTAT).[18]

Second, the SHARELIFE database reports the net value of labor earnings whereas, according to the Italian legislation, mandatory contributions are calculated with respect to gross labor earnings, so including income taxes. To calculate income taxes, we assume that the tax base consists exclusively of incomes from wages, self-employment and small firms profits.[19] The Italian personal income tax, namely IRPEF, underwent many reforms from 1950 onward (e.g., 14 acts since the 'big' tax reform adopted with Presidential Decree 600/1973). As

[17]This is particularly relevant if considering the impact of gender-specific redistributive policies (e.g. fictitious contribution for maternity leave or caregiving) as opposed to the impact on the gender-gap of rich-to-poor redistributive policies in general.

[18]The earnings growth rate for each year is obtained from yearly variations in gross hourly earnings in main economic sectors from ISTAT' report "Numeri indice delle retribuzioni contrattuali orarie lorde per alcuni settori di attività economica e qualifica professionale - Anni 1955-2015". By merging the work type classification in SHARELIFE (wave 7) with that used by ISTAT, we are able to disentangle the following macro sectors: agriculture, hunting, forestry, fishing; primary and secondary sector; transport services; public administration; wholesale and retail trade; general economy.

[19]Mainly, this excludes shareholder's profits, capital gains, cadastral and real estate incomes, whose impact however is expected to be small, because the greatest part of capital incomes (interests from bonds, bank accounts and deposits) and real estate incomes (rents) are source taxed according to the Italian legislation, and so excluded from the personal income taxation.

such, we opted for an approximation of the evolution of the Italian tax system by identifying three different time periods. The time span of these periods has been determined in such a way as to keep as much homogeneity as possible.[20] For labor earnings from 1951 to 1992, income taxes are calculated by considering tax brackets and marginal tax rates in the 1974 tax system. For the time interval 1992-1997, we apply tax brackets and marginal tax rates in force in 1992, as modified by Amato reform. Finally, for taxes from 1998 to 2016, we apply the 2016 tax system in force from 2007.[21] Due to the lack of information in SHARE, tax expenditures are neglected except for the tax deduction of the 1/3 of total amount of pension savings[22], whose rate is fixed at the 33% and 20%[23] for employees and self-employed workers respectively.

Third, our analysis is mainly but not entirely retrospective, in that we also consider still-in-job respondents in 2016, who are supposed to retire no later than 2027 (prospective analysis). While the actual pension benefit is directly reported by retirees in the SHARE database, for still-in-job respondents we calculate the actual pension benefit – to be received after 2016 but within 2027 – assuming that (i) individuals choose to retire at the first chance according to eligibility requirements in force in the 2020 (see section 2.1)[24], (ii) the job position in 2016 is preserved up to retirement, (iii) earnings increase, by macro sector, at the observed earnings growth rate until 2020 and at the average 2016-2020 earnings growth rate in case of retirement after 2020[25].

Forth, the official Transformation Coefficients used for the calculation of pension benefits in the NDC scheme (formally updated by the government in charge every two years) are currently available up to 2022. Hence, to calculate actual and virtual pension benefits for individuals retiring after 2022 (prospective analysis), we also need to update the Transformation Coefficients in such a way as to account for the dynamics of life expectancy. In the actuarial literature a variety of alternative methodologies for projecting mortality have been proposed (Lee and Carter 1992, Booth and Tickle 2008, Russolillo et al. 2011). Following the official estimation strategy implemented by ISTAT, we refer to the Lee-Carter model and apply it to mortality data provided by the Human Mortality Database (HMD). The study is performed on the Italian male and female populations ranging from 1960 to 2017, for ages from 0 up to 102 years, considered by single calendar year and by single year of age (see section A.1 in the appendix for details on the estimation strategy). Hence, forecasted mortality

[20] Before 1973, the Italian tax system was sensibly different from modern tax systems, and mostly based on withholding and indirect taxation.

[21] For details on the evolution of the Italian personal income tax see Visco (1993), OECD (2005), and Pellegrino and Panteghini (2020).

[22] According to the Italian pension system, 1/3 of the overall pension savings accrued for the worker must be paid by the worker itself, whereas 2/3 are paid by the employer.

[23] The contribution rate for self-employment is not uniquely defined for different types of self-employed workers and has been sensibly modified in the last decades (mostly increased). Here, we use the 20% as a proxy for all of the different categories which we cannot disentangle from the information available in the SHARE database.

[24] Due to lack of information, we do not consider departures from the main eligibility criteria applied to specific work categories (e.g. special treatment for heavy occupations). In addition, we do not consider the so called "Opzione Donna" (first introduced by Law 243/2004), by which females with specific age and seniority requirements may opt for early retirement but accepting the application of the NDC scheme for the entire contribution career.

[25] We consider hourly earnings growth rate from ISTAT's "Indici delle retribuzioni contrattuali orarie per raggruppamenti principali di contratto" until September 2020 differentiated by macro sectors (agriculture, industry, public administration, general index).

rates for 13 years ahead from 2018 to 2030 and survival and death probabilities are derived and, in turn, Transformation Coefficients for bienniums 2023-24, 2025-26 and 2027-28 are obtained by using as baseline years, respectively, 2022, 2024 and 2026.[26]

Finally, given the labor earnings of individuals during their entire working life, the application of the NDC scheme to calculate the virtual distribution of pension benefits (under the hypothesis of a fully NDC scheme in each cell) poses an additional threat for the capitalization of contributions paid from 1950 to 1962 and for 2020 onward. Indeed, ISTAT provides official capitalization rates to be applied in the NDC scheme exclusively for years from 1962 to 2020, whereas we also need the capitalization for the calculation of virtual pension benefits of individuals who entered the labor market before 1962 and for those individuals (still-in-job) expected to retire after 2020. To fill this gap for both time intervals, we simulate the same procedure implemented by the ISTAT by taking the five-year moving averaging of the GDP growth rate as reported in the official statistics.[27]

3.3 Results

After reconstructing the entire working career of individuals by cohort and year of retirement, we calculate (i) the actual pension benefit at the first year of retirement for still-in-job respondents in 2016 (which is instead reported for retirees), and (ii) the virtual pension benefit for each respondent. This computation involves the application of different benefit formulas, either DB or NDC, along the working career. To avoid the impact of outliers – often coming from wrong imputation of the currency type in the SHARELIFE database for Italy[28] – observations below and above the 5^{th} and the 95^{th} centile in the distributions of virtual and actual pension benefits have been dropped (e.g., Jarvis and Jenkins 1998).[29]

Following the Dini reform discussed in Section 2.1, the NDC scheme progressively replaces the DB in the application of the benefit formula. The dynamics of the composition of the population in each cell with respect to the pension scheme in force is key for a proper understanding of main results discussed in this section. Specifically, in Cell 1, 165 out of 168 retirees (98.2%) obtain a fully DB pension. In Cell 2, instead, 18 out of 171 retirees (10.5%) get a fully DB pension due to more than 18 years of contribution in 1995 and retirement before 2012; for 138 out of 171 retirees (80.7%) the NDC applies from 2012 up to retirement; for 15 out of 171 retirees (8.8%) the NDC applies from 1996 up to retirement. Finally in Cell 3, for 15 out of 105 retirees (14.3%) the NDC only applies after 2012 to retirement, whereas for 90 out of 105 (85.7%) the

[26] Notice that mortality projections do not account for the impact of the Covid-19 since data provided by the HMD are updated to 2017. However, to the extent that Transformation Coefficients are uniformly applied to males and females according to current Italian legislation, Covid-19 is not expected to sensibly affect the gender gap.

[27] The GDP grow rate at market prices (chained values; reference year = 2010) from 1950 to 2017 is extracted from "La Ricostruzione Banca d'italia - Istat 1861-2017" available from the official website of the ISTAT. For the period 2018-2020, we use ISTAT's official National Accounts quarterly statistics.

[28] In some cases, the Euro is indicated for some employment spells even if the Italian Lira is clearly intended, and vice versa.

[29] Centiles are calculated separately for virtual and actual incomes, so that an observation is dropped if it falls in the range of outliers at least for one of the two distributions.

NDC applies from 1996 up to retirement. The progressive replacement of the DB scheme with the NDC one is particularly important for our analysis since it allows to assess the dynamics of the gender gap at retirement as influenced by both the dynamics of the labor market and the replacement of the DB with the NDC scheme.

For each cell, the actual and the virtual mean pension benefit is reported in Table 4. Both means and standard deviations are obtained by accounting for sample weights reported in the SHARE database.

Table 4: Summary statistics by gender for Cells 1-2-3.

(Males)	**Cell 1**: cohort 1940-49, retirement 1980-09				
Variable	**Obs**	**Mean***	**Std.Dev***	**Min**	**Max**
Actual Pension	*108*	*19878.2*	*7989.0*	*8272.7*	*44387.1*
Virtual Pension	*108*	*17061.0*	*17365.4*	*1994.2*	*88502.1*
(Females)	cohort 1940-49, retirement 1980-09				
Variable	**Obs**	**Mean***	**Std.Dev***	**Min**	**Max**
Actual Pension	*60*	*14123.2*	*5612.1*	*3923.7*	*25890.4*
Virtual Pension	*60*	*11634.9*	*6261.1*	*3351.3*	*27108.9*

(Males)	**Cell 2**: cohort 1950-59, retirement 2010-19				
Variable	**Obs**	**Mean***	**Std.Dev***	**Min**	**Max**
Actual Pension	*109*	*25724.0*	*15936.9*	*2667.6*	*85229.3*
Virtual Pension	*109*	*20665.8*	*12258.7*	*6910.0*	*55998.6*
(Females)	cohort 1950-59, retirement 2010-19				
Variable	**Obs**	**Mean***	**Std.Dev***	**Min**	**Max**
Actual Pension	*62*	*21014.7*	*7346.8*	*8.2341.6*	*40765.0*
Virtual Pension	*62*	*16091.6*	*10344.9*	*4502.6*	*55609.2*

(Males)	**Cell 3**: cohort 1960-69, retirement 2020-27				
Variable	**Obs**	**Mean***	**Std.Dev***	**Min**	**Max**
Actual Pension	*52*	*22865.9*	*8545.6*	*5549.3*	*42491.5*
Virtual Pension	*52*	*21241.2*	*8651.5*	*5799.3*	*38036.7*
(Females)	cohort 1960-69, retirement 2020-27				
Variable	**Obs**	**Mean***	**Std.Dev***	**Min**	**Max**
Actual Pension	*53*	*18477.9*	*7662.3*	*2414.4*	*29161.8*
Virtual Pension	*53*	*17536.3*	*7695.3*	*2237.7*	*27828.8*

From the first panel in Table 4 (Cell 1), the gross actual pension benefit is found to be higher than the virtual one for both males and females, with males receiving a greater benefit than females. This is just what one may expect since the NDC scheme is known to be less generous than the Italian DB pension formula, and females usually accrue less contributions than males during the working life. Not surprisingly, the same evidence is confirmed for Cell 2 and Cell 3, even if the gap between actual and virtual benefits is found to be sensibly lower in Cell 3 due to the greater application of the NDC scheme to the working career of these individuals.

As concerns the dynamics of actual pension benefits across cells, it is worth observing that, for both males and females, actual pension benefits are first increasing from Cell 1 to Cell 2, then decreasing from Cell 2 to Cell 3. This is mostly the result of two driving forces moving in opposite directions. On the one hand, labor earnings have increased in Italy from the eighties, with a remarkable jump due to the transition from the Lira to the Euro. This has clearly increased pensionable earnings in the application of the modified DB scheme. On the other hand, to the extent that the NDC scheme is not generous as the DB scheme, and since the latter is progressively replaced by the NDC with cohorts and years of retirement passing by (i.e. from Cell 1 to Cell 2 and from Cell 2 to Cell 3), we find that the first effect – due to increasing labor earnings from the eighties – is dominant from Cell 1 to Cell 2, whereas the lower rate of return of the NDC scheme becomes dominant from Cell 2 to Cell 3, causing the reduction of mean pension benefits for both males and females.

As for the dynamics of the virtual pension benefit, this is sensibly increasing across cells due to the sole impact of increasing wage, especially for cohorts starting to work in the early sixties (see Table 2). Most importantly, the positive variation is more substantial for females since improving labor market conditions for women has permitted greater accrual of contributions.

3.3.1 GGP analysis

From Table 4 and equation (1), we obtain the actual and virtual GGPs reported in Table 5.

Table 5: Gender Gap in Pension (GGP)

	Groups birth/retirement		
Gender gap	Cell 1	Cell 2	Cell 3
Actual GGP	*0.2895*	*0.1831*	*0.1919*
Virtual GGP	*0.3180*	*0.2213*	*0.1744*

From the comparison between the actual and the virtual GGP in Cell 1, the redistributive impact of the DB pension scheme, compared to the actuarially fair NDC scheme, is clearly highlighted. Indeed, as we mentioned above, the population of retirees in Cell 1 is almost entirely characterized by the application of a fully DB scheme, so the redistributive impact is almost entirely captured through the comparison to the virtual GGP (fully NDC) in Cell 1. We also observe a very high actual GGP in Cell 1, which is originating from both high wage differentials (see the GPG in Table 3) and career discontinuities of females. The effect of career discontinuities is evident from the 'gender gap in seniority' – defined as the ratio between the absolute gender gap in terms of average years of contribution and the average years of contribution for males – which is 8.6% in Cell 1.[30]

In Cell 2, as reported at the beginning of this section, the population is mostly characterized by a minor application of the NDC, which mostly applies to contributions paid after 2011. Here, the actual GGP is found sensibly lower than in the previous cell due to improving labor market conditions for females. This is clearly observable both from the reduction of the GPG in main job (see Table 3) and from the sensible reduction of the gender gap in seniority, which decreases from 8.6% to 2.7% from Cell 1 to Cell 2. Consistently, the virtual GGP sensibly falls down from 0.3180 to 0.2213. As for the redistribution induced by

[30]The average years of contribution for males and females are, respectively, 37.3 and 34.1.

the pension scheme, in Cell 2 the actual GGP is found to be, once again, lower than the virtual GGP, in that the DB scheme is still overwhelming in this cell.

The results of the GGP are sensibly different when considering Cell 3, for two reasons at least. First, the actual GGP is unexpectedly increasing from Cell 2 to Cell 3. This result is even more surprising if one considers that both the GPG (Table 3) and the gender gap in seniority are still decreasing from Cell 2 to Cell 3, even if at a lower rate (the gender gap in seniority reduces from 2.7% to 1.1% from Cell 2 to Cell 3). Actually, this unexpected finding is motivated by the transition to a less generous pension plan, the NDC scheme, which causes a substantial reduction of the mean actual pension benefit for both males and females. Indeed, a closer look reveals that the *absolute* fall of the mean actual pension benefit from Cell 2 to Cell 3 is almost similar for both males and females (see Table 4). However, while the numerator of the actual GGP (i.e. the absolute gap on average) does not change significantly, the reduction of the denominator from Cell 2 to Cell 3 is substantial, so as to explain the observation of a higher actual GGP in Cell 3.

Second, in Cell 3 the virtual GGP is found to be surprisingly lower than the actual GGP (respectively, 0.1744 and 0.1919), meaning that, females would have done better relative to males – not absolutely – under a fully NDC scheme. The motivation, in this case, is to be found in gender differences with respect to the starting working age and career discontinuities in the early working life. Indeed, for the greatest part of the population in Cell 3, the DB scheme applies up to 1995, whereas the NDC scheme is in force for the rest of the working life. Since the starting working age is, on average, higher for females than for males (see Table 2) and since career discontinuities are more frequent in the early working life of females, the quota of years of contribution accrued in the DB scheme (i.e. before 1996) is, on average, higher for males than for females, implying that the generous DB schemes applies relatively more to males as compared to females in the same cell (Cell 3).[31] Hence, due to the design of the pro-rata mechanism and to gender differences in the early contribution career, females are penalized by a relatively stronger application of the NDC scheme with respect to males.

Overall, the transition from Cell 2 to Cell 3 reveals that the absolute gap in terms of mean actual pension benefits is mainly unchanged (Table 4), but the overwhelming application of the NDC scheme (i) substantially reduces mean actual pension benefits for both males and females, so as to determine the increase of the actual GGP, and (ii) rules out any redistributive effect of the pension scheme, which was instead relevant in Cell 2, while penalizing females during the transition to a fully NDC scheme for higher starting working age and career discontinuities in the early working life.

3.3.2 GE decomposition

We also propose an alternative approach to the measurement of the gender gap at retirement, by which the size and the dynamics of both within-gender and overall inequality are observed in addition to between-gender inequality. With this purpose in mind, we calculate and decompose the class of GE (Generalized-Entropy) inequality measures discussed above (eq. 3). In Table 6, we only report results obtained under the hypothesis $\alpha = 1$, which is known as Theil index;

[31] More precisely, this occurs for the greatest part of the population in Cell 3 which is expected to become eligible first for an old-age (not seniority) pension.

results for different values of the parameter α do not differ substantially from each other and are reported in appendix A.2 (Table 7).

Table 6: actual and virtual subgroup inequality components (Theil index).

Cell 1: cohort 1940-49, retirement 1980-09

Distribution	**W(M)**	**W(F)**	**W**	**B**	**Overall**
Actual	*0.074*	*0.080*	*0.076*	*0.013*	*0.089*
Virtual	*0.236*	*0.134*	*0.182*	*0.016*	*0.197*
Actual(%)	-	-	*0.856*	*0.144*	*1*
Virtual(%)	-	-	*0.919*	*0.081*	*1*

Cell 2: cohort 1950-59, retirement 2010-19

Distribution	**W(M)**	**W(F)**	**W**	**B**	**Overall**
Actual	*0.158*	*0.078*	*0.134*	*0.004*	*0.139*
Virtual	*0.181*	*0.142*	*0.169*	*0.006*	*0.176*
Actual(%)	-	-	*0.969*	*0.030*	*1*
Virtual(%)	-	-	*0.963*	*0.037*	*1*

Cell 3: cohort 1960-69, retirement 2020-27

Distribution	**W(M)**	**W(F)**	**W**	**B**	**Overall**
Actual	*0.085*	*0.095*	*0.090*	*0.006*	*0.097*
Virtual	*0.095*	*0.102*	*0.098*	*0.004*	*0.103*
Actual(%)	-	-	*0.926*	*0.074*	*1*
Virtual(%)	-	-	*0.962*	*0.038*	*1*

We first observe that all of the results obtained from the GGP analysis are confirmed when decomposing the Theil inequality index. Specifically, by looking at the between-gender component (column B), we find that the between-gender inequality in the virtual distribution of pension benefits is greater than in the actual one for both Cell 1 (0.016 vs 0.013) and Cell 2 (0.006 vs 0.004) but not for Cell 3 (0.004 vs 0.006), where a reversal occurs like in the GGP analysis. In addition, the U-shape of the actual GGP across cells is confirmed here, since actual between-gender inequality is found to decrease from Cell 1 to Cell 2, while it increases from Cell 2 to Cell 3.

Since the GE decomposition also provides information on overall inequality among retirees in each cell, in Table 6 we also report the share (%) of actual and virtual between-gender inequality with respect to the overall inequality for each cell (column B). It is worth observing that the share of between-gender inequality first falls down from Cell 1 to Cell 2 (from 14.4% to 3%), then increases again in Cell 3 (7.4%). This is particularly interesting since it highlights that, even if the absolute gender gap of actual pension benefits has remained almost unchanged from Cell 2 to Cell 3 (Table 4), the share of gender disparities with respect to overall inequalities has increased across cells, meaning that gender inequality has become relatively more important among retirees with an old-age or seniority pension. This is consistent with previous evidences for the entire population in Atkinson and Morelli (2011) and Abatemarco (2016).

From Table 6, we also observe the dynamics of within-gender (column W) and overall inequality (column Overall). As one would expect, the DB pension system reduces within-gender inequality, W, for both males (column $W(M)$)

and females (column $W(F)$), as well as overall inequality. This is particularly evident from overall inequality in Cell 1, where the Theil inequality index for the virtual distribution (0.197) is twice the one calculated with respect to the actual distribution of pension benefits (0.089). Differently, the redistributive effect in terms of overall inequality almost disappears in Cell 3 (0.103 vs 0.097) due to the greater application of the NDC benefit formula. This loss of redistributive power of the pension scheme across cells is the origin of the observed reduction of between-gender redistribution, which is found even perverse (i.e. poor-to-rich) in Cell 3 for the same reasons discussed in the previous section (i.e. gender differences in the early working life).

As a minor point, it is worth observing that in the transition from Cell 2 to Cell 3, the sensible reduction of virtual within-gender inequality, for both males (from 0.181 to 0.095) and females (from 0.142 to 0.102), reveals a decreasing inequality (of contribution) in the labor market, at least for individuals obtaining an old-age or seniority pension. However, while decreasing inequality in the labor market reduces the inequality of actual pension benefits among males (from 0.158 to 0.085), this is not the case for females (from 0.078 to 0.095). This happens to be the case because, for females, the loss of redistributive power due to the transition from the DB to the NDC scheme is dominating the reduction of inequality in the labor market.[32]

4 Concluding Remarks

The assessment of the recent trend in the evolution of the gender gap at retirement is particularly important in Italy, because it allows to gather key information on the impact of pension reforms adopted during the nineties and, eventually, to correct for undesirable tendencies.

To account for the interaction between pension reforms and evolving labor market conditions of women, in this paper a counterfactual analysis is implemented by which the gender gap at retirement is calculated – across cohorts and years of retirement – using both the actual and the virtual distribution of pension benefits, with the latter being obtained under the hypothesis of a fully NDC scheme. Given the actual and virtual distributions of pension benefits, both the GGP and the GE decomposition have been implemented. The two methodologies conduce to similar results on the dynamics of the gender gap at retirement; the GE decomposition also highlights the loss of the redistributive power due to the transition from the DB to the NDC scheme, as well as the incidence of gender disparities on overall and within-gender disparities among retirees with an old-age or seniority pension.

We find a U-shaped behavior of the actual gender gap at retirement in Italy,

[32] In the transition from Cell 1 to Cell 2 (Table 6), actual within-gender inequality increases whereas virtual within-gender inequality moves in the opposite direction. This result is driven by the significant lack of actuarial fairness of the DB scheme (Cell 1), which is captured by the substantial gap between virtual within-gender inequality (reflecting inequality in lifetime earnings) and actual within-gender inequality (reflecting inequality in pensionable earnings and years of contribution). In Cell 2, pensionable earnings become less relevant as opposed to lifetime earnings due to the initial transition from the DB to the NDC scheme. As a result, inequality in the virtual distribution of lifetime earnings is partly transposed in the actual distribution of pension benefits, so as to observe more balanced values (0.169 and 0.134 respectively), with an increase in actual within-gender inequality.

with an ascendant pattern starting from 2020. Hence, we conclude that, while the improvement of labor market conditions for women has been dominating up to 2020 so as to reduce the gender gap at retirement, this effect is expected to be dominated by the loss of redistributive power of the pension scheme after 2020. Even worst, the share of gender inequalities with respect to overall inequality among retirees is found to have increased in recent times, meaning that gender disparities are becoming relatively more important among all other determinants of inequality.

We also show that the application of the pro-rata mechanism during the transition from the DB to the NDC scheme is additionally penalizing for women in that, on average, (i) the higher starting working age and (ii) career discontinuities in early working life, reduce, especially for women, the quota of pension savings falling in the more generous DB scheme. This effect is limited but not negligible since it makes the actual gender gap at retirement observed after 2020 greater than what this would have been if a fully NDC scheme were applied.

Altogether, in the transition from the DB to the NDC scheme, women turn out to be sensibly penalized by both the loss of redistributive power of the pension plan, as well as by lower pension savings in the early working life with respect to men. As such, our analysis suggests that gender-specific redistributive policies, especially those related to family caring in the early working life, are urgently required in Italy to stop the increasing trend of the gender gap at retirement observed in recent times.

Appendix

A.1) Transformation Coefficients: definition and estimation strategy

Definition
According to the Italian Legislation, Transformation Coefficients are used to transform in pension the contributions accrued until the retirement age.
Let $P_x = (TC_x)(MC_x)$ be the annual pension benefit for a worker retiring at age x, where MC_x is the total amount of accrued contributions at retirement age x, and $TC_x = \frac{1}{\Delta_x}$ is the Transformation Coefficient at retirement age x with

$$\Delta_x = \frac{\sum_{s=m,f}\left(a_{x,s}^{v(t)} + A_{x,s}^{v(t)}\right)}{2} - k$$

known as the Divisor.
The Divisor, making use of actuarial symbology, involves both the average present value of the individual's pension, $a_{x,s}^{v(t)}$, and the average present value of the survivor's pension of both men and women, $A_{x,s}^{v(t)}$, where:

$$a_{x,s}^{v(t)} = \sum_{t=0}^{w-x} \frac{l_{x+t,s}}{l_{x,s}} \left(\frac{1+r}{1+\sigma}\right)^{-t}$$

and

$$A_{x,s}^{v(t)} = \sum_{t=0}^{w-x} \frac{l_{x+t,s}}{l_{x,s}} q_{x+t,s} \left(\frac{1+r}{1+\sigma}\right)^{-t} \Theta_{x+t,s}\eta\delta_s \sum_{\tau=1}^{w-x-t+\varepsilon_s} \frac{l^{ved}_{x+t+\tau-\varepsilon_{x,s},\bar{s}}}{l^{ved}_{x+t+1-\varepsilon_{x,s},\bar{s}}} \left(\frac{1+r}{1+\sigma}\right)^{-\tau}$$

w = ultimate age
s = sex (m=male; f=female)
$\bar{s}$ = sex of the surviving spouse
$\frac{l_{x+t,s}}{l_{x,s}}$ = survival probability between age x and $x+t$
$q_{x+t,s}$ = probability of death between age x and $x+t$
$\Theta_{x+t,s}$ = probability to leave the family for a person aged $x+t$
$l^{ved}_{x+t,s}$ = probability of the survivor to die or remarry
$\varepsilon_{x,s}$ = age gap between retiree and spouse
η = survivor benefit rate (fixed at 0.6)
δ_s = income-based means-tested percentage reduction of the survivor benefit rate (fixed at 0.9 for males, 0.7 for females)
r = internal rate of return
σ = indexing factor
$\left(\frac{1+r}{1+\sigma}\right)^{-\tau}$ = discount rate (with $\left(\frac{1+r}{1+\sigma}\right)$ fixed at 1.015)
k = correction factor for monthly payments in advance during the year (fixed at 0.4615).

TC_x (or better its reciprocal, i.e. the Divisor) is expected to ensure the equivalence between the amount of accrued contributions and the annuity payed to the retiree until s/he or her/his survivors die (depending on life expectancy).

Estimation strategy

Currently, official TC_xs from ISTAT are available until 2022. To update the TC_xs from 2023 ahead, we project survival probabilities at the year of retirement of the retirees – ranging from 57 up to 71 years old according to the Italian legislation – throughout the Lee-Carter model (Lee and Carter 1992) characterized by the following equation:

$$\ln m_{x,t} = \alpha_x + \beta_x \kappa_t + \varepsilon_{x,t}$$

where $\ln m_{x,t}$ is the logarithm of the observed mortality rate $m_{x,t}$ for age x and year t. On the right hand side of the equation, α_x is an age-specific and time-independent component, while the second component is given by the product of a time-varying parameter κ_t, reflecting the general level of mortality, and β_x, an age-specific component indicating how mortality at each age varies when the general level of mortality changes. $\varepsilon_{x,t}$ designates the error term, which is assumed to be homoschedastic and normally distributed.

As the projected survival probabilities at the extreme age undertake irrelevant values, we assume that the ultimate survival probabilities (from 103 up to 119 years old) are set equal to the expected survival probability at the selected ultimate age (102 years old).

The steps for forecasting $m_{x,t}$ are summarized as follows.

1. The basic Lee-Carter model is fitted to the selected dataset. Using the Singular Value Decomposition (SVD) method, assuming suitable normality constraints in order to obtain a unique solution, the model is fitted to a matrix of age-specific observed mortality rates.

2. The model parameters α_x, β_x and κ_t are estimated, and to obtain a unique solution, we impose that the sum of the β_x coefficients is equal to one, and the sum of the κ_t parameters is equal to zero.

3. Next, the mortality index κ_t are forecasted by using ARIMA models.

4. Finally, forecasted mortality rates for 13 years ahead from 2018 to 2030 and survival and death probabilities are derived.

It has to be highlighted that the TC_xs have been updated by taking into account not only the changes occurred in the probability of death, but also other parameters provided by ISTAT. Specifically, we use ISTAT data on the projected probabilities of death or remarriage of the surviving spouse; the average age differential between spouses at death of partner; the probability of leaving the family, which is inferred by ISTAT from the relative frequency distribution of deaths by age in completed years, sex, and marital status. For the purposes of our analysis, we set $t = 2022$, 2024, 2026 as baseline years, respectively, for the TC_xs in bienniums 2023-24, 2025-26, and 2027-28.

A.2) Decomposition of Generalized Entropy measures

Table 7: Inequality decomposition

Cell 1: cohort 1940-49, retirement 1980-09

Actual Pension	**GE(-1)**	**GE(0)**	**GE(1)**	**GE(2)**	**Gini**
W-ineq (1)	*0.093*	*0.079*	*0.076*	*0.081*	*n.a.*
W-males	*0.078*	*0.074*	*0.074*	*0.080*	*0.215*
W-females	*0.105*	*0.088*	*0.080*	*0.078*	*0.224*
B-ineq (2)	*0.014*	*0.013*	*0.013*	*0.012*	*n.a.*
Overall (1+2)	*0.107*	*0.092*	*0.089*	*0.094*	*0.233*
Virtual Pension	**GE(-1)**	**GE(0)**	**GE(1)**	**GE(2)**	**Gini**
W-ineq (1)	*0.206*	*0.187*	*0.182*	*0.246*	*n.a.*
W-males	*0.317*	*0.228*	*0.236*	*0.353*	*0.358*
W-females	*0.159*	*0.139*	*0.134*	*0.142*	*0.291*
B-ineq (2)	*0.017*	*0.017*	*0.016*	*0.015*	*n.a.*
Overall (1+2)	*0.224*	*0.204*	*0.197*	*0.261*	*0.333*

Cell 2: cohort 1950-59, retirement 2010-19

Actual Pension	**GE(-1)**	**GE(0)**	**GE(1)**	**GE(2)**	**Gini**
W-ineq (1)	*0.193*	*0.152*	*0.134*	*0.160*	*n.a.*
W-males	*0.263*	*0.195*	*0.158*	*0.190*	*0.332*
W-females	*0.072*	*0.064*	*0.078*	*0.060*	*0.195*
B-ineq (2)	*0.005*	*0.004*	*0.004*	*0.004*	*n.a.*
Overall (1+2)	*0.198*	*0.156*	*0.139*	*0.164*	*0.301*
Virtual Pension	**GE(-1)**	**GE(0)**	**GE(1)**	**GE(2)**	**Gini**
W-ineq (1)	*0.178*	*0.159*	*0.169*	*0.183*	*n.a.*
W-males	*0.185*	*0.164*	*0.181*	*0.174*	*0.320*
W-females	*0.160*	*0.149*	*0.142*	*0.203*	*0.302*
B-ineq (2)	*0.007*	*0.007*	*0.006*	*0.006*	*n.a.*
Overall (1+2)	*0.185*	*0.166*	*0.176*	*0.189*	*0.323*

Cell 3: cohort 1960-69, retirement 2020-27

Actual Pension	**GE(-1)**	**GE(0)**	**GE(1)**	**GE(2)**	**Gini**
W-ineq (1)	*0.123*	*0.089*	*0.090*	*0.071*	*n.a.*
W-males	*0.095*	*0.077*	*0.085*	*0.064*	*0.204*
W-females	*0.161*	*0.114*	*0.095*	*0.088*	*0.240*
B-ineq (2)	*0.008*	*0.007*	*0.006*	*0.007*	*n.a.*
Overall (1+2)	*0.130*	*0.097*	*0.097*	*0.078*	*0.225*
Virtual Pension	**GE(-1)**	**GE(0)**	**GE(1)**	**GE(2)**	**Gini**
W-ineq (1)	*0.134*	*0.103*	*0.098*	*0.085*	*n.a.*
W-males	*0.111*	*0.094*	*0.095*	*0.081*	*0.231*
W-females	*0.170*	*0.122*	*0.102*	*0.094*	*0.247*
B-ineq (2)	*0.004*	*0.004*	*0.004*	*0.004*	*n.a.*
Overall (1+2)	*0.138*	*0.107*	*0.103*	*0.089*	*0.243*

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