Life Expectancy Heterogeneity and Pension Fairness: an Italian North-South Divide

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Abstract

This work documents the persistence in life expectancy heterogeneity by gender at level NUTS-1, macro areas, and NUTS-2, regions, for Italy during 1974-2016. Based on gender-by-geography deviations of life expectancy at age 65, it retrieves associated tax/subsidy rates triggered by the adoption of a single, common, factor for longevity in the pension formula.

Using data for life expectancy extracted from ISTAT mortality tables for age 65 from 1974 to 2016, empirical evidence at national level shows that female and male are subsidised and taxed by around 10% respectively. Differences by geography persist along the Italian territory. Since 1996 South and Islands have being taxed by 2%, Center and North-West macro-areas are being subsidised by around 1%, whereas North-East by 2%. At NUTS-2 level, directional transfers remain valid and more pronounced. It is shown that a gender-differentiation of the longevity factor in the pension formula would reduce the intensity of the redistributive mechanism.

JEL Codes: D81, H55, J11, J14, J17, J18.

Keywords: Life Expectancy Heterogeneity, Tax/Subsidy Mechanism, NDC Pension Systems, Italian Economy, Regional Divide.

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1 Introduction

From the second half of the XIX century, world population have been experiencing continuous increases in life expectancy, by around three months every year (Oeppen and Vaupel, 2002). This result was firstly obtained by improvements in infant mortality and, since the second half of the XX century, by improvements for people in old age. Italy was not immune from this trend[1]. Worldwide, to date, Italy is one of the most longeve country.
Since '90s, increases in life expectancy among old people have urged policy makers to reform the public pension systems. In fact, it is well-known than an ageing population threatens the financial sustainability of public pension systems. To counteract continuous improvements in longevity, increases in retirement age have been an unavoidable, but not innocuous, solution. Increasing retirement age without is not harmless in a context of systematic longevity heterogeneity, by some socioeconomic dimensions, among retirees. On this point, see Auerbach et al. (2017) for US and Whitehouse and Zaidi (2008) for OECD countries.
Recalling the definition of (average) actuarial fairness Holzmann and Palmer (2006), the internal rate of return that equals the discounted sum of pension contributions and payments over the life course must be (on average) the same across individuals. Accordingly, individuals known for their living shorter should be compensated from those who are known for their living longer. A pension system that does not account for such (systematic) heterogeneity violates (on average) actuarial fairness and triggers, instead, a redistribution of public resources that penalise those socioeconomic groups associated with shorter lives. Since improvements in longevity are neither randomly nor uniformly distributed across individuals, the resulting tax/subsidy mechanism redistribute resources among retirees. If, as often the case, life expectancy at retirement positively correlates with income, then such redistribution is regressive (Holzmann, 2017).
One of identifying properties of a Non-financial (unfunded) Defined-Contribution

[1] Caselli, Peracchi, Barbi and Lipsi (2003) estimates the gain (in years) in life expectancy by gender for different age groups between 1930-1950 and 1970-1995. For males aged 1-14, it decreased from 3.36 to 0.43, while for those aged 60-79 raised from 0.58 to 2.01 years. Similarly, for females aged 1-14 it decreased from 3.92 to 0.33 and increased for those aged 60-79 from 0.83 to 3.04 years.

(NDC[2]) is that pension benefits are constructed to reflect life expectancy at retirement Holzmann and Palmer (2006). This connection is expressed through a longevity factor which transforms the accumulated (and notionally capitalised) sum of pension contributions to a pension annuity. Since the longevity factor applied in practice is the (ex-ante) estimated for the whole population, systematic (ex-post) deviations trigger a stable redistribution of resources from those groups who systematically live shorter to those who live longer than commonly assumed. Hence, in an ageing population it becomes politically relevant to be aware on persistent redistributive patterns along some relevant socioeconomic dimensions. A typical case is from men to women (Holzmann and Palmer, 2006). As surveyed by Ayuso et al. (2017*b*), other dimensions over which one or more subgroups are being systematically subsidised or taxed are cohort, gender, education, geography, income, cohort, race, marital and health status. Empirical evidence confirms that heterogeneity in life expectancy, and thus the associated transfer mechanisms, is a phenomenon persisting for many industrialised countries over decades.

Since pension annuities are computed once for all, the ideal logic is to apply accurate estimates of life expectancy at time of retirement for each individual and keep updated such estimates. In this regard, Italy adopts an automatic revision of conversion factors every three (two, from 2019) years based on newly updated periodic mortality table. Belloni and Maccheroni (2013) shows that the more frequent the revision of coefficients, the lower the transfer across adjacent cohorts. While Ayuso et al. (2018) stresses the importance of using cohort, and not period, mortlaity tables in to update longevity factors.

Among possible interventions, Ayuso et al. (2017*a*) distinguishes among accumulation (post-contribution) phase, benefit determination (at retirement) and disbursement phase (after the first payment), and discuss pros and cons for each of them. These policy interventions are further examined by Holzmann et al. (2017). Interventions at retirement result desirable since changes in individual socioeconomic characteristics are less likely to occur after retirement.

The contribution of this work is threefold. Firstly, it extends and updates

[2]Despite the paper mainly focuses on the Italian NDC public pension system, much of the discussion is also valid for Defined-Benefit pension schemes. See Ayuso et al. (2018) for an analysis on Portuguese and Spanish public pension systems.

the geography of life expectancy in Italy for both males and females over 1974-2016. Secondly, it computes associated profiles of tax/subsidy rates between genders across different geographical areas (NUTS-1 and NUTS-2). Thirdly, it compares the intensity of the transfer mechanism with the case where pension formula is gender-differentiatiated[3].

Structure. This paper is organised as follows. Section 2 reviews the empirical literature on life expectancy heterogeneity in Italy. Section 3 provides empirical evidence. Section 4 computes associated tax/subsidy rates across Italian territories and by gender, proposes a policy of gender-differentiation and compares resulting intensities with the unconditional case. Section 5 concludes.

2 An Empirical Literature Review

The empirical literature on differentials in longevity across different socioeconomic groups can be dated back at least to Antonovsky (1967), who documents for U.S. the inequality in longevity by age, income class and profession[4]. A vast literature has then developed, favoured by an increasing availability of mortality data differentiated by some relevant socioeconomic groups. Recently for US, Chetty et al. (2016) reports that between 2001 and 2014 inequality in longevity across income groups has increased a great variation persists over geographical areas. Currie and Schwandt (2016) provides empirical evidence for inequality in longevity by age, etnies and gender for the period 1990-2010.

One of the early contributions for Italy is Natale and Bernassola (1973), which analyses mortality patterns by causes of death over 1790-1964. Caselli (1983) is the first work that, focusing on males aged 30-60 born in 1921, analyses differences across cohorts and along the Italian territory. It considers regions (NUTS-2) of Lombardy, Veneto, Latium and Calabria as representative for four Italian macro areas (NUTS-1), territorial disparities in longevity

[3]The author recognises that the practice of gender-differentiation is politically debatable and, even more, current legislation in various European countries request unisex mortality for calculations of pension annuities Ayuso et al. (2017*a*). This notwithstanding, it is relevant to make transparent the economic implications of standard pension rules.

[4]In the upfront of his paper, he recall the official casualty list of the Titanic among females: 4 out of 143 (2.8%) from first class, 15 out of 93 (16.13%) from the second class and 81 out of 179 (45.25%) from the third class were drowned.

increase from age 30 to age 60. The study is then extended by Caselli and Reale (1999) to include both genders, the regions of Tuscany and Sicily and considers the period from 1951 to 1992. North-West gradually improves its position, North-East has recently improved, Centre Italy has improved in some regions and deteriorates in others, while the advantage of the South in the post-war years gradually diminishes. Overall, the geography of longevity is evolving over decades. The work of Caselli, Peracchi, Barbi and Lipsi (2003) is the first thatrelates heterogeneity in longevity with the actuarial fairness of the newly introduced NDC in 1996 in Italy. They estimate the difference between region-by-gender life expectancies and currently legislated values adopted when pension annuities are computed, concluding that conversions factors are very sensible to small variations in mortality probabilities. Given a survival gain of 1.2 years (1.5) for men (women) at age 60, they estimate that conversion factors for pension annuities need to be lowered by $2.5-3.2\%$ for ages 57-65 and by $3.6-4.3\%$ for ages 65+. Instead, by gender, they would need to be lowered by $0.5-1.81\%$ $(4.7-6.8\%)$.

Focusing on the greography of mortality in Italy, Caselli, Cerbara, Heinsg and Lipsi (2003) describes describing the evolution of patterns for 94 provinces (level NUTS-3) by causes of death over early 70s and early 90s, thus presenting the first picture covering almost the totality of the national territory. Two contrasting, but expected, images emerge: a wealthier North and a poorer South that continually lags behind. Also Maccheroni (2006) concludes that dispersion is persistent, despite reducing, for Italian regions over the period 1960-2000 especially among females. Other works have focused on other relevant socioeconomic dimensions like education Luy et al. (2011); Maccheroni (n.d.); Mackenbach et al. (2016); Mazzaferro et al. (2012), income inequality De Vogli et al. (2005); Materia et al. (2005), income quintiles Belloni et al. (2013) and occupations Belloni and Maccheroni (2013); Lallo and Raitano (2018); Mackenbach et al. (2016). Unfortunately, all these studies limit their findings at most up to the year 2000, with the only exception being Lallo and Raitano (2018); Maccheroni and Nocito (2017); Mackenbach et al. (2016) which use data beyond early 2000s but do not focus on geographical heterogeneity[5]. See table 1 for a comparative overview.

[5] Mackenbach et al. (2016) focuses on the city of Turin, while Maccheroni and Nocito (2017) adopts the four-decades time series provided by ISTAT to backtest two popular models in mortality forecasting and Lallo and Raitano (2018) considers a time span lasting five years suing microdata.

REFERENCE	SOCIOECONOMIC DIMENSION	DATASET	TIME PERIOD
Natale (1973)	Gender		1790 - 1964
Caselli (1983)	Cohort	Regional Mortality Tables	1882 - 1953
Caselli (1999)	Gender, Geography	Regional Mortality Tables	1952 - 1992
Caselli (2003a)	Cohort, Gender, Geography	ISTAT	1887 - 1997
Caselli (2003b)	Causes of Death, Cohort, Gender, Geography	Provincial Mortality Tables	1971-73, 1981-83, 1991-93
Conti (2003)	Cause of Death, Gender	ISTAT + ISS	1970, 1980, 1990, 1997
Materia (2005)	Gender, Income (Inequality)	ISTAT + MEF	1994
De Vogli (2005)	Income (Inequality)	ISTAT + SHIW + UN	1995, 1998, 2000, 2001, 2003
Caselli (2006)	Age (80-100), Gender, Sardinia	Provincial Mortality Tables	1975-77, 1996-97, 1998-2000
Maccheroni (2006)	Education, Gender, Geography	ISTAT	1960, 1970, 1980, 1990, 2000
Maccheroni (2008)	Education, Gender	ISTAT + CENSUS	2001
Luy (2011)	Education, Men, Occupation	ISTAT + CENSUS	1980 - 1994
Mazzaferro (2012)	Education, Income	ISTAT	1975 - 2000
Belloni (2013a)	Income (Quintiles)	INPS	1979 - 1990, 1991 - 2001
Belloni (2013b)	Cohort, Gender, Occupation	INPS + SHIW	1985 - 1997
Mackenbach (2016)	Education, Occupation	Turin Mortality Table	1990 - 2010
Maccheroni (2017)	Gender	ISTAT	1975 - 2014
Lallo (2018)	Occupation	EU-SILC + INPS	2005 - 2009

Table 1: *Empirical literature on life expectancy heterogeneity in Italy. Datasource*: *ISTAT* refers to mortality tables provided by the Italian Statistical Institute; *ISS* refers to the Istituto Superiore di Sanità; *MEF* to the Ministry of Economics and Finance; *SHIW* refers to the Survey of Household Income and Wealth from the Bank of Italy; *UN* stands for United Nations; *CENSUS* indicates Italian census data; *INPS* is the Italian social security institute; *EU-SILC* is the European Statistics on Income and Living Conditions.

Thus, no study documents geographical disparities in life expectancy after the financial crisis of 2007. Focusing on the period 1974-2016 and geography (NUTS-1 and NUTS-2), this work extends Caselli and Reale (1999) and Caselli, Cerbara, Heinsg and Lipsi (2003); Caselli, Peracchi, Barbi and Lipsi (2003) to a longer time span and a complete territorial coverage. Like Caselli, Peracchi, Barbi and Lipsi (2003); Maccheroni (2006); Mazzaferro et al. (2012) and Belloni and Maccheroni (2013), this work goes beyond the characterisation of the geography of mortality in Italy and analyses the link between longevity heterogeneity and distributional aspects of the Italian NDC pension system. The adoption of a unique, homogeneous, longeviy factor at population level triggers a redistributive mechanism. Focus is on geography and gender, for which dimensions longevity heterogeneity at retirement is translated in tax/subsidy rates. It finally measures the intensity of the transfer mechanism, as proposed by Holzmann (2017), and compares the standard case with an intervention at retirement for which gender differentials in longevity are explicitly considered.

3 Empirical Evidence

3.1 Data

This work uses data on life expectancy extracted from ISTAT database for mortality tables covering the period 1974-2016. This administrative dataset links death certificates of individuals in a given year to the area where resident. Implicitly, individuals are assumed to live in the area where the death certificate is registered. Time series are disaggregated by gender (Female, Male, Total) and by geography, i.e. NUTS-1 for macroareas and NUTS-2 for regions (see figure 1). This work focuses life expectancy at the age 65, proxy for retirement age, corresponding to the number of residual years that an individual aged 65 is expected to live[6].

[6] For a similar choice of age 65 as proxy for retirement, see also Ayuso et al. (2017*a*, 2018); Holzmann et al. (2017); Mackenbach et al. (2016); Whitehouse (2007); Whitehouse and Zaidi (2008). For lower (higher) ages, evidence and results provided in following sections can be considered as an upper (lower) bound, since dispersion in life expectancy usually increase with age reaching the peak at retirement. A refinement of the estimates f the tax/subsidy mechanism is to consider the effective retirement age and not the statutory limit. This exercise is left for further research.

NUTS-0	COUNTRY	NUTS-1	MACRO AREA	NUTS-2	REGION
IT	Italy	**ITC**	North-West	**ITC1**	Piedmont
				ITC2	Aosta Valley*
				ITC3	Liguria
				ITC4	Lombardy
		ITF	South	**ITF1**	Abruzzo
				ITF2	Molise*
				ITF3	Campania
				ITF4	Apulia
				ITF5	Basilicata
				ITF6	Calabria
		ITG	Islands	**ITG1**	Sicily
				ITG2	Sardinia
		ITH	North-East	**ITH1**	Province of Bolzano*
				ITH2	Province of Trento*
				ITH3	Veneto
				ITH4	Friuli-Venezia Giulia
				ITH5	Emilia-Romagna
		ITI	Center	**ITI1**	Tuscany
				ITI2	Umbria
				ITI3	March
				ITI4	Latium

Figure 1: *Classification of the Italian territory. Source: Eurostat (2018).*
*: Excluded for negligible size of population.

3.2 Evidence by Geography

Empirical evidence population level shows for Italy that life expectancy at age 65 increased during 1974-2016 from 15.14 to 20.72 (figure 2).

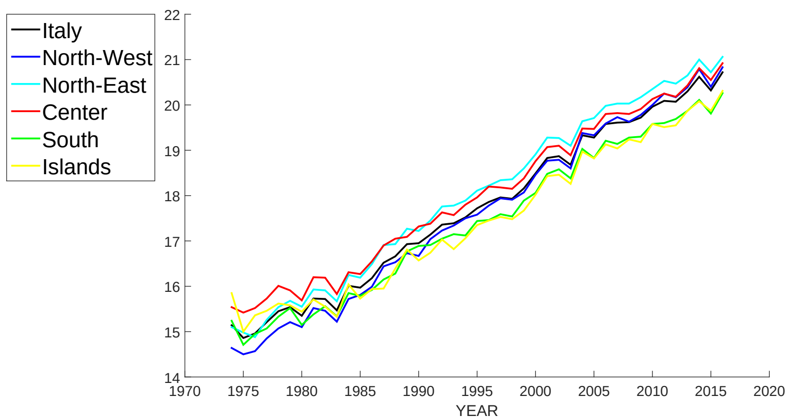

Figure 2: *Life Expectancy at age 65, from 1974 to 2016, for the total population in Italy across macro areas (NUTS-1). Source: ISTAT (2018).*

The division of Italy into macro areas depicts a clear divergence. Starting from the beginning of 90s, Mezzogiorno (South and Islands) has exhibited a lower profile compared to rest of Italy. In 1974, while Mezzogiorno and Center shared the same level of life expectancy (15.45 and 15.54 years, respectively), with North (North-East and North-West) showing the lowest (14.82 years), their position reversed from the second half of the '80s. In 2016, North Italy shares the same value with Center (20.92 years), while Mezzogiorno's longevity is half year lower (20.28 years). Moving to regions (figure 3), Campania in the South and Sicily in the Islands shows the lowest profile[7]. Whereas Trentino (North-East) and Marche (Center) show the highest value of longevity at 65.

[7] The result of Campania was also noted by Maccheroni (2006), which highlights the incidence of very high diabete-related mortality and cardiovascular diseases in the two regions. Also Caselli, Cerbara, Heinsg and Lipsi (2003) detects a pattern reversal, from North-East in 1971-73 to the South and Islands in 1991-93, of cyrrosis of the liver.

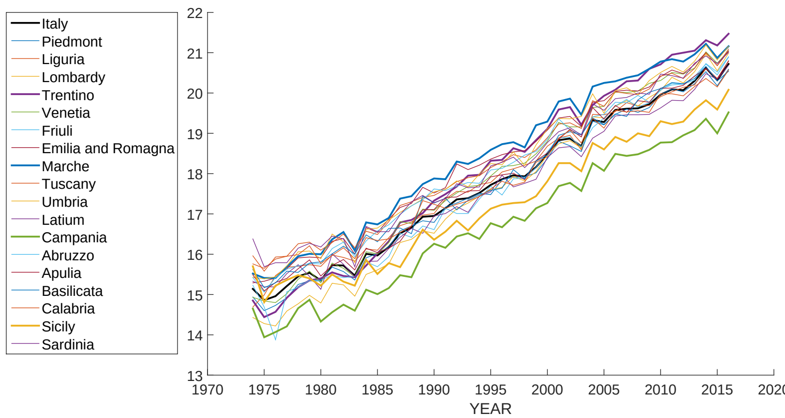

Figure 3: *Life Expectancy at age 65 for the total population in Italy, from 1974 to 2016, across regions (NUTS-2). Source: ISTAT (2018).*

It is interesting to note that in 1974 Campania and Trentino shared the same longevity (14.65 and 14.85 years), similar to Sicily and Marche (15.7 and 15.52). In 2016, after four decades, their values are 19.52 and 21.47 (2 years gap), 20.08 and 21.16 (one year gap) respectively.

3.3 Evidence by Gender

Persistent differences in life expectancy at age 65 characterise the Italian. South and Islands actually show the lowest profiles of longevity. This is especially true for Campania in the South, Sicily in the Islands. The rest of Italy, especially the regions of Trentino in North-East and March in the Center, enjoys an above-average longevity. Such geographical patterns also remains when longevity profiles are disaggregated by gender.
As figure 4 confirms, females live longer than men. A gap that increased to four years in 1974-1995, remained stable in 1996-2005 to reduce to three years since 2005 as it was four decades ago. Reasons for this narrowing in gender gap can be found in convergent, but unhealthy, lifestyle (stress, smoking, drinking) arose since women's emancipation (Caselli, Peracchi, Barbi and Lipsi, 2003; Conti et al., 2003; Liu et al., 2012; Maccheroni, 2006; Trovato and Lalu, 1996, 1998). Unlike the unisex picture provided at national level, disaggregation by gender depicted reveals that females of Mezzogiorno (South

and Islands) have always maintained a negative gap with the rest of Italy since 1974. On the contrary, the male counterpart has started to diverge in 2005.

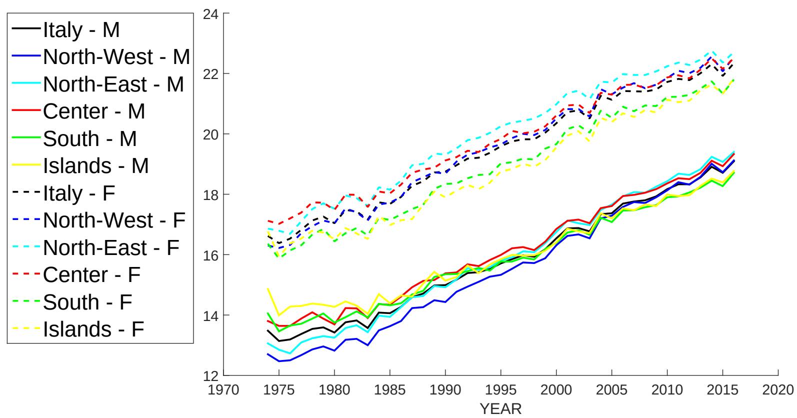

Figure 4: *Life Expectancy at age 65 for male and female population in Italy, from 1974 to 2016, across macro areas (NUTS-1). Source: ISTAT (2018).*

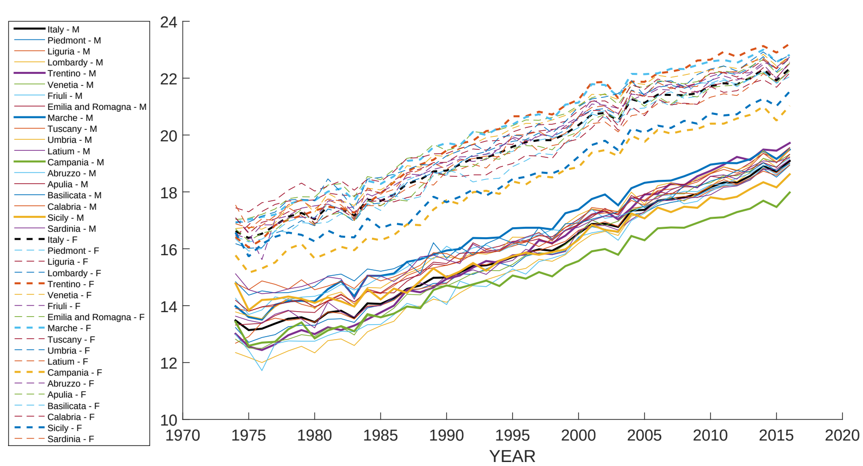

Figure 5: *Life Expectancy at age 65 for male and female population in Italy, from 1974 to 2016, across regions (NUTS-2). Source: ISTAT (2018).*

Figure 5 confirms tha regions of Campania and Sicily are those contributing the most to the divergence between Mezzogiorno (South and Islands) and

the rest of Italy. Regions of March and Trentino, instead, share the highest values of longevity at age 65 both for male and female.
It is interesting to also report the evolution of dispersion, measured in standard deviation, of longevity across Italian territories. Dispersion across macro-areas (left panel) decreased from 0.4 in 1974 to a minimal of 0.25 in 1985 and increased to around 0.4 years in 2016. Dispersion across regions (right panel) shows a more stable pattern of around 6 months (0.5 years) during the four decades. In both cases, differences in life expectancy by geography are more pronounced for female than for male. Moreover, since 1996 dispersion is reducing for female but is increasing for males. Convergence is taking however place after 2005.

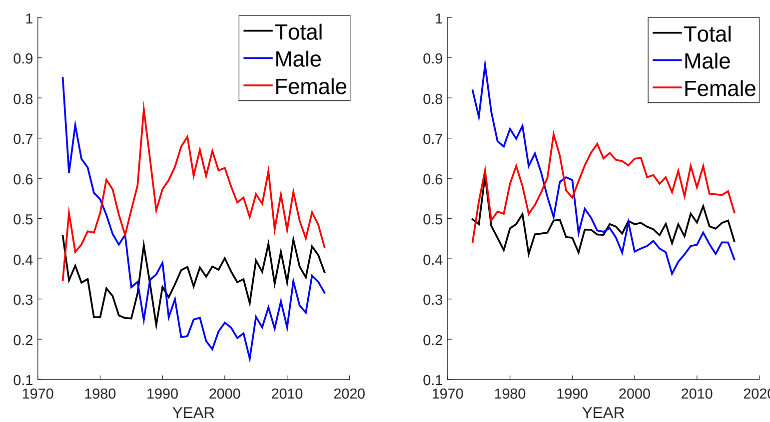

Figure 6: *Standard deviation of life expectancy In Italy at age 65 by gender and geography: macro areas (NUTS-1, left) and regions (NUTS-2, right). Source: Author's own elaboration on data from ISTAT (2018).*

At a first sight, a level of dispersion in life expectancy at age 65 of less than half year seem more than acceptable for a country like Italy. Next section will translate such persistent disalignments by gender and by geography into tax/subsidy rates. This will characterises the transfer mechanism operating from those areas where individuals live shorter (and so, they are taxed) to those where individuals live longer (and so, they are subsidised) than the common value imputed in the pension formula.

4 Results

4.1 The Tax/Subsidy Mechanism

This section provides results from computation of the implicit tax/subsidy rates specific for each gender-by-geography subgroups. Gender and territorial heterogeneity in longevity is now translated into rates at which the adoption of an homogeneous value for life expectancy reflects as tax/subsidy to individuals living shorter/longer than average. If deviations from the common value are systematic, then individuals receive a pension annuity which is lower/higher than the actuarially fair value.

To illustrate the connection in the NDC pension formula between longevity heterogeneity at retirement and tax/subsidy rate, let K be the value of pension capital at retirement for individuals i. Assume that a NDC pension annuity is simply computed dividing K by the value of life expectancy at population level LE. If (ex-post) deviations are systematic, i.e. $LE_i \neq LE$, then actuarial fairness would imply $P_i^F = \frac{K}{LE_i} \neq P = \frac{K}{LE}$. The tax/subsidy rate represents the percentage deviation of the standard pension P with the one that is actuarially fair for individual i, i.e. P_i^F. The rate τ_i can thus be expressed as:

$$\tau_i = \frac{P - P_i^F}{P_i^F} = \frac{\frac{K}{LE} - \frac{K}{LE_i}}{\frac{K}{LE_i}} = LE_i \left(\frac{1}{LE} - \frac{1}{LE_i} \right) = \frac{LE_i}{LE} - 1 \qquad (1)$$

The rate is negative/positive if individual i lives shorter/longer than imputed in P, i.e. if $LE_i < / > LE$. Pension capital is thus taxed/subsidised in the sense that the public pension system, implicitly through its pension formula, extracts/imputes extra resources from/to short/long-living retirees.

Following the logic expressed by equation 1, time profiles of tax/subsidy rates across Italian macro areas and regions are firstly reported for the whole population. Profiles are then disaggregated by gender. Lastly, a policy exercise of gender-differentiation is considered.

4.2 Tax/Subsidy Rates: geographical profiles

Let LE_t be the homogeneous value of life expectancy for individuals aged 65 at time t through which pension annuities are computed. Let $LE_{t,a}$ be the value of LE_t specific to the geographical area indexed by a and referring either to a macro area (NUTS-1) or to a region (NUTS-2). Recalling equation 1, the rate of transfer at time t specific to area a, $\tau_{t,a}$, is defined as:

$$\tau_{t,a} = \frac{LE_{t,a}}{LE_t} - 1 \tag{2}$$

where index t ranges from 1974 to 2016 and a represents an area of the Italian territory. The rate $\tau_{t,a}$ is positive if individuals in area a have a life expectancy at age 65 higher than that at country level LE_t. The rate is negative in the opposite scenario.

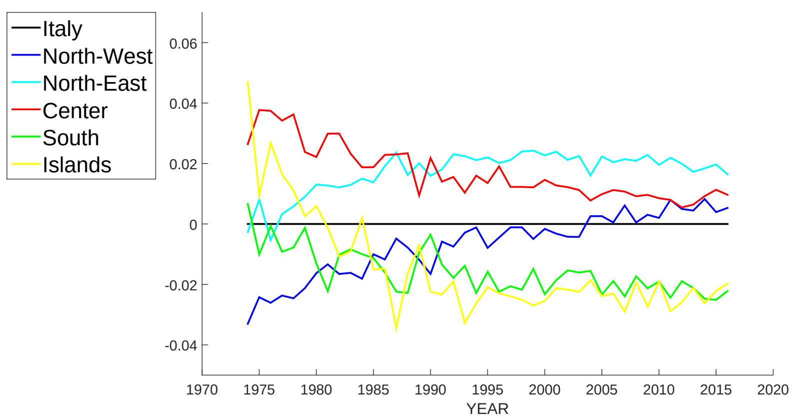

Figure 7: *Tax/Subsidy rate for Italian population aged 65 from 1974 to 2016 across macro areas (NUTS-1). Source: author's own elaboration on data from ISTAT (2018).*

As expected, figure 7 shows that the redistributive transfer within Italy persists over the last two decades. Individuals living in Mezzogiorno (South and Islands) are taxed by an average 2%. North-West and Center are both subsidised by 1% whereas North-East by 2%. Note that, after 2005, North-West reversed its position from tax-payer to subsidy-recipient. The North-South gap is increasing in the last decade. Figure 8 reports the same figures disaggregated by regions (NUTS-2), with rates ranging between 4% and -6%. Campania in the South is the most taxed region (around 6%), followed by Sicily in the Islands with around 4%). Among subsidised regions, Trentino in the North-East receives 4% while March in the Center declines from 4% to 2% after 2010.

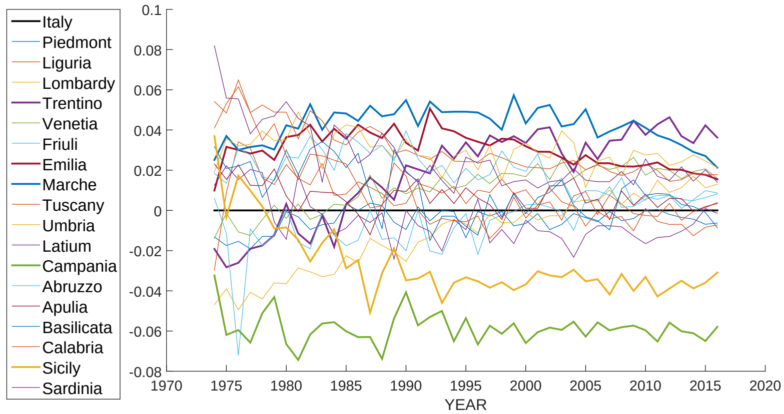

Figure 8: *Tax/Subsidy rate for Italian population aged 65 from 1974 to 2016 across regions (NUTS-2). Source: author's own elaboration on data from ISTAT (2018).*

4.3 Tax/Subsidy Rates: geography-by-gender profiles

Results are now disaggregated by gender. Recalling the tax/subsidy rate $ts_{t,a}$ defined in equation 2, the tax/subsidy rate specific to each geography-by-gender group at age 65, $\tau_{t,a,g}$, is computed as:

$$\tau_{t,a,g} = \frac{LE_{t,a,g}}{LE_t} - 1 \tag{3}$$

where $g = M$ stands for male and $g = F$ for female. As figure 9 shows, differences in life expectancy by gender translates into a stable transfer from males to females of around 10%[8]. Among males it is possible to observe territorial convergence between 1996-2005 followed by divergence of Mezzogiorno (South and Islands) since 2006. It is interesting to observe the rapid improvement of North-East, whose tax profile moved from around 15% during 1975 to 10% after 1995 to be the lowest with around -6%. Female in Mezzogiorno do not show reversal trends since they have always had the lowest profile.

[8]Estimates of around 10% are also found for other (Southern) European countries like Portugal and Spain Ayuso et al. (2017*a*,*b*, 2018). In 2014, while males are more taxed in Portugal than in Spain, females are more subsidised in Spain than in Portugal.

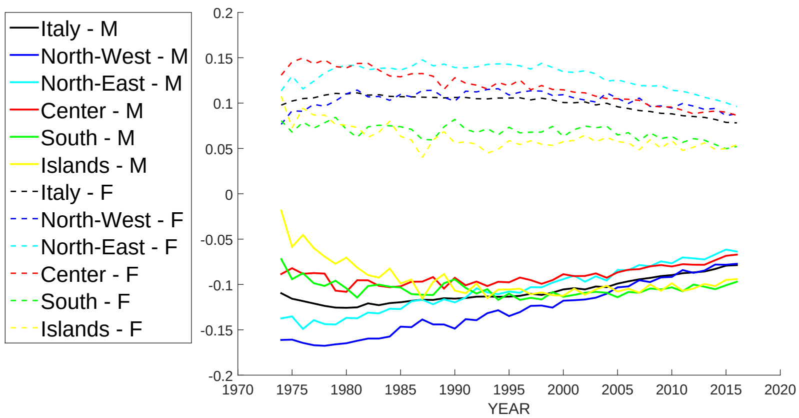

Figure 9: *Tax/Subsidy rate for Italian male and female population aged 65 from 1974 to 2016 across macro areas (NUTS-1). Source: author's own elaboration on data from ISTAT (2018).*

The geography of tax/subsidy profiles remain valid also if regions, and not macro areas, are considered. As depicted by figure 10, regions of Trentino (North-East), Marche (Center), Campania (South) and Sicily (Islands) lead results of the their macro area.

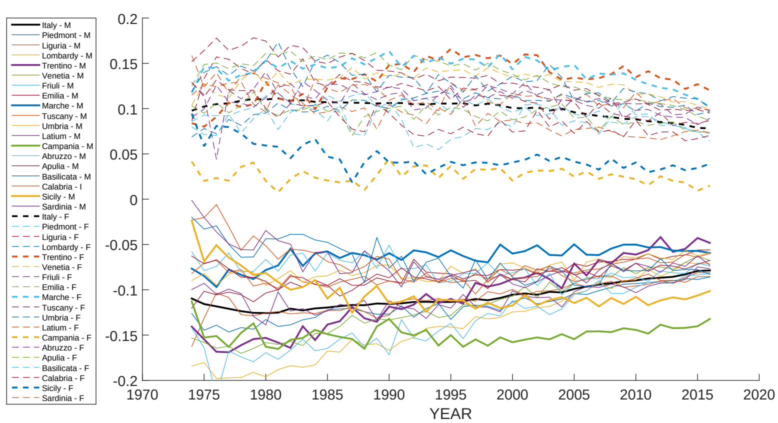

Figure 10: *Tax/Subsidy rate for Italian male and female population aged 65 from 1974 to 2016 across regions (NUTS-2). Source: author's own elaboration on data from ISTAT (2018).*

Lastly, figure 11 provides evidence for which dispersion of tax/subsidy rates is a longlasting feature. Morevoer, time profiles of standard deviations reveal that dispersion in life expectancy at age 65 within the Italian territory, for macro areas (NUTS-1, left) or regions (NUTS-2, right) is higher for female than for male but converging to 2%. In factm while dispersion among females is reducing, the one for male is increasing especially after the financial crisis of 2007-09 and the sovereign-debt crisis of 2010-2012.

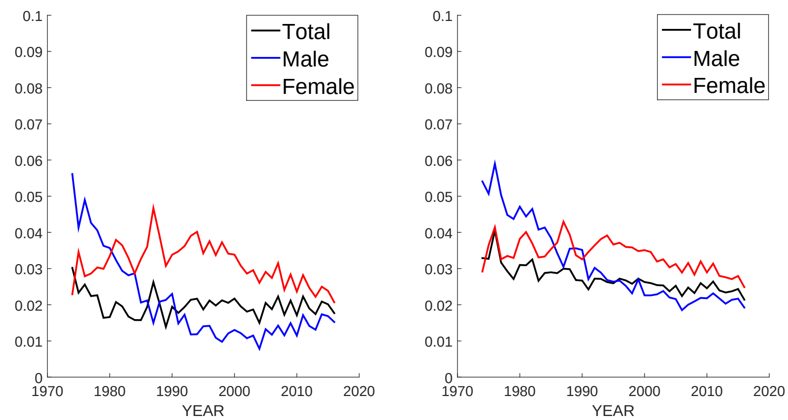

Figure 11: *Standard deviation of Tax/Subsidy rate for Italian total, male and female population aged 65 from 1974 to 2016 by geography: macro areas (NUTS-1, left) and regions (NUTS-2, right). Source: author's own elaboration on data from ISTAT (2018).*

4.4 Tax/Subsidy Rates: gender-differentiation

The case of gender-differentiation is now considered[9]. Given $LE_{t,g}$ the average life expectancy at 65 specific for gender g, the tax/subsidy rate $\tilde{\tau}_{t,a,g}$ at time t in area a under the gender-differentiated scheme is defined as:

$$\tilde{\tau}_{t,a,g} = \frac{LE_{t,a,g}}{LE_{t,g}} - 1 \tag{4}$$

Accounting for differences in life expectancy by gender is expected to reduce, *sic et simpliciter*, the intensity of the tax/subsidy mechanism at retirement since controlling for gender-related differences silent the channel of heterogeneity due to gender-related factors[10]. Looking at 12 two figures emerge. Firstly, compared to the (unconditional) casein figure 9, the magnitude of tax/subsidy rates reduces to one third, from ±6% to ±2% over the period 1974-2016. Secondly, from 2005, South and Islands have been the only taxed macro areas.

[9] The case of differentiation by geography is also considered. Overall, results show that intensity of the tax/subsidy mechanism is less reduced compared to the gender-differentiation case. Since gender differences are not accounted for, a stable gap persists also netting out geographical differences. Ask author for related material. Moreover, second-round effects resulting from possible manipulation of the residence just prior to retirement (especially for those living at the border between two different areas), let geographical differentiation a case which deserves further analysis. On the contrary, the gender dimension is less subject to manipulation in this respect.

[10] As discussed by Ayuso et al. (2017*a*) and Holzmann et al. (2017), intervention at retirement is desirable since information about health status and past work career are known with less uncertainty. Operatively, it is easily implementable, perfectly verifiable and less subject to manipulation at individual level. On the other side, one should bear in mind that pension reforms implementing a gender-differentiation in the pension formula are likely to have an effect on labour careers of female individuals. What is expected, at least among the most sensible under *ceteris paribus* conditions, is that an increase in (effective) taxation will make their labour supply lasting longer.

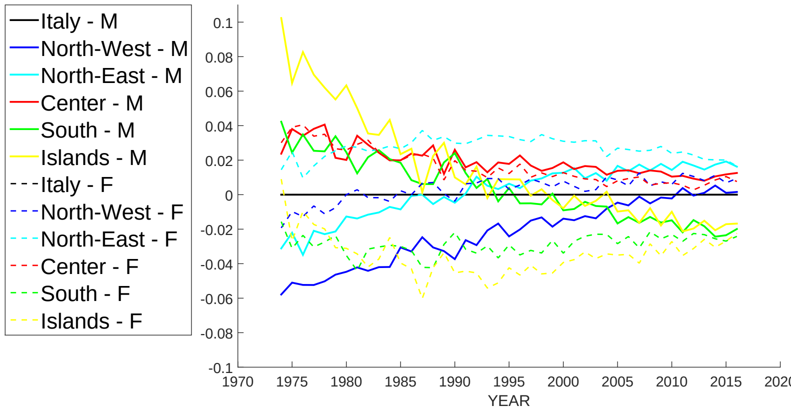

Figure 12: *Gender-differentiated tax/subsidy rate Italian population aged 65 from 1974 to 2016 by gender and by macro areas (NUTS-1). Source: author's own elaboration on data from ISTAT (2018).*

Disaggregation at regional level depicted by figure 13 confirms such general trends. Regions of Trentino and March are the most subsidised while Sicily and Campania are the most taxed. Unlike before, tax/subsidy profiles are now within a smaller band reducing from ±15% in the standard case (figure 10), to ±5%.

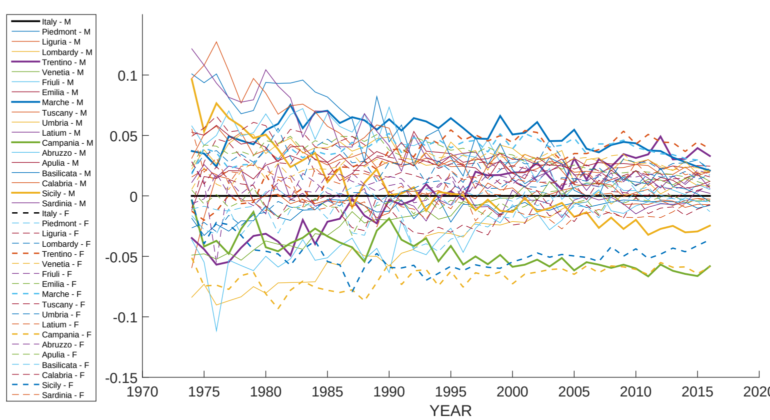

Figure 13: *Gender-differentiated tax/subsidy rate for Italian population aged 65 from 1974 to 2016 by regions (NUTS-2) and by gender. Source: author's own elaboration on data from ISTAT (2018).*

Finally, figure 14 reports that, if gender-specific value for life expectancy had been applied in the computation of pension annuities, dispersion of territorial profiles would have converged to a value of 2%. This is the same as in the unconditional case depicted in figure 11, meaning that considering gender-specific factors for longevity in the pension formula reduces only the magnitude of the transfer profiles (first-moment effect) but substantially does not impact on dispersion along geographical areas (NUTS-1, left, and NUTS-2, right).

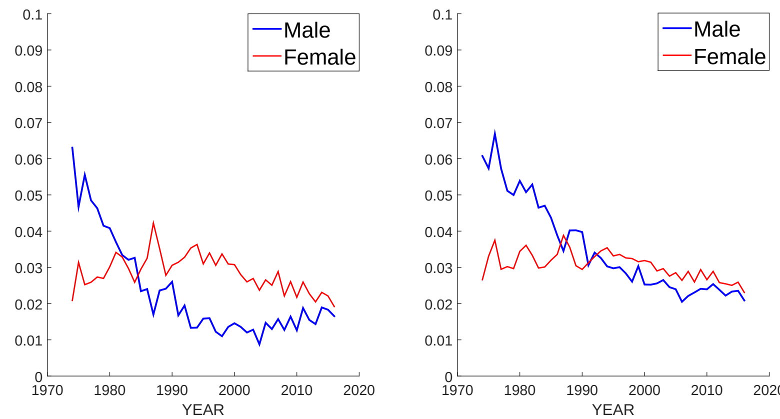

Figure 14: *Standard deviations of Tax/Subsidy rate for Italian population aged 65 from 1974 to 2016 by gender and by geography: macro areas (NUTS-1, left) and regions (NUTS-2, right). Source: author's own elaboration on data from ISTAT (2018).*

4.5 TATSI Analysis

Once profiles of unconditional tax/subsidy rate $\tau_{t,a,g}$ in equation 3 and gender-differentiated $\tilde{\tau}_{t,a,g}$ in equation 4 are retrieved, it is possible to measure intensity of the mechanism under each regimes and then compare them. At this aim, the Total Absolute Tax/Subsidy Index (TATSI, Ayuso et al. (2017*a*); Holzmann (2017)) is computed. Focus is on the last two decades, i.e. on the period 1996-2016.
Defined as sum of absolute values over the socioeconomic dimension of analysis (i.e. geography), let $TATSI_{t,g}$ and $\widetilde{TATSI}_{t,g}$ be the index at time t for gender g for the standard and the gender-differentiated case respectively.

Thus:

$$TATSI_{t,g} = \sum_a |\tau_{t,a,g}| \tag{5}$$

$$\widetilde{TATSI}_{t,g} = \sum_a |\tilde{\tau}_{t,a,g}| \tag{6}$$

where $|\cdot|$ refers the absolute value function.
As confirmed by figure 15, if public pension annuities had been computed under the gender-differentiated regime since the introduction of the NDC pension regime in Italy (i.e. the year 1996), the overall magnitude of the tax/subsidy mechanism across macro areas (NUTS-1, left) and regions (NUTS-2, right) would have been stabilised to around 0.1 and 0.5. On the contrary, the unconditional TATSI decreased from 0.6 in 1996 to around 0.5% in 2016 for macro areas and from 2 to 1.5 for regions[11].

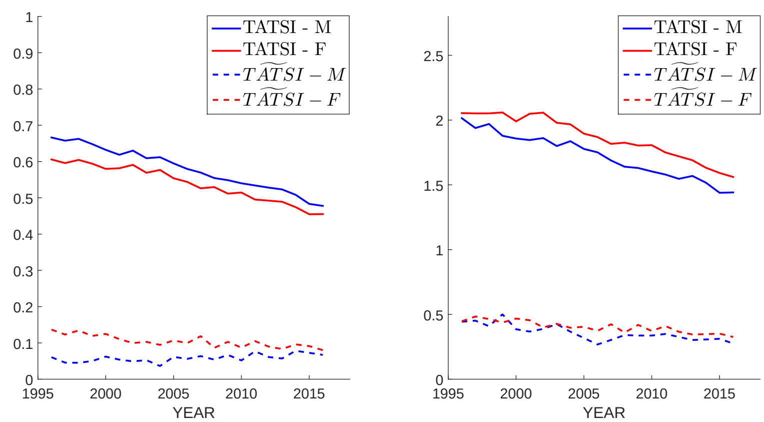

Figure 15: *TATSI profiles for unconditional and gender-differentiated tax/subsidy rates for Italian population aged 65 from 1996 to 2016 across for males and females. Aggregation by sub-macro-areas (left) and regions (right). Source: author's own elaboration on data from ISTAT (2018).*

[11]Note that the value of TATSI increases when one moves the analysis from macro areas to regions. This is does not necessarily reflect a sproportionately higher intensity of the tax/subsidy mechanism among regions compared to acro areas. Indeed, since the higher the number entries the higher the corresponding intensity in terms of TATSI, a scaling factor is needed to correct such inflationary trend of the TATSI. Further improvements of this index are left for future research.

5 Conclusions

This work provides empirical evidence for the evolution of life expectancy heterogeneity by gender and by geography, across macro areas (NUTS-1) and regions (NUTS-2), in Italy for the period $1974 - 2016$. The resulting analysis enriches the empirical literature on the relation between life expectancy heterogeneity and the actuarial fairness of pension systems. Profiles of tax/subsidy rates confirm that redistribution of pension resources still persists within the Italian territory. Divergence is observed between macro area of Mezzogiorno (South and Islands) and the rest of Italy. Regions of Campania and Sicily drives the tax profile of South and Islands respectively, whereas Trentino and March do the opposite for macro areas of North-East and Center. Concerning differences by gender, female (male) lives longer (shorter) than average which translates into persistent and sizeable profiles of tax/subsidy rates.

The standard design of the Italian public pension systems needs to be reformed towards a differentiation of its structural parameters, e.g. the longevity factor adopted to compute pension annuities. Doing so reduces the intensity of the tax/subsidy mechanism triggered at retirement, e.g. at age 65. Empirical results show that the intensity, measured in terms of TATSI, substantially lower both among males, females, across macro areas (NUTS-1) and regions (NUTS-2). Legislative constraints may impose the adoption of common life tables for computation of pension annuities, e.g. countries in the Europe Union (Ayuso et al., 2017*a*). This notwithstanding, a closer and updated monitoring of longevity heterogeneity along relevant socioeconomic dimensions is needed to make fully transparent redistributive performances of standard rules in public pension systems.

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