Addressing Longevity Heterogeneity in Pension Design and Reform

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MAIN OBJECTIVES

This paper demonstrates that the link between heterogeneity in longevity and lifetime income across countries is mostly high and often increasing.

It translates into an implicit tax/subsidy, with rates reaching 20 percent and higher in some countries.

Such rates risk perverting redistributive objectives of pension schemes and distorting individual lifecycle labor supply and savings decisions.

This in turn risks invalidating current reform approaches of a closer contribution-benefit link and life expectancy-indexed retirement age.

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MAIN OBJECTIVES

The paper suggests and explores a number of interventions in the accumulation, benefit determination, and disbursement stages to address longevity' heterogeneity.

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Outline

1. Introduction and Motivation
2. Scope and trends in longevity heterogeneity
3. Modeling and forecasting longevity heterogeneity
4. Heterogeneity in longevity as an implicit tax/subsidy
5. Implications of longevity heterogeneity for pension reform
6. Policy options to address longevity heteogeneity
7. Final remarks and discussion

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Introduction and Motivation

- Heterogeneity in longevity disaggregated by socioeconomic characteristics (e.g., gender, education, job, marital status,…) is **sizable**, is becoming **more prevalent,** and **shows few signals of abating in the near future.**

- Heterogeneity of longevity across socioeconomic factors is **highly correlated with income,** the contribution base of earnings-related social programs and saving efforts.

- Positive correlations between longevity and lifetime income results in **major implicit taxes and subsidies** for some groups.

- Heterogeneity **modifies the redistributive feature of pensions schemes**.

- Implications for pension reforms and schemes design are substantial as **taxes/subsidies counteract the effects of recent reforms.**

Scope of longevity heterogeneity by...

Ayuso, M., Bravo, J. M., Holzmann, R. (2016). On the Heterogeneity in Longevity among Socioeconomic Groups: Scope, Trends, and Implications for Earnings-Related Pension Schemes. IZA Discussion, Paper No. 10060, July 2016.

- **Age**
  - Life expectancy has been increasing at all ages (with few exceptions) but major differences exist across countries and regions.

- **Gender**
  - Women across all countries exhibit a much higher life expectancy than men albeit the differences at birth and at retirement between countries.

- **Health status and lifestyle**
  - The objective or subjective health status of individuals has a major bearing on remaining life expectancy for individuals
  - Health status as an outcome is not independent of individual lifestyle choices (inputs), e.g., smoking.

Scope of longevity heterogeneity by...

- **Level of education**
  - Close link between level of education and longevity.
  - Years of education is clearly a proxy for many other variables that impact longevity such as socioeconomic background (e.g., family status, as input) and market income (as outcome).
  - Education –as an outcome- is likely to also directly affect longevity through knowledge about lifestyles.

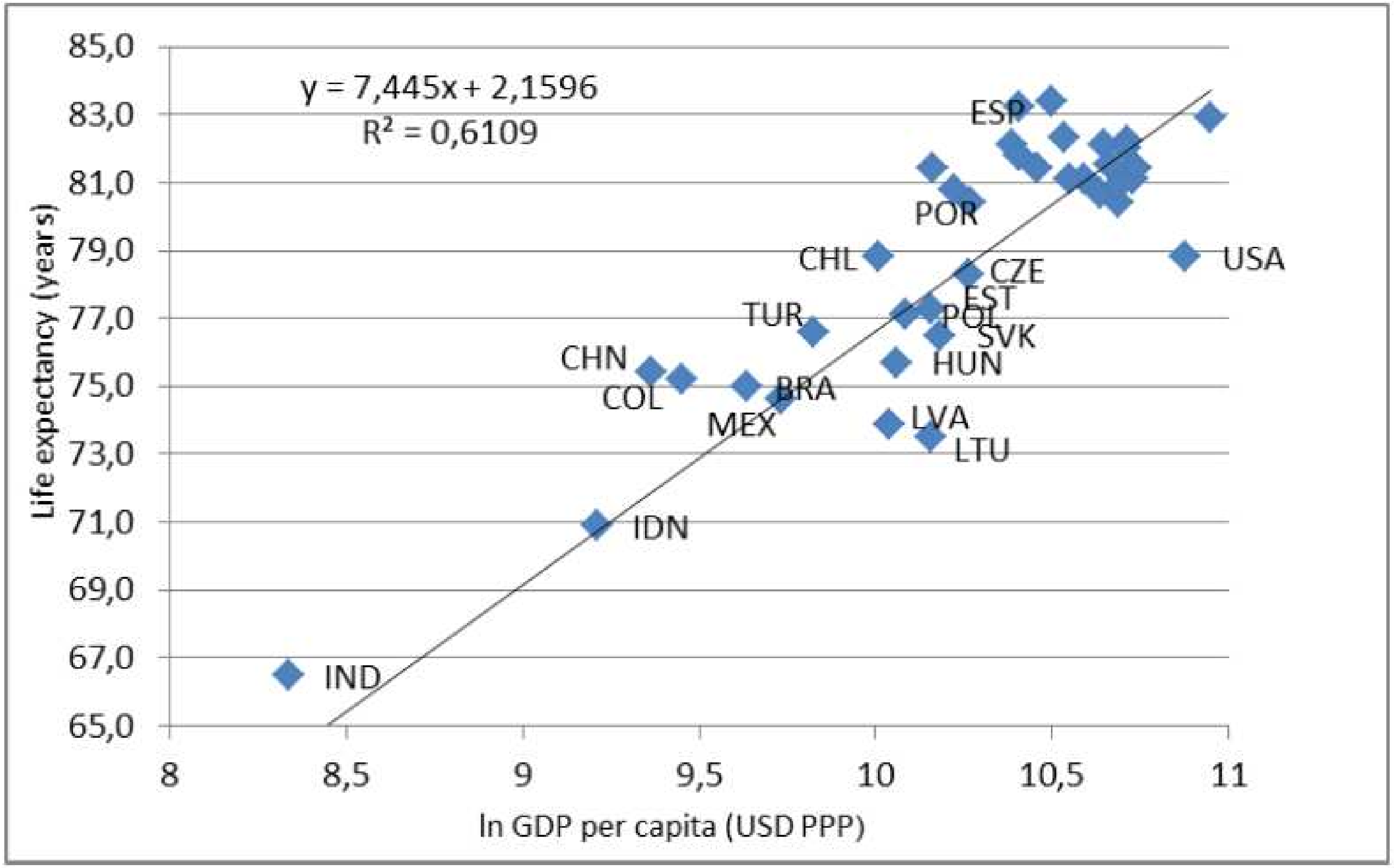
- **Marital status**
  - Male and female married individuals tend to live longer than widows.

- **Type of labor activity**
  - Studies suggest a relationship between type of economic activity and life expectancy (e.g., liberal professions vs manual professions).
  - Type of professional activity may serve as a proxy for other channels (e.g., income) or have a direct impact on longevity (e.g., via professional satisfaction).

Scope of longevity heterogeneity by...

- **Geographical area**
  - Region of residency in a country has an impact on life expectancy.
  - Region may serve as a proxy for income level, health infrastructure, and other inputs.
- **Income**
  - Cross-country data clearly indicate that income per capita is correlated with longevity.
  - Major differences in life expectancy can depend on position within a national (lifetime) income distribution.
  - Income level is an indicator for access to health care and other survival-relevant infrastructure.
  - Closely linked to other variables discussed (e.g., education, lifestyle).
  - Key variable since it determines the level of retirement income.
- **Combination of factors** (age, gender, race, income level, geographic zone, marital status,…).
  - Disaggregation allows insights into the joint distribution of heterogeneity-affecting indicators.

Life expectancy at birth and GDP per capita, 2013

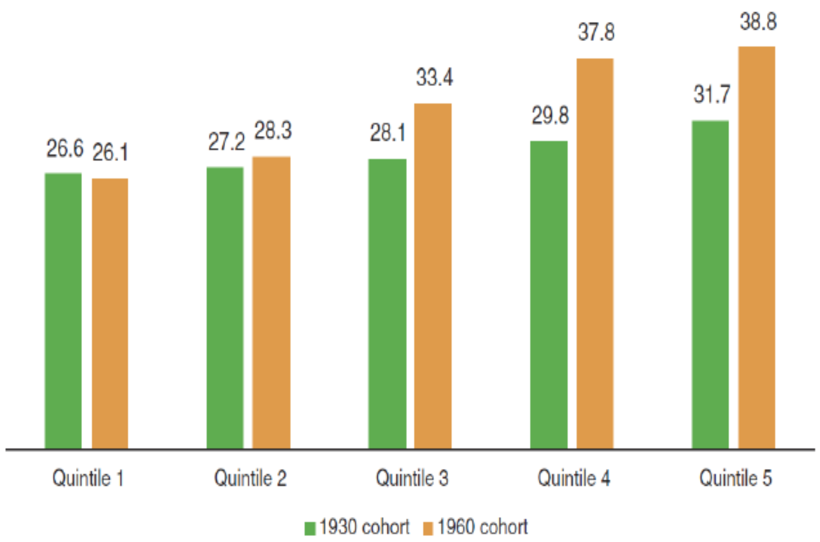


Source: OECD Health Statistic 2015.

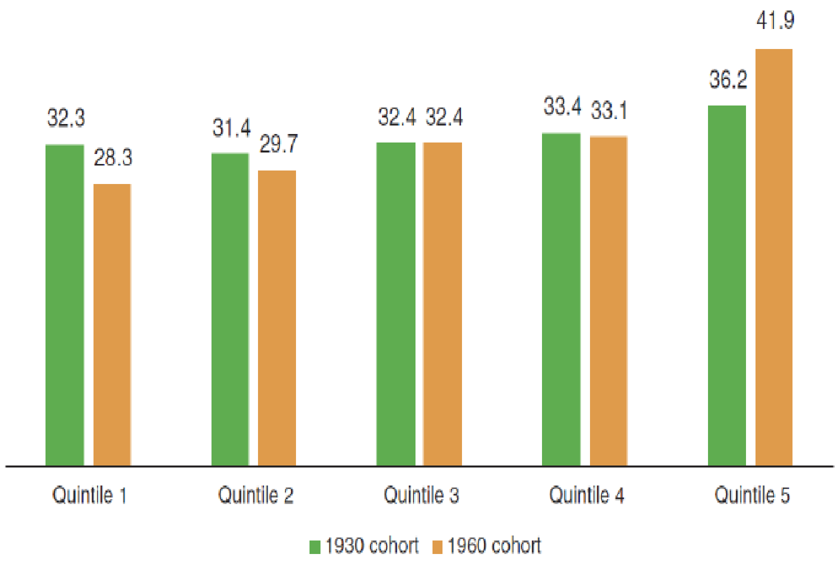
Scope of longevity heterogeneity by...

- **Lifetime income**
  - the gradient in life expectancy by income between the lowest and the highest (and most educated) income group has risen over time

Male life expectancy at age 50 by age cohort and lifetime income quintile, US
(Source: National Academies of Sciences, 2015)



Female life expectancy at age 50 by age cohort and lifetime income quintile, US
(Source: National Academies of Sciences, 2015)



Scope of longevity heterogeneity by...

Key results are highlighted in quintiles and for both cohorts and for males and females, respectively. both figures that present the life expectancy at age 50 by income

For both birth cohorts and for both gender the life-expectancy gap increase with the income quintile (except in one case).

Furthermore the gap has increased between the birth cohorts, for the 5th compared to the 1st quintile from 5.1 to 12.7 years for males, and from 3.9 to 13.6 years for females. These are large gaps and frightening trends.

Scope in heterogeneity in longevity for selected indicators

Socioeconomic dimension	Gap in years of LE	Country	Year	Comments (re: column 2)
Gender[a]	3.0/6.0 5.0/7.0	World Europe	2013	at birth/age 60
	4.0/5.9 4.0/6.4 3.0/4.8 3.0/6.9	Spain Portugal United States Hungary	2013	at birth/age 65
Level of wealth[b]	15.0	Norway-India	2013 (India,2009)	at birth
Level of income[c]	4.8/2.3 2.0/0.6	Canada	2005-2007	at birth (men/women) age 65 (men/women)
	5.1/3.9 12.7/13.6	United States	Cohort 1930 Cohort 1960	age 50 (men/women)
Health status[d]	15.9/21.0 14.7/19.7 12.8/21.0 7.6/13.1 12.4/18.2 18.3/24.3	EU(28) Spain Portugal Norway Hungary Estonia	2012	at birth (men/women)
Education level[e]	4.3/1.8 3.6/1.8 5.1/3.9 12.1/5.5 15.0/8.1	Portugal Italy Norway Hungary Estonia	2012	at age 30 (men/women)

Note: [a]Difference between men and women. [b]Difference between high and low GDP per capita (OECD 2015). [c]Difference between 5th (highest) and 1st (lowest) income quintile. [d]Difference between total life expectancy and healthy life expectancy. [e]Difference between adults with high and low levels of education. *Source:* Authors based on numerous studies.

Trends in longevity heterogeneity

Socioeconomic dimension	Changes in life expectancy differences in years	Country	Period	Comments (column 2)
Gender[a]	constant/constant constant/+1	World Europe	1990–2013	at birth/ at age 60
	-1/+0.1 -0,5/+0.1 -1.2/-0.7 -1.5/+0.1	Spain Portugal Norway Hungary	2002–2013	at birth/at age 60
Health status[b]	+1/+2 +1/+1	Portugal Spain	2000–2013	at birth (women/men)
Education[c]	+0.6/-2.5 +0.1/-0.7 +1.1/+0.6	Norway Italy Sweden	2007–2013	at birth (women/men)
	+1.2/+2	Portugal	2010–2013	at birth (women/men)
Labor activity[d]	+2/+2.1	England/Wales	1972–2006	at birth (women/men)
Income[e]	-0.2/-0.4	Canada	2000/2002 to 2005/2007	at birth (women/men)
	+7.6/+9.7	United States	Cohorts 1930/1960	at age 50 (women/men)

Note: [a]Change in difference in life expectancy between women and men along the period. [b]Change in difference between total life expectancy and healthy life expectancy along the period. [c]Change in difference in life expectancy between individuals with high and low levels of education along the period. [d]Change in difference in life expectancy for individuals with liberal profession and unqualified labor jobs along the period. [e]Change in difference in life expectancy for individuals with high and low levels of income (5th vs 1st quintile) along the period. *Source*: Authors based on quoted references.

Modeling and forecasting longevity heterogeneity

- Measuring baseline mortality differentials and projecting differences in improvements by socioeconomic characteristics requires significant data and appropriate estimation approaches.
- Multi-population stochastic mortality models
  - Li and Lee (2005): Lee-Carter model including a common trend factor
  - Russolillo et al. (2011): LC + subpopulation parameter that captures trend differences in mortality rates over time
  - Li and Hardy (2011), Cairns et al. (2011): cointegrated Lee-Carter model
  - Madrigal et al. (2011): Generalized linear models
  - Dowd et al. (2011): Gravity model for two interconnected populations of different size
  - Villegas and Haberman (2014): Relative modeling approach
  - Kleinow (2015): Multi-population model including a common age effect

Heterogeneity in longevity as an implícit tax/subsidy

- Compared to the average of participants in a scheme, an individual with a below (above)-average life expectancy receives a lower (higher) annuity value for his contributions.

- This is akin to a tax (subsidy) on his contributions whereby the tax (subsidy) rate is higher the lower (higher) his life expectancy relative to the pool's average.

- Consider individuals who have all accumulated the same savings amount at retirement to be converted into an annuity.

- Assume they retire at the same age and face the same interest rate, but have different life expectancies.

Heterogeneity in longevity as an implícit tax/subsidy

- Notation:

  t(s) = implicit tax (subsidy) rate
  AK = accumulation at retirement
  α = annuity rate
  p = pension benefit
  LE = life expectancy
  PW = pension wealth

  The subscript *i* denotes individual values and subscript *a* the average values of these variables

- The pension for each individual is:

$$p_i = \alpha \times AK_i$$

- Assuming the interest rate *r* equals the indexation rate of pensions, *d*, each individual PW_i is a function of its LE_i :

$$PW_i = p_i \times LE_i = \alpha \times AK_i \times LE_i$$

Heterogeneity in longevity as an implícit tax/subsidy

- The **tax (subsidy) rate** is defined as the difference in pension wealth compared to the average:

$$t(s)_i = \frac{(\alpha AK_i LE_i - \alpha AK_i LE_a)}{\alpha AK_i LE_a} = \frac{LE_i}{LE_a} - 1$$

with negative (positive) values representing the tax (subsidy) rate.

- General case with $d \neq r$:

$$t(s)_i = \frac{\sum_{\tau=0}^{\omega-x} p_{\tau+1,i} \left(\frac{1+d}{1+r}\right)^{\tau}}{\sum_{\tau=0}^{\omega-x} p_{\tau+1,a} \left(\frac{1+d}{1+r}\right)^{\tau}} - 1 = \frac{\sum_{\tau=0}^{\omega-x} p_{\tau+1,i} w^{\tau}}{\sum_{\tau=0}^{\omega-x} p_{\tau+1,a}^{\tau} w^{\tau}} - 1$$

  - if $w^{\tau} < 1$ (i.e., $d < r$), the tax rate as well as the subsidy rate decrease with the difference between indexation and interest rate
  - if $w^{\tau} > 1$ (i.e., $d > r$) both tax rate and subsidy rate increase

The scope of the tax/subsidy by gender (pension benefits in Portugal and Spain)

Table 4. Implicit Tax and Subsidy Rates in the Calculation of Life-time Annuities in Portugal and Spain, 2014 a/

	PORTUGAL		SPAIN	
Age	Male	Female	Male	Female
50	-8,28%	7,13%	-7,60%	7,23%
51	-8,42%	7,21%	-7,76%	7,36%
52	-8,54%	7,28%	-7,91%	7,48%
53	-8,63%	7,31%	-8,06%	7,60%
54	-8,76%	7,38%	-8,22%	7,73%
55	-8,87%	7,42%	-8,39%	7,86%
56	-8,99%	7,47%	-8,54%	7,97%
57	-9,10%	7,50%	-8,71%	8,10%
58	-9,19%	7,51%	-8,87%	8,22%
59	-9,32%	7,55%	-9,04%	8,34%
60	-9,43%	7,57%	-9,19%	8,43%
61	-9,55%	7,59%	-9,34%	8,51%
62	-9,69%	7,62%	-9,50%	8,60%
63	-9,82%	7,63%	-9,64%	8,66%
64	-9,99%	7,66%	-9,78%	8,72%
65	-10,13%	7,66%	-9,93%	8,77%
66	-10,26%	7,64%	-10,05%	8,80%
67	-10,40%	7,63%	-10,16%	8,80%
68	-10,59%	7,65%	-10,31%	8,83%
69	-10,75%	7,64%	-10,43%	8,82%
70	-10,90%	7,60%	-10,58%	8,84%
71	-10,98%	7,46%	-10,71%	8,83%
72	-11,21%	7,45%	-10,84%	8,79%
73	-11,46%	7,43%	-11,00%	8,78%
74	-11,64%	7,32%	-11,13%	8,71%
75	-11,84%	7,19%	-11,21%	8,60%

Source: Authors' calculations

Notes: a/ Calculated from remaining life expectancy, i.e. assuming annual pension indexation rate equals discount/interest rate.

The scope of the tax/subsidy by gender (Spain)

Table 5: Implicit Tax and Subsidy Rates in the Calculation of Life-time Annuities in Spain 2014 under Alternative Pension Indexation and Discount Rates

Male population to population average									
	Pension indexation rate								
Interest rate	0.000	0.005	0.010	0.015	0.020	0.025	0.030	0.040	0.050
0.000	-9.2%	-9.6%	-10.0%	-10.5%	-10.9%	-11.4%	-11.9%	-12.8%	-13.8%
0.005	-8.8%	-9.2%							-13.3%
0.010	-8.4%		-9.2%						-12.8%
0.015	-8.0%			-9.2%					-12.3%
0.020	-7.7%				-9.2%				-11.8%
0.025	-7.3%					-9.2%			-11.3%
0.030	-7.0%						-9.2%		-10.9%
0.040	-6.4%							-9.2%	-10.0%
0.050	-5.9%	-6.2%	-6.5%	-6.8%	-7.1%	-7.4%	-7.7%	-8.4%	-9.2%

Female population to population average									
Interest rate	0.000	0.005	0.010	0.015	0.020	0.025	0.030	0.040	0.050
0.000	8.4%	8.8%	9.2%	9.6%	10.0%	10.4%	10.8%	11.6%	12.5%
0.005	8.1%	8.4%							12.1%
0.010	7.7%		8.4%						11.6%
0.015	7.4%			8.4%					11.2%
0.020	7.1%				8.4%				10.7%
0.025	6.8%					8.4%			10.3%
0.030	6.5%						8.4%		9.9%
0.040	6.0%							8.4%	9.1%
0.050	5.5%	5.7%	6.0%	6.2%	6.5%	6.8%	7.1%	7.8%	8.4%

Source: Authors calculations

Notes: Calculated from weighted remaining life expectancy at age 60.

Scope of the tax/subsidy by lifetime income quintiles, US

Table 6: Implicit Tax/Subsidy Rates by Life-time Income Quintiles in the US 1/

Male	**Quintile 1**	**Quintile 2**	**Quintile 3**	**Quintile 4**	**Quintile 5**
Cohort 1930	-5.3	-3.2	0.0	+6.0	+12.8
Cohort 1960	-21.9	-15.3	0.0	+13.2	+16.2

Female	**Quintile 1**	**Quintile 2**	**Quintile 3**	**Quintile 4**	**Quintile 5**
Cohort 1930	-0.3	-3.1	0.0	+3.1	+11.7
Cohort 1960	-12.7	-8.3	0.0	+2.2	+29.3

Notes: 1/ Applies for fully actuarial annuity. – signals a tax, and + a subsidy rate. The estimates assume the pension indexation equal to the discount rate.
Source: Authors' calculations based on data from National Academies of Sciences (2015)

The estimated tax/subsidy rates for both males and females for the outer quintiles are, indeed, very high and have dramatically increased between the birth cohorts only 30 years apart. The tax rates for males can reach 21.9 percent, for females 12.7 percent; for the subsidy rate the females lead with 29.3 percent the males with 16.2 percent.

Implications of longevity heterogeneity for pension reform

- The economic effect of the implicit tax/subsidy rate on **labor market decisions** is equivalent to levying an additional tax/subsidy on social security contributions or mandated savings rates; operates via
    - the effect on the informality decision (tax evasion)
    - the effect on contribution density (tax avoidance)
    - and the effect on the retirement decision.

- Longevity heterogeneity has important **implications for the analysis and reform of pension schemes** because they:
    - modify the redistributive features and overall progressivity of pension schemes,
    - counteract the desired effect of recent pension reforms, aiming
        - a closer contribution-benefit link,
        - a later formal retirement age to address population aging,
        - more individual funding and private annuities to compensate for reduced public generosity

Perverting the redistributive objectives of pensions schemes

- Survival probabilities play a key role in computing initial and subsequent pension benefits, or the time during which the pension will be paid or in defining the qualifying conditions for pensions.
- With longevity heterogeneity, even if a pension scheme is actuarially fair for the population as a whole it will be actuarially unfair to groups with systematically shorter life expectancy.

Counteracting the objectives of recent reform approaches

Strengthening contributory principles

- Strengthening the link between pension entitlements and the length and value of contributory records:
  - makes the redistributive process more transparent and explicit,
  - offers better labor market incentives.

- The strengthening of contributory principles was accomplished by:
  - shifting from DB to DC schemes;
  - increasing the contribution period from best years to average lifetime earnings;
  - linking pension rules to life expectancy and introducing other automatic stabilizers;
  - increasing the minimum pension eligibility age and equalizing pensionable ages between women and men;
  - reforming early exit benefits.

Counteracting the objectives of recent reform approaches

Strengthening contributory principles

- These reforms have been typically implemented in a uniform way, applied to all participants, and mostly focused on the accumulation stage of retirement schemes.
- With systematic differences in life expectancy, actuarial fairness concepts cannot be defined across the population, but must be reformulated across homogeneous socioeconomic groups.
- Pension reforms that increase the number of years in the benefit formula uniformly for all workers are likely to redistribute in favor of high-skilled (and, generally, high-income) workers, who can more easily remain in the labor market and retire with full careers.

Counteracting the objectives of recent reform approaches

Achieving longer working lives

- With heterogeneity, individuals of different socioeconomic groups retiring at the same age can expect very different lengths of retirement.
- Policies encouraging people to retire later using average increases in life expectancy unevenly penalize individuals in lower socioeconomic groups who will work longer but not necessarily live longer.
- Uniform increases in the minimum pension eligibility age are likely to affect labor supply and savings decisions in a non-uniform way via pension wealth levels and implicit taxes on continued work.
- Uniform increases in the retirement age reduces the payout period of the high-skilled less, in relative terms, than that of the low-skilled.

Policy options to address longevity heterogeneity

- The redesign of pension schemes should eliminate/reduce the distortions (tax/subsidy effects) created by heterogeneity on individual labor supply and savings decisions.
- Benefit redesign may include **ex-ante or ex-post redistribution**.
- Intervention can occur at the **accumulation, annuitization, and decumulation phase**.

Policy options to address longevity heterogeneity

Interventions at contribution payment stage

- Differential social contribution rates by socioeconomic group: high (low) taxes for high- (low-) income groups.
- Application of a two-tier contribution scheme of individual and flat-rate allocation to individual accounts (in DC schemes).
- Differential accrual rates by socioeconomic group: high (low) accruals for low- (high-) income groups.
- Application of different revalorization indexes (of contribution or benefits accounts) across income groups.
- Matching contributions for short-lived income groups.

Policy options to address longevity heterogeneity

Interventions at benefit calculation stage

- Linkage of statutory retirement age with socioeconomic group-specific life expectancy (relational or frailty models, numerical rating system).
- Calculation of annuity factors for substandard mortality groups using an age-rating or age-shifting model.
- Two-tier benefit schemes: lump sum plus earnings-related payments (in DB schemes).
- Use of differential demographic sustainability factors by socioeconomic group.

Interventions at benefit calculation stage

Computing group specific annuity factors: Example

- Differential mortality model: numerical rating system

$$q_x^D = \begin{cases} \lambda q_x^S, & \lambda q_x^S < 1 \\ 1 & \text{otherwise} \end{cases}, \text{ with } \lambda = \left(1 + \sum_{h=1}^{k} \rho_h\right)$$

where h is a set of risk factors (socioeconomic characteristics).

- Assuming the pension scheme pays an immediate life annuity at retirement age x, the annual benefit is p_i

$$p_i = \frac{AK_{x,i}}{\sum_{t=0}^{\omega-x} v^t \cdot {}_t p_x^D} = \frac{AK_{x,i}}{\sum_{t=0}^{\omega-x} v^t \prod_{j=0}^{t-1} \left(1 - \lambda q_{x+j}^S\right)}$$

Policy options to address longevity heterogeneity

Interventions at benefit disbursement stage

- Indexation of annual benefits to cohort-specific life expectancy.
- Use of differential pension indexation rules by socioeconomic group.
- Deferred annuities with a sharing of common and asymmetric longevity development between annuity calculation and disbursement.

- **Mixed interventions** that combine elements of all three stages.

Interventions at benefit calculation stage

Two-tier contribution allocation structure

- The **total contribution rate tc%** is split into:
  - a **social component** with a contribution rate of **sc%** and
  - an **individual component of rate nc%**
- The social component sc% of the average contribution base Y_a is allocated to each individual account in a lump-sum manner (i.e., sc% × Y_a), while the individual component nc% is allocated in the traditional way (i.e., nc% × Y_i).
- At retirement the individual receives a pension benefit that consists of two components:
  - a flat-rate benefit that is proportional to the length of activity, social contribution rate, and average contribution base, and
  - a contribution-based benefit that is proportional to length of activity, individual contribution rate, and individual contribution base.
  - Both components are indexed with the same sustainable rate of return.

Interventions at benefit calculation stage

Two-tier contribution allocation structure

To gain intuition about the magnitude of the contribution split and its capacity to compensate for unequal life expectancy (which is linked with lifetime income), the analysis makes use of the tax/subsidy structure of both the heterogeneus life expectancy and the split contribution rate.

Interventions at benefit calculation stage

Two-tier contribution allocation structure

- Applying a two-tier contribution schedule to individuals with equal life expectancy but different lifetime incomes measured at retirement amounts to a tax (subsidy) for those with above (below)-average income.

$$t(s)_i = ((tc - nc)/tc)*(1 - Y_a/Y_i)$$

with negative (positive) values representing the subsidy (tax) rate.

- Combining the tax/subsidy rates yields the link for how the relationship between *LEi* and individual lifetime income needs to be structured so that no tax/subsidy element remains.

$$LE_i = LE_a\,[1 - (tc - nc)/tc)\,(1 - Y_a/Y_i)]$$

Interventions at benefit calculation stage

Two-tier contribution allocation structure

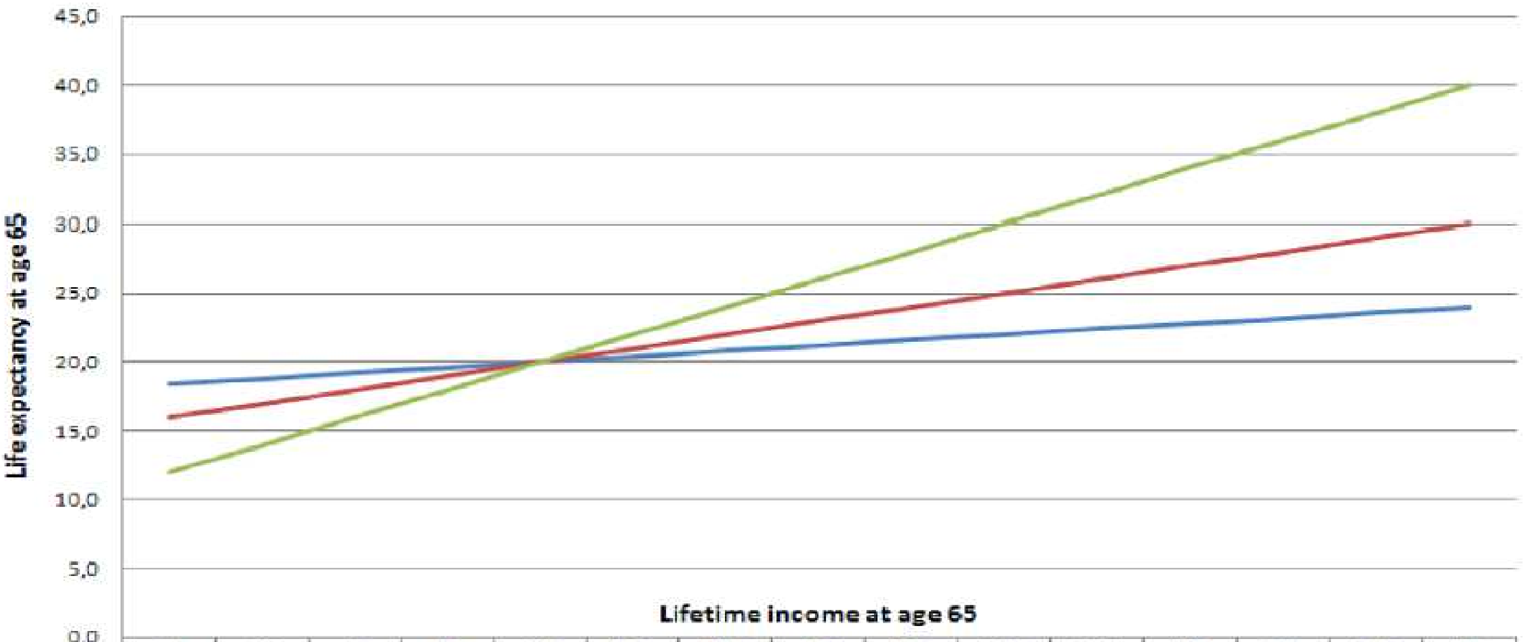
Next figure presents the linear link graphically for a selection of social contribution rates of 2, 5 and 10% under a total contribution rate of 20%, normalized values of lifetime income between 10 and 300, in steps of 10 (with an average of 100), and an assumed average life expectancy of 20 years at the assumed retirement age at 65.

Example

a social contribution amounting to a quarter of the total contribution rate of 20% would accommodate a lower life expectancy of 2.5 years for somebody who has only 50% of the average lifetime income, or a 5 years higher life expectancy for somebody who has double the average lifetime income

Interventions at benefit calculation stage

Two-tier contribution allocation structure



	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
SC_2%	18,4	18,8	19,2	19,6	20,0	20,4	20,8	21,2	21,6	22,0	22,4	22,8	23,2	23,6	24,0
SC_5%	16,0	17,0	18,0	19,0	20,0	21,0	22,0	23,0	24,0	25,0	26,0	27,0	28,0	29,0	30,0
SC_10%	12,0	14,0	16,0	18,0	20,0	22,0	24,0	26,0	28,0	30,0	32,0	34,0	36,0	38,0	40,0

A Two-tier contribution scheme and the tax/subsidy neutral link between life expectancy and life time income at 65

Source: Authors' elaborations.

Final remarks

- Heterogeneity in longevity by lifetime income is high and often rising,
  - it translates into an implicit tax/subsidy mechanism with rates > 20%,
  - perverting the redistributive objectives of pension schemes and distorting individual lifecycle labor supply and savings decisions,
  - invalidating or at least diminishing recent reform approaches, particularly those moving to a closer contribution-benefit link and increasing the minimum retirement age.
- It is important to develop mechanisms that neutralize/reduce the effect of heterogeneity in longevity through changes in pension design.
- Such interventions can happen at the level of contribution payment, annuity calculation, and benefit disbursement.
- If the tax/subsidy mechanism is the correct assessment of the implications of longevity heterogeneity on a pension scheme, then the best intervention is at the level of annuity calculation, followed by interventions at the contribution payment and lastly at benefit disbursement.

Addressing Longevity Heterogeneity in Pension Design and Reform

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