REGRESSIVITY IN PUBLIC PENSION SYSTEMS: THE CASE OF PERU

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Abstract

We study the role of income-mortality differentials and pension eligibility conditions on the level of regressivity and progressivity of Peru's public pension system, using administrative records from 1999 to 2018 to do so. We consider the joint effect of insufficient contributions, by which the poorest contribute to the pension system but ultimately do not qualify for pensions, and differing mortality by socioeconomic status in contributing to the regressivity of the system. We find that the impact of insufficient contributions is more important than the impact of higher mortality in making the system regressive.

Keywords: pay-as-you-go, pension progressivity, pension wealth, mortality. JEL-classification: G22, H55, J14.

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1 Introduction

By establishing minimum and maximum pensions, pay-as-you-go (PAYG) systems acquire a progressive character, as those with lower incomes would receive, in relative terms, higher pensions. In particular, when there is an established minimum pension, those with lower incomes benefit from higher salary replacement rates (RR). This progressive effect is reinforced with the implementation of a maximum pension limit, resulting in those with higher incomes seeing a lower RR (Altamirano et al. (2019)).

Such limits on pensions are a common practice in PAYG systems, as are requirements for a minimum number of contributions to qualify for a pension. Pension systems in Latin America require around 22 years of contributions to obtain a minimum pension, while Peru, the focus of this work, requires 20 years (see Table A–1 in the Appendix). The requirement of a minimum number of contributions could render the pension system regressive because those with lower incomes tend to accumulate fewer contributions throughout their working lives than those with higher incomes (Montenegro Trujillo et al. (2013); Altamirano et al. (2019)). Such regressivity has been documented for Colombia, Uruguay, Brazil, Ecuador, and Argentina, as well as for Latin America and the Caribbean in general (Lasso (2004), Méndez (2009), Azuero Zúñiga (2020), Montenegro Trujillo et al. (2013), Cisoe et al. (2019), Álvarez et al. (2020), Altamirano et al. (2018) and Alonso et al. (2014)).

In addition to contribution requirements, varying life expectancies by socioeconomic status (SES) may also lead to regressivity in pension systems. Evidence from developed countries suggests that people with a lower SES have a shorter life expectancy than people with a higher SES (e.g., Deaton (2002), Gerdtham and Johannesson (2004), Von Gaudecker and Scholz (2007), Smith (2007), Smith and Goldman (2007), Dowd et al. (2011), Belloni et al. (2013)). Hence, even if qualifying for a pension, low-income retirees could receive a pension for a shorter period than high-income retirees. Therefore, a higher RR for low-income retirees does not guarantee progressive income distribution in the public pension system. The correlation between life expectancy and SES means that the uniform application of pension rules to all individuals may result in a penalty for low-income individuals and a bonus for high-income ones, introducing another regressive component to the system. Whitehouse and Zaidi (2008) have documented significant socioeconomic differences in mortality among men in the United States, Germany, and the United Kingdom and how these differences reduce progressivity in the pension system. Cristia (2009) corroborates these findings for the United States, warning that differential mortality could undermine the progressivity built into social security benefit formulas.

This study assesses how early mortality of low-income individuals and contribution requirements affect the level of progressivity (or regressivity) in the Peruvian PAYG pension system. Our underlying hypothesis is that low-income individuals have higher mortality and contribute less than high-income individuals. To assess whether this is true as well as the effects of this on the system, we analyze the administrative records of the Peruvian PAYG system from July 1999 to August 2018, including information on all affiliated individuals who survived to at least age 65.

Following closely the strategy employed by Von Gaudecker and Scholz (2007) for the German pension system, we estimate SES levels as a function of accumulated earning points during the pre-retirement period in order to capture individuals' SES in the years before and close to retirement. The distribution of earning points shows a concentration at very low levels, implying that only one-fourth of enrolled individuals would be able to receive a pension. We can compare SES and the distribution of expected pension wealth to assess the extent to which the pension system punishes or favors income redistribution among its affiliates. Because the concept of expected pension wealth uses the mortality profiles of different individuals (e.g., rich and poor, men and women), we also estimate the differential effects of the income-mortality gradient on the levels and distribution of pension wealth.

We find that the poorest individuals contribute less and live less. On average, those in the lowest income quartile contribute 15 fewer years and live 5 fewer years than those in the highest quartile (i.e., at age 65, those in the lowest quartile have a life expectancy of five fewer years than those in the highest quartile). Consequently, for the poorest, both contributions to a pension system for which they will not qualify and a shorter life expectancy contribute to pension system regressivity, with the contributions causing more of the system regressivity.

We also assess the possible effects of a pension policy implemented in late 2021 to allow those with 10 or 15 years of contributions to qualify for lower, "proportional" minimum pensions. While this new policy mitigates the distributional problems of the public pension system, it is insufficient to make the system fully progressive.

Our work makes three significant contributions to the literature: (i) it provides evidence on the regressivity caused by the insufficiency of contributions in PAYG systems, (ii) it documents the effects of early mortality among low-income people in a developing country and its consequent regressive impact on pensions, and (iii) it shows the joint effect of insufficient contributions and early mortality, making a novel contribution to the specialized literature. Our study of the distributional effects of minimum periods of contributions and possible solutions such as reduced minimum pensions will also be of interest to other countries with pension systems having similar requirements.

The rest of the paper is organized as follows. Section 2 describes the pension system in Peru. Section 3 describes the data we use in the analysis. Section 4 details the empirical strategy. Section 5 presents and discusses the empirical results. Section 6 presents our conclusions and policy implications.

2 The Peruvian Pay-As-You-Go pension system

The Peruvian pension system comprises two primary schemes, offering distinct choices to individuals. Firstly, the Private Pension System (SPP, by its acronym in Spanish), launched in June 1993, is a defined contribution (DC) system using individual retirement accounts. Pension fund managers, known as AFP (*Administradoras de Fondos de Pensiones*), receive contributions and invest these personalized savings in regulated and supervised investments. Secondly, the Public Pension System, known as the National Pension System (SNP, by its acronym in Spanish), functions as a defined benefit (DB) system. The SNP operates as a PAYG system, with contributions from individuals and supplementary government transfers ensuring the disbursement of pension benefits.

When individuals first enter the workforce, they are required to choose one of these schemes. If they do not do so within ten days, they are enrolled in the SPP. Individuals can switch from the SNP to the SPP at any time, but the reverse is not permitted. Although the regulatory framework is designed to promote affiliations with the SPP, many workers are associated with and prefer the SNP[1].

A key influence on the preference for one system over the other is how pension benefits are calculated and provided. Unlike the SNP, the SPP does not have a guaranteed minimum pension except for a specific group of affiliates (born before 1945) who previously switched between systems. This means that the pension savings accrued during retirement in the SPP are not supplemented with government transfers. The SNP determines benefits based on specific pension regulations, including minimum and maximum pension amounts.

Until October 2021, it was necessary to complete 20 years of contributions to receive a pension at the legal retirement age in the SNP. Any contribution period less than these 240 months would not qualify for pension entitlement. Contributions are not refunded for individuals who did not meet this minimum contribution requirement.

Since November 2021, workers who made at least 10 years of contributions can request "proportional" retirement pensions. For those who contributed at least 20 years, the SNP offers a minimum pension of 500 soles per month (54% of the minimum wage) and a maximum pension of 893 soles per month (96% of the minimum wage). Those who contributed at least 10 but fewer than 15 years can receive pensions of 250 soles per month, while those who contributed at least 15 but fewer than 20 years can receive 350 soles per month.

In both systems, the retirement age is set at 65, and contributions are based on labor earnings that meet or exceed the minimum wage (930 soles). While there are variations in contribution rates and fees between the two schemes, they both operate on the premise of 12 payments per year. This implies that the income base for pension contributions does not

[1] As of September 2023, the SPP has 9.06 million individuals affiliated with it, while the SNP has 4.65 million individuals under its membership.

include the two additional salary bonuses specified in labor legislation. The SNP has a total contribution rate of 13%; the SPP contribution rate is 10% but it increases up to 11.9%-13% when managing fees and insurance premium fees are added.

Formal sector employees are required to contribute to a pension system, while self-employed and other workers may contribute voluntarily. The substantial size of Peru's informal labor market leads to lower coverage by infrequent contributions to the pension system. In 2022, 47% of the labor force was registered in the SPP and 25% in the SNP, but consistent contributors were limited to 19% of the labor force in the SPP and 8% in the SNP.

A crucial distinction between the two pension schemes lies in their financial sustainability. While SPP pensions are inherently self-sufficient and do not rely on government support, their implementation in 1993 and the subsequent transition were not without costs. The primary public expenditures associated with the SPP are Recognition Bonds *(Bonos de Reconocimiento)*, constituting a pledged public transfer to individuals who shifted from the public pension system to the private one. These bonds were granted around the time of the pension system transition, and a portion of the contributions made to the public system were acknowledged.

Conversely, the SNP relies on the contributions of current affiliates to fund present pensions. The government channels resources to help finance these payments. Additionally, the SNP operates with a reserve fund known as the *Fondo Consolidado de Reserva* (FCR), which contributes resources to cover pension expenditures. In 2020, 64% of the pension payroll was financed through contributions, 34% through the FCR, and the remaining 2% through treasury transfers.

3 Data

To assess the progressivity of the SNP, we use three types of administrative records: contribution records from the country's tax collection agency (SUNAT), pension claims from the Pension Normalization Office (ONP), and mortality information from the National Registry of Identification and Civil Status (RENIEC).

The SUNAT data are longitudinal with monthly information from July 1999 to August 2018 on contributions, labor income, sex, and date of birth. The ONP data include the number of contributions made during the entire working life for members that are known to have applied for a pension. Information on contributions has been digitized from July 1999 onwards; previous periods are only known once the member applies for qualification and the ONP constructs the history of previous contributions.

Our sample considers members born between 1939 and 1952 who survived to age 65. We estimate SES for these individuals by examining contributions during the five years before retirement. Our sample consists of 267,885 people. Table 1 presents descriptive statistics of our sample. We find that the average contribution density is 44% and that 7% of the members died during the time horizon analyzed. By SES, contribution density is 0.3% for the bottom quartile and 94.1% for the top quartile. Mortality is greater in the lower quartiles than the higher ones. Among our sample, only 43% applied for a pension; of those applying, 89% met the requirement of contributing at least 20 years.

Table 1: Descriptives

	N	Average density	Percentage of deaths	Earning points Average	P25	Median	P75
Total	276,885	44.2%	7.3%	26.0	0.2	12.1	37.9
Sex							
Male	187,548	41.7%	8.1%	26.4	0.2	10.3	38.3
Female	89,337	49.4%	5.6%	25.2	0.2	17.1	37.4
SES Q1							
	69,085	0.3%	8.2%	0.001	0	0	0
Q2	69,237	10.9%	9.6%	4.0	1.1	2.9	6.4
Q3	69,285	71.4%	6.5%	27.1	20.0	28.7	34.4
Q4	69,278	94.1%	4.9%	72.9	44.8	54.9	84.9
Application							
No	158,305	29.0%	7.9%	17.4	0	2.4	24.3
Yes	118,580	64.5%	6.5%	37.5	9.0	33.4	48.5
Accepted	105,147	65.5%	6.5%	37.9	10	33.9	48.7
Denied	13,433	56.4%	6.7%	34.4	4.2	27.5	46.9
Cohort							
1939	7,954	45.7%	22.5%	26.4	4.3	18.2	31.7
1940	8,557	47.6%	19.6%	27.6	2.7	16.7	34.9
1941	8,535	45.3%	18.5%	26.7	0.9	13.9	34.5
1942	11,005	41.9%	16.2%	24.7	0.4	10.0	34.1
1943	12,396	42.0%	13.9%	24,7	0	9.9	35.1
1944	14,889	40.7%	12.3%	24.0	0	8.4	35.0
1945	17,299	42.0%	10.2%	24.8	0	9.4	37.1
1946	20,093	43.4%	8.6%	25.7	0.2	11.2	38.2
1947	23,107	43.6%	6.9%	25.8	0.2	11.4	38.2
1948	24,933	44.3%	5.5%	26.2	0.2	12.3	39.5
1949	27,500	45.0%	4.7%	25.7	0	12.2	38.6
1950	30,924	44.9%	3.2%	26.6	0	12.2	39.1
1951	32,529	45.6%	2.0%	27.0	0	13.1	39.3
1952	37,164	44.9%	1.1%	26.7	0	12.6	38.6

Notes: Prepared by the authors with information from administrative records of the SNP.

4 Empirical strategy

We need to undertake four tasks to analyze the distributional effect of insufficient contributions and early mortality of the poorest on pension wealth. These are (i) establishing a criterion for measuring SES, (ii) estimating the contributions of individuals who have not applied for a pension, (iii) determining survival probabilities, and (iv) defining the variables that gauge the wealth of individuals.

4.1 Socio-Economic Status (SES)

There is no standardized method for estimating SES (Braveman et al. (2005); Christiansen et al. (2018)). Researchers employ a variety of strategies to determine SES depending on their conceptual model, study design, and available data. For instance, previous research has estimated through (i) the summation of all income received by families adjusted for inflation, as Dowd et al. (2011) did in the United States; (ii) the summation of pensions, as Belloni et al. (2013) did for Italy; and (iii) the "earning points" strategy, where wealth is calculated as the sum of relative income concerning average income, as illustrated by Von Gaudecker and Scholz (2007) in the context of Germany.

We are closely following the "earning points" (EP) strategy to estimate SES as a function of accumulated EP during the pre-retirement period. Specifically, we construct EPs using information on labor income between the ages of 60 and 64. We define the indicator so that a member who has not contributed in that period would obtain a score of 0 while those who always contributed and whose salaries were always equal to the average would receive a score of 60. By estimating EPs this way, we can compare wealth across individuals, as we calculate individual wealth at the same stage of life for each individual.

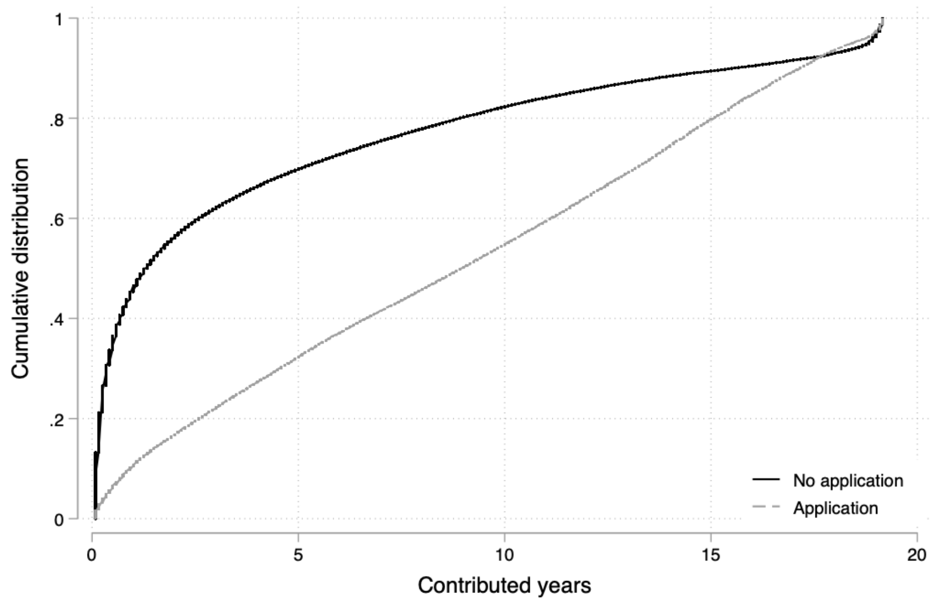
Table 1 shows the bottom quartile of our sample accumulated no more than 0.2 EPs. The median number of EPs among our sample was 12.1, while the average was 26.0. Figure B–1 shows the asymmetric distribution of EPs among our sample. We derive quartiles from the number of EPs for each individual.

4.2 Contribution prediction

Not all people who reach retirement age initiate an application, and they may never do so due to their small number of contributions. In fact, as noted earlier, we find only 43% of individuals in our sample completed an application for a pension. Put another way, individuals may decline to apply and later receive a pension for the same reason that an application is denied: insufficient contributions.

For individuals who have not applied for a pension, we only know contributions since the digitization of contribution records in July 1999. Figure 1 shows the difference in contributions between those who applied and those who did not apply since then. Among those who did not apply, 60 percent contributed fewer than 2.5 years, while among those who did apply, only 20 percent contributed such a small number of years. Similarly, contribution density is 23 percent for those who did not apply but 47 percent among those who did.

Figure 1: Distribution of contributions between 1999 and 2018



Notes: The figure plots the cumulative distribution of contributions between 1999 and 2018.

We performed a Heckman regression to estimate the contributions unobserved before July 1999. The dependent variable is the total contributions credited by the ONP, and the main independent variable is the amount of contributions observed since July 1999. The selection equation measures the probability that members submit a request to access a pension; we used contributions made between 60 and 64 years of age as an exclusion variable. Table C–1 in the appendix presents our equation results, which we use to estimate the accumulated contributions of those who at age 65 did not apply for a pension with the ONP[2].

Our results indicate some evidence of selection bias in the sample. Figure C–1 shows the differences in estimated contributions between our OLS estimate and the Heckman estimate, and Figure C–2 shows the distribution of estimated contributions for those who did not apply as well as for those who did apply.

[2] Values imputed with $E(y_{1i}|x_{1i}\,, y_{2i}=0) = x_{1i}\beta_1 - \sigma_2 \frac{f(-x_{2i}\beta_2/\sigma_2)}{F(-x_{2i}\beta_2/\sigma_2)}$, where x_{1i} are explanatory of the regression, and x_{2i} the determinants of the selection equation.

Table 2 shows the average predicted values for both unobserved and observed contributions. For those who applied, the results are statistically equivalent: both ONP and the Heckman estimates suggest about 26 years of contributions. From the Heckman model on those who did not apply, and who lack records before 1999, we estimate 7.7 years of contributions each by age 65. It is found that the mean number of years of contributions is 10.0 for those in the bottom SES quartile and 24.8 for those in the top quartile (see Table C–2). We further estimate that 65% of the sample will not reach the 20 years of contributions needed to qualify for a pension.

Table 2: Contributions observed and estimated by the Heckman model

Application	Accredited by the ONP	Heckman's model
Did not apply		7.7
		(0.011)
Applied	26.0	25.7
	(0.026)	(0.014)
Total	26.0	15.5
	(0.026)	(0.019)

Notes: Prepared by the authors with information from administrative records of the SNP. SE in parenthesis.

4.3 Survival analysis

Receipt of pensions depends on surviving to and past the age of eligibility. In the data we analyze, 93 percent of individuals remain alive through the study period (Table 1). This makes it imperative to estimate the duration of their survival so as to calculate how much they will ultimately receive from the pension program. We estimate survival probabilities by quartiles with a proportional hazard model that assumes a parametric Gompertz-type survival. Under this logic, the hazard ratio is specified as:

$$ht_j = h_0(t)g(x_j). \tag{1}$$

where:

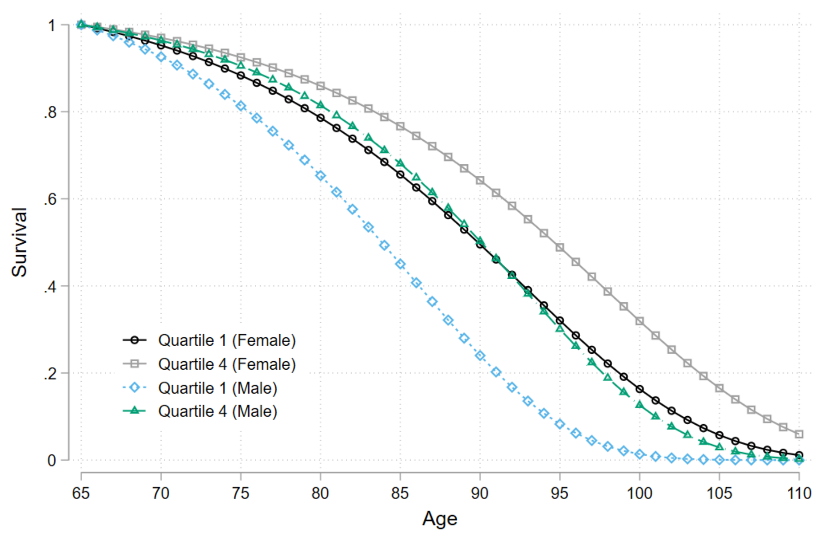
$$g(x_j) = exp(x_j b). \tag{2}$$

and $h_0(t)$ is assumed to follow a Gompertz-type distribution.

We measure survival from the attainment of 65 years to death or censoring at the end of the observation period. The regression controls for SES quartiles by sex are shown in Table D–1. We estimate mortality tables by using the survival functions as input for each socioeconomic level, differentiating by sex. The latter is possible because the population under study is all 65 or older, so the jump from survival to age at death or censorship is direct. Assuming a parametric function such as Gompertz also allows us to extrapolate survival to unobserved ages in the sample. Thus, considering a maximum survival age of 110 years, one can construct the actuarial operator "*number of survivors at age x*", l_x, as $l_x = 100{,}000 \cdot S(x)$. The estimated values of l_x make it possible to calculate the annuity price (PA) needed to estimate pension wealth[3].

As Figure 2 shows, survival is higher for women than for men and higher for those in the top SES quartile than the bottom one. Residual life expectancy measured at age 65 is estimated at 21.5 years for women in the bottom quartile and 18.4 years for men, while women in the top quartile have a residual life expectancy of 25.3 years and men have one of 24.1 years (see Figures D–1 and D–2 in the Appendix).

Figure 2: Survival functions by SES quartiles



Notes: The figure shows the survival functions after assuming a Gompertz-type function in the survival model.

[3] The annuity price is the amount of capital required to finance one unit of pension for life, taking into account a discount interest rate and mortality tables. The l_x are the key elements of the mortality tables. The factor 100,000 is just the conventional assumption of an initial population at age zero.

4.4 Pension wealth

We examine three outcomes of pension wealth. The first outcome is *Pension Wealth* (PW), which is the sum of all pension benefits and those expected to be received. The calculation of this variable follows the methodology employed by Olivera (2019). Instead of using life expectancy as the time horizon for receiving the pension, we use the annuity price (AP) specific to each individual. The income flows are brought to present value to ensure comparability across generations and maintain neutrality to inflation when the individual turns 65.

The age x at which individual i receives his first pension could be higher than 65 depending on the time it takes to process; in the first pension, the first payment includes interest and accruals; this value is called *Initial* and corresponds to the first summand of equation (3). The pensions paid are observed up to the age y, at the end of the study period, or when the person dies, the amount paid is the second summand. After that age, if the person survives, pensions are paid as long as the person is still alive. Hence, this summand considers the survival probabilities; this component is the third summand. The maximum age to which the pension would be paid (actuarial infinity) is denoted by ω *(110)*. The pension payment is estimated beyond age and considers life tables estimated with the survival models differentiating quartile, q, and *sex*.

$$PW_{i,x,y,q,sex} = \frac{Initial}{(1+r)^{x-65}} + \frac{P \cdot FF(y,x)}{(1+r)^{x-65}} + \frac{P \cdot PA(y,q,sex)}{(1+r)^{y-65}} \qquad (3)$$

$$PA_{y,q,sex} = \sum_{t=1}^{\omega-y} \frac{1}{(1+r)^t} \cdot \frac{l_{y+t}^{q,sex}}{l_y^{q,sex}} \qquad (4)$$

$$FF_{y,x} = \sum_{t=1}^{y-x} \frac{1}{(1+r)^t}. \qquad (5)$$

in this formula, r represents the assumed interest rate (2%), $l_{y+t}^{q,sex}/l_y^{q,sex}$ is the probability of surviving during t periods for a person of an age belonging to quartile q and of a given *sex*, and P is the amount of the annual pension (null in the case of the deceased observed in the study period and of those who lack sufficient contributions for a pension).

Our second outcome of interest is *Pension Net Wealth* (*PNW*), defined as the difference between *Pension Wealth* and contributions (A) made. We can estimate the contributions accumulated by a person i at age 65, assuming a constant contribution density during their working life, by:

$$A_i = w \cdot \tau \cdot d \cdot \frac{(1+r)^{46} - 1}{r}. \qquad (6)$$

where w is the annual salary; t is the contribution rate; $d = C/46$; and C is the time in years contributed by members in their working life (accredited by the ONP in the case of those who applied or estimated with the Heckman model for those who did not). We assume that people's working life begins at 20, consistent with the most frequent value observed for the start of the first contribution in the SNP.

Therefore, *Net Pensionable Wealth* (NPW) is defined as:

$$NPW_{i,x,y,q,sex} = PW_{i,x,y,q,sex} - A_i. \qquad (7)$$

Both PW and NPW are expressed in relative terms concerning the average annual wage observed, in a logic similar to the usual definition of replacement rate.

Finally, our third outcome is the *Relative Pension Wealth* (RPW), which we define as:

$$RPW_{i,x,y,q,sex} = \frac{PW_{i,x,y,q,sex}}{A_i}. \qquad (8)$$

We propose to study the effect of heterogeneity in life expectancy and exclusion of pensions on PW, NPW, and RPW. To do this, we first estimate a baseline scenario in which all actual individual characteristics and binding pension rules are used. We then estimate three alternative counterfactual scenarios in which we manipulate some of the individuals' characteristics and pension rules. Comparing the baseline with the counterfactual allows us to assess the "effects" of these manipulated characteristics and regulations on the degree of regressivity or progressivity in the pension system. The counterfactual scenarios are:

1. *Greater survival*: the individuals of lower SES are assigned higher survival, which we consider by assuming that survival is the same for everyone and corresponds to that of the highest quartile.

2. *Non-exclusion*: everyone receives a pension, meaning that the individuals with contributions below the threshold receive a hypothetical pension proportional to the contributions made and whose maximum value corresponds to the minimum legal pension.

3. *Combined effect*: the joint effect of (1) and (2).

5 Results

5.1 Main effects

Table 3 illustrates the regressive effects of the SNP. In the baseline scenario, *Pension Wealth* for those in the first quartile is 3.1 times the annual salary, and 12.7 times the annual salary for those in the fourth quartile. Similarly, those in the first quartile see a loss in *Net Pension Wealth* that is equivalent to 0.6 times their annual salary, while those in the fourth quartile see net pension wealth 6.8 times their annual salary. The results of the *Relative Pension Wealth* indicate that, on average, the system may be regarded as almost actuarially fair (pensions are 1.1 times the contributions), but there is significant heterogeneity across quartiles. For example, those belonging to the first quartile receive, on average, half of what they have contributed, while those in the last quartile receive twice as much.

Thus, the actuarially fair result is achieved with an inequitable distribution, where the poorest finance the pensions of the less poor. In monetary terms, this regressive result implies that those belonging to the first quartile finance the contributions of those belonging to the upper quartiles. In particular, 33% of the subsidized pensions in the upper quartiles are implicitly funded by the contributions of the lower quartiles (see Table E–1 in the appendix).

The lower survival and insufficient contributions of the poorest affect the progressive nature that the distribution of pension wealth should have. We can conclude this after assuming maximum survival and no exclusion and their effect on the gradient of *Pension Wealth*, *Net Wealth*, and *Relative Pension Wealth* with respect to SES. The results show that the gradients of all outcome variables improve after the simulations. Notably, in the case of the RPW, the distribution becomes progressive. We can explain this result by the fact that the poorest are also the lowest contributors. The average effects are shown in Table 3 and Figure 3, and the entire distribution of changes is shown in Figure E–1 in the Appendix.

The level of regressivity for those in the first quartile is reduced once we assume non-exclusion and maximum survival. The PW in quartile 1 goes from 3.1 times the annual income to 9.4 times under this combined effect. NPW for the first quartile goes from a net loss, or 0.6 times the annual salary, to 5.8 times under the combined effects of the simulation. Finally, RPW for the first quartile increases from 0.5 times annual salary to 2.5 times under the combined effect. In all cases, proportional pensions have a greater effect than higher survival on pension wealth (See Table 3). We find no significant differential effects when performing the analysis by sex or birth cohort (See Tables E–2, E–3, E–4, E–5, E–6 in the Appendix).

It is worth noting that net pension wealth is lower than pension wealth because this indicator considers the size of contributions. In distributive terms, this is especially important when the pension is zero because while pension wealth accumulates all zeros in this scenario, net wealth has a negative balance equal to the amount contributed during the working life.

As noted above, the non-exclusion counterfactual has a more critical impact than survival on pension wealth, and therefore constitutes the primary source of regressivity. One implication of this finding is the need for public policy to seek a less regressive design, although this can be costly. In fact, moving from a positive gradient to one with a zero slope using proportional pensions requires a government transfer that is equivalent to an amount similar to the contributions of its members, because the RPW goes from 1.1 (an actuarial equilibrium) to a value of 2.1. This scenario could be less onerous if the SNP did not compete with the SPP for higher-income members.

Table 3: Average effect on pension wealth by quartiles

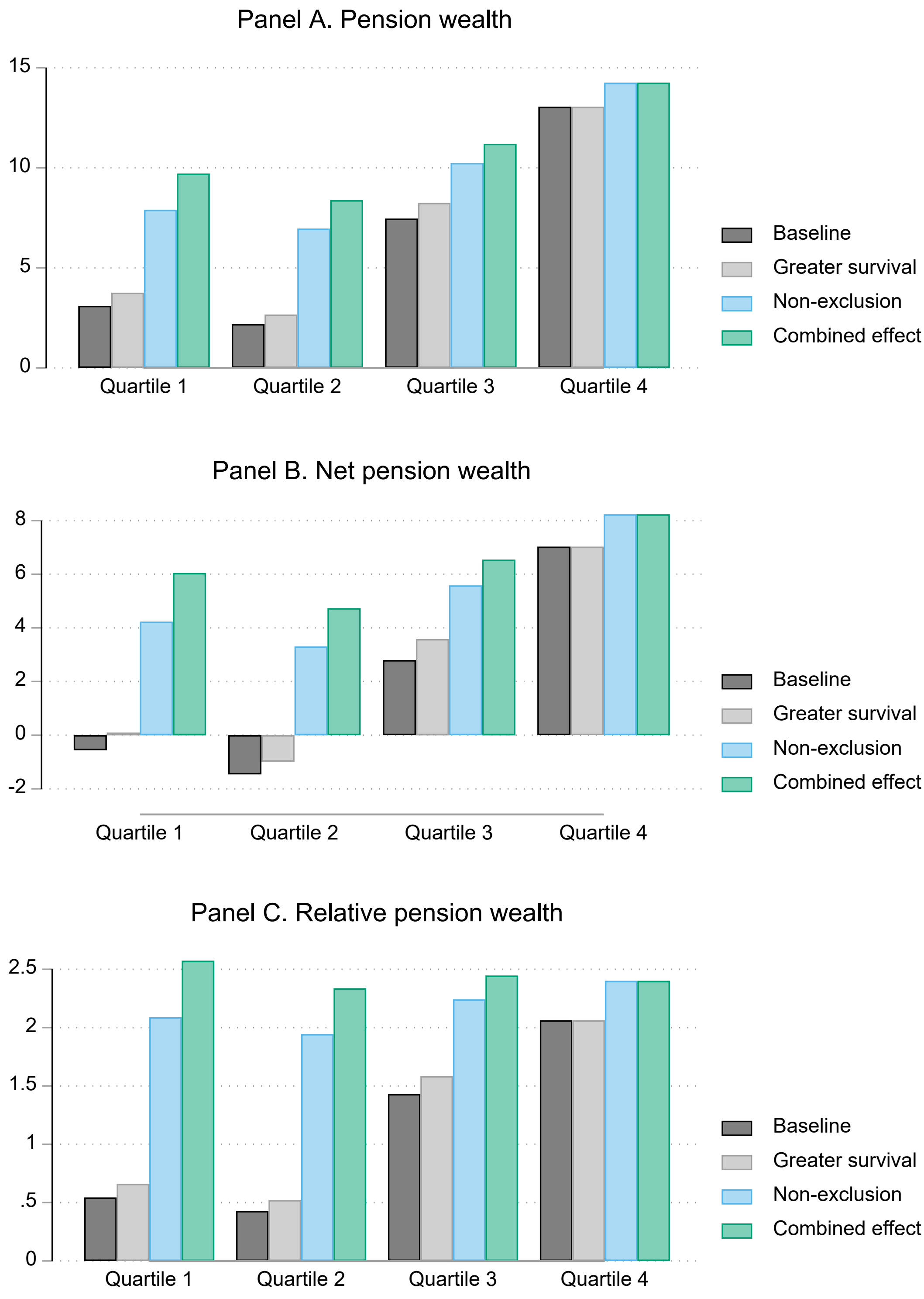
	Pension wealth (PW)			
Quartile	Baseline	Greater survival[(1)]	Non-exclusion[(2)]	Combined effect[(3)]
1	3.1	3.7	7.6	9.4
	(0.03)	(0.03)	(0.02)	(0.02)
2	2.1	2.6	6.7	8.1
	(0.02)	(0.02)	(0.01)	(0.01)
3	7.2	7.9	9.8	10.8
	(0.02)	(0.02)	(0.01)	(0.01)
4	12.7	12.7	13.8	13.8
	(0.03)	(0.03)	(0.02)	(0.02)
Total	6.3	6.7	9.5	10.5
	(0.01)	(0.02)	(0.01)	(0.01)

	Net pension wealth (NPW)			
Quartile	Baseline	Greater survival[(1)]	Non-exclusion[(2)]	Combined effect[(3)]
1	-0.6	0.0	4.0	5.8
	(0.02)	(0.03)	(0.02)	(0.02)
2	-1.5	-1.0	3.1	4.5
	(0.02)	(0.02)	(0.01)	(0.01)
3	2.6	3.4	5.3	6.2
	(0.02)	(0.02)	(0.01)	(0.01)
4	6.8	6.8	8.0	8.0
	(0.02)	(0.02)	(0.02)	(0.02)
Total	1.8	2.3	5.1	6.1
	(0.01)	(0.01)	(0.01)	(0.01)

	Relative pension wealth (RPW)			
Quartile	Baseline	Greater survival[(1)]	Non-exclusion[(2)]	Combined effect[(3)]
1	0.5	0.7	2.0	2.5
	(0.004)	(0.005)	(0.002)	(0.002)
2	0.4	0.5	1.9	2.3
	(0.004)	(0.005)	(0.006)	(0.006)
3	1.4	1.6	2.1	2.3
	(0.004)	(0.005)	(0.006)	(0.006)
4	2.1	2.1	2.3	2.3
	(0.004)	(0.004)	(0.006)	(0.006)
Total	1.1	1.2	2.1	2.4
	(0.002)	(0.003)	(0.004)	(0.006)

Notes: The table is based on administrative data from the SNP. Standard errors are reported in parenthesis. (1) The individuals of lower SES are assigned higher survival, which we consider by assuming that survival is the same for everyone and corresponds to the highest quartile; (2) everyone receives a pension, meaning that the individuals with contributions below the threshold receive a hypothetical pension proportional to the contributions made and whose maximum value corresponds to the minimum legal pension; (3) the joint effect of (1) and (2).

Figure 3: Average effect on pension wealth by quartiles



Notes: The figure plots the survival functions by SES quartiles. *Greater survival:* the individuals of lower SES are assigned higher survival, which we consider by assuming that survival is the same for everyone and corresponds to the highest quartile; *Non-exclusion:* everyone receives a pension, meaning that the individuals with contributions below the threshold receive a hypothetical pension proportional to the contributions made and whose maximum value corresponds to the minimum legal pension; *Combined effect:* the joint effect of (1) and (2).

5.2 Robustness analysis

We note here the implications for *Pension Wealth* of two assumptions used in the estimation: the rate of return and the survival function. In addition to the rate of return of r = 2%, we consider the rates of r = 1%, r = 3%, and r = 4%. In the case of survival, we explore the implications of assuming Exponential and Weibull-type distribution functions rather than Gompertz.

Figures F–1, F–2, and F–3, in the appendix show the results of simulations that use alternative return rates, while Figures F–4 and F–5 report the results of simulations that assume alternative survival functions. In all cases, the simulations show that the general conclusions do not change. Early mortality of the poorest and exclusion for not reaching the minimum threshold are regressive elements in a system that claims to be progressive. Nor does it change the conclusion that the most important effect is caused by the exclusion criteria. Although the effects of mortality and exclusion on pension wealth outcomes may differ in magnitude with respect to our first results, our alternative simulations still show a positive correlation between SES and these outcomes.

6 Conclusions

The aim of this study was to test the hypothesis that a public pension system, which is intended to be progressive, can actually be regressive due to both the system's regulations and socio-economic inequalities in mortality. The Peruvian public pension system is examined to investigate the impact of shorter lifespans among the poorest individuals and the minimum contribution requirement for accessing pensions on pension wealth. This analysis aims to determine the level of progressivity or regressivity of the system.

To test this hypothesis, we used administrative records with monthly information from July 1999 to August 2018, from which it was possible to obtain data on the contributions made, remuneration, date of death in applicable cases, and whether the member started a pension application, had the minimum number of years of contributions needed to qualify for a pension, and the amount of the pension received.

We accessed unique administrative data of affiliates and pensioners and found that the poorest tend to contribute less and have a lower life expectancy than others in the pension system. Through simulations and the use of alternative counterfactuals, we found that not providing pensions to members who may contribute but do not qualify for them has a more significant regressive impact than the effect of early mortality. An internal regulation that strictly denies a pension to individuals who have not contributed for at least 20 years can cause more harm than the well-known gradient between mortality and SES. These results remain unchanged with demographic structure and are robust to different discount rates and survival functions.

Our work is consistent with previous findings on the regressivity caused by insufficient contributions in PAYG systems in some countries in the region (Lasso (2004), Méndez (2009), Azuero Zúñiga (2020), Montenegro Trujillo et al. (2013), Cisoe et al. (2019), Álvarez et al. (2020), Altamirano et al. (2018) and Alonso et al. (2014)), and also with the evidence provided for developed countries on the early mortality of the poorest and its regressive effects. The novelty of this research has been to show the joint effects of insufficient contributions and early mortality, and its finding that the impact of insufficient contributions is more significant than that of early mortality.

The analysis reveals two policy implications. Firstly, to increase the welfare of individuals with the lowest SES, the contribution rate should be directly related to income, ensuring that those with lower incomes have a lower contribution rate as they live the shortest. Secondly, since people with lower SES tend to contribute less and thus risk not reaching the minimum contribution amount, alternatives can be considered to compensate this subset of members. In this regard, a recent policy has established alternative minimum contribution thresholds to grant new "proportional minimum pensions". If an individual's contributions fall within the range of 10 to 15 years, the minimum pension is set at half of the standard value, while those whose span is 15 to 20 years would receive a minimum pension at 75% of the ordinary value.

A limitation of the empirical analysis in this paper is that it was not possible to estimate socio-economic status using the entire wealth history over the life cycles of individuals due to data limitations. We also do not know the socio-economic status of the household to which the member belongs. Instead, we used the history of individual contributions in the last five years before the legal retirement age to estimate SES. While imperfect, this can be considered an adequate method because it is applied at the same stage of life for all individuals. Another challenge to our empirical analysis is that the sample is truncated due to the lack of information on people who died before July 1999. This may mean our results show low-bound effects of those in the poorest quartile: should such individuals, on average, die earlier and not be observed in the sample, then we may find that the regressive effects are greater than estimated.

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Appendix

A Pay-as-you-go pensions in selected countries

Table A–1: Some parameters in the public PAYG systems for selected countries

Country	Legal retirement age, male/female (effective 2017) (1)(2)(3)(4)	Minimum and maximum pension in US, ideally adjusted by PPP
Argentina	65 / 60	For 2015, the minimum monthly pension (based on three components: a basic flat-rate old-age pension, a compensatory pension based on years of contributions and service before July 1994, and an additional pension based on years of contributions since July 1, 1994), was US$ 456.38, and the maximum monthly pension was US$ 3343.5. (11)
Brasil	65 / 60	The minimum monthly pension is equal to the legal minimum wage. For January 2016, the legal minimum salary was US$ 216.75, therefore, the minimum pension. The maximum pension for January 2016 was US$ 1278.28. (8) and (11)
Colombia	62 / 57	The minimum pension cannot be less than the current minimum wage or more than 25 times the minimum wage, as established by the Political Constitution. (7) and (11)
Costa Rica	65	For the calculation of the pension, the last 240 salaries or accrued income on which contributions have been made, adjusted by the consumer price index, are used as a reference. For each contribution in excess of the 240 quotas, the pension is adjusted by an additional percentage of 0.0833%. If the insured decides to postpone retirement, an additional amount of 0.1333% per month over the average salary is recognized. For 2019, the minimum contributory pension was set at ¢136,865 (US$241) while the upper caps correspond to ¢1,612,851 (US$2,839) without deferral and ¢2,282,184 (US$4,018) with deferral. (6) and (11)

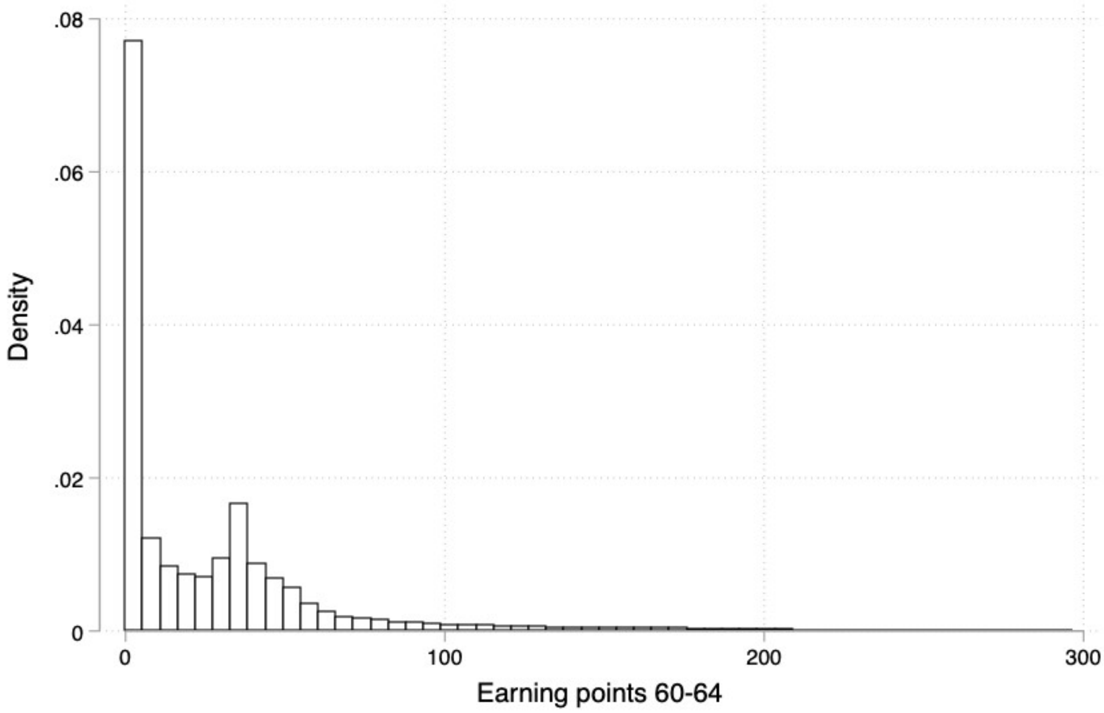
Honduras	65 / 60	In the IHSS system *(El Instituto Hondureño de Seguridad Social)*, the pension must not be less than 50% or more than 80% of the base contribution salary. The pension is calculated on the basis of the last 180 monthly wages earned or the income used as the monthly contribution base salary, indexed to the month in which the insured person qualifies for the pension. (10) and (11)
Panama	62 / 57	In 2015, the minimum monthly pension was US$ 245. The minimum monthly old-age pension increases by US$ 10 per month every 5 years (the government can freeze the level of benefits). The maximum monthly social security pension is US$1,500 (US$2,000 with 25 years of contributions and an average monthly salary of US$2,000 for the highest 15 years of contributions or US$2,500 with 30 years of contributions and an average monthly salary of US$2,500 for the highest 20 years of contributions). The maximum monthly pension under the mixed social security system is 500 US$. (9) and (11)
Peru	65	In 2015, the minimum monthly pension was US$ 128.48, and the maximum monthly pension was US$ 265.44. (11)
Uruguay	60	For 2015, the minimum monthly pension was US$ 264.01, and the maximum monthly pension was US$ 1,138.17 (social security and individual account) or US$ 1,683.11 (social security only). As of 2003, for each year of work exceeding 60 years of age, the minimum pension increases by 12% with a cap of 120%. (11)
USA	66	For the minimum pension: minimum age (age 62), $1,700 per month; full age (age 67), $3,627 per month; maximum age (age 70), $4,555 per month (5). The maximum monthly pension for workers retiring in 2015 at full retirement age is $2,663 ($2,639 in 2016). (11)
Chile	65 / 60	Social Security: The minimum monthly pension is US$176.25 for those under age 70, US$193.42 for those 70 to 75, and US$206.37 for those 75 or older. (11)
Venezuela	60 / 55	The minimum pension is the monthly legal minimum wage. The minimum monthly legal minimum wage is $ 1531.46 per month (December 2015). (11)

Note: Value of the dollar in local currency by country ranking: 9.42 Argentine pesos, 4.06 reales, 1.00 balboa, 3.23 nuevos soles, 28.90 Uruguayan pesos, 698.85 Chilean pesos, 6.30 bolivares.

(1) https://lc.cx/5q03SF
(2) https://lc.cx/bn4RQQ
(3) https://lc.cx/jvqPDk
(4) https://lc.cx/YKMPhu
(5) https://lc.cx/JbRxbh
(6) https://lc.cx/1pIjKE
(7) https://onx.la/f1931
(8) https://lc.cx/EwYCuG
(9) https://lc.cx/n2l0dG
(10) https://lc.cx/QbdEKp
(11) https://lc.cx/x6Ioeu

B Earning Points

Figure B–1: Distribution of earning points



Notes: The figure plots the distribution of earning points.

C Heckman's model

Table C–1: Heckman's model

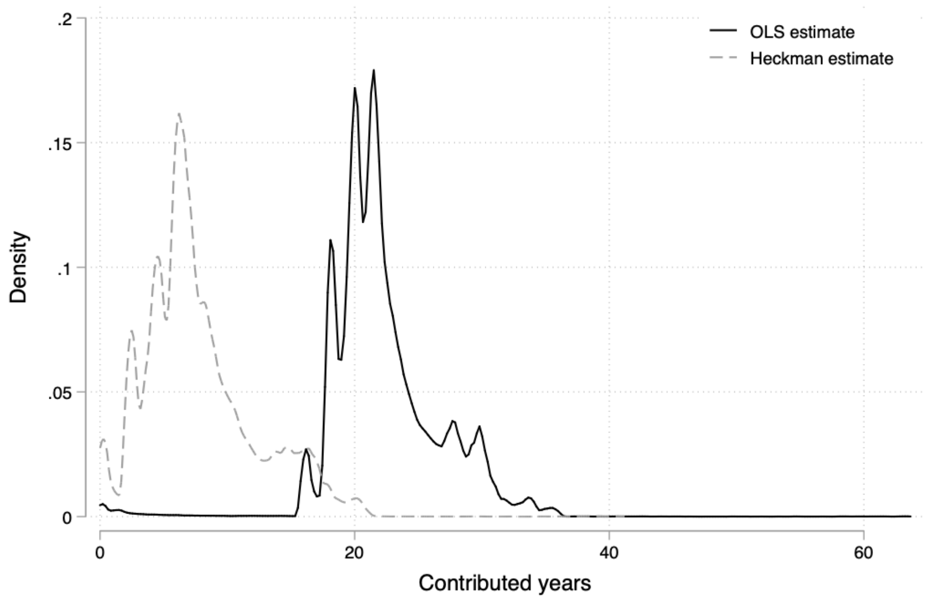
	(1)	(2)	(3)
Regression equation			
Contributions Observed	1.422***	1.483***	
	(316.86)	(305.23)	
Death=1		2.254***	-0.739***
		(14.55)	(-6.24)
Female=1		-3.004***	-2.608***
		(-35.14)	(-42.35)
Selection equation			
Cont. Obs. 60-64	0.0214***	0.0215***	0.0174***
	(107.40)	(107.64)	(82.89)
Contributions Observed	-0.00144	-0.000737	
	(-1.79)	(-0.91)	
Death=1		0.00152	-0.292***
		(0.15)	(-28.05)
Female=1		-0.133***	-0.121***
		(-24.30)	(-21.47)
Constant	-0.759***	-0.724***	-0.0487*
	(-199.94)	(-173.41)	(-2.30)
mills			
lambda	16.04***	16.37***	8.761***
	(329.87)	(302.90)	(54.12)
N	277,227	277,227	277,227

t statistics in parentheses

Model 3 includes cohort fixed effects and their interaction with observed contributions.

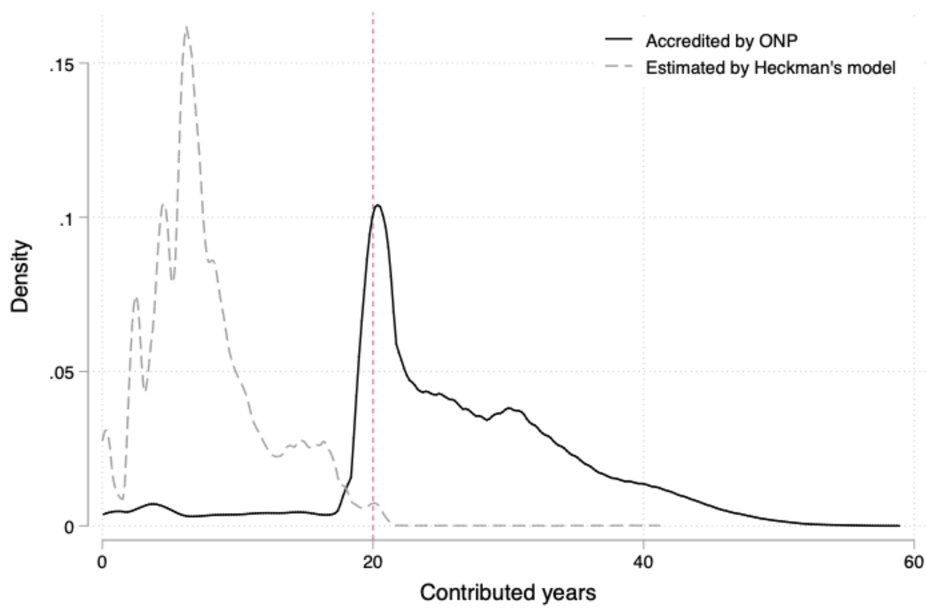
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure C–1: Contributed years estimated (not applications)



Notes: The figure shows the difference caused by not considering the selection bias in estimating the contributions of those who did not submit a pension claim.

Figure C–2: Distribution of accumulated contributions at the end of working life



Notes: The figure shows the distribution of observed and estimated inputs using a Heckman model.

Table C–2: Contributed years

Quartile	Mean	P25	P50	P75
1	10.0	4.5	6.5	10.5
2	9.9	4.8	6.8	11.3
3	17.6	9.1	20	23.2
4	24.8	16.0	24.3	33
Total	15.6	6.2	11.9	23

Notes: The table is based on administrative data from the SNP..

D Tables and figures of survival models

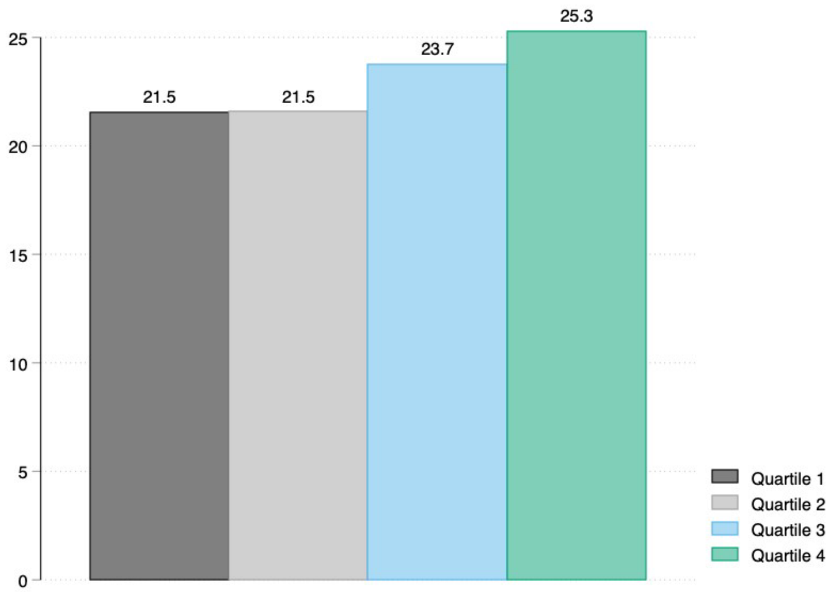
Table D–1: Gompertz regression (log relative-hazard form)

	Female	Male
Quartile= 1	0.463***	0.730***
	(0.0462)	(0.0249)
Quartile= 2	0.459***	0.550***
	(0.0450)	(0.0241)
Quartile= 3	0.189***	0.202***
	(0.0447)	(0.0270)
Quartile= 4	-5.325***	-5.184***
	(0.0405)	(0.0232)
Gamma	0.088***	0.105***
	(0.0041)	(0.0024)
Obs.	89,340	187,519
AIC	42,736	117,381
Log-Likelihood	-21,363	-58,686
chi2	159.7.3	1125.5

S.E. in parenthesis.

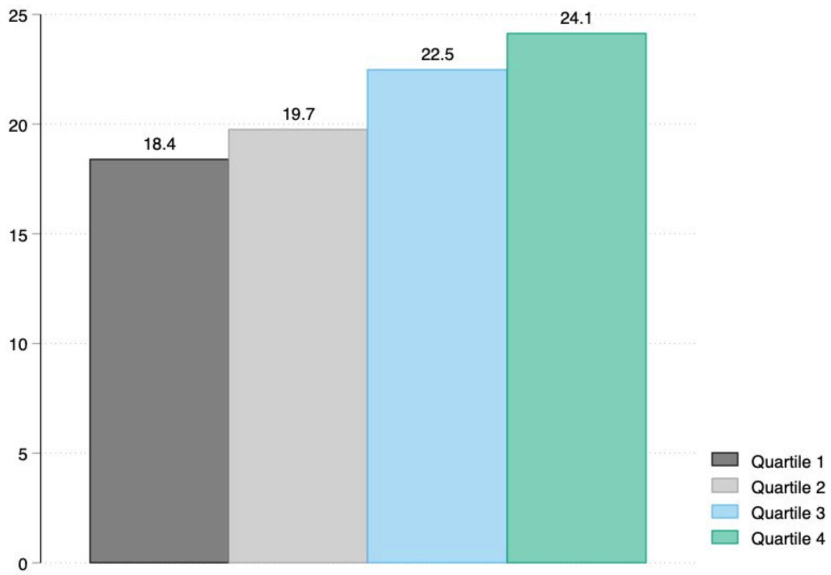
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure D–1: Females: Life expectancy at age 65



Notes: The figure plots the life expectancy by quartile.

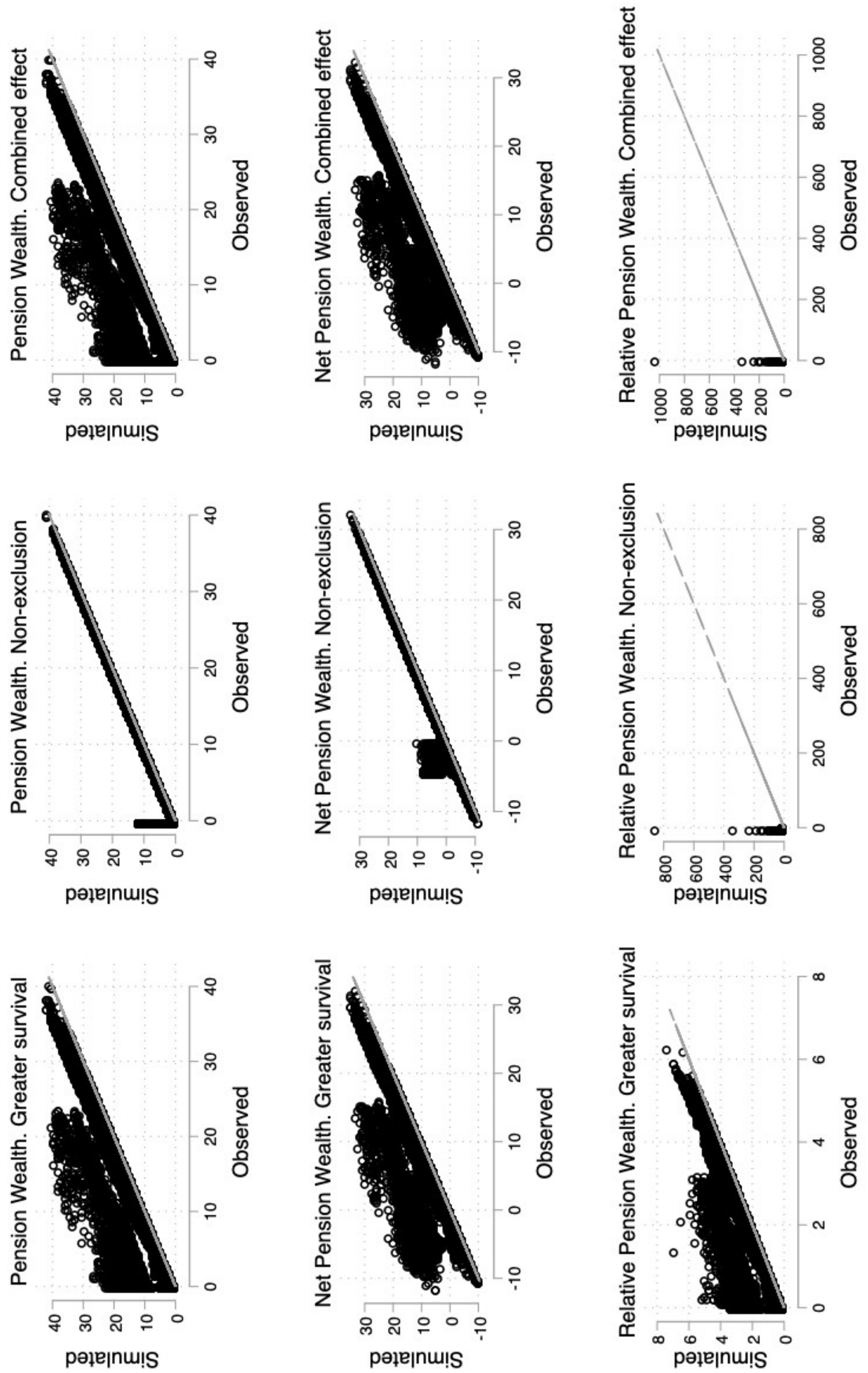
Figure D–2: Males: Life expectancy at age 65



Notes: The figure plots the life expectancy by quartile.

E Tables and figures of effects

Figure E–1: Effects of simulations



Notes: The figure shows the effect of the simulations for the outcome variables considered.

Table E–1: Pension wealth and contributions in millions

Quartile	N	Pension Wealth	Contributions	Net Pension Wealth
Q1	69,085	2,414	2,902	-488
Q2	69,237	1,918	3,654	-1,736
Q3	69,285	6,120	4,503	1,617
Q4	69,278	10,254	5,249	5,005
Total	276,885	20,706	16,309	4,397

Notes: The table is based on administrative data from the SNP.

Table E–2: Average effect on pension wealth by quartiles for males

	Pension wealth (PW)			
Quartile	Baseline	Greater survival(1)	Non-exclusion(2)	Combined effect(3)
1	3.4	4.2	7.7	9.7
	(0.03)	(0.04)	(0.02)	(0.03)
2	2.2	2.8	6.8	8.3
	(0.02)	(0.03)	(0.02)	(0.02)
3	7.1	7.9	9.7	10.7
	(0.03)	(0.03)	(0.02)	(0.02)
4	12.6	12.6	13.7	13.7
	(0.03)	(0.03)	(0.03)	(0.03)
Total	6.3	6.8	9.4	10.6
	(0.02)	(0.02)	(0.01)	(0.01)
	Net pension wealth (NPW)			
Quartile	Baseline	Greater survival(1)	Non-exclusion(2)	Combined effect(3)
1	-0.4	0.4	3.9	5.9
	(0.03)	(0.03)	(0.02)	(0.02)
2	-1.5	-1.0	3.0	4.6
	(0.02)	(0.02)	(0.01)	(0.01)
3	2.4	3.3	5.1	6.1
	(0.03)	(0.03)	(0.02)	(0.02)
4	6.7	6.7	7.7	7.7
	(0.03)	(0.03)	(0.02)	(0.02)
Total	1.7	2.3	4.9	6.1
	(0.01)	(0.02)	(0.01)	(0.01)
	Relative pension wealth (RPW)			
Quartile	Baseline	Greater survival(1)	Non-exclusion(2)	Combined effect(3)
1	0.6	0.7	1.9	2.5
	(0.005)	(0.006)	(0.003)	(0.003)
2	0.4	0.5	1.8	2.2
	(0.004)	(0.005)	(0.004)	(0.005)
3	1.4	1.5	2.1	2.3
	(0.006)	(0.006)	(0.006)	(0.006)
4	2.1	2.1	2.3	2.3
	(0.005)	(0.005)	(0.008)	(0.008)
Total	1.1	1.2	2.0	2.3
	(0.003)	(0.003)	(0.003)	(0.003)

Notes: Prepared by the authors with information from administrative records of the SNP. Standard errors are reported in parenthesis. (1) the individuals of lower SES are assigned higher survival, which we consider by assuming that survival is the same for everyone and corresponds to the highest quartile; (2) everyone receives a pension, meaning that the individuals with contributions below the threshold receive a hypothetical pension proportional to the contributions made and whose maximum value corresponds to the minimum legal pension; (3) the joint effect of (1) and (2).

Table E–3: Average effect on pension wealth by quartiles for females

	Pension wealth (PW)			
Quartile	Baseline	Greater survival(1)	Non-exclusion(2)	Combined effect(3)
1	2.4	2.7	7.6	8.8
	(0.04)	(0.05)	(0.03)	(0.03)
2	1.9	2.2	6.6	7.7
	(0.03)	(0.04)	(0.02)	(0.02)
3	7.3	8.0	10.0	10.9
	(0.04)	(0.04)	(0.02)	(0.02)
4	12.8	12.8	14.1	14.1
	(0.05)	(0.05)	(0.04)	(0.04)
Total	6.2	6.6	9.7	10.5
	(0.03)	(0.03)	(0.02)	(0.02)
	Net pension wealth (NPW)			
Quartile	Baseline	Greater survival(1)	Non-exclusion(2)	Combined effect(3)
1	-0.9	-0.6	4.3	5.4
	(0.04)	(0.04)	(0.03)	(0.03)
2	-1.5	-1.2	3.3	4.4
	(0.03)	(0.03)	(0.02)	(0.02)
3	2.9	3.5	5.6	6.4
	(0.03)	(0.03)	(0.02)	(0.02)
4	7.3	7.3	8.6	8.6
	(0.02)	(0.04)	(0.03)	(0.03)
Total	2.0	2.4	5.5	6.3
	(0.02)	(0.02)	(0.01)	(0.01)
	Relative pension wealth (RPW)			
Quartile	Baseline	Greater survival(1)	Non-exclusion(2)	Combined effect(3)
1	0.4	0.5	2.2	2.5
	(0.007)	(0.008)	(0.004)	(0.004)
2	0.4	0.5	2.0	2.3
	(0.007)	(0.007)	(0.046)	(0.055)
3	1.5	1.6	2.2	2.4
	(0.007)	(0.008)	(0.011)	(0.011)
4	2.3	2.3	2.4	2.4
	(0.007)	(0.007)	(0.005)	(0.005)
Total	1.2	1.2	2.2	2.4
	(0.004)	(0.005)	(0.010)	(0.012)

Notes: Prepared by the authors with information from administrative records of the SNP. Standard errors are reported in parenthesis. (1) the individuals of lower SES are assigned higher survival, which we consider by assuming that survival is the same for everyone and corresponds to the highest quartile; (2) everyone receives a pension, meaning that the individuals with contributions below the threshold receive a hypothetical pension proportional to the contributions made and whose maximum value corresponds to the minimum legal pension; (3) the joint effect of (1) and (2).

Table E–4: Average effect on pension wealth by quartiles for cohort 1939-1943

	Pension wealth (PW)			
Quartile	**Baseline**	**Greater survival(1)**	**Non-exclusion(2)**	**Combined effect(3)**
1	6.9	8.3	9.8	12.2
	(0.12)	(0.14)	(0.10)	(0.11)
2	3.1	3.9	6.0	7.4
	(0.05)	(0.05)	(0.04)	(0.04)
3	7.7	8.9	8.7	10.0
	(0.05)	(0.05)	(0.05)	(0.05)
4	12.1	12.1	12.3	12.3
	(0.08)	(0.08)	(0.07)	(0.07)
Total	7.1	7.9	8.8	10.0
	(0.04)	(0.04)	(0.03)	(0.03)
	Net pension wealth (NPW)			
Quartile	**Baseline**	**Greater survival(1)**	**Non-exclusion(2)**	**Combined effect(3)**
1	2.4	3.9	5.4	7.8
	(0.10)	(0.12)	(0.08)	(0.09)
2	-1.0	-0.3	1.8	3.3
	(0.04)	(0.05)	(0.03)	(0.04)
3	2.9	4.1	3.9	5.1
	(0.05)	(0.05)	(0.04)	(0.04)
4	5.8	5.8	6.0	6.0
	(0.07)	(0.07)	(0.07)	(0.07)
Total	2.2	3.0	3.9	5.2
	(0.03)	(0.03)	(0.03)	(0.03)
	Relative pension wealth (RPW)			
Quartile	**Baseline**	**Greater survival(1)**	**Non-exclusion(2)**	**Combined effect(3)**
1	1.1	1.3	2.0	2.5
	(0.018)	(0.020)	(0.011)	(0.012)
2	0.6	0.7	1.5	1.8
	(0.008)	(0.010)	(0.055)	(0.066)
3	1.5	1.8	1.8	2.1
	(0.010)	(0.010)	(0.008)	(0.008)
4	1.9	1.9	2.0	2.0
	(0.011)	(0.011)	(0.011)	(0.011)
Total	1.2	1.4	1.7	2.0
	(0.006)	(0.006)	(0.018)	(0.022)

Notes: Prepared by the authors with information from administrative records of the SNP. Standard errors are reported in parenthesis. (1) the individuals of lower SES are assigned higher survival, which we consider by assuming that survival is the same for everyone and corresponds to the highest quartile; (2) everyone receives a pension, meaning that the individuals with contributions below the threshold receive a hypothetical pension proportional to the contributions made and whose maximum value corresponds to the minimum legal pension; (3) the joint effect of (1) and (2).

Table E–5: Average effect on pension wealth by quartiles for cohort 1944-1948

	Pension wealth (PW)			
Quartile	Baseline	Greater survival[(1)]	Non-exclusion[(2)]	Combined effect[(3)]
1	3.9	4.8	8.0	9.9
	(0.05)	(0.06)	(0.04)	(0.04)
2	2.2	2.7	6.9	8.4
	(0.03)	(0.03)	(0.02)	(0.02)
3	8.5	9.4	10.4	11.4
	(0.04)	(0.04)	(0.03)	(0.02)
4	14.6	14.6	15.0	15.0
	(0.04)	(0.04)	(0.04)	(0.04)
Total	7.2	7.8	10.0	11.2
	(0.02)	(0.03)	(0.02)	(0.02)
	Net pension wealth (NPW)			
Quartile	**Baseline**	**Greater survival[(1)]**	**Non-exclusion[(2)]**	**Combined effect[(3)]**
1	0.1	0.9	4.1	6.1
	(0.04)	(0.05)	(0.03)	(0.03)
2	-1.5	-1.0	3.2	4.7
	(0.02)	(0.03)	(0.01)	(0.01)
3	3.6	4.5	5.5	6.6
	(0.03)	(0.03)	(0.02)	(0.02)
4	8.1	8.1	8.5	8.5
	(0.03)	(0.03)	(0.03)	(0.03)
Total	2.5	3.1	5.3	6.4
	(0.02)	(0.02)	(0.01)	(0.01)
	Relative pension wealth (RPW)			
Quartile	**Baseline**	**Greater survival[(1)]**	**Non-exclusion[(2)]**	**Combined effect[(3)]**
1	0.7	0.8	2.0	2.5
	(0.008)	(0.009)	(0.004)	(0.004)
2	0.4	0.5	1.9	2.3
	(0.005)	(0.007)	(0.012)	(0.012)
3	1.6	1.8	2.2	2.4
	(0.007)	(0.007)	(0.012)	(0.012)
4	2.2	2.2	2.3	2.3
	(0.005)	(0.005)	(0.014)	(0.014)
Total	1.2	1.3	2.1	2.4
	(0.004)	(0.004)	(0.005)	(0.005)

Notes: Prepared by the authors with information from administrative records of the SNP. Standard errors are reported in parenthesis. (1) the individuals of lower SES are assigned higher survival, which we consider by assuming that survival is the same for everyone and corresponds to the highest quartile; (2) everyone receives a pension, meaning that the individuals with contributions below the threshold receive a hypothetical pension proportional to the contributions made and whose maximum value corresponds to the minimum legal pension; (3) the joint effect of (1) and (2).

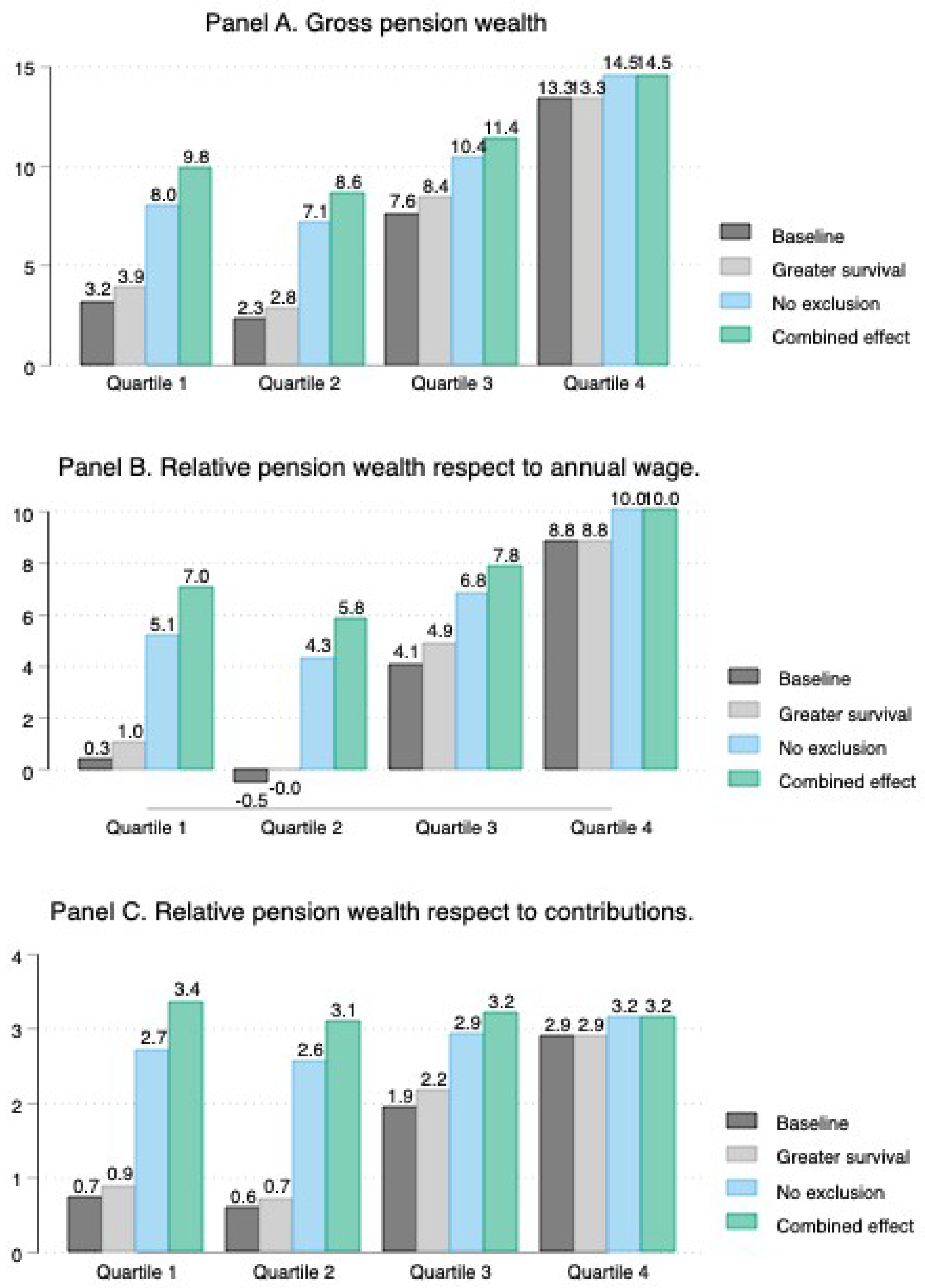
Table E–6: Average effect on pension wealth by quartiles for cohort 1949-1952

	Pension wealth (PW)			
Quartile	Baseline	Greater survival(1)	Non-exclusion(2)	Combined effect(3)
1	1.6	1.9	6.9	8.5
	(0.02)	(0.03)	(0.01)	(0.02)
2	1.6	1.8	7.1	8.3
	(0.02)	(0.03)	(0.01)	(0.02)
3	5.9	6.4	10.0	10.6
	(0.03)	(0.04)	(0.02)	(0.02)
4	11.3	11.3	13.4	13.4
	(0.04)	(0.04)	(0.03)	(0.03)
Total	5.2	5.4	9.4	10.3
	(0.02)	(0.02)	(0.01)	(0.01)
	Net pension wealth (NPW)			
Quartile	Baseline	Greater survival(1)	Non-exclusion(2)	Combined effect(3)
1	-1.7	-1.4	3.6	5.1
	(0.02)	(0.02)	(0.01)	(0.01)
2	-1.8	-1.5	3.7	5.0
	(0.02)	(0.02)	(0.01)	(0.01)
3	1.7	2.2	5.8	6.4
	(0.03)	(0.03)	(0.01)	(0.01)
4	6.2	6.2	8.3	8.3
	(0.03)	(0.03)	(0.02)	(0.02)
Total	1.2	1.4	5.4	6.2
	(0.02)	(0.02)	(0.01)	(0.01)
	Relative pension wealth (RPW)			
Quartile	Baseline	Greater survival(1)	Non-exclusion(2)	Combined effect(3)
1	0.3	0.4	2.1	2.5
	(0.004)	(0.005)	(0.002)	(0.002)
2	0.3	0.4	2.1	2.5
	(0.005)	(0.006)	(0.006)	(0.007)
3	1.2	1.3	2.3	2.5
	(0.007)	(0.007)	(0.008)	(0.008)
4	2.1	2.1	2.4	2.4
	(0.006)	(0.006)	(0.003)	(0.003)
Total	1.0	1.0	2.2	2.5
	(0.003)	(0.004)	(0.003)	(0.003)

Notes: Prepared by the authors with information from administrative records of the SNP. Standard errors are reported in parenthesis. (1) the individuals of lower SES are assigned higher survival, which we consider by assuming that survival is the same for everyone and corresponds to the highest quartile; (2) everyone receives a pension, meaning that the individuals with contributions below the threshold receive a hypothetical pension proportional to the contributions made and whose maximum value corresponds to the minimum legal pension; (3) the joint effect of (1) and (2).

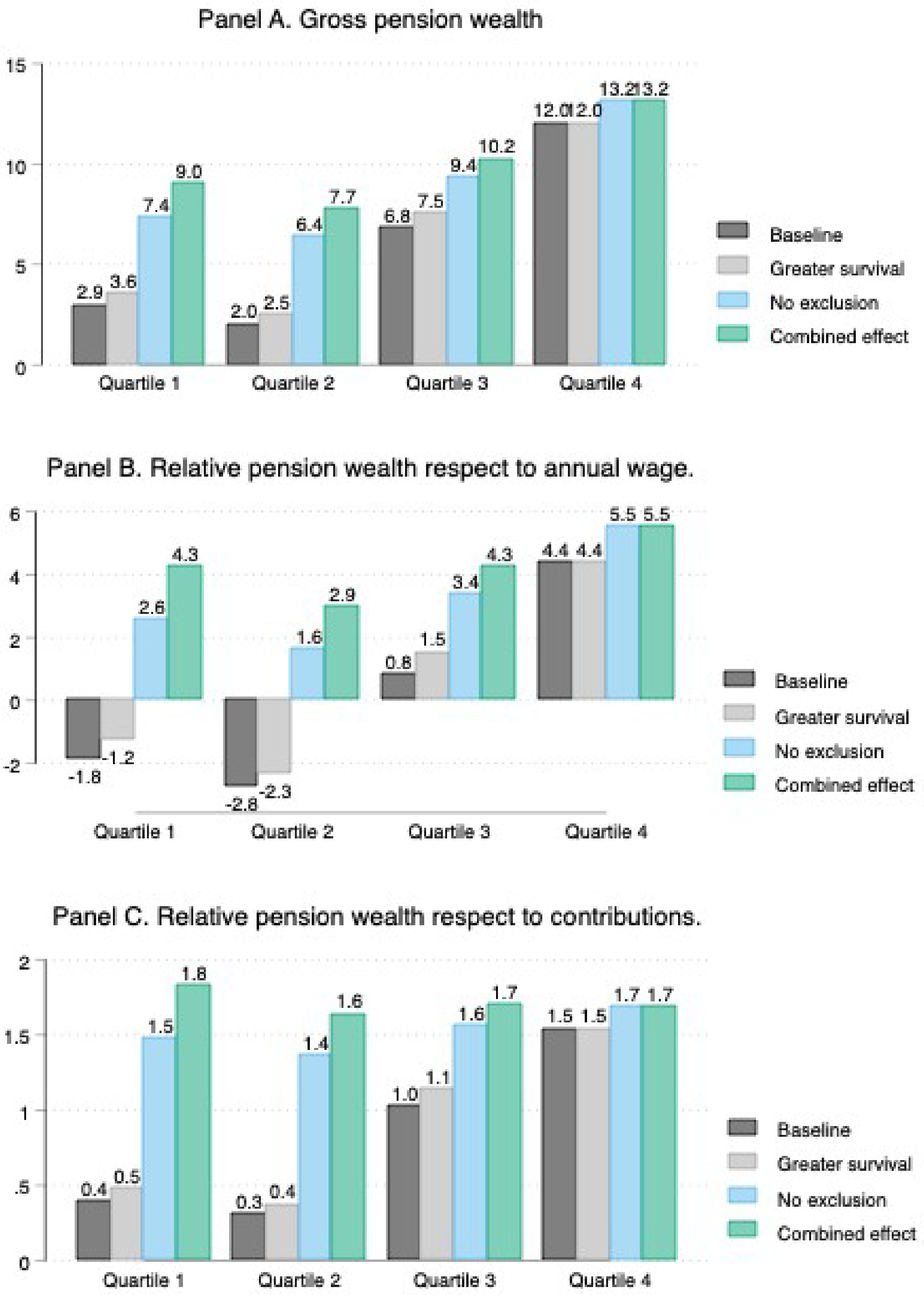
F Sensitivity and robustness checks

Figure F–1: Robustness $r = 0.01$



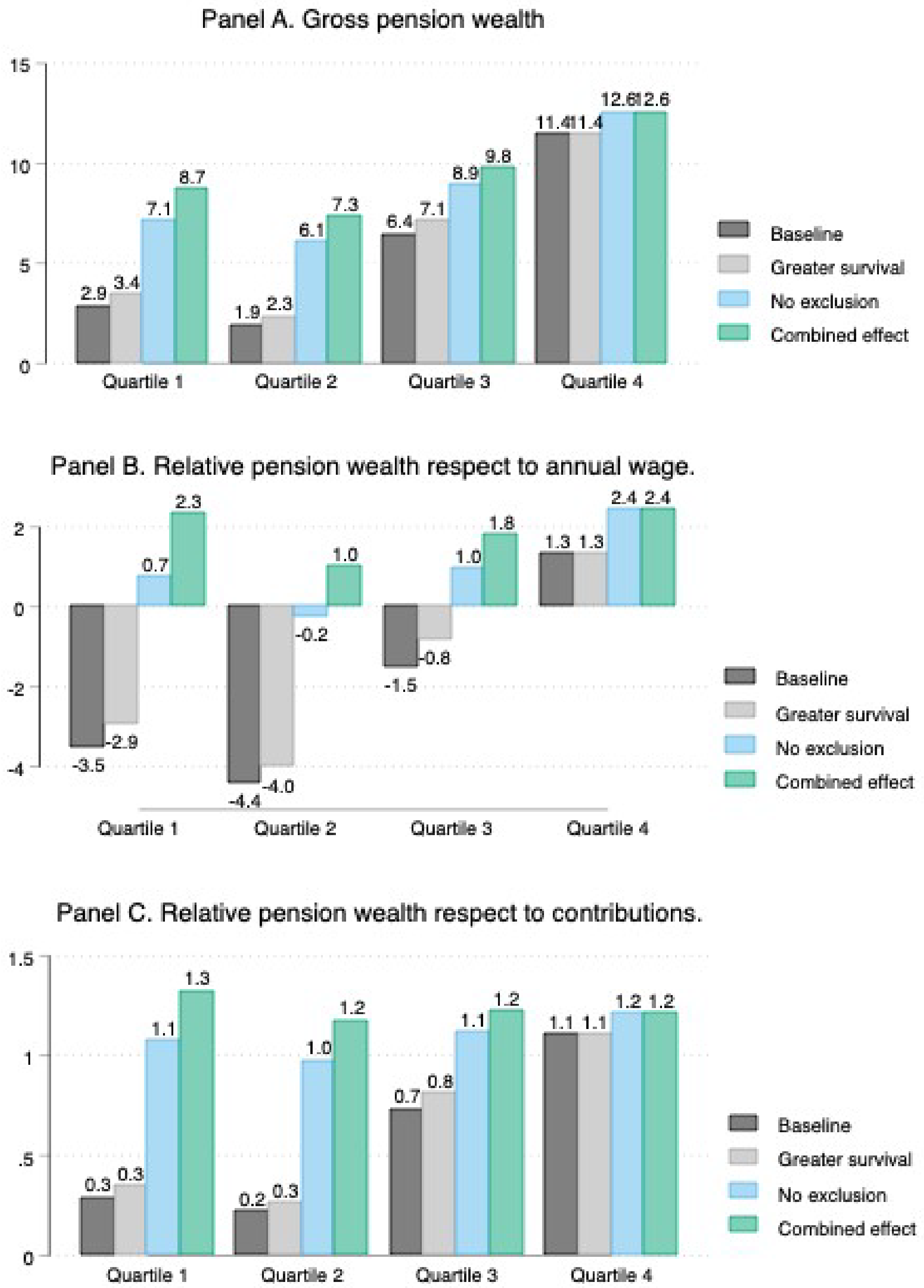
Notes: The figure shows the effect of the simulations per outcome variable according to quartiles.

Figure F–2: Robustness r = 0.03



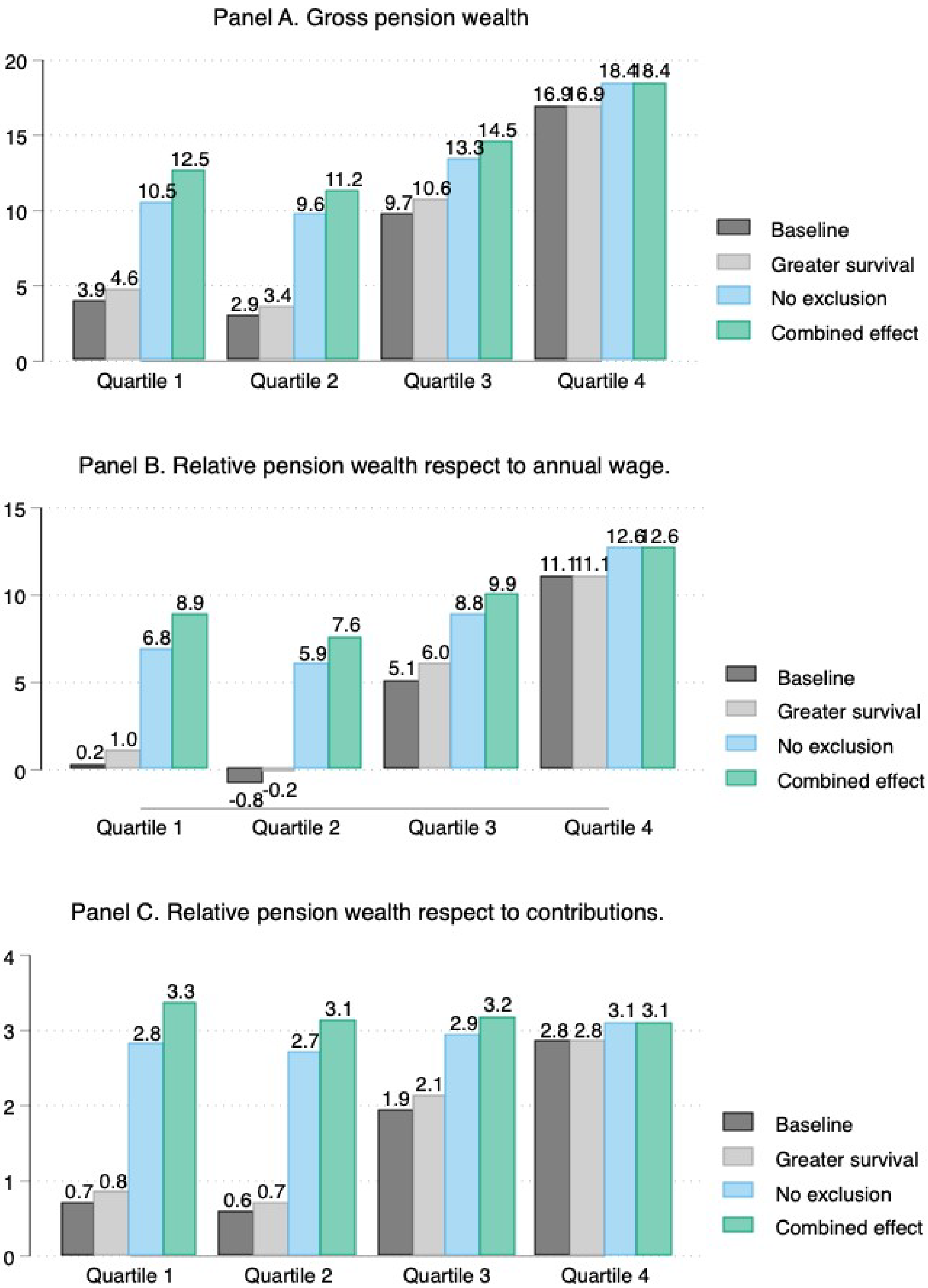
Notes: The figure shows the effect of the simulations per outcome variable according to quartiles.

Figure F–3: Robustness $r = 0.04$



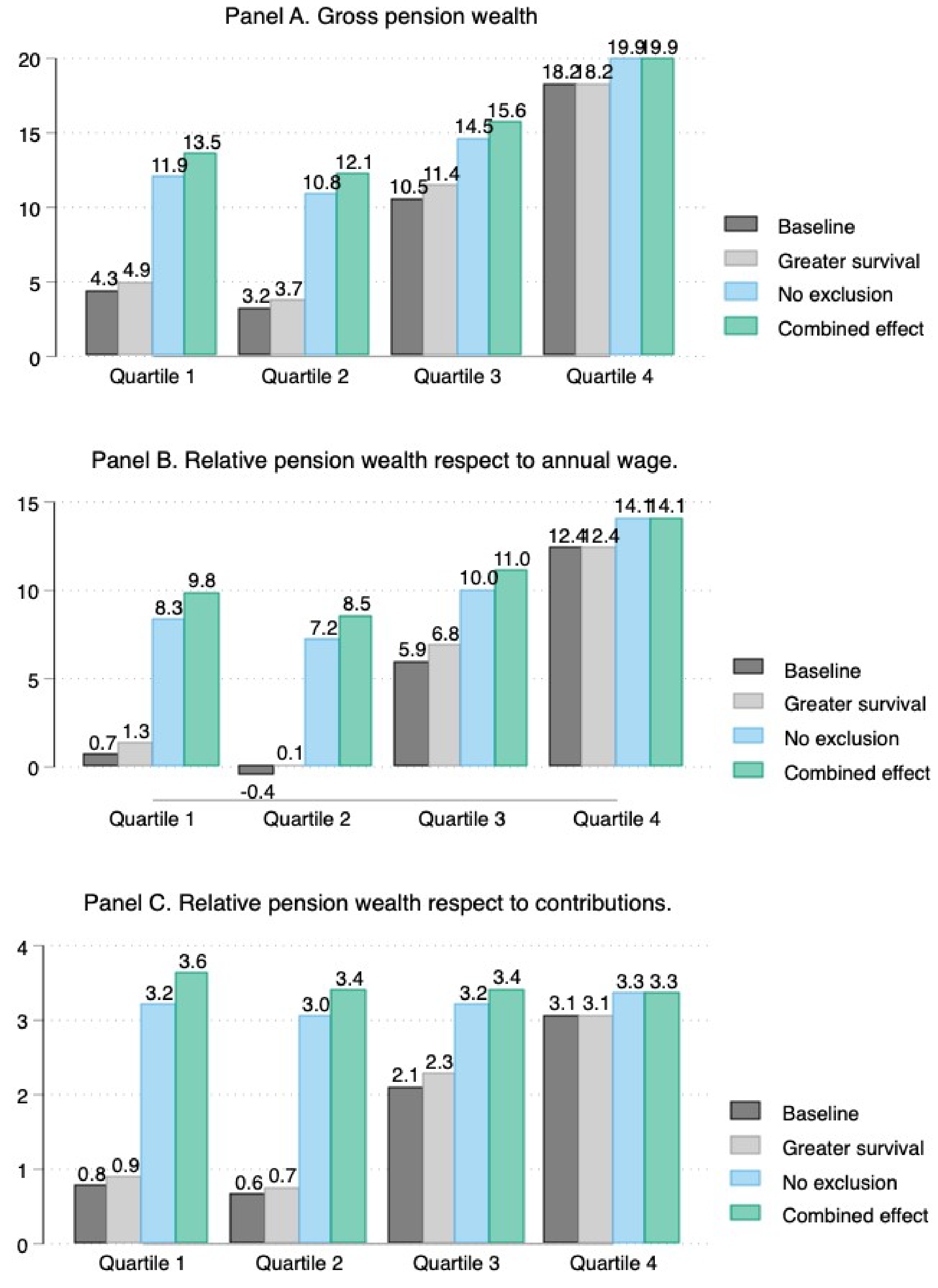
Notes: The figure shows the effect of the simulations per outcome variable according to quartiles.

Figure F–4: Weibull



Notes: The figure shows the effect of the simulations per outcome variable according to quartiles.

Figure F–5: Exponential



Notes: The figure shows the effect of the simulations per outcome variable according to quartiles.