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Javier Olivera

Yadiraah Iparraguirre

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Javier Olivera
Luxembourg Institute of Socio-Economics Inequality (LISER)
Yadiraah Iparraguirre
Pontificia Universidad Catolica del Peru (PUCP)

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Keyword: Gender gap, Pension savings, Financial literacy, Unconditional quantile, Peru

JEL Cassification: D31, G23, J16, J32

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†Luxembourg Institute of Socio-Economic Research (LISER), and Department of Economics, Pontificia Universidad Catolica del Peru; e-mail: javier.olivera@liser.lu; e-mail: olivera.j@pucp.edu.pe

‡Innovations for Poverty Action, and Department of Economics, Pontificia Universidad Catolica del Peru; e-mail: yadiraah.iparraguirre@pucp.edu.pe; e-mail: yiparraguirre@poverty-action.org.

1 Introduction

During the wave of structural reforms in the 1990s, various Latin American countries reformed their pension systems by implementing schemes based on individual retirement accounts (IRA). The previous public pension schemes mostly based on pay-as-you-go (PAYG) financing were fully or partially replaced by the new IRA systems. Among the frequently mentioned goals of these reforms were solving public financial imbalances and facilitating individuals' access to better pensions by means of individual capitalization. A number of studies have assessed the benefits of and problems created by these reforms in different dimensions, such as pension adequacy, saving behavior, and capital market development (e.g. Bosch et al., 2013; Arenas de Mesa, 2019; Altamirano-Montoya et al., 2018), but few have examined gender gaps in pension savings accumulation.

It has been found that the key factors to understand the gender gap and its trends in pensions are the effects of women's life course, including their participation in the labor market, differential mortality, and the institutional characteristics of the pension system (Bando, 2019; Madero-Cabib et al., 2019). Despite advances in the educational attainment of women, family roles and labor market characteristics remain strong determinants of gender gaps. Women often participate less in the labor market, spend disproportionately more time carrying out household tasks, and have lower wages (Cordova et al., 2021; Arza, 2015; Madero-Cabib et al., 2019). It has been shown that these conditions may hamper women's long-term ability to accumulate pension savings and generate adequate levels of pensions (Altamirano-Montoya et al., 2018).

The design of the pension system and its rules have an important role in determining pension outcomes by gender. For example, minimum contribution spells, minimum pensions, retirement age, mortality tables used to compute pension benefits, and the link between benefits and earnings all play a key role in the gender differences observed in pensions (Arza, 2015; Bertranou, 2001). This means that IRA systems—which strengthen the link between lifetime wages and pensions—bring about a new set of gender equality issues. The gender gap could grow further if we consider that financial knowledge, which translates into the ability to make better investment choices and perform annuity management, is more prevalent among men than among women (Lusardi and Mitchell, 2010; Hastings et al., 2010; Fonseca et al., 2012).

We seek to contribute to the literature on the gender pension gap by studying the case of Peru, a country where the main compulsory pension system is based on IRA. This is the Private Pension System (known as SPP, due to its Spanish name *Sistema Privado de Pensiones*). Although there is an alternative public pension system (known as SNP, due to its Spanish name *Sistema Nacional de Pensiones*), most new workers enroll in the SPP.[1] We use representative samples of the non-retired population affiliated to the SPP, randomly selected from administrative records in 2005, 2006, 2013, 2015, 2016, and 2019. Our data allows us to analyze gender gaps in pension balances along birth cohorts and across the years of our period of analysis.

[1] In 2019, the ratio of new affiliates in the schemes was about 5 to 1 for the SPP and the SNP.

Few previous empirical studies have assessed gender gaps in pension wealth generated in IRA systems. However, it should be noted that a recent study by Cordova et al. (2021) shows that in Germany, the reduced participation rate and capitalization for women in private pension plans may explain their lower pensions. Thus, low pensions are mainly explained by the type of occupation, income level, hours of work, and the presence of children at home. Also for Germany, Flory (2012) finds that the pension wealth gap is heterogeneous by birth cohort groups. The gender gap tends to be lower among younger cohorts than among older ones. In the United Kingdom, Foster and Smetherham (2013) show that the factors strongly associated with individual contribution rates are income, economic position, the type of occupation, and having young children; with these predictors being more salient for women than for men.

Studies on net worth also show a gender gap favoring men over women. Schneebaum et al. (2018) exploit the Household, Finance and Consumption Survey (HFCS) to study the gender gap throughout the distribution of net wealth across single-person households in eight European countries. They find that the gap increases with the percentiles of the distribution of net wealth, showing evidence of a "glass ceiling" problem. When looking at the gender gap by the type of wealth, it does not stem from asset wealth in the household, but from the disparity in occupational pensions. Furthermore, the researchers show that the gender gap increases when both the cohort is older and the percentile is higher, with the exceptions of Germany and Spain. Likewise, the study by Meriküll et al. (2021) on Estonia finds an increasing gender gap in favor of men across the quantiles of household net wealth. The factors explaining this result are labor market status (self-employment, retirement), education level, occupation type, and marital status. Moreover, studies such as those by Frémeaux and Leturcq (2020) and Sierminska et al. (2019) exploit individualized wealth portfolios to understand several drivers of gender wealth gaps.

Similar to some of the previous studies mentioned, we use unconditional quantile regressions to estimate gender gaps along the distribution of pension wealth. We find a gender gap in favor of men at each percentile of the distribution of pension funds, yet this decreases constantly along the percentiles until reaching a form of "glass ceiling" around the 85th percentile. From that point, the gender gap rapidly increases in the top section of the distribution of pension wealth. Overall, our results suggest that on the one hand, there is a reduction of the gender gap in pension wealth across birth cohorts, which is line with other findings concerning the increase of female labor participation and wage improvements. However, on the other hand, we observe that this not enough to consistently reduce the pension wealth gap once we consider the effects of capitalization across the working life-span. The capitalization of individual pension contributions—operating via the capital market returns of pension funds—amplifies any early and small gender gap observed at the beginning of the working life.

Moreover, in a country where only 28 percent of the adult population scores correctly in financial literacy questions about interest rates, inflation, and risk diversification (see Klapper et al., 2015), it is important to understand whether this could play a role in the gender wealth gap for pensions. We are able to capture financial literacy by observing how individuals move from default options in the risk composition of their portfolio investments, which we term *Awareness of portfolio management*. As has been shown in other studies (e.g., Lusardi et al., 2017) that find an effect of financial literacy on household wealth inequality, we document that financial literacy may increase inequality in pension savings. Furthermore, the importance of the *Awareness of portfolio management* in explaining a pension savings gap increases along the distribution of pension wealth, meaning that differences in financial literacy may exacerbate gender gaps as well as pension savings inequality.

The remainder of the article is organized as follows. Section 2 describes the institutional framework of the pension system in Peru. Section 3 describes the data and empirical strategy. Section 4 reports and discusses the main results, and Section 5 exploits available information on portfolio risk choices to study the role of financial literacy on the distribution of pension savings and gender gaps. Section 6 presents additional results regarding a measurement of extended pension wealth and the distribution of income. Lastly, Section 7 presents the conclusions.

2 Institutional Background

The Peruvian pension system is composed of two schemes that offer individuals two mutually exclusive options. First, the SPP is a defined contribution (DC) system, which is based on individual retirement accounts (IRA) and started in June 1993. The introduction of this type of system was part of a wave of pension reforms inspired by the Chilean example that spread widely across Latin America during the 1990s. The pension fund managers (the so-called AFP) are companies that receive the pension contributions and invest the individualized savings. These investments are tightly regulated by the Superintendent of Banking, Insurance and Pension Funds (known as SBS due to its Spanish name *Superintendencia de Banca, Seguros y Fondos de Pensiones*). Second, the National Pension System (SNP) is a defined benefit (DB) system operating on a PAYG basis. Individuals must choose one of these pension schemes at the beginning of their working lives. If the SPP is chosen, the individual must remain in the scheme, but changing from SNP to SPP is possible at any time. In order to recognize the part of any contributions made to the SNP, the government issued "Recognition Bonds," the values of which are updated monthly based on the official prices index. To date, there are three types of bonds, issued from 1992, 1996, and 2001. There are currently four AFP in Peru: Prima, Integra, Profuturo, and Habitat. Others were previously operating, but they gradually left the market or merged with other companies over time. After several changes to the regulations, a worker currently contributes 10 percent (plus administrative fees and an insurance premium) of their gross salary to the AFP, or 13 percent to the SNP.[2]

IRA systems have been strongly criticized for their distributive impacts. These systems

[2]The contribution rate was 11 percent in 1993–1995, 8 percent in 1996–2005, and has been 10 percent since 2005.

tend to favor people with higher incomes and do not guarantee a minimum retirement income, leaving many people with small pensions during old age and limiting their eligibility for social assistance programs. In Peru, for example, an individual is eligible to social pensions only if they are older than 65, extremely poor, and have no private or public pensions. The disequalizing effects of IRA systems are aggravated in contexts with high levels of informality and high turnover between formal and informal employment, as these factors reduce the frequency of contributions. Likewise, these systems are criticized for their high fees and administrative costs. Yet IRA systems have also attracted support when the assessment of them focuses on the positive contributions regarding national savings, economic growth, and the development of new annuity markets.

The SPP could also exacerbate the inequalities observed in labor income through the capitalization process and the disparity between individuals in the frequency of contributions. This means that the process of capitalization, together with the fact that richer individuals contribute more frequently, could generate larger differences in pension savings than in incomes. In addition, these inequalities may further increase once we take into account the absence of minimum guaranteed benefits in the SPP and the fact that the computation of pensions uses gender-differentiated mortality tables, which favor men over women.[3] This differs from DB systems, which tend to reduce inequality through minimum guaranteed pensions and the use of unisex mortality tables to determine the amount of pension benefits. Consequently, gender inequality in pension savings could be significant in IRA type systems. We can see some of the main factors driving gender gaps in pension savings with the following stylized equations:

$$B_i = a \sum_{j=25}^{65-j} (w_{ij} d_{ij})(1+r)^{(65-j)} \qquad i = m, f \tag{1}$$

$$Gender\ Gap = B_m - B_f = a \sum_{j=25}^{65-j} (w_{mj} d_{mj} - w_{fj} d_{fj})(1+r)^{(65-j)} \tag{2}$$

The equation 1 indicates the level of pension balance (B_i) accumulated at retirement age by men (m) or women (f). The value depends on income (w), frequency of contributions ($d \in [0,1]$), contribution rate (a), return rate (r), and the period of capitalization ($65 - j$) (assumed between age 25 and 65). The gender gap is reported in equation 2, showing the difference in pension balances accrued by men and women on retirement age. We observe that two main components affect the level of the gender gap: the wages and the capitalization process. On the one hand, there are the differences in labor income, weighted by the frequency of contributions, which may reflect occupational status and the extent of formal employment. On the other hand,

[3] Women have a longer life expectancy than men, and this needs to be reflected in the annuity price formula used to compute pensions in the SPP. For example, the difference in pensions attributed to differential sex mortality would be about 10 percent (in favor men over women) when we compute an annuity at age 65 using the SPP's official life tables for a single a man and a single woman with the same level of pension balance, and a discount interest rate of 3 percent.

there is the capitalization process, which is driven by the pension fund return rate and the length of the capitalization period. A gender gap could potentially be observed at any period of an individual's labor span, but it is key to recognize that it is only at retirement age that it would be possible to fully account for all the capitalization process affecting the full value of pension savings.

3 Data and Empirical Strategy

3.1 The Data

We use cross-sectional samples of the total non-retired population from the SPP administrative records for 2005, 2006, 2013, 2015, 2016, and 2019. The samples are random, stratified, and representative of the following strata for each sampling year: 5-year age group, sex, and year of enrolment in the SPP. These are the only available datasets that include information about each individual's pension balance, management fees, and income, together with some demographic variables. For each year, the sample is equivalent to 2 percent of the total non-retired population in the SPP.[4]

The initial sample comprises 600,360 observations, corresponding to individuals aged between 21 and 64 in each sample year. We do not consider individuals older than 65, as this is the legal retirement age. After dropping individuals with no information on pension balance (165), affiliated for less than one month (1,307), being in pension fund type zero (1,536), and with zero pension balance (64,152), we obtain a final sample of 533,200 observations. The balances with a zero value may reveal that the individual is not able or does not want to accumulate pension funds. Given that our interest lies in assessing the pension fund gender gaps of people who save for pensions, we removed the individuals with no pension savings.[5] Thus, our analysis is representative of the non-retired population who have contributed at least once to their retirement savings in the SPP.

The micro-data include information on age, gender, employment situation, and income at the individual level. The data also include information about the pension account, such as the enrollment date, AFP, last contribution date, pension balance, type of fee (load factor or balance fee), type of pension fund, information about recognition bonds, and contribution density. This last variable indicates the proportion of contributions made by an individual with respect to the theoretical total number of contributions that they should have made, so that the values range between 0 and 1. This variable is only available for the samples extracted in 2015, 2016, and

[4]The sample size is 1.8 percent of the SPP non-retired population for 2005 and 2006, and is 2 percent for each of the other years.

[5]Among the individuals with a zero pension balance, 28 percent have been enrolled in the SPP for 15 years or more, 45 percent for between 5 and 14 years, and 23 percent for between 1 and 4 years. Possible explanations for this behavior are that the individuals were enrolled while they were working in an activity with no obligation to contribute (informal sector working, or self-employed) or inactive (e.g., students). There are also the so-called "ghost affiliates": individuals who never realized they were enrolled at some point by an AFP salesman.

2019; however, we are still able to use the date of the last recorded contribution, available for all the sample years, to compute a proxy variable. The variable *Regular contributor* takes the value of 1 if the last contribution recorded for the individual was made in the sampling year, and 0 otherwise.

There are four main types of pension funds. Fund type 0 is designed to maintain capital, offers both very low return and volatility, and is intended for individuals who are in the process of acquiring a pension. Fund type 1 involves investments with relatively low returns and volatility, and is mandatory for individuals aged 60–65, unless they have expressly chosen to be assigned to fund type 0 or 2. Fund type 2 includes investments with moderate growth and volatility and combines both fixed-income instruments and equities. Fund type 3 is generally composed of investments with higher returns and volatility, such as equities.[6] When an individual enrolls for the first time into an AFP, the default pension fund is type 2. Choosing another type of fund requires a special administrative procedure. In line with Bernal and Olivera (2020), we use these pension fund risk defaults to compute a measurement of how active individuals are with regard to their portfolio management. The variable *Active portfolio management* takes the value of 1 if an individual under 60 has a pension fund of type 1 or 3, or if an individual older than 60 has a pension fund other than type 1; and takes the value of 0 otherwise. This variable indicates that an individual has taken action to move away from the default pension fund risk portfolio. We argue that this variable captures awareness about risk diversification and may therefore be a proxy for financial literacy. We expect that more sophisticated individual investors will be more likely to deviate from the defaults.

3.2 Empirical strategy

First, we use OLS regressions to explore and estimate the gender gap in pension balances according to the following equation:

$$B_i = \alpha + \beta_1 male_i + \beta_j C_{ji} + \pi year_i + \gamma_j C_{ji} \times male_i + X_i^{'} \theta + \varepsilon_i \quad (3)$$

Where B_i is the pension balance of individual i, C_{ji} is an indicator variable for the birth year cohort j of the individual, $year_i$ is the year of the sample draw, $male_i$ is an indicator variable for men, $X_i^{'}$ is a vector of covariates, and ε_i is the error term.

As we are interested in estimating the gender gap magnitudes along the distribution of pension wealth, we perform unconditional quantile regressions (UQR). These regressions are based on an extension of the Recentered Influence Function (RIF), which provides a linear approximation of the unconditional quantiles of the dependent variable of analysis (Firpo et al., 2009). This function is defined as the following:

[6] Fund type 0 invests 100 percent in fixed-income instruments. Fund type 1 invests up to 90 percent in short-term fixed-income instruments and up to 10 percent in equities. Fund type 2 invests up to 55 percent in short-term fixed-income instruments and up to 45 percent in equities. Fund type 3 comprises investments of up to 80 percent in equities and up to 20 percent in short-term fixed-income instruments.

$$RIF(B;Q_\tau,F) = Q_\tau + IF(B;Q_\tau,F) \tag{4}$$

Where Q_τ is the value of pension balance B at quantile τ in the unconditional distribution F of pension balances, and $IF(B;Q_\tau,F)$ is the quantile influence function. The influence function of a statistic (in our case, the quantile) indicates how sensitive this statistic is to different areas of the distribution (Choe and Van Kerm, 2018). This function is represented as follows:

$$IF(B;Q_\tau,F) = \frac{(\tau - I[B \leq Q_\tau])}{f_B(Q_\tau)} \tag{5}$$

Where $f_B(Q_\tau)$ is the density function up to the percentile τ and $I[B \leq Q_\tau]$ is a binary variable that takes the value of 1 when the value of B is lower than the corresponding percentile, and 0 otherwise. Introducing equation 5 into 4 we obtain equation 6 that represents the RIF. Using the RIF ensures that the change in its average value over time is equal to the change in the statistic of interest (Davies et al., 2017).

$$RIF(B,Q_\tau) = Q_\tau + \frac{(\tau - I[B \leq Q_\tau])}{f_B(Q_\tau)} \tag{6}$$

Once the RIF estimators of B are computed, the following equation can be estimated by OLS:

$$RIF(B,Q_\tau) = \alpha + \beta_1 male_i + \beta_j C_{ji} + X_i^{'}\theta + \varepsilon_i \tag{7}$$

The RIF regression allows us to evaluate the impact of any covariate on the statistic of interest, and to determine which variable is associated with the greatest influence on the distribution. The coefficients obtained from the regression can be interpreted as the extent to which an infinitesimal change in the distribution of the covariate influences a given quantile—maintaining everything else constant—termed the unconditional quantile partial effect (UQPE). This method allows us to focus on a certain point of the distribution of the pension balance (high or low percentile), regardless of whether the values of the covariates are the same (Firpo et al., 2009; Choe and Van Kerm, 2018). This represents an advantage for studying gender gaps, compared with the conditional quantile regression (CQR) method. The reason is that the CQR estimates can only be interpreted for a set of individuals sharing covariates with the same values, and cannot be used to estimate the impact of a variable of interest on the corresponding unconditional percentile (Firpo et al., 2009). Thus, we could evaluate the effect of increasing the participation of men or increasing a year of affiliation in a certain upper percentile of the distribution, in which there are probably more men than women.

In addition, we use the Oaxaca-Blinder decomposition based on the RIF regressions for men and women at given percentiles. Following the standard decomposition equation, we have the following:

$$\bar{B}_{m,\tau} - \bar{B}_{f,\tau} = \left(\overline{X}_m - \overline{X}_f\right)\beta_{m,\tau} + \overline{X}_f\left(\beta_{m,\tau} - \beta_{f,\tau}\right) \tag{8}$$

Where $\bar{B}_{m,\tau} - \bar{B}_{f,\tau}$ represents the gender gap in pension wealth at percentile τ, $\overline{X}_m$ and $\overline{X}_f$ represent the average values of the explanatory variables, and $\beta_{m,\tau}$ and $\beta_{f,\tau}$ are the coefficients that come from running RIF regressions for men and women. The decomposition allows the gender gap to be separated into two components: a component explained by differences in the characteristics between men and women, and an unexplained component that has its origin in the differences in the returns of the variables that are typically linked to gender discrimination in the labor market.

4 Results

4.1 Descriptive analysis

Table 1 reports the percentiles of the distribution of pension savings for men and women, and the raw gender gap observed at each of these percentiles. On average, men have 37 percent more pension funds than women do, but this gap is different across the distribution of pension funds.[7] The gender gaps show a type of U shape, being about 60 percent higher for men in the three first deciles, and then reducing until the 89th percentile. From that point, the gap increases rapidly toward the top section of the distribution of pension savings. For example, the gender gap grows from 22 percent at the 90th percentile, to 43 percent at the 99.5th percentile. The findings are similar to those in other studies assessing gender wealth gaps. For instance, Anglade et al. (2017) also find a U-shaped distribution of gender gaps in the distribution of wealth of single individuals in Ecuador. Given that pension fund accumulation in IRA systems can mimic savings from earnings—an important component of financial wealth—it is no surprise that our findings concerning the distribution of gender gaps follow established patterns in gender wealth gaps.

The results of Table 1 also confirm the high levels of inequality in the distribution of pension wealth. For example, women in the 99th percentile have 41 times more savings than women in the 50th percentile. For men, the figures are 49 times more savings for those in the 99th percentile compared with the 50th. Overall, the Gini index of pension savings is 0.75, while for income in 2019 it is 0.42 (according to World Bank Open Data). These differences in the distribution of pension savings and income are well aligned with general patterns showing that wealth tends to be more unequally distributed than income. When we replicate the results of Table 1 for each sampling year (see Figure A.1 in the Appendix), we observe that the raw gender gaps (measured as men-to-women ratios of pension savings) were increasing in the lower percentiles of the distribution of pension funds between 2005 and 2019, while the gaps observed in the top percentiles show a relatively stable pattern for the same period.[8]

[7] The raw gender gap is 7,942 Soles, which represents about eight times the minimum wage in Peru.

[8] We only plot the 50th percentile for the bottom group, but other percentiles in the bottom section of the distribution also show an increase in the raw gender gaps. We also note that in 2005 and 2006, women had larger levels of pension wealth than men until about the 80th percentile. The 99th percentile shows a decrease in gender

Table 1: Raw gender gaps in pension savings in 2019 (Soles)

Variables	Mean	Percentile											
		10	20	30	40	50	60	70	80	90	95	99	99.5
Male	29,332	439	1,204	2,469	4,579	7,875	13,117	21,430	36,224	67,340	114,827	323,676	477,979
Female	21,390	274	750	1,534	2,803	4,943	8,383	14,505	27,016	55,359	87,017	239,763	335,168
Gap (M-F)	7,942	164	454	934	1,776	2,932	4,734	6,925	9,207	11,982	27,810	83,913	142,811
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Men-to-women ratio	1.37	1.60	1.61	1.61	1.63	1.59	1.56	1.48	1.34	1.22	1.32	1.35	1.43

Note: The table uses the sample of registers drawn in December 2019 (N=124,942, N male=76,029, N female=48,913).

Table 2 reports the means of pension balances by gender and various characteristics of the individuals for the sampling year 2019. As expected, older cohorts accumulate more pension savings than younger cohorts, and we also observe a reduction in the absolute amounts of gender gaps among younger cohorts. However, the gender gaps in percentage terms do not show a clear decreasing pattern along birth cohorts, as is the case for the absolute values, but we can see that the percentage gender gap is higher in the oldest cohorts than in the youngest ones.

Table 2: Unconditional means by gender in pension savings in 2019 (Soles)

Variables	Total		Male		Female		Diff (M-F)		Gap in %
	Mean	S. D.	Mean	S. D.	Mean	S. D.	Difference	S. E.	
All	26,223	(71,536)	29,332	(80,145)	21,390	(55,222)	7,942***	(414)	37.1
Birth cohorts									
1996-1998	1,441	(1,698)	1,549	(1,810)	1,302	(1,533)	247***	(38)	19.0
1989-1991	7,488	(10,216)	7,857	(10,529)	7,002	(9,768)	855***	(191)	12.2
1979-1981	23,471	(37,944)	25,427	(38,005)	20,399	(37,647)	5,029***	(731)	24.6
1969-1971	48,808	(98,800)	51,970	(108,708)	43,178	(77,806)	8,792***	(2,258)	20.4
1959-1961	69,919	(166,585)	74,857	(178,212)	59,501	(138,400)	15,356**	(6,334)	25.9
Years enrolled in SPP									
1-3	2,142	(5,958)	2,450	(7,656)	1,784	(2,906)	666***	(86)	37.3
9-11	14,155	(24,872)	14,912	(27,581)	12,957	(19,790)	1,956***	(453)	15.1
19-21	40,335	(65,332)	42,263	(70,628)	36,810	(54,159)	5,453***	(1,213)	14.8
25-27	89,839	(168,542)	93,014	(180,244)	82,536	(137,661)	10,478***	(3,835)	12.7
Regular contributor									
No	10,828	(31,089)	12,103	(34,833)	8,863	(24,076)	3,240***	(278)	36.6
Yes	37,319	(88,397)	41,683	(98,950)	30,495	(68,164)	11,188***	(671)	36.7
AFP									
Habitat	12,305	(70,062)	15,374	(87,196)	8,569	(40,035)	6,805***	(1,025)	79.4
Integra	32,697	(73,963)	35,632	(81,267)	28,064	(60,380)	7,568***	(783)	27.0
Prima	25,513	(77,090)	29,615	(87,993)	19,686	(57,698)	9,929***	(783)	50.4
Profuturo	27,945	(59,036)	29,051	(62,107)	25,674	(52,096)	3,377***	(741)	13.2
Recognition Bond									
No	23,766	(61,627)	26,516	(68,949)	19,498	(47,788)	7,018***	(359)	36.0
Yes	186,133	(254,390)	206,694	(281,452)	151,320	(195,731)	55,374***	(12,003)	36.6

Note: The table uses the sample of registers drawn in December 2019 (N=124,942, N male=76,029, N female=48,913). The mean differences are computed using two-sample equal variance t-tests by gender. *p<0.10, **p<0.05, ***p<0.01.

The years of affiliation play an important role in the accumulation of savings, particularly if the contributions are more frequent. The descriptive statistics show that the gender gap amounts

gaps (47 percent in 2005 and 35 percent in 2019), but the other top proportions show little change in the period.

can increase substantially with the number of years affiliated in the SPP. Figure A.2 in the Appendix utilizes the pooled sample of 2005-2019 to show the gender gap for each period of affiliation, regardless of the calendar year of the sample. We also observe a substantial increase in the gender gap value for each year of affiliation, yet the relatively large intervals of confidence may reveal that there is still substantial heterogeneity within each period of accumulation.

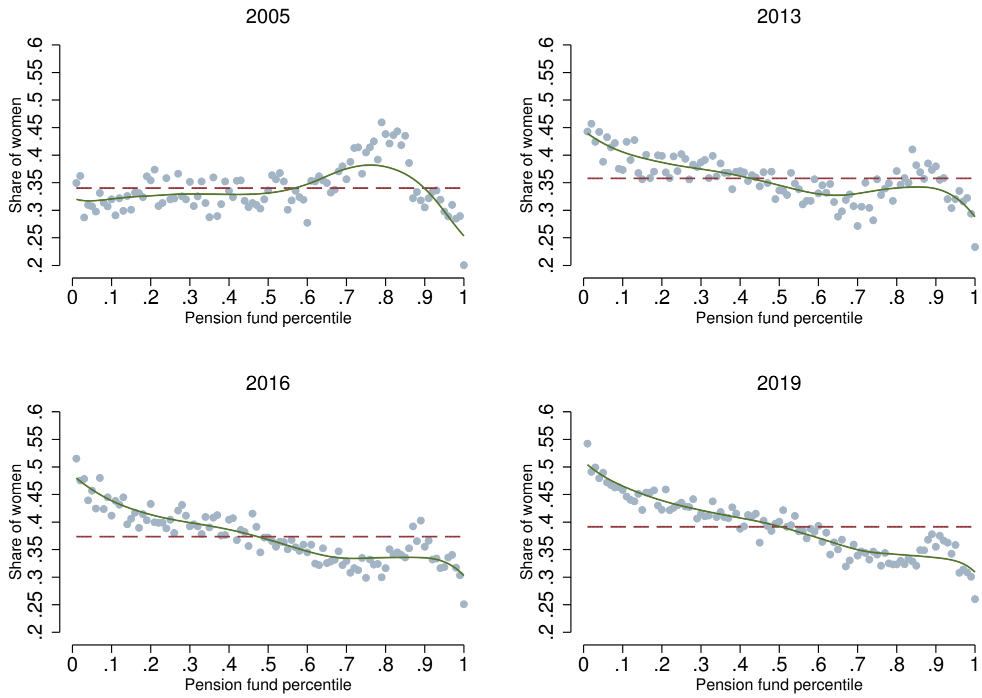
We also note that the gender gaps in percentage terms tend to decrease with the number of years of affiliation. This could indicate that for each period of accumulation, there are women who are not completely "left behind" in terms of pension balance accumulation. This is supported to some extent by the fact that the percentage gender gap is similar for those individuals with a regular contribution behavior as for those showing an irregular contribution pattern, meaning that men and women are similarly distributed in terms of contribution frequency. This last point is supported by Figure A.3 in the Appendix, which reports a similar distribution of pension contributions between men and women.

The mean is one of the moments of the whole distribution and it could mask different values of the gender gaps along the distribution of pension funds. In Table 1, we can already see that the gender gap is very high at the 99th percentile of the pension fund distribution, reaching 83,913 Soles, while this is 2,932 Soles at the median of the distribution. Figures A.4. and A.5 in the Appendix report the gender gaps at different percentiles of the distribution of pension funds across cohorts and selected sampling years. In all cases, the gender gap increases substantially from around the 90th percentile.

With regard to the gender gap by AFP, there are some notable differences steaming from the composition of affiliates in each company. AFP Habitat reports the largest percentage gender gap of all AFP, in which men have on average 79 percent more pension savings than women do. By comparison, this gap is only 13 percent in AFP Profuturo. One of the reasons behind this difference is that Habitat is the youngest company in the market, hence their affiliates have been participating in the SPP for fewer years (people have contributed on average for 59 months in Habitat, and 198 months in Profuturo). In this regard, we have already noted that the percentage gender gap falls with the years of enrolment in the SPP. Lastly, the gender gap by Recognition Bond (RB) status shows a much larger gap for those affiliates who have this bond than for those who do not. The reason is that the individuals with RB are mostly older and have already capitalized sizable savings. Nevertheless, there are practically no differences in the percentage gender gap by RB.

Figure 1 shows an additional way of exploring gender differences in pension savings. This figure plots the proportion of women within the percentiles of the distribution of pension funds observed in four different years, and also reports the average proportion of women in the SPP (shown in dotted lines). First, we observe that the average participation of women in the SPP masks important differences across the distribution of pension funds. Second, we observe how the plots move toward a more clear negative-slope curve from 2005 to 2019, meaning that the participation of women decreases within the wealthiest percentiles and increases within the poorest ones. While in 2005, the proportion of women in the percentiles (mostly under the 70th percentile) was similar and around the average, in 2019 we observe a strong negative relationship between women's participation and the percentiles of pension funds. These results could point to a deteriorating position of women in the distribution of pension savings.

Figure 1: Proportion of women across the unconditional distribution of pension savings



Note: The figures show the proportion of women across the unconditional distribution of pension balance for each year. The adjusted curves show the lowess-smoothed proportions of women, and the dotted lines indicate the average proportion of women in the SPP.

4.2 Pooled OLS

Table 3 shows the estimates of pension balances on a pooled sample including all the year data sets. With no covariates, apart from year fixed effect, the gender gap in pension savings is on average 5,513 Soles in favor of men. Once we control for AFP and birth cohort, the gap becomes 3,405 Soles (Model 3), which represents about 16 percent and 63 percent of the mean and median pension balances in the sample, respectively. Model 4 shows the results from the estimation of equation 3, which includes interactions between cohorts and gender. These estimates are useful to retrieve the expected gender gap by cohort $\beta_1 + \gamma_j C_{ji}$ (shown in Figure A.6 in the Appendix). Model 5 adds interactions between sample year and gender, and between sample year and cohorts, which allows us to retrieve the gap by cohort for each year shown in Figure 2.

Table 3: OLS estimates of pension savings (2005-2019)

Variables	(1)	(2)	(3)	(4)	(5)
Male	5,513.0***	3,461.8***	3,405.2***	18,342.5**	18,582.2**
	(160.7)	(142.7)	(143.2)	(7,980.9)	(8,092.6)
Regular contributor		20,144.5***	20,249.8***	20,370.5***	20,616.2***
		(128.3)	(128.9)	(130.3)	(132.3)
Recognition Bond		59,334.1***	59,022.7***	59,640.7***	60,591.9***
		(1,172.9)	(1,202.6)	(1,214.5)	(1,227.8)
Years enrolled in SPP		-123.8**	-347.1***	-331.1***	124.1**
		(56.3)	(56.3)	(56.1)	(53.3)
Years enrolled in SPP^2 /100		12,364.0***	12,213.5***	12,144.2***	10,186.8***
		(275.5)	(280.5)	(279.5)	(267.7)
Constant	5,624***	-12,821.5***	-22,487.6***	-35,817.2***	-38,167.1***
	(146.4)	(346.9)	(4,421.0)	(6,268.6)	(6,389.1)
Year	Yes	Yes	Yes	Yes	Yes
AFP		Yes	Yes	Yes	Yes
Cohort			Yes	Yes	Yes
Cohort*Male				Yes	Yes
Year*Male					Yes
Cohort*Year					Yes
Observations	533,200	533,200	533,200	533,200	533,200
R-squared	0.008	0.155	0.161	0.162	0.162

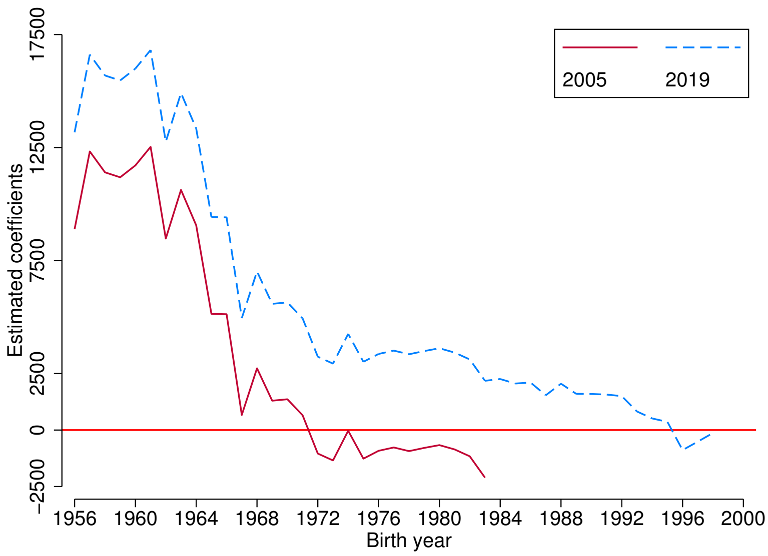
Notes: The sample corresponds to the pooled samples drawn in 2005, 2006, 2013, 2015, 2016 and 2019. The dependent variable for all regressions is the pension balance. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

One of the first findings is that the gender gap reduces among younger cohorts (see Figure A.6 in the Appendix). There is a statistically significant positive gender gap up to approximately the 1983 cohort, but younger cohorts tend to exhibit a gender gap that is not statistically different from zero. It is interesting to observe a decline in the gender gap among younger cohorts, but this could be masking some important heterogeneity across sample years. The capitalization of pension balances could potentially hinder individuals who do not contribute frequently and/or have a lower income. Thus, if women were more likely to have lower incomes, then a longer period enrolled in the pension system could exacerbate the differences in the pension pots between women and men. Figure 2 could help to clarify this.

Figure 2 could help to clarify the role of the capitalization process by showing the expected cohort gender gap observed in 2005 and 2019, which are the two most distanced sample years of our data. It is clear from the figure that for a given cohort, the pension gap increases with the length of the period affiliated in the SPP.[9] On the one hand, we observe a decreasing gender gap among younger cohorts, which is in line with other findings in the labor market; however, on the other hand, the length of time participating in the pension system increases the gap by means of the capitalization process.

[9]Starting in 2005, the gender gap increases on average by S/. 1,550, S/. 2,356, S/. 3,409, and S/.4,285 in 2013, 2015, 2016, and 2019, respectively.

Figure 2: Conditional gender gap by cohorts in 2005 and 2019



Notes: The figure plots the sum of estimated coefficients from Model 5 of Table 3, representing the expected gender gap by birth year cohort and sample year.

4.3 Unconditional quantile regression analysis

We obtain two important findings in the OLS regressions: first, there is a positive gender gap in pension balances favoring men over women; second, the gap is heterogeneous at the cohort level, being higher for older cohorts and lower for younger groups. Given that we are interested in studying the gender gap along the distribution of pension savings, we estimate unconditional quantile regressions using RIF regressions. As explained before, the RIF regressions allow us to measure how a marginal increase in the participation of men affects the dispersion of pension savings, as this could indicate an increase in the gender gap for pension savings. We exploit the sample of year 2019 to avoid contaminating our results with different distributions of previous years. Unlike the pooled sample, we introduce some additional variables that are available for the year and may be interesting to explore. These covariates are the contribution density (a continuous variable between 0 and 1), type of pension fund risk, and region of residence. Table 4 reports the RIF regression coefficients for the 25th, 50th, 75th, 90th, 95th, and 99th quantiles, along with bootstrapped (1,000 iterations) standard errors.

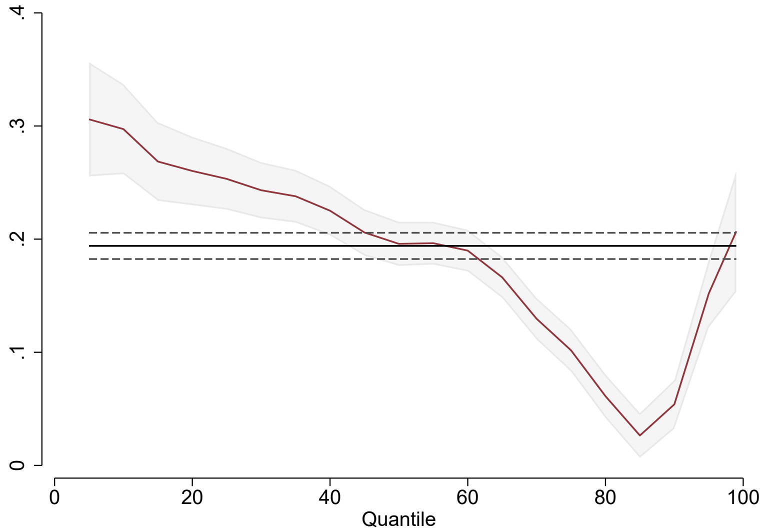
Table 4: Unconditional quantile regression coefficients on logs of pension savings (2019)

Variables	OLS	Q25	Q50	Q75	Q90	Q95	Q99
Male	0.194***	0.253***	0.196***	0.102***	0.0540***	0.152***	0.207***
	(0.00589)	(0.0139)	(0.00996)	(0.00966)	(0.0110)	(0.0154)	(0.0273)
Contribution density	3.537***	4.158***	4.082***	3.337***	2.027***	1.816***	1.309***
	(0.00923)	(0.0196)	(0.0137)	(0.0146)	(0.0188)	(0.0266)	(0.0455)
Years enrolled in SPP	0.375***	0.598***	0.472***	0.202***	0.0409***	0.0296***	-0.0142*
	(0.00203)	(0.00460)	(0.00297)	(0.00290)	(0.00319)	(0.00444)	(0.00729)
Years enrolled in SPP^2/100	-0.823***	-1.572***	-1.100***	-0.175***	0.245***	0.249***	0.355***
	(0.00733)	(0.0159)	(0.0110)	(0.0111)	(0.0132)	(0.0188)	(0.0324)
Recognition Bond	0.716***	-0.110***	0.219***	0.946***	2.276***	3.753***	6.893***
	(0.0293)	(0.0417)	(0.0366)	(0.0382)	(0.0820)	(0.161)	(0.457)
Fund type 2	-0.271***	0.298***	-0.0773	-0.890***	-1.255***	-1.471***	-2.013***
	(0.0477)	(0.0607)	(0.0552)	(0.0718)	(0.130)	(0.233)	(0.709)
Fund type 3	0.0981**	0.0839	0.192***	0.104	-0.0149	0.257	-0.749
	(0.0491)	(0.0636)	(0.0584)	(0.0766)	(0.138)	(0.245)	(0.724)
Constant	4.558***	1.078***	3.254***	7.443***	10.63***	11.58***	14.25***
	(0.0769)	(0.164)	(0.118)	(0.121)	(0.172)	(0.283)	(0.805)
Observations	124,829	124,829	124,829	124,829	124,829	124,829	124,829
R-squared	0.751	0.425	0.591	0.532	0.320	0.203	0.081

Notes: The regressions use the sample drawn on December 2019. The dependent variable for all regressions is the pension balance in logarithm. All regressions control for birth cohort, AFP, and region. Bootstrapped standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The regression results show that a marginal increase in the proportion of men shifts the overall pension balance distribution upward. In other words, the replacement of women by a greater number of men leads to a more unequal distribution, which could imply a growing gender gap to the detriment of women. Figure 3 illustrates the non-monotonic effects of gender across the different quantiles, since the effect of gender is different at each point of the distribution.

Figure 3: Male coefficients of unconditional quantile regressions, 2019



Notes: The graph plots the coefficients for male of unconditional quantile regressions. The specification of these is the same as in Table 4. The shadowed area indicates 95 percent confidence intervals.

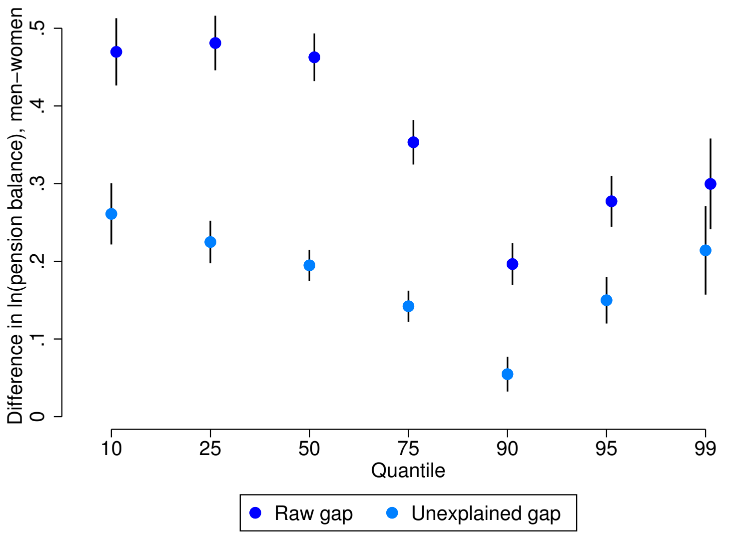
The first result observed in Figure 3 is that a larger proportion of men results in a positive gender gap and increases the dispersion of pension savings for all the percentiles. A second result is that the gender gap decreases consistently along the quantiles until approximately the 85th quantile, after which the gap starts to grow rapidly toward the top quantiles. Thus, greater participation of men in the top quantiles accelerates the growth of the gender gap in pension savings, and generates more inequality. This result may reflect a type of "glass ceiling effect." The explanations for this effect are related to the fact that compared with men, women are more likely to be in jobs with lower salaries and in lower ranked positions in a company. Thus, women have fewer opportunities and lower resources to capitalize in the pension system. Given the direct link between pension savings, labor income, and occupational status in an IRA system, it is not completely surprising finding a gendered ceiling in pension savings.

4.4 Oaxaca–Blinder decomposition of gender differentials in pension funds

The full regression results of the Oaxaca-Blinder decomposition are presented in Table A.3 in the Appendix, while Figure 4 below plots the estimated raw gender gap and the unexplained component of this gap along distinctive quantiles of the pension fund distribution. The gender gap is positive for any quantile and follows the previously reported negative trend up to approximately the 90th quantile, after which it increases toward the upper end of the distribution. The unexplained proportion of the gap decreases consistently along the quantiles until about the 90th quantile (56, 47, 42, 40, and 28 percent for the 10th, 25th, 50th, 75th, and 90th quantiles, respectively), but then increases to 54 percent at the 95th quantile and 72 percent at the 99th.

This behavior is consistent with the previously described "glass ceiling effect." The most important variables increasing the unexplained gender gap in pension savings in the top quantiles (95th and 99th) of the pension funds distribution are the density of contributions and the years of affiliation. These variables substantially determine the pension balance accrued across years, and are directly linked to labor market outcomes (incomes, occupation, skills, etc.) in an IRA system. Thus, the factors behind the unexplained or "discriminated" part of gender income gaps in the labor market will not only be translated into the gender gap in pension savings, but will also be exacerbated because of the capitalization process over time embedded in the IRA system.

Figure 4: The gender gap in quantiles of pension savings



Notes: The graph plots the raw and unexplained gender gaps in pension balance across quantiles of the distribution of pension funds. The estimates are based on Oaxaca-Blinder RIF decomposition, which are reported in Table A.3 in the Appendix. The vertical axis shows the estimated values of the raw gap and the unexplained gap (men minus women). The bars indicate 95 percent confidence intervals.

5 The Role of Financial Literacy

We next explore the role of financial literacy on gender gaps in pension savings and on the distribution of pension savings. We capture financial literacy by exploiting the individual choices (or not making a choice) of pension fund portfolios with different risk attributes. As an individual always has the option to opt out of the default pension fund risk allocation, we consider that this action implies awareness concerning portfolio management and therefore may involve higher levels of financial literacy. This strategy was also used byBernal and Olivera (2020), in analyzing a reform of pension fund management fees in Peru, in which the affiliates could opt out of the *default* determined by the pension policy. It has been noted that knowledge or awareness of risk diversification enables individuals to make better choices of annuities (Lusardi and

Mitchell, 2010; Hastings et al., 2010; Banks et al., 2015) and correct decisions in retirement (Clark et al., 2011; Agnew and Szykman, 2011).

As defined before in section 3, we use the variable *Active portfolio management* to capture the role of financial literacy on gender gaps. Table 5 exploits the samples obtained between 2013 and 2019, and offers a first insight into the ways in which financial literacy, gender, and pension wealth distribution may be linked.[10] Overall, we observe that only 6.2 percent and 4.8 percent of men and women, respectively, could be considered as financially savvy, which implies that the great majority of people do not opt out of the default pension fund risk choices set up by the regulations. In the bottom half of the distribution of pension funds, only 0.9 percent and 1.3 percent of women and men, respectively, are actively managing their portfolios. However, these proportions increase along wealthier groups in the distribution of pension savings. Thus, the richer the individual, the higher their likelihood of being financially savvy. For example, 28.2 percent and 34.7 percent of, respectively, women and men belonging to the top 1 percent are actively managing their portfolios; these figures are, respectively, 20.3 percent and 44.7 percent for women and men belonging to the top 0.1 percent. Furthermore, we observe an increasing difference between the percentage of women and men with financial literacy along the distribution of pension funds. This difference is 1.4 percentage points across all affiliates, but it is 24.3 percentage points for the affiliates located in the top 0.1 percent of the distribution of pension funds. All in all, women tend to be less financially savvy than men—even among the wealthier group of affiliates—which could contribute to expanding the gender gap in pension wealth.

Table 5: Percentage of people with *Active portfolio management* by pension savings shares (2013-2019)

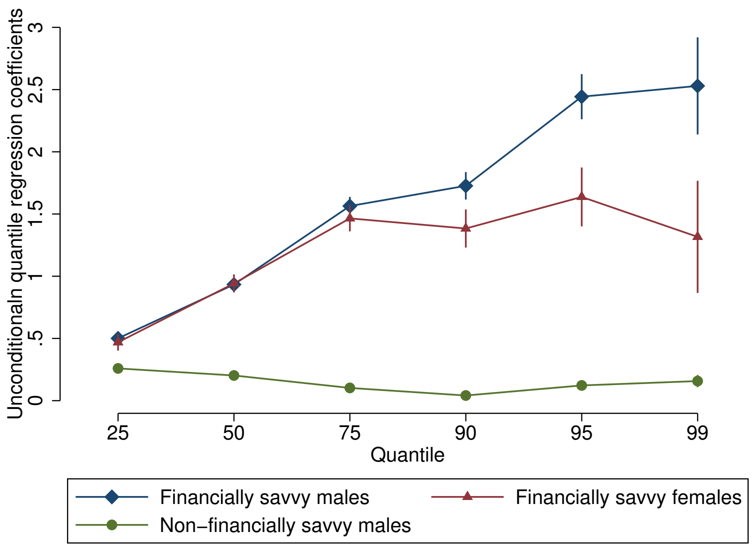
Pension savings share	Female	Male	Diff (M-F)	P-value	N
Overall	4.8	6.2	1.4	0.00	430,698
Bottom 50%	0.9	1.3	0.3	0.00	215,368
P50-90th	7.0	7.4	0.4	0.00	172,280
Top 10%	20.1	22.8	2.7	0.00	43,050
Top 5%	24.7	28.0	3.2	0.00	21,516
Top 1%	28.2	34.7	6.5	0.00	4,299
Top 0.5%	27.4	37.2	9.8	0.00	2,148
Top 0.1%	20.3	44.7	24.3	0.00	429

Notes: The sample is composed of individuals from sampling years 2013, 2015, 2016, and 2019. For each sample year, we compute 1,000 quantiles for the distribution of pension savings, and then we pool all the samples. We use the pooled sample to compute the percentage of people with *Active portfolio management* within distinctive groups of quantiles, irrespective of the sample year. The pooled sample size is 430,698 observations: N=94,315 in 2013, N=103,399 in 2015, N=108,091 in 2016, and N=124,942 in 2019.

[10] The pension funds with different risk compositions were implemented in 2006. However, our sample of December 2006 lacks available information about the pension fund type chosen by the individuals. Accordingly, we use the other available samples drawn between 2013 and 2019.

Following on our previous models of unconditional quantile regressions, we assess the role of financial literacy on the distribution of wealth and gender gaps. The only difference with respect to the models of Table 4 is that this time we include two additional covariates in the regressions: the dummy variable *Active portfolio management* and its interaction with *Male*. The full results of these regressions are reported in Table A.4 in the Appendix, but we plot our coefficients of interest in Figure 5. We plot the combined coefficients, and their 95 percent confidence intervals, indicating three distinctive groups: financially savvy males (i.e., males who actively manage their portfolios), financially savvy females, and non-financially savvy males. We observe that, in general, financial literacy has stronger effects at higher quantiles, shifting the distribution of pension wealth upward. Thus, increased participation of individuals (regardless of gender) with financial knowledge contributes to a greater dispersion of pension wealth; in other words, more inequality. A second observation is that financially savvy males can contribute more to the dispersion of pension savings than financially savvy females (the coefficients curve of financially savvy males is always above that for females in Figure 5). Therefore, the gender gaps in pension savings could expand along the distribution of pension funds.

Figure 5: Unconditional quantile coefficients of *Active portfolio management*



Notes: The graph plots the UQR coefficients for financially savvy males, financially savvy females and non-financially savvy males retrieved from Table A.4 in the Appendix. The vertical bars indicate 95 percnt confidence intervals.

6 Additional Results

6.1 Extended pension wealth

Some SPP affiliates who were previously in the public pension system have Recognition Bonds (RB), which represent past pension contributions made to the public system. These bonds are paid at retirement and added into the pension balance of affiliates in order to compute pension amounts. The total pension wealth of these affiliates should thus include the BR value. Accordingly, we use a concept of "extended pension wealth" by adding the updated RB value to the pension balance. We run the same quantile regressions we used previously, but for this new outcome, and report the results in Table A.5 in the Appendix. The results are practically the same as those illustrated in Table 4.

6.2 Imputed income

One of the problems with using registers data is the limited availability of updated wages. For the 2019 sample, about 58 percent of the individuals contributed in the year of the sampling draw and therefore they have updated information for their wages. Some 35 percent have outdated wage information but have the date of last contribution, and 7 percent have no wage information or details of the date of last contribution. We do not use wage information in our main analysis due to the limited availability, but we could at least attempt to impute and update them to explore the relationship between our results on gender pension wealth gaps and gender income gaps.

The procedure to impute monthly earnings for the 2019 sample is as follows: the initial value of the wage is the last value recorded in the sample. In the event that the value corresponds to any year before 2019, we update the recorded value by inflation and wage premiums per cohort (5-year groups), sex, and contribution behavior.[11] For the imputation of incomes for the affiliates who lack this information, we use the predicted values from a regression of wage (in logs) against sex, recognition bond, decile of contribution density, type of administrative fee, AFP, type of pension risk fund, affiliation duration in the SPP, percentile of pension balance, age, age squared, and region. In the SPP, the contributions are calculated over wages, the value of which must be at least equal to the minimum wage (equal to 930 Soles). Thus, we set up that earnings cannot be lower than the official minimum wage.

Table 6 reports the means and percentiles of the distribution of monthly earnings in our 2019 sample. The raw gender gap in earnings is 19 percent, which is approximately half the gender gap in pension savings (37 percent). We do not observe gaps along the first three deciles, because of our assumption that affiliates must earn at least the minimum wage. The gender income gap is about 11 percent at the 40th percentile and increases smoothly until 18 percent at

[11]The wage premiums are estimated using the 2015, 2016 and 2019 samples. We estimate the variations in the median wages by sex, birth cohorts, and whether the individual contributed in the sampling year.

the 95th percentile. The income gap then increases rapidly to 31 percent and 40 percent at the 99th and 99.5th percentiles, respectively. The values of the gaps in income and pension wealth can differ greatly along the first percentiles and even beyond the medians of both distributions, but their values tend to converge toward the top 1 percent and beyond (see Table 1). At the median of each distribution, the pension wealth gap is 59 percent, but it is only 15 percent for incomes. By comparison, at the 90th percentile, the pension wealth gap is 22 percent and for incomes it is 16 percent. As reported in other studies assessing gender wealth gaps, we also observe a larger gender gap along the distribution of pension wealth than along the distribution of incomes.

Table 6: Raw gender gaps in earnings and pension savings-to-earnings ratio in 2019 (Soles)

Variables	Mean	Percentile											
		10	20	30	40	50	60	70	80	90	95	99	99.5
Distribution of earnings:													
Male	2,445	930	930	930	1,119	1,378	1,649	2,034	2,724	4,421	7,000	17,141	24,643
Female	2,053	930	930	930	1,009	1,200	1,430	1,760	2,335	3,800	5,945	13,106	17,574
Gap (M-F)	393	0	0	0	110	178	219	274	389	621	1,055	4,035	7,069
P-value	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Men-to-women ratio	1.19	1.00	1.00	1.00	1.11	1.15	1.15	1.16	1.17	1.16	1.18	1.31	1.40

Note: The table uses the sample of registers drawn in December 2019. The table shows the means and percentiles of the distribution of monthly earnings, which include updated and imputed salaries for individuals who did not contribute in 2019 or had missing income information.

We also compute the ratio between pension savings and monthly earnings for each individual, indicating the number of months of income accumulated in the retirement account. Some studies on income and wealth inequality (e.g., Piketty and Zucman (2014) and Cowell et al. (2017)) use the wealth-to-income ratio to explore the evolution and country differences in wealth inequality due to changes in asset prices and income returns. The left-hand panel of Table 7 reports the average of individual pension savings-to-earning ratios by distinctive income groups of the distribution of earnings. Overall, the gender gap in pension savings-to-earning ratio is 2.2 (i.e. men have 2.2 more months of income in their pension accounts than women) but this gap but this gap is 3 months for the individuals who belong to the bottom 50 percent of the earnings distribution. For the individuals belonging to the top 10, 5, and 1 percent of the earnings distribution, the gaps are equal to 1.2, 1.8, and 2.2, respectively. However, it should be noted that these values use the earnings of the corresponding income group. These are higher in the top groups, and hence the level of pension wealth is larger in the top income groups. For example, Table 6 shows that a woman and man in the 99th income percentile earn, respectively, about 11 and 12 times more than a woman and man in the 50th percentile. In order to capture these differences in income, the right-hand panel of Table 7 shows the pension savings to earning ratios expressed as the mean pension savings of a particular income group over the mean income across all affiliates, rather than the mean income for that group. Overall, the gender gap is 3.5 months of average income, but the gap is larger in the top income groups: 10.9, 17.5, and 36.5 months for the top 10, 5, and 1 percent income proportions, respectively.

Table 7: Raw gender gaps in pension savings-to-earnings ratio in 2019 (Soles)

	Using mean earnings of each income group						Using overall mean earnings					
	Mean	Bottom 50%	P50-90th	Top 10%	Top 5%	Top 1%	Mean	Bottom 50%	P50-90th	Top 10%	Top 5%	Top 1%
Male	10.9	9.6	11.5	14.3	14.6	12.7	12.8	4.2	11.0	57.3	81.4	150.1
Female	8.8	6.6	10.9	13.1	12.8	10.5	9.3	2.9	10.1	46.4	63.9	113.6
Gap (M-F)	2.2	3.0	0.6	1.2	1.8	2.2	3.5	1.3	1.0	10.9	17.5	36.5
P-value	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Note: The table uses the sample of registers drawn in December 2019. The left-hand side panel shows the average of individual pension savings-to-earning ratios by distinctive income groups of the distribution of earnings. The right-hand side panel is similar to the other panel, but the pension savings-to-earning ratios is computed as the mean pension saving of a particular income group over the mean income across all affiliates rather than the mean income for that group.

7 Conclusions

Our study uncovers a large gender gap in favor of men in pension savings. Although this gap is reduced for younger cohorts (because the salary gap is also lower in these groups), the IRA system's capitalization process may be reversing this improvement, thereby increasing the gap in pension savings across the life cycle. We also explore gender gaps along the distribution of pension savings and find that the gap favoring men is always positive at each percentile, but that it decreases until it reaches a form of "glass ceiling" around the 85th percentile, when the gap increases substantially. The low levels of financial education captured by individuals' risk management of pension fund portfolios (i.e., the ability to opt out of the default choices of risk-specific pension funds) contribute to the increase of inequality in the distribution of pension funds, and to widening the gender pension savings gap. Indeed, pension-savings-rich individuals have higher levels of awareness of risk portfolio management, and among them, financially savvy males contribute more than financially savvy females to increasing inequality in pension savings.

Thus, we observe that on the one hand, financial literacy is an important determinant of overall pension wealth inequality, and on the other hand, it is also key to explaining increasing gender gaps in pension savings. This situation is not helped by the fact that Peru has very low levels of financial literacy. Accordingly, policy-makers should rethink the design of existing default choices in the risk composition of pension fund portfolios. Requiring greater financial knowledge about the returns and risks of pension funds may mostly affect groups with low financial literacy, such as women and individuals employed in low-skilled occupations.

We also note that some instruments capable of attenuating gender pension savings inequality, such as minimum pension guarantees and unisex life tables, are absent in Peru's IRA system. Thus, extending social assistance pension programs and/or setting pension guarantees could help in the short term. Nevertheless, there are pending long-term problems regarding the gender gap in pension wealth and pensions. For example, there is still room to improve the adequacy of benefits, the distribution of household chores between men and women, and the social protection culture, in particular among people who do not work in the formal labor market.

Overall, our results could be useful to other countries with IRA systems, or countries that are considering increasing the relative importance of these systems in their pension models. These systems are conceived to improve the incentive alignment between individual contributions and retirement savings, but one danger is that of exacerbating gender pension gaps, among other problems such as low levels of pensions and pension inequality. Further, more needs to be done regarding the periods when women are less able to contribute (for example, due to pregnancy and child rearing) or in the event of divorce, as the IRA are fully individualized and are not part of the shared household wealth. We also consider our paper is useful to investigate a component of wealth distribution (pension savings) that is closely related to earnings savings. Very few developing countries have wealth surveys and are thus unable to study wealth distribution patterns, but some of them have IRA systems. Accordingly, a way forward to study wealth distributions in greater detail would be to exploit data for individual pension accounts, as we have done in this research. We hope that our study will open up new avenues for future research on gender gaps in wealth and pensions, in particular in developing countries, which still show low levels and high dispersion of financial literacy.

Declarations

Ethical Approval
Not applicable.

Competing interests
The authors (Javier Olivera and Yadiraah Iparraguirre) declare that there are no interests to disclose.

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Availability of data and materials
The data generated during the current study are available from the corresponding author on reasonable request.

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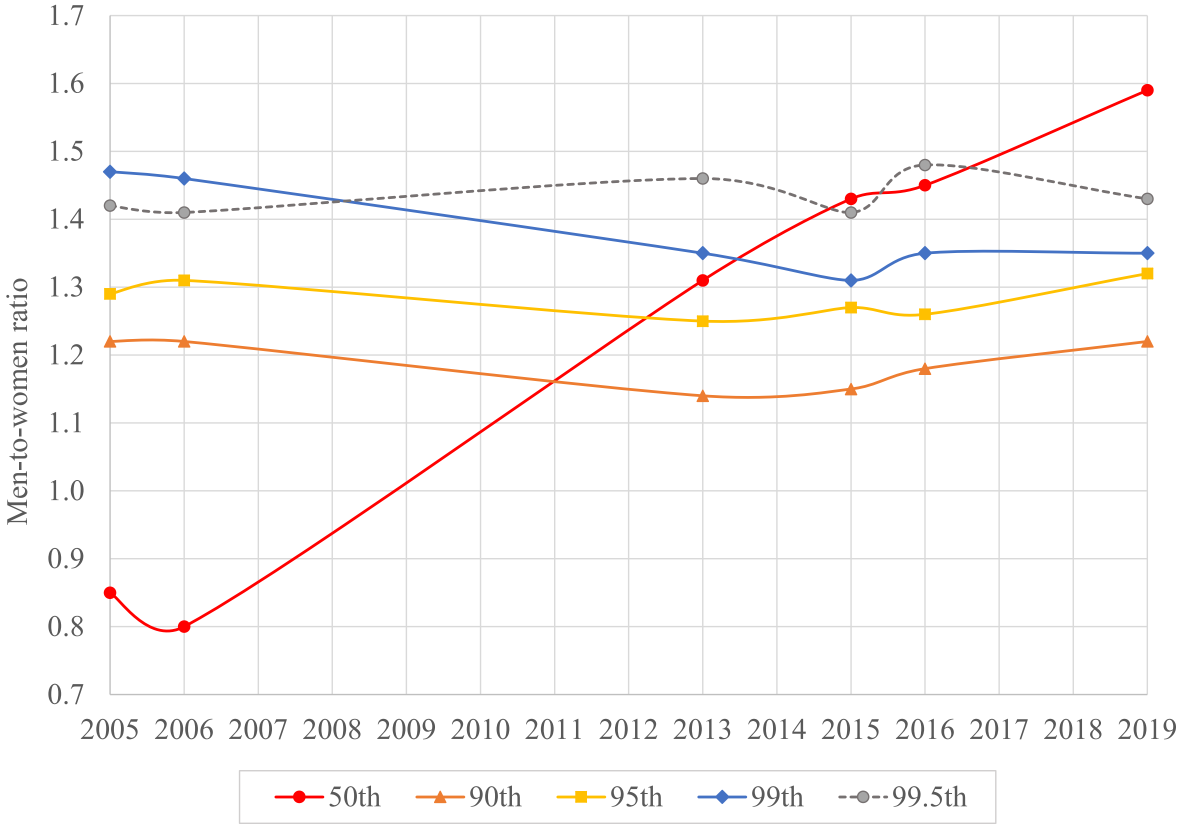
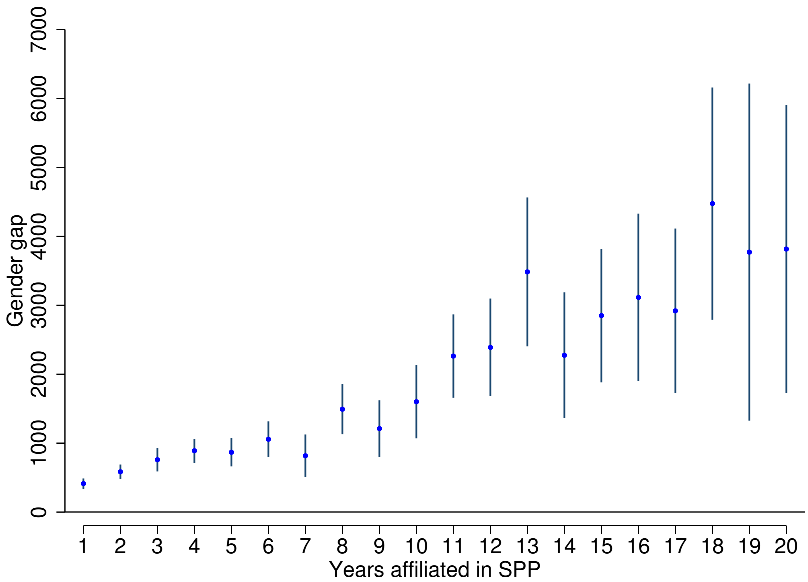
Appendix

Figure A.1: Raw gender gaps in pension savings at specific percentiles of the pension savings distribution (2005-2019)



Note: The figure plots the raw ratio of men's pension savings to women's pension savings at distinctive percentiles of the distribution of pension funds of each available sample year.

Figure A.2: Unconditional gender gaps by number of years enrolled in SPP (pooled sample)



Note: The figure uses the pooled sample of 2005–2019. The vertical lines indicate confidence intervals at 95 percent.

Figure A.3: Histograms of contribution density by gender (2015-2019)

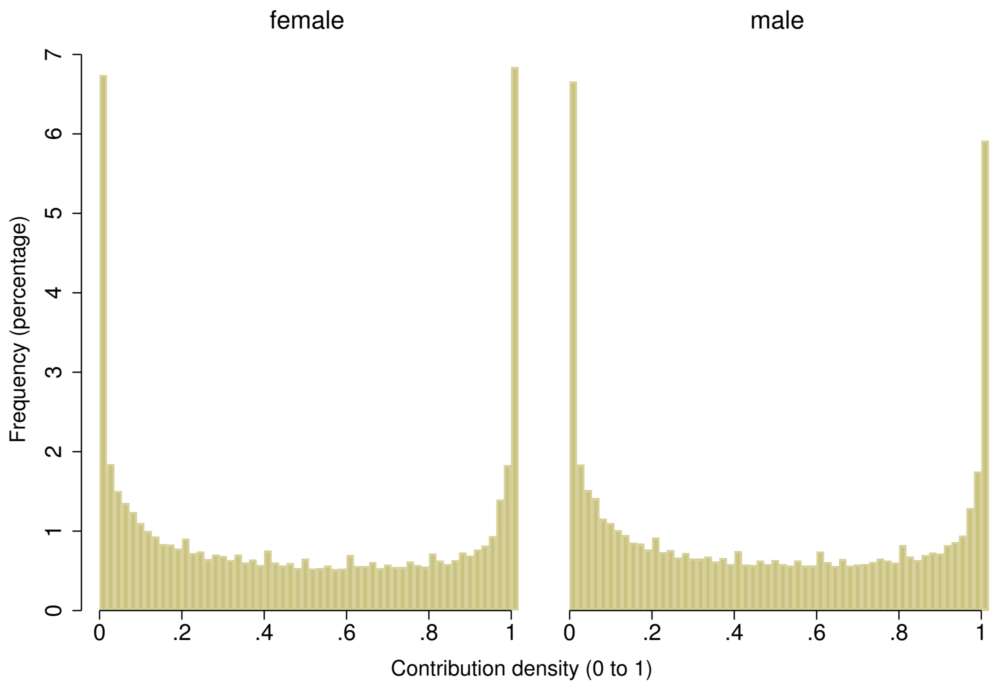
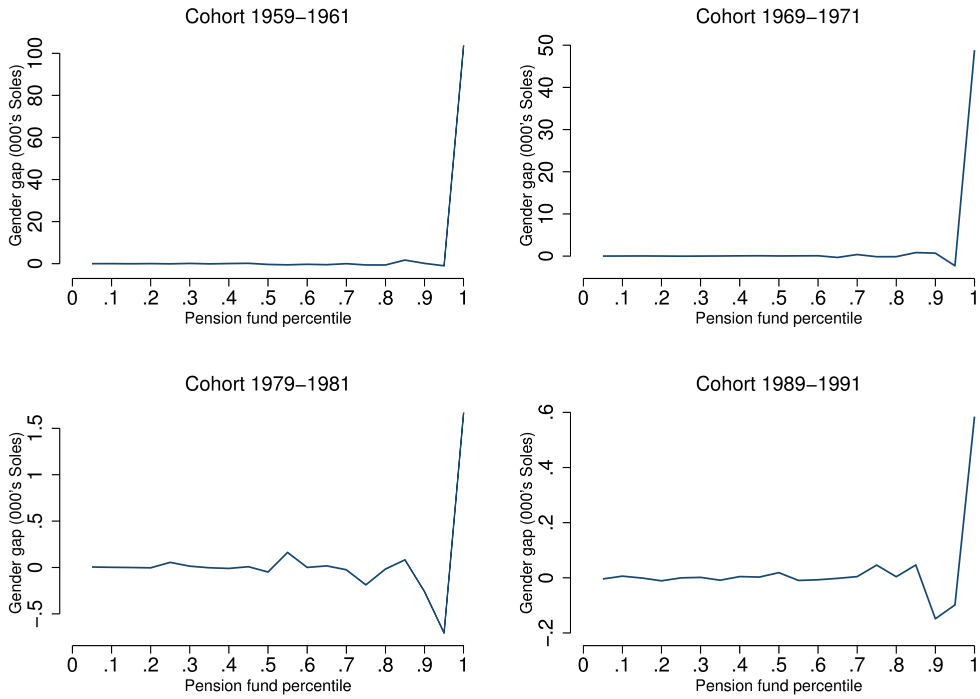
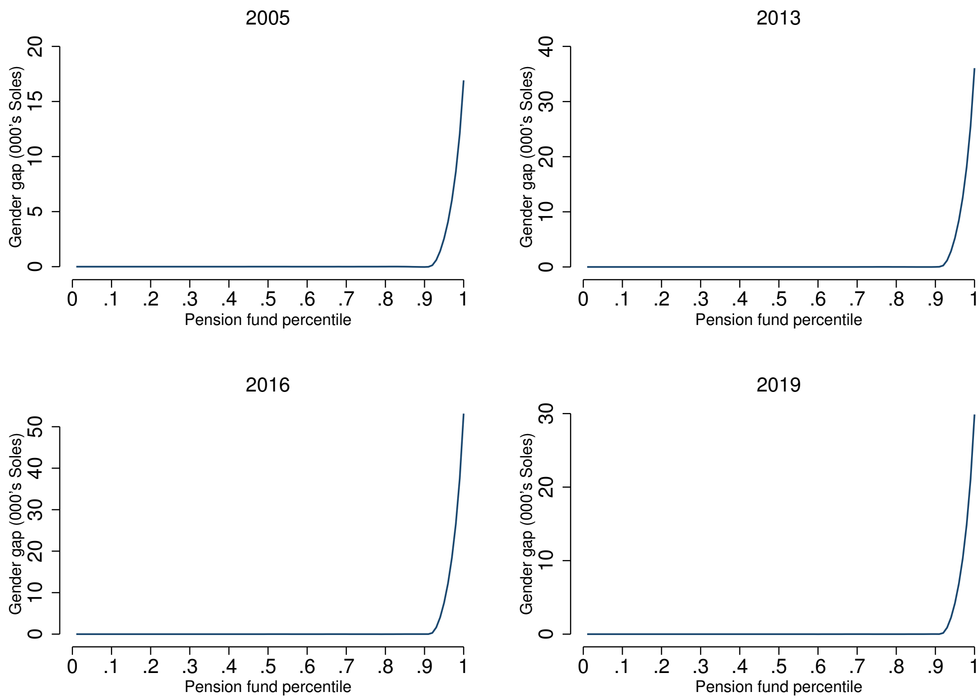


Figure A.4: Cohort-specific gender gap across the unconditional distribution of pension balance (2019)



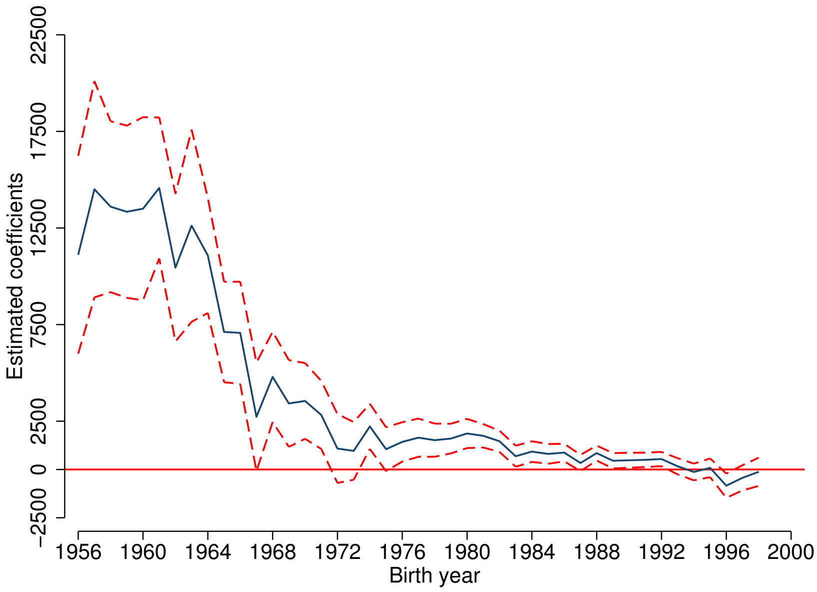
Note: The figures show the lowess-smoothed gender gaps across the unconditional distribution of pension balance for each cohort in 2019.

Figure A.5: Cohort-specific gender gap across the unconditional pension fund distribution in various years



Note: The figures show the lowess-smoothed gender gaps across the unconditional distribution of pension balance for each year.

Figure A.6: Conditional gender gaps by cohorts (pooled sample)



Notes: The figure plots the sum of estimated coefficients from Model 4 of Table 3, representing the expected gender gap by birth-year cohort. The dotted lines indicate 95 percent confidence intervals.

Table A.1: Additional descriptives

	(1) 2005	(2) 2006	(3) 2013	(4) 2015	(5) 2016	(6) 2019
Pension balance	9,261.02	14,580.27	20,105.94	22,376.41	24,292.47	26,239.68
	(105.14)	(181.62)	(184.16)	(193.65)	(229.78)	(202.43)
Pension balance + RB	12,560.84	17,689.31	21,497.46	23,488.38	25,262.47	26,676.40
	(153.45)	(222.42)	(202.49)	(208.09)	(242.91)	(208.56)
Age	37.33	37.69	38.07	38.47	38.50	38.33
	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Years enrolled in SPP	7.22	8.22	10.83	11.64	11.92	12.30
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Regular contributor	0.57	0.61	0.62	0.59	0.58	0.58
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Contribution density	-	-	-	0.48	0.49	0.48
				(0.00)	(0.00)	(0.00)
Recognition Bond (RB)	0.11	0.10	0.04	0.03	0.03	0.02
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
RB value	3,300	3,109	1,392	1,112	970	437
	(68.09)	(65.84)	(34.24)	(28.79)	(26.83)	(15.69)
Active portfolio management	-	-	0.06	0.06	0.05	0.06
			(0.00)	(0.00)	(0.00)	(0.00)

Notes: The table shows the main descriptive statistics of our sample.

Table A.2: Unconditional quantile regressions of pension balance (2005, 2013 and 2019)

Variables	OLS	Q25	Q50	Q75	Q90	Q95	Q99
2005:							
Male	-0.00079	-0.0278	-0.0984***	-0.0539***	0.204***	0.256***	0.361***
	(0.0129)	(0.0253)	(0.0185)	(0.0139)	(0.0238)	(0.0291)	(0.0445)
Regular contributor	1.391***	2.010***	1.811***	0.792***	0.618***	0.509***	0.281***
	(0.0130)	(0.0255)	(0.0191)	(0.0135)	(0.0219)	(0.0260)	(0.0381)
Years enrolled in SPP	0.640***	1.198***	0.792***	0.0724***	-0.0384***	-0.124***	-0.184***
	(0.00861)	(0.0172)	(0.0104)	(0.00752)	(0.0124)	(0.0149)	(0.0224)
Years enrolled in SPP^2	-3.050***	-6.674***	-3.810***	0.682***	1.298***	1.770***	1.942***
	(0.0621)	(0.117)	(0.0813)	(0.0627)	(0.106)	(0.129)	(0.197)
Recognition Bond	1.158***	0.666***	1.103***	1.388***	2.440***	2.751***	2.687***
	(0.0218)	(0.0290)	(0.0271)	(0.0301)	(0.0703)	(0.0983)	(0.176)
Constant	3.974***	0.690***	3.410***	7.505***	8.310***	9.150***	11.11***
	(0.163)	(0.246)	(0.182)	(0.154)	(0.336)	(0.461)	(0.949)
2013:							
Male	0.0950***	0.133***	0.0944***	-0.0531***	0.0592***	0.119***	0.227***
	(0.00915)	(0.0169)	(0.0129)	(0.0127)	(0.0134)	(0.0216)	(0.0314)
Regular contributor	1.779***	2.321***	1.934***	1.502***	0.836***	0.926***	0.527***
	(0.00984)	(0.0176)	(0.0133)	(0.0131)	(0.0134)	(0.0209)	(0.0294)
Years enrolled in SPP	0.253***	0.418***	0.396***	0.105***	-0.00887**	-0.0398***	-0.0967***
	(0.00355)	(0.00720)	(0.00473)	(0.00438)	(0.00435)	(0.00670)	(0.00965)
Years enrolled in SPP^2	-0.440***	-1.129***	-0.940***	0.299***	0.499***	0.661***	0.746***
	(0.0162)	(0.0302)	(0.0218)	(0.0220)	(0.0235)	(0.0372)	(0.0558)
Recognition Bond	1.222***	0.423***	0.831***	1.633***	2.545***	4.532***	5.013***
	(0.0234)	(0.0278)	(0.0250)	(0.0348)	(0.0646)	(0.135)	(0.275)
Constant	3.617***	-0.156	4.083***	6.863***	9.346***	10.17***	12.80***
	(0.0827)	(0.121)	(0.0920)	(0.104)	(0.138)	(0.279)	(0.633)
2019:							
Male	0.174***	0.225***	0.169***	0.0933***	0.0472***	0.138***	0.187***
	(0.00797)	(0.0152)	(0.0117)	(0.0110)	(0.0115)	(0.0156)	(0.0272)
Regular contributor	1.815***	2.192***	2.101***	1.606***	0.962***	0.884***	0.648***
	(0.00841)	(0.0152)	(0.0122)	(0.0117)	(0.0119)	(0.0160)	(0.0262)
Years enrolled in SPP	0.335***	0.548***	0.425***	0.162***	0.0219***	0.0195***	-0.0180**
	(0.00249)	(0.00489)	(0.00312)	(0.00303)	(0.00324)	(0.00446)	(0.00719)
Years enrolled in SPP^2	-0.663***	-1.386***	-0.918***	-0.0141	0.340***	0.328***	0.408***
	(0.00909)	(0.0168)	(0.0120)	(0.0123)	(0.0139)	(0.0194)	(0.0329)
Recognition Bond	1.250***	0.502***	0.831***	1.466***	2.608***	4.077***	7.155***
	(0.0295)	(0.0334)	(0.0302)	(0.0407)	(0.0852)	(0.164)	(0.460)
Constant	4.199***	1.234***	3.427***	6.598***	9.262***	9.945***	12.72***
	(0.0672)	(0.113)	(0.0833)	(0.0862)	(0.122)	(0.200)	(0.580)

Notes: Bootstrapped standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. N = 49,448 for 2005, N = 94,315 for 2013, and N = 124,829 for 2019. All regressions control for AFP, and birth cohort.

Table A.3: Results of the detailed decomposition of the gender gap in pension balance over quantiles (2019)

	Q10	Q25	Q50	Q75	Q90	Q95	Q99
Male	6.086***	7.479***	8.973***	10.23***	11.12***	11.65***	12.69***
	(0.0139)	(0.0112)	(0.00956)	(0.00825)	(0.00858)	(0.0115)	(0.0190)
Female	5.616***	6.998***	8.511***	9.881***	10.92***	11.37***	12.39***
	(0.0172)	(0.0140)	(0.0124)	(0.0121)	(0.0106)	(0.0121)	(0.0229)
Gap	0.470***	0.481***	0.463***	0.353***	0.196***	0.277***	0.300***
	(0.0221)	(0.0179)	(0.0156)	(0.0146)	(0.0137)	(0.0167)	(0.0298)
Explained gap							
Total	0.209***	0.256***	0.268***	0.211***	0.141***	0.127***	0.0834***
	(0.0113)	(0.0123)	(0.0121)	(0.00967)	(0.00776)	(0.00866)	(0.0103)
Contribution density	-0.0145*	-0.0159*	-0.0159*	-0.0121*	-0.00804*	-0.00747*	-0.00520*
	(0.00786)	(0.00866)	(0.00862)	(0.00658)	(0.00437)	(0.00406)	(0.00284)
Years enrolled in SPP	0.819***	0.927***	0.683***	0.267***	0.0745***	0.0592***	0.00503
	(0.0271)	(0.0284)	(0.0209)	(0.00978)	(0.00775)	(0.0108)	(0.0189)
Years enrolled in SPP^2/100	-0.534***	-0.592***	-0.382***	-0.0508***	0.0686***	0.0742***	0.102***
	(0.0201)	(0.0203)	(0.0133)	(0.00526)	(0.00665)	(0.00931)	(0.0163)
Recognition Bond	-0.000398	-0.000140	0.000275*	0.00127*	0.00303*	0.00521*	0.00925*
	(0.000257)	(0.000123)	(0.000165)	(0.000695)	(0.00165)	(0.00284)	(0.00504)
Fund type 2	-0.0137***	-0.00782***	0.000430	0.0173***	0.0285***	0.0346***	0.0620***
	(0.00388)	(0.00266)	(0.00188)	(0.00206)	(0.00283)	(0.00383)	(0.00681)
Fund type 3	0.00262	0.00203	0.00292***	0.00200**	0.000789	0.00252	-0.0181***
	(0.00203)	(0.00141)	(0.00104)	(0.000956)	(0.00118)	(0.00170)	(0.00344)
Unexplained gap							
Total	0.261***	0.225***	0.195***	0.142***	0.0552***	0.151***	0.216***
	(0.0201)	(0.0140)	(0.0102)	(0.0102)	(0.0114)	(0.0153)	(0.0291)
Contribution density	-0.0113	-0.0293	-1.35e-05	-0.237***	0.0172	0.194***	0.0636
	(0.0273)	(0.0190)	(0.0139)	(0.0138)	(0.0155)	(0.0208)	(0.0397)
Years enrolled in SPP	0.602***	0.0348	-1.053***	-1.034***	0.199**	0.287***	0.639***
	(0.145)	(0.100)	(0.0735)	(0.0728)	(0.0821)	(0.110)	(0.210)
Years enrolled in SPP^2/100	-0.263***	0.0329	0.545***	0.272***	-0.387***	-0.294***	-0.586***
	(0.0868)	(0.0603)	(0.0442)	(0.0439)	(0.0493)	(0.0657)	(0.126)
Recognition Bond	0.000246	-0.00106	0.000235	0.00131	0.00243*	0.0126***	0.00118
	(0.00258)	(0.00179)	(0.00131)	(0.00131)	(0.00146)	(0.00200)	(0.00374)
Fund type 2	0.214	0.0635	0.199	0.426***	-0.161	0.0855	-2.199***
	(0.261)	(0.181)	(0.133)	(0.132)	(0.148)	(0.196)	(0.378)
Fund type 3	0.0103	0.00707	0.00748	0.00944*	-0.000118	0.0124*	-0.0861***
	(0.00984)	(0.00683)	(0.00501)	(0.00499)	(0.00557)	(0.00740)	(0.0144)
Constant	-2.384*	-2.294**	-0.104	0.240	0.484	-0.703	3.952**
	(1.349)	(0.939)	(0.694)	(0.709)	(0.754)	(0.960)	(1.934)

Notes: The regressions use the Blinder-Oaxaca decomposition method, based on RIF. Bootstrapped standard errors are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. N = 75,961 for group 1 (male), N = 48,868 for group 2 (female). All regressions control for AFP, birth cohort, and region.

Table A.4: Unconditional quantile regression coefficients on logs of pension savings, including financial literacy variables (2019)

Variables	OLS	Q25	Q50	Q75	Q90	Q95	Q99
Male	0.194***	0.259***	0.202***	0.102***	0.0415***	0.122***	0.158***
	(0.00804)	(0.0157)	(0.0119)	(0.0110)	(0.0111)	(0.0147)	(0.0251)
Active portfolio management	0.901***	0.470***	0.942***	1.465***	1.384***	1.637***	1.317***
	(0.0266)	(0.0345)	(0.0369)	(0.0533)	(0.0782)	(0.121)	(0.230)
Male*Active portfolio mana.	-0.0615*	-0.228***	-0.211***	-0.00303	0.302***	0.683***	1.055***
	(0.0324)	(0.0414)	(0.0440)	(0.0636)	(0.0956)	(0.152)	(0.304)
Regular contributor	1.782***	2.178***	2.068***	1.554***	0.906***	0.809***	0.578***
	(0.00824)	(0.0151)	(0.0121)	(0.0116)	(0.0117)	(0.0156)	(0.0252)
Years enrolled exact	0.323***	0.540***	0.412***	0.147***	0.00556*	-0.00236	-0.0400***
	(0.00246)	(0.00491)	(0.00312)	(0.00300)	(0.00319)	(0.00440)	(0.00732)
Years enrolled exact^2/100	-0.656***	-1.389***	-0.909***	0.000870	0.357***	0.350***	0.432***
	(0.00893)	(0.0167)	(0.0119)	(0.0121)	(0.0137)	(0.0191)	(0.0330)
Recognition Bond	1.192***	0.452***	0.773***	1.407***	2.542***	3.974***	7.028***
	(0.0290)	(0.0338)	(0.0307)	(0.0416)	(0.0847)	(0.162)	(0.457)
Constant	4.922***	2.178***	4.083***	6.995***	8.684***	9.592***	14.14***
	(0.496)	(0.455)	(0.639)	(0.637)	(0.836)	(1.267)	(4.283)
Observations	124,829	124,829	124,829	124,829	124,829	124,829	124,829
R-squared	0.566	0.325	0.451	0.403	0.266	0.180	0.079

Notes: The regressions use the sample drawn on December 2019. The dependent variable for all regressions is the pension balance in logarithm. All regressions control for birth cohort, AFP, and region. Bootstrapped standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.5: Unconditional quantile regression coefficients on log of extended pension wealth (2019)

Variables	OLS	Q25	Q50	Q75	Q90	Q95	Q99
Male	0.194***	0.253***	0.196***	0.101***	0.0546***	0.152***	0.202***
	(0.00590)	(0.0139)	(0.00997)	(0.00969)	(0.0110)	(0.0153)	(0.0275)
Contribution density	3.529***	4.155***	4.079***	3.329***	2.010***	1.777***	1.294***
	(0.00923)	(0.0196)	(0.0137)	(0.0146)	(0.0189)	(0.0266)	(0.0456)
Years enrolled in SPP	0.375***	0.598***	0.473***	0.202***	0.0411***	0.0265***	-0.0120
	(0.00203)	(0.00460)	(0.00297)	(0.00290)	(0.00321)	(0.00444)	(0.00729)
Years enrolled in SPP^2/100	-0.823***	-1.571***	-1.101***	-0.174***	0.241***	0.257***	0.339***
	(0.00733)	(0.0159)	(0.0110)	(0.0111)	(0.0133)	(0.0188)	(0.0324)
Recognition Bond	0.959***	-0.0511	0.307***	1.197***	3.062***	4.701***	8.415***
	(0.0296)	(0.0417)	(0.0373)	(0.0365)	(0.0762)	(0.163)	(0.487)
Fund type 2	-0.279***	0.293***	-0.0832	-0.917***	-1.285***	-1.601***	-1.859***
	(0.0474)	(0.0608)	(0.0554)	(0.0720)	(0.130)	(0.231)	(0.718)
Fund type 3	0.0930*	0.0817	0.188***	0.0893	-0.0479	0.111	-0.635
	(0.0489)	(0.0637)	(0.0585)	(0.0768)	(0.138)	(0.243)	(0.733)
Constant	4.356***	1.343***	3.180***	6.565***	9.494***	10.57***	13.90***
	(0.0704)	(0.169)	(0.116)	(0.109)	(0.135)	(0.212)	(0.611)
Observations	124,829	124,829	124,829	124,829	124,829	124,829	124,829
R-squared	0.752	0.425	0.590	0.533	0.331	0.216	0.093

Notes: The dependent variable for all regressions is the log of extended pension wealth, that is the sum of the pension balance and the updated Recognition Bond. All regressions control for birth cohort, AFP, and region. Bootstrapped standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.