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The Impact of Lump-Sum Retirement Withdrawals on Labor Supply: Evidence from Peru
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ABSTRACT

We examine the labor supply impact of a 2016 policy that allows retirement-eligible individuals covered by Peru's private pension system to receive retirement benefits as a lump sum rather than as an annuity. We present a theoretical model predicting that, for liquidity constrained workers, the lump sum option makes formal employment (requiring pension participation) more attractive relative to informal employment (not requiring pension participation); it also encourages early retirement. Using household panel data, we estimate the impact of the 2016 policy on the labor supply of workers covered by the private pension system compared to workers covered by the alternative pay-as-you-go defined benefit pension (which was unaffected by the policy). The policy is associated with an increase in the probability of being retired at ages 50 (early retirement age for women), 55 (early retirement age for men), and 65 (full retirement age for all workers). We also find increases in formal sector employment among women in their late 40s and men in their early 50s, consistent with increased efforts to qualify for early retirement (which requires recent pension contributions). The policy's effects are concentrated among workers with less education, who are more likely to be liquidity constrained.

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1 Introduction

Pension plans frequently offer individuals a choice between receiving benefits as a lump sum or a life annuity. Annuities provide protection against length-of-life risk, and standard life cycle models predict that risk-averse individuals will be willing to buy them even if the terms are actuarially unfair. Empirically, however, people often fail to annuitize wealth to the extent that the life-cycle model predicts, a phenomenon known as the "annuity puzzle" (Yaari, 1965; Mitchell et al., 1999; Warner and Pleeter, 2001; Bütler and Teppa, 2007). This issue arises in the context of public pension systems as well. For example, in the U.S. Social Security system, individuals can choose to start receiving benefits at any age between 62 and 70. Delaying benefits within this window amounts to purchasing an annuity as it requires forgoing benefits now in exchange for higher monthly benefits for life. Although the terms for delay are actuarially generous, most people claim early, possibly reflecting the low value they attach to the annuity available through delay. Indeed, Maurer et al. (2021) and Maurer et al. (2018) present evidence suggesting that offering the gains from delay as a lump sum (payable upon claiming) would likely induce delays in both claiming and retirement. [1]

We contribute to this literature by studying the labor supply impact of an immediate lump-sum withdrawal option on the national pension system of Peru. Participation in the Peruvian pension system is mandatory for formal sector workers (a minority of the labor force), and individuals make a choice at the start of their career to enroll in a defined benefit plan operating under pay-as-you-go (PAYG) funding, or in a defined contribution plan with individual accounts. Prior to 2016, those eligible for benefits under the private system had to either make gradual withdrawals or buy an annuity. In 2016, a law was passed allowing individuals who had not yet started receiving benefits to withdraw the balance of their accounts as a lump sum. Consistent with the annuity puzzle literature, over 95% of people currently take a lump-sum pay-out when claiming benefits (OECD, 2019). We examine the pre- and post-policy labor market choices of middle-aged and older individuals covered by the private system (who became eligible to withdraw balances as a lump sum) relative to those of individuals covered by the PAYG system (who were unaffected by the policy).

The labor market impact of the lump sum withdrawal option is likely to be influenced by rules around pension eligibility. Under the pay-as-you-go system, workers are eligible for a full retirement benefit at age 65 if they have 20 years of contributions. Actuarially reduced retirement benefits are available starting at age 50 for women who have made 25 years of contributions, and at age 55 for men who have made 30 years of contributions. Under the private pension system, workers can access their account balances at age 65 regardless of their years of contributions. Early benefits are available

[1] This work is part of a broader literature on the impact of pension incentives on labor supply behavior - see, e.g., Rabaté and Rochut (2020), Mastrobuoni (2009), Fetter and Lockwood (2018), Liebman et al. (2009).

starting at age 50 for women and 55 for men. Qualifying for early benefits requires a recent contribution history (72 months of contributions during the prior 120 months) and a sufficiently large balance. Under both the pay-as-you go and private systems, workers stop making contributions once they have claimed benefits. There is also no earnings test in either system: individuals may receive pension benefits and continue to work in either the formal or informal sectors.

In the context of these rules, a lump-sum withdrawal option can affect labor supply in multiple ways. For workers below the eligibility age who are covered by the private pension system, the lump sum option is likely to induce a shift from informal to formal employment. There are two reasons such a shift may occur. First, workers receive a more valued benefit (a lump sum rather than an annuity) in exchange for their pension contributions; thus, the required pension contributions constitute less of a deterrent to formal sector employment. Second, if workers nearing early eligibility age find the lump sum payout more attractive than an equivalent annuity or phased withdrawal, they may increase their formal sector work to meet the recent contribution requirements for early benefits.[2] In addition to shifting work towards the formal sector, the lump sum option may induce retirement among those who are eligible to receive a benefit from the private system. The ability to receive a benefit as a lump sum increases real income by alleviating liquidity constraints and providing a payment stream that people appear to prefer compared to an actuarially equivalent annuity. This increase in real income is likely to reduce labor supply via the income effect.

We begin by illustrating some of these predictions in a five-period life cycle model. In the model, the preference for the lump sum distribution over an actuarially equivalent annuity comes from a borrowing constraint. We compare workers' labor supply and retirement decisions under pension systems in which benefits are paid as a lump sum or an annuity. We show that when pension benefits are paid as a lump sum, workers are more likely to take formal jobs and retire early. We show that the lump sum policy has a larger impact on the labor supply of low-income, low-wealth workers, who are more liquidity constrained than other workers. This heterogeneity highlights the important role of liquidity constraints.

Next, we use panel data from Peru's large and representative National Survey of Households (Encuesta Nacional de Hogares, ENAHO), to examine the impact of the 2016 law on the age distribution of labor force status. Using a difference-in-differences approach, we show that the 2016 law is associated with an increase in formal sector work, and a decrease in informal sector work, among workers covered by the private pension system relative to workers covered by the pay-as-you-go system. This shift

[2]The attractiveness of the lump sum option may also induce workers entering the formal sector for the first time to opt for the private system rather than the PAYG system. We do not study this impact, however, as the policy affects all workers and therefore leaves no natural control group.

towards formal employment occurs just before age 55, possibly indicating a policy-induced effort to qualify for early retirement. In particular, the probability of formal sector employment rises by 7.0 percentage points (relative to a pre-policy mean of 62.1 percent) at age 53 and by 7.6 percentage points (relative to a pre-policy mean of 62.4 percent) at age 54. There are corresponding declines in the probabilities of being either informally employed or retired at these ages. We also find that the 2016 law is associated with an increase in the probability of being retired around ages 50, 55, and 65 for workers covered by the private system relative to the pay-as-you go system. In particular, the probability of being retired increases by 4.0 percentage points (relative to a pre-policy mean of 4.8 percent) at age 50, by 6.3 percentage points (relative to a pre-policy mean of 5.3 percent) at age 55, and by 8.5 percentage points (relative to a pre-policy mean of 14.0) at age 65.

We explore heterogeneity across demographic and socioeconomic groups by estimating results separately for men, women, individuals with less than a high school education, and individuals with a high school education or more. In line with theoretical predictions, the labor supply effects discussed above are concentrated among workers with less than a high school education, who tend to have lower incomes and are more likely to be liquidity constrained. The pre-age-55 shifts from informal to formal employment are concentrated among men, consistent with increased efforts to qualify for early retirement at age 55. We find a further policy-associated shift from informal to formal employment for women in their late 40s, consistent with increased efforts to qualify for early retirement at age 50. Finally, we find that the increased probability of retirement around ages 50, 55, and 65 occurs primarily among women.

2 Institutional Background

The Peruvian pension system has two components. The first component - called "Pension 65" - is a noncontributory program that is means-tested and targeted towards individuals 65 years and older who are at risk of poverty (Saco et al., 2018). The second component is based on payroll contributions made by workers. These contributions are calculated as a percentage of the worker's monthly income. However, pension contributions can only be enforced in the formal sector. The informal sector is unregulated by the government[3], eluding taxes and mandatory savings.

With almost 70% of the Peruvian labor force working in informal jobs (ILO, 2022)[4], the coverage of the contributory system is limited. Less than 30% of the people over

[3]In Peru, informal jobs are generally not black market activities (Maloney, 2004). They are best understood as "under the table" work arrangements, small entrepreneurial activities, or self-employment.

[4]This figure reflects the International Labor Organization's estimate of the proportion of the non-agricultural labor force working in informal employment in 2022

65 years old receive a pension from the contributory system (Cruz Saco and Gil, 2021). Another 24% receive a non-contributory pension (OECD, 2019). The remainder of the elderly rely on informal safety nets, family support, personal savings, or continued work.

Since the 1992 pension reform, the contributory component of the pension system has been further subdivided into two parallel schemes. The first is the Sistema Privado de Pensiones (SPP), a private, fully funded pension system based on individual accounts. The second is the Sistema Nacional de Pensiones (SNP), a public pay-as-you-go (PAYG) system with defined benefits. At the start of their first formal sector employment, workers must choose only one system to be enrolled in and to contribute to during their working life. The two schemes are mutually exclusive and impose the same burden on the worker's monthly income, about 13%, including contributions plus fees (Saco et al., 2018). Workers stop making pension contributions once they have claimed benefits. There is also no earnings test: individuals may receive pension benefits and continue to work in either the formal or informal sectors.

The difference between the private and PAYG systems lies in their benefit payouts. In the public PAYG system, pensions are based on a formula that replaces a fraction of the last five years of earnings. An individual who is eligible for a full pension benefit is guaranteed a payment equal to 54% of the minimum wage. The pension amount is also subject to a maximum of 92% of the minimum wage. Workers are eligible for a full retirement benefit at age 65 if they have 20 years of contributions. Actuarially reduced retirement benefits are available starting at age 50 for women who have made 25 years of contributions, and at age 55 for men who have made 30 years of contributions.

The individual account system is run by four private fund managers. There is no minimum pension guarantee; benefits are based solely on workers' contributions and market returns. Workers can access their account balances at age 65 regardless of their years of contributions. Early benefits are available starting at age 50 for women and 55 for men. Qualifying for early benefits requires a recent contribution history (72 months of contributions during the prior 10 years), as well as an account balance sufficient to provide a benefit that is at least 40 percent of the worker's average indexed earnings over the past 10 years. Pension payout options include programmed withdrawals, annuities, a combination of withdrawals and annuities, and, since 2016, lump sum retrieval of 95.5% of the account balance (the remaining 4.5% is paid to the workers' health program).

3 Theoretical Model

We develop a five-period model consisting of near-retirement workers in an economy with a formal and an informal sector. Within this model, we compare two alternative

defined contribution, account-based pension systems. The first pension system pays benefits in the form of an annuity, while the second pays benefits in the form of a lump sum. Both pension systems require contributions from formal sector workers. We solve for the optimal labor supply decisions of a simulated distribution of workers under both pension systems. This comparison allows us to illustrate the potential impact of a lump sum pension payout on hours supplied in the formal versus informal sectors (the formality rate), and overall labor supply in the period prior to retirement (early retirement).

3.1 Model Setup

We begin by describing the basic setup of the model, including individual preferences, the labor market, and asset accumulation.

Environment
Consider an economy consisting of workers who live for five periods. The model begins towards the end of each individual's working life, and all individuals enter the model with preexisting savings out of prior earnings. In the first three periods, individuals are still part of the labor force. In the fourth and fifth periods, individuals are retired.

Each individual's lifetime utility is given by

$$u(c_1) + \beta u(c_2) + \beta^2[u(c_3) - \phi L] + \beta^3 u(c_4) + \beta^4 u(c_5),$$

where c_t is consumption in period t, $u'(c_t) > 0$, $u''(c_t) < 0$. We assume $u(c_t)$ exhibits constant relative risk aversion (CRRA). The time discount factor is $\beta \in (0, 1)$. Workers choose consumption, c_t, in each period. During the first and second periods, labor supply is inelastic and there is no disutility of work effort.

The Peruvian pension design allows individuals to continue to work after claiming a pension; indeed, this choice appears to be common in the data. We model this feature by giving workers access to their pensions (whether as an annuity or lump sum) in period 3. Workers also choose total working hours, L, while facing a constant disutility of work, ϕ, for each hour supplied. This setup allows workers to opt for partial (or full) retirement in period 3. Consistent with the design of the Peruvian pension system, workers are not required to make pension contributions in period 3.

Workers make a one-time decision at the start of the model regarding what fraction of working hours in periods 1, 2, and 3 to devote to the formal sector (this fraction is constrained to be the same across working periods). In the last two periods, individuals are completely retired and consume out of their pensions. There are no sources of uncertainty, so individuals have perfect information and foresight.

Labor Market

In line with the Peruvian labor market, workers can allocate their work hours between the formal and informal sectors. Following empirical evidence on the wage gap between sectors, work in the formal sector yields a higher after-tax wage than work in the informal sector (Alcaraz et al., 2011; Maloney, 1999; Saavedra and Chong, 1999). However, workers are required to contribute a fraction, x, of formal earnings to the pension system. This mandated savings policy is enforced only in the formal sector, making the informal sector attractive for individuals who are liquidity-constrained (Moreno, 2020).

In the first and second periods, individuals supply labor inelastically. However, they chose the shares of their labor supply allocated to the formal and informal sectors, $s = \{f, i\}$. We let h^s denote the fraction of hours supplied in sector s, with $h^f + h^i = 1$. The fractions h^f and h^i - chosen in the first period - are binding for any work done in the second period as well. Work done in sector s in period t pays an after-tax hourly wage of w_t^s. We assume wages in the informal sector are a constant fraction, φ, of the wages in the formal sector. That is,

$$w_t^i = \varphi w_t^f \quad \text{where} \quad \varphi \in (0, 1) \forall t.$$

In our simulations, we allow the two wage levels to vary across workers (although the ratio of informal to formal wages stays fixed).

In the third period, workers can opt for partial or full retirement by choosing their working hours, L; workers are also no longer required to contribute the mandatory fraction, x, of earnings to their pension accounts. The fractions of these hours that are allocated to the formal and informal sectors are constrained to be the same as the first period and second periods (h^f and h^i). Wages increase every period for both sectors, although the wage gap (informal wages as a fraction of formal wages) stays constant.

We solve the model for workers with different productivity levels, allowing us to make predictions about the differing impact of lump sum payments on low-income workers versus high-income workers.

Assets

Workers enter the model with an ex-ante distribution of accumulated wealth that is perfectly correlated with the wage distribution. Initial wealth, m_0, is added to each worker's pension fund and available only at retirement.

To smooth consumption, individuals can save in the form of a liquid asset, a_t, initially set to zero, which earns an interest rate r. Additionally, we impose a borrowing constraint in all periods such that $a_t \geq 0$. Because wages are increasing over time and there is no precautionary motive, it is not optimal to save in a liquid form during the early working years. Therefore, we set a_1 and a_2 to zero.

In line with the Peruvian private pension system, workers are mandated to save for retirement in individual pension accounts. Every working period, workers contribute a percentage, x, of their formal sector income to a pension fund, which yields a return ρ and is only available starting in the third period. Empirically, the rate of return on pension assets, ρ, can be higher than the rate of return on the liquid asset, r.

3.2 Annuity Pension

We consider two alternative pension payout structures. First, we consider a system in which benefits are paid as an annuity during the last three periods. The maximization problem for each individual is described in Equation (1):

$$\max_{h^f, L, a_3, a_4} u(c_1) + \beta u(c_2) + \beta^2[u(c_3) - \phi L] + \beta^3 u(c_4) + \beta^4 u(c_5) \tag{1}$$

$$\begin{aligned} & s.t. \\ c_1 &= [(1-x)w_1^f h^f + w_1^i h^i], \\ c_2 &= [(1-x)w_2^f h^f + w_2^i h^i], \\ c_3 &= [w_3^f h^f + w_3^i h^i]L + P - a_3, \\ c_4 &= a_3(1+r) + P - a_4, \\ c_5 &= a_4(1+r) + P, \\ a_t &\geq 0 \\ 1 &= h^f + h^i \end{aligned}$$

Workers choose the percentage of their working time to spend in the formal sector (h^f). Labor supply during the first two periods is normalized to 1; therefore, L is the fraction of these hours worked in the third period. The amount of liquid savings accumulated at the end of periods 3 and 4, which are transferred to periods 4 and 5, are a_3 and a_4, respectively.

Under this pension scheme, the law of motion for pension wealth, m_t, is

$$\begin{aligned} m_1 &= m_0 + x w_1^f h^f, \\ m_2 &= m_1(1+\rho) + x w_2^f h^f, \end{aligned}$$

where m_0 is the initial level of pension wealth, m_1 is the amount of pension wealth accumulated after the first period, and m_2 is the final level of pension wealth. The pension benefit P, paid in periods 3, 4, and 5, is an annuity calculated using the simple annuity formula given a worker's final pension fund level m_2 and the pension rate of return, ρ, such that:

$$P = \frac{\rho}{1 - (1+\rho)^{-3}}(m_2).$$

3.3 Lump-Sum Pension

Next, we consider a pension system that pays a lump sum benefit. As in the previous case, contributions to the pension system are saved in a private account with a balance of m_t; however, now workers can access the totality of their savings during the third period.

Workers maximiz lifetime utility by choosing the fraction of working hours to allocate to the formal sector (h^f), the number of hours to work during the third period (L), and the amount of liquid wealth to transfer to the future (a_3 and a_4). The problem for each individual is as follows:

$$\max_{h^f, L, a_3, a_4} u(c_1) + \beta u(c_2) + \beta^2[u(c_3) - \phi L] + \beta^3 u(c_4) + \beta^4 u(c_5) \tag{2}$$

$$\begin{aligned}
&s.t.\\
c_1 &= [(1-x)w_1^f h^f + w_1^i h^i],\\
c_2 &= [(1-x)w_2^f h^f + w_2^i h^i],\\
c_3 &= [w_3^f h^f + w_3^i h^i]L + (1+\rho)m_2 - a_3,\\
c_4 &= a_3(1+r) - a_4,\\
c_5 &= a_4(1+r),\\
a_t &\geq 0\\
1 &= h^f + h^i\\
m_2 &= (m_0 + x w_1^f h^f)(1+\rho) + x w_2^f h^f
\end{aligned}$$

In equation (2), m_2 is the worker's accumulated pension fund delivered as a lump sum.

3.4 Solution and Simulation

We solve the model analytically and simulate results for a set of workers who vary in their wage levels. Our simulations illustrate how lump-sum payments create an incentive to change labor supply decisions.

The full solution to the model is found in appendix A, but we sketch the intuition here.

Formal sector decision

From the first-order conditions for the annuity problem, we show that the optimal fraction of hours supplied in the formal sector depends on a worker's assessment of the relative benefit of working formally versus informally. This relative benefit is based on two key factors. First, during the working periods, formal jobs pay a wage premium (Ω) but require liquidity-reducing contributions to the pension system (x). Second,

during retirement periods, workers receive an annuity (P) that is increasing in formal hours worked. Specifically, the first-order-condition is

$$u'(c_1)(\Omega_1 - x)w_1^f + \beta u'(c_2)(\Omega_2 - x)w_2^f + \beta^2 u'(c_3)(\Omega_3 w_3^f L) + \frac{\partial P}{\partial h^f}(\beta^2 u'(c_3) + \beta^3 u'(c_4) + \beta^4 u'(c_5)) \geq 0.$$

Here the marginal benefit of time spent in the formal sector is derived from the annuity value of the additional required pension contributions, or:

$$\frac{\partial P}{\partial h^f} = \frac{\rho}{1 - (1+\rho)^{-3}}[(1+\rho)xw_1^f + xw_2^f]$$

The value of this annuity to the worker depends on the discounted marginal utility of consumption across periods 3, 4, and 5.

The first-order-condition for the lump sum scenario is

$$u'(c_1)(\Omega_1 - x)w_1^f + \beta u'(c_2)(\Omega_2 - x)w_2^f + \beta^2 u'(c_3)(\Omega_3 w_3^f L) + \beta^2 u'(c_3)[(1+\rho)^2 xw_1^f + (1+\rho)xw_2^f] \geq 0.$$

Comparing the first-order conditions for the annuity and lump-sum problems, the first two terms are identical. However, the third term differs. This third term in the lump sum problem reflects the value of accessing the full retirement savings account in the third period. Impatient individuals (low β) will discount at higher rates the benefits of a pension annuity. Thus, workers derive a higher marginal benefit from formal sector when they receive their contributions as a lump sum in the third period. This higher marginal benefit creates an increased incentive to work in the formal sector.

Early retirement decision

Workers determine the fraction of working hours (L) during the third period (when partial retirement is available) by comparing the disutility of work to the potential increase in current consumption. Specifically, the first-order condition for both pension setups is

$$u'(c_3)[(\Omega_3 w_3^f h^f + w_3^i] \geq \phi.$$

When workers have access to their entire pension fund at the end of the third period, consumption is higher due to the relaxing of liquidity constraints. The marginal utility of consumption - and, correspondingly, the benefit of working during the third period - is, therefore, smaller in the lump sum system compared to the annuity system. Thus, workers supply less labor in period 3 when pensions are paid out as a lump sum than they do when pensions are paid out as an annuity.

The solutions for the optimal levels of the liquid assets, a_3 and a_4, are less interesting as these saving instruments are only used to transfer resources to the future. Under the annuity pension system, workers only transfer resources to their retirement periods if the annuity is small enough. Under the lump sum pension system, liquid saving is the only instrument available to distribute the lump sum pension across time. Without uncertainty, workers will choose the optimal amount of liquid savings to smooth consumption. In this case, the lump sum system will provide workers with the option to optimally smooth consumption, while the annuity system forces workers to distribute retirement savings equally across the last three periods. The consumption smoothing benefits of a lump sum pension would be greater in a more uncertain environment (with health, financial, or other kinds of shocks). On the other hand, these benefits would be smaller in workers with myopic behavior.

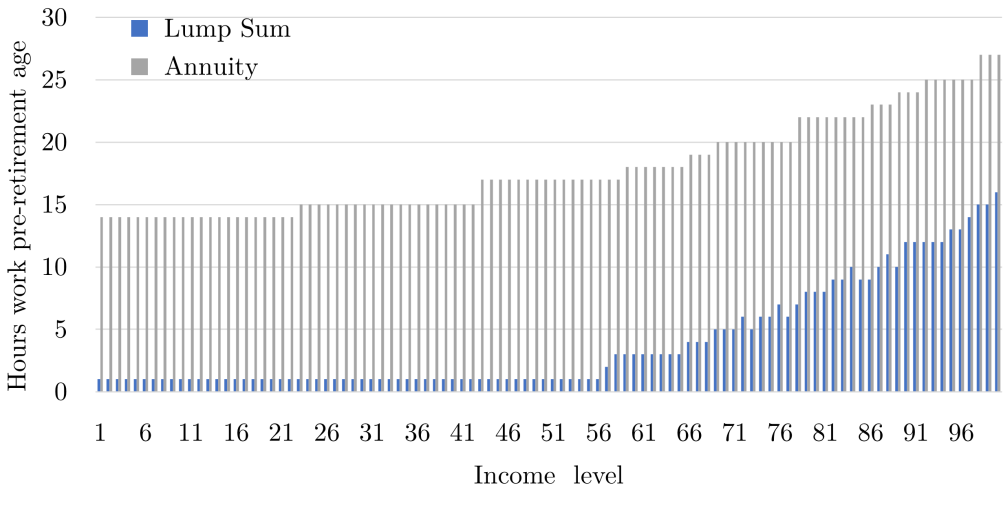
Simulation

We solve both problems for a simulated distribution of a hundred workers with different levels of productivity, which translates to different income levels. For all workers, informal wages are a constant fraction (φ) of formal wages every period. However, in each sector, the highest-productivity worker's wage is twice that of the lowest-productivity worker's wage. The wage distribution is perfectly correlated with the distribution of initial wealth, as initial wealth represents accumulated pension savings out of previous earnings.

To capture differences in health status as workers approach retirement, the disutility of work (ϕ), caused by deteriorating health, is also correlated with the income distribution. In particular, low-income workers will experience a higher disutility of work than high-income workers. For simplicity, we set pension returns equal to the return on liquid savings. A list of the parameters used to simulate the model is found in the appendix section B.1

We find that when workers can access their retirement savings as a lump sum, they reduce their labor supply during the second period. Figure 1 compares hours worked for the simulated workers under an annuity pension system versus a lump sum pension system. As suggested by the figure, individuals at all income levels work fewer hours when the pension is paid as a lump sum. However, the effect of the lump sum payout on labor supply is greater for low-income workers, who are more liquidity constrained and in worse health. As suggested by the first-order conditions, the marginal utility of working is reduced once the workers have immediate access to all their pension funds. As they face a higher disutility of work, low-income workers will supply zero hours (early retirement) in period 3.

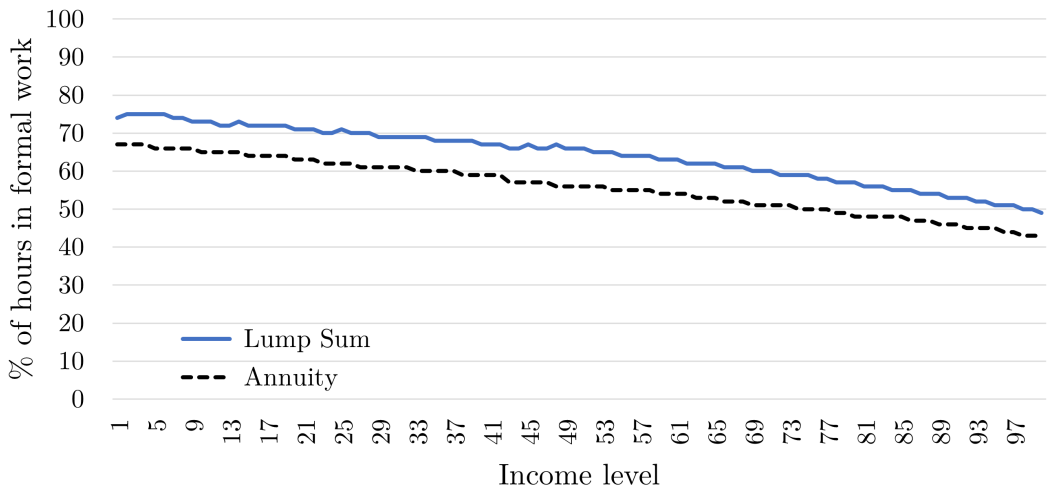
Figure 1: Hours of work before retirement(as percentage of total hours)



We also find that the lump sum pension system results in an increase in formal sector work. Figure 2 shows the percent of hours allocated to formal work at each income level under each pension system. Under both pension systems, high-income workers choose to work fewer hours in the formal sector than low-income workers. In the lump-sum scenario, low-income workers tend to value formal sector work because of the higher wage premium that can be enjoyed in period 3. In contrast, high-income workers, who already have high levels of pension wealth, are more impacted by the required pension contributions that reduce their liquidity during working periods. When pension contributions can be accessed as a lump sum, formal jobs become more attractive to all. Workers at all income levels choose to supply a higher fraction of their labor in the formal sector.

While we do not model it, pension eligibility may be another factor contributing to the desirability of formal jobs. The desirability of a lump sum (relative to an annuity) may incentivize more formal work close to retirement as workers attempt to qualify for early pension benefits based on recent contributions.

Figure 2: Hours worked in the formal sector (as percentage of total hours)



Finally, in the model, the lump sum option provides a higher lifetime utility than the annuity option. As workers do not face any uncertainty, they perfectly smooth consumption after receiving the lump sum[5]. Thus, in the presence of liquidity constraints, the lump sum option is welfare-improving compared to the annuity. The simulation shows a larger difference in lifetime utility for low-income low-wealth individuals, who experience greater liquidity needs. The assumption of perfect consumption smoothing is strong. If workers were "behavioral" and did not fully smooth consumption once they received the lump sum, they might be better off under an annuity pension system. However, our goal is to highlight the labor supply implications, rather than the welfare implications, of the alternative pension systems.

4 Empirical Analysis

Our main source of data is Peru's large and representative National Survey of Households (Encuesta Nacional de Hogares, ENAHO). Using a difference-in-differences methodology, we compare post-policy employment trends among those covered by the private pension system compared to a control group of individuals covered by the PAYG system. We find that the lump sum payout policy is associated with an increase in the probability of retirement around key pension eligibility ages. We also find a policy-associated increase in formal employment prior to early eligibility age. We explore how

[5]Lifetime utility and consumption levels under both pension systems are presented in appendix section B

these results vary across subgroups.

4.1 Data and Methods

We begin by describing the ENAHO data and sample selection. Next, we present our difference-in-differences methodology.

Data

The ENAHO is an ongoing series of surveys consisting of overlapping panels in which individuals are followed for two to five years. We use the six surveys that were conducted over the time periods 2011-15, 2012-16, 2013-17, 2014-18, 2015-20, and 2016-21. In each survey, each respondent is designated as part of a panel that may range from two to five years. For example, in the 2011-15 survey, individuals may be part of one of five two-year panels (interviewed each year during 2011-12, 2012-13, 2013-14, or 2014-15), one of three three-year panels (interviewed each year during 2011-13, 2012-14, or 2013-15), one of two four-year panels (interviewed each year during 2011-14 or 2012-15), or a single five year panel (interviewed each year during 2011-15). We combine all six surveys and use panels of all lengths. Thus, some individuals are only in our dataset for two years, while others are followed for up to five years. However, we drop all observations from 2020 and 2021, as the COVID-19 pandemic is likely to have caused atypical labor supply behavior.

We use these panels to construct a set of four mutually exclusive labor force status indicators based on two survey variables. The first variable is derived from a survey question asking individuals to classify themselves as working, unemployed and looking for work, unemployed and not looking for work (a category that captures discouraged workers), or out of the labor force. In the context of this question, working encompasses both informal and formal sector work. The second variable we use is imputed by ENAHO research staff and indicates whether a respondent who is working is employed in the formal or informal sector. Our first labor force status indicator takes on a value of 1 if the individual is working in the informal sector and zero otherwise. The second labor force status indicator takes on a value of 1 if the individual is working in the formal sector and zero otherwise. Our third labor force status indicator takes on a value of 1 if the individual reports being out of the labor force (our definition of retirement) and zero otherwise. The final indicator takes on a value of 1 if the individual reports being unemployed (whether looking for work or not) and zero otherwise.

The survey also includes indicators for whether a respondent reports being covered by PAYG pension system (SNP) or the private pension system (SPP). We cannot, however, accurately observe pension claiming decisions. Respondents are asked about pension income receipt; however, this pension income generally does not include lump sum withdrawals. Thus, we can only observe when an individual begins an annuity or

regular withdrawals, not when they receive a lump sum distribution. In addition, the survey does not collect information about assets; thus, we cannot identify lump sum withdrawals via increases in assets. We are also unable to observe pension eligibility, as the survey does not include questions about a respondent's work or contribution history.

The survey includes people of all ages. However, to study retirement behavior, we restrict the sample to those aged 45-69. We also restrict the sample to those who report being covered by either the PAYG system or the private pension system. We drop a small number of observations in which the respondent reports being covered by both systems (likely data errors), as well as observations with a missing or invalid labor force status or imputed formality indicator. We also drop observations for individuals who report being covered by different pension systems in different years. While individuals are allowed to make a one-time switch from the PAYG to the private pension system, we observe individuals shifting in both directions, suggesting that these records (around 5 percent of the sample) are more likely to reflect reporting or data coding errors. Following sample selection, we drop all singleton observations (individuals who are only observed in a single wave).

Methods

We estimate the impact of the lump sum withdrawal option on labor market behavior using a difference-in-differences approach. Because the treatment - the introduction of the lump-sum option - is not staggared, we use a traditional difference-in-differences model with two-way fixed effects. We define the treatment group as individuals who report being covered by the private pension system. In 2016, these individuals became eligible to withdraw their private account balance as a lump sum once they reached their pension eligibility age. The control group includes those who are covered by the PAYG system. Since the payout options remained the same in the PAYG system, these individuals were unaffected by the lump sum withdrawal policy.

As discussed in the Introduction, the impact of the lump sum distribution option is likely to vary by age. For individuals who are not yet eligible for retirement, the option may cause a shift towards formal sector work. For individuals who become eligible for a pension benefit, the option may cause an increase in retirement. We therefore estimate the impact of the lump sum option at each age using the following regression:

$$
\begin{aligned}
y_{it} = & \sum_{j=46}^{69} a_j \cdot I(age_{it} = j) + \sum_{j=46}^{69} \delta_j \cdot privpen_i \cdot I(age_{it} = j) \\
& + \sum_{j=46}^{69} \lambda_j \cdot post2016_t \cdot I(age_{it} = j) + \sum_{j=45}^{69} \theta_j \cdot privpen_i \cdot post2016_t \cdot I(age_{it} = j) \\
& + \gamma_i + \mu_t + \epsilon_{it}
\end{aligned} \tag{3}
$$

In this equation, y_{it} represents any of the labor force status variables, $I(age_{it} = j)$ is an indicator that takes on a value of 1 if individual i is aged j in year t; $private_i$ is an indicator that takes on a value of 1 if individual i is covered by the private pension system and zero if individual i is covered by the PAYG system; $post2016_t$ takes on a value of 1 if the year is 2016 or later (i.e., lump sum withdrawals are allowed) and zero otherwise; γ_i is an individual fixed effect; and μ_t is a year fixed effect.

This specification allows us to estimate the impact of the policy on the labor force status of individuals at each single year of age. The terms in the first summation capture the age distribution of labor force status in the control group before the policy; each coefficient a_j is the probability that $y_i = 1$ at age j (relative to the probability that $y_i = 1$ at age 45) in this group. The probability that $y_i = 1$ at the omitted age (45) is incorporated into the relevant individual- and year-specific intercepts. The second summation represents any pre-policy differences in the age distribution of labor force status for those in the private pension system; for this group, $a_j + \delta_j$ is the pre-policy probability that $y_i = 1$ at age j (relative to the probability that $y_i = 1$ at age 45). Again, the pre-policy probability that $y_i = 1$ at the omitted age (45) is incorporated into the relevant intercept terms. The third summation captures any post-policy differences in the age distribution of labor force status that are common to both control and treatment groups; any difference at the omitted age (45) is incorporated into the year dummies. Finally, the fourth summation captures the impact of the policy: each coefficient θ_j indicates the increase in the probability that $y_{it} = 1$ at age j in the treatment group during the post-treatment period. That is, it captures the shift in the probability that $y_{it} = 1$ at age j in the treatment group relative to the control group. This change can be estimated at all ages, including age 45, by combining cross-sectional and time-series variation.

The lump sum policy applies to individuals who become eligible for a pension in 2016 and later. Those who began receiving regular payments from a pension prior to 2016 could not switch to a lump sum. However, our $privpen_i$ indicator does not depend on prior pension receipt. Thus, some individuals who are not affected by the policy - because they began receiving a pension before 2016 - are misclassified as part of the treatment group. This misclassification likely biases the impact of the policy towards zero. As a robustness check, we reestimate the model after relassifying all individuals who report pension income before 2016 as part of the control group (along with those not reporting pre-2016 pension income who are covered by the PAYG system). Our findings are robust to this reclassification. (We do not report these results, but they are available upon request.)

4.2 Results

We begin by presenting descriptive statistics for our sample. We then present estimates of equation (3) for the full sample and four subsamples: men, women, individuals with less than a high school education, and individuals with a high school education or more. Finally, we perform some robustness checks.

Descriptive Statistics

Table 1 shows summary statistics for all variables used in our analysis. These variables include the labor supply measures described above, the indicator for being covered by the private pension system, basic demographic information (age and sex), and education (high school completion). Within our sample, more than 60 percent of individuals work in the formal sector. This fraction is high relative to the overall Peruvian labor market because our sample is restricted to individuals who report being covered by either the private or the PAYG pension system; thus, it is conditioned on having current or prior formal sector experience. Even within this selected sample, the fraction working in the informal sector is substantial - 28 percent.

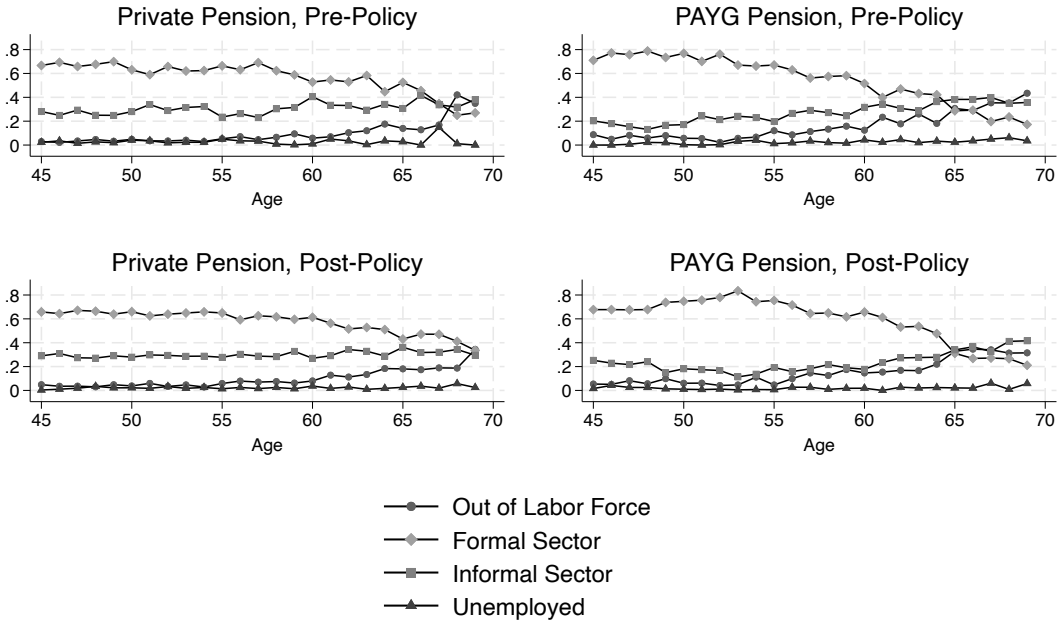
Table 2 shows the means and standard deviations of these variables broken down by pension system and whether the observation is before or after the lump sum policy went into effect. Before the policy, the probability of being out of the labor force was three times as high among those covered by the PAYG system compared to the private system. After the policy, we observe increases in both groups in the probability of being out of the labor force and the probability of being employed in the formal sector. Figure 3 shows the mean of each labor force status variable by age, broken down by pension system and whether the lump sum policy is in effect.

Table 1: Summary Statistics: Full Sample

Variable	Obs	Mean	Std. dev.	Min	Max
Out of Labor Force	53115	0.10	0.30	0	1
Formal Sector	53115	0.60	0.49	0	1
Informal Sector	53115	0.28	0.45	0	1
Unemployed	53115	0.02	0.15	0	1
Private Pension	53115	0.64	0.48	0	1
Age	53115	54.90	6.63	45	69
Year	53115	2015.83	2.04	2011	2019
Female	53115	0.35	0.48	0	1
High School or More	53115	0.49	0.50	0	1

Authors' calculations based on household data from ENAHO. See text for details.

Figure 3: Labor Force Status by Age



Authors' calculations based on household data from ENAHO. See text for details.

Table 2: Summary Statistics by Pension and Pre/Post Policy

Variable	Obs	Mean	Std. dev.	Obs	Mean	Std. dev.
	Private Pension - Pre-Policy			*Private Pension - Post-Policy*		
Out of Labor Force	13568	0.06	0.23	20235	0.07	0.25
Formal Sector	13568	0.63	0.48	20235	0.62	0.49
Informal Sector	13568	0.29	0.45	20235	0.29	0.46
Unemployed	13568	0.03	0.16	20235	0.02	0.14
Private Pension	13568	1.00	0.00	20235	1.00	0.00
Age	13568	52.86	5.85	20235	53.54	5.99
Year	13568	2013.88	1.20	20235	2017.31	1.05
Female	13568	0.30	0.46	20235	0.32	0.47
High School or More	13568	0.49	0.50	20235	0.50	0.50
	PAYG Pension - Pre-Policy			*PAYG Pension - Post-Policy*		
Out of Labor Force	8926	0.16	0.36	10386	0.16	0.37
Formal Sector	8926	0.54	0.50	10386	0.58	0.49
Informal Sector	8926	0.27	0.45	10386	0.24	0.43
Unemployed	8926	0.02	0.16	10386	0.02	0.14
Private Pension	8926	0.00	0.00	10386	0.00	0.00
Age	8926	57.50	6.73	10386	58.00	6.83
Year	8926	2013.78	1.23	10386	2017.25	1.05
Female	8926	0.39	0.49	10386	0.46	0.50
High School or More	8926	0.45	0.50	10386	0.51	0.50

Authors' calculations based on household data from ENAHO. See text for details.

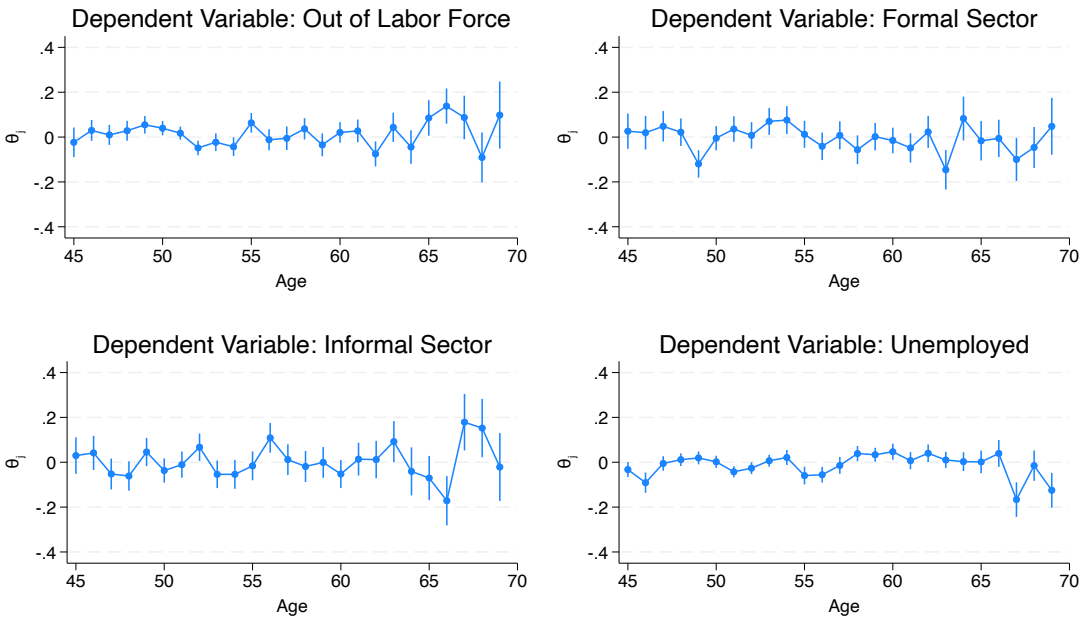
Full Sample Regression Results

Figure 4 shows the estimates of θ_j from equation (3) for the full sample.[6] The top left panel of the figure shows that the lump sum withdrawal policy is associated with statistically significant increases in the probability of being retired around ages 50, 55, and 65. The other three panels suggest that there are also increases in informal employment, decreases in formal employment, and decreases in unemployment at these ages. Ages 50, 55, and 65 are key pension eligibility ages. The full retirement age for both men and women is 65, and anyone covered by the private pension system can start receiving benefits at that age. However, men can start benefits as early as age 55, and women can start benefits as early as age 50, if they they qualify. Qualifying for early benefits requires a history of making pension contributions for 72 out of the last 120 months and as well as a sufficiently high account balance, or a current unemployment spell of 12 consecutive months. Those facing hazardous working conditions can start

[6]Numerical estimate of θ_j from all regressions in this section are provided in Tables 3 through 7 of Appendix C. Full regression results are available upon request.

benefits even earlier - between 40 and 54.

Figure 4: Impact of Lump Sum Withdrawal Option on Labor Force Status: Full Sample



Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

To be more specific, Figure 4 shows that there are increases in the probability of being retired at ages 49 and 50, respectively, of 5.5 and 4.0 percentage points. These increases are large relative to the pre-policy treatment group probabilities of being retired of 3.2 percent (age 49) and 4.8 percent (age 50) (as shown in Figure 3).[7] The increase at age 49 may be driven by individuals in hazardous occupations who are eligible to retire before age 50. However, it may also be driven by the timing of interviews relative to respondents' birthdays (e.g., an individual approaching their 50th birthday may stop work in anticipation of a lump sum withdrawal at age 50). There is a 6.3 percentage point increase in the probability of being retired at age 55, also a large effect compared to the pre-treatement mean of 5.3 percent. There are also increases in the probability of being retired of 8.5 percentage points at age 65 and 13.8 percentage points at age 66. The treatment group pre-policy probability of being retired is 14

[7]Numerical values of the pre-policy treatment group means are shown in Table 8 of Appendix C.

percent at age 65 and 12.8 percent at age 66.

The top right panel of Figure 4 also shows that there is a shift into formal employment at ages 53 and 54 - just below the early retirement age for men. The policy is associated with a 7.0 percentage point increase in the probability of formal employment at age 53 and a 7.6 percentage point increase in the probability of formal employment at age 54. The pre-policy probability of formal employment in the treatment group (shown in Figure 4) is 62.1 percent age 53 and 62.4 percent age 54. These increases in formal employment appear to be offset by a decline in the probability of informal employment and retirement. These shifts are consistent with a policy-driven increase in the attractiveness of formal sector employment due to the additional liquidity afforded by a lump sum option. Under existing pension eligibility rules, individuals are incentivized to exert additional efforts to qualify for early retirement by making recent contributions.

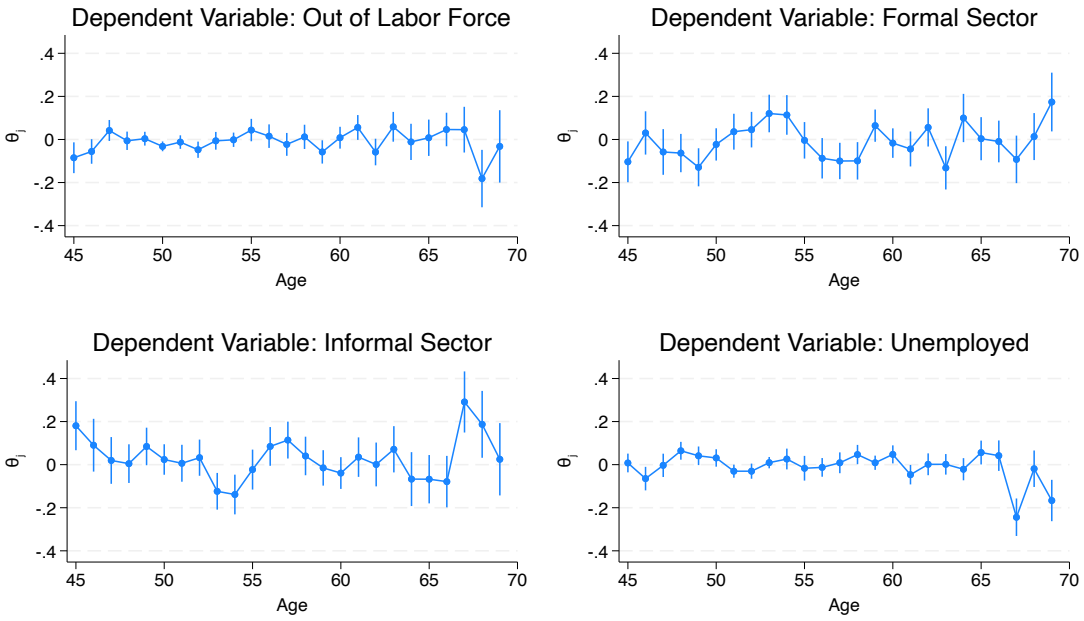
Subgroup Regression Results

Figure 5 shows the estimates of θ_j from equation (3) for men, who face an early retirement age of 55 and a full retirement age of 65. The top left panel shows that the increases in retirement at ages 50 and 65 that are observed in the full sample are not present for men; in fact, there is a statistically significant *decrease* in the probability of being retired at age 50. The point estimate suggests a 4.4 percentage point increase in the probability of retirement at age 55; however, this coefficient is insignificant. The top right and bottom left panels suggest that the post-policy shifts into formal employment before age 55 are concentrated among men: there is a 12.1 percentage point increase in the probability of formal work at age 53 and an 11.4 percentage point increase in the probability of formal work at age 54. These shifts are consistent with increased efforts by men to qualify for early retirement. Around age 55, there is a post-policy shift in the opposite direction: informal employment increases and formal employment decreases. There is also a shift out of unemployment and into informal employment after age 65.

Figure 6 shows the estimates of θ_j for women, who are eligible for early pension benefits at age 50 and full benefits at age 65. The top left panel suggests that the post policy increases in retirement at ages 50, 55, and 65 observed in the full sample are concentrated among women. These increases are all large: 11 percentage points or more. There is also a post-policy shift towards formal employment before age 50. Again, this shift is consistent with increased efforts by women to qualify for early retirement by making contributions. After age 65, both formal and informal employment decrease, while the probability of retirement increases.[8]

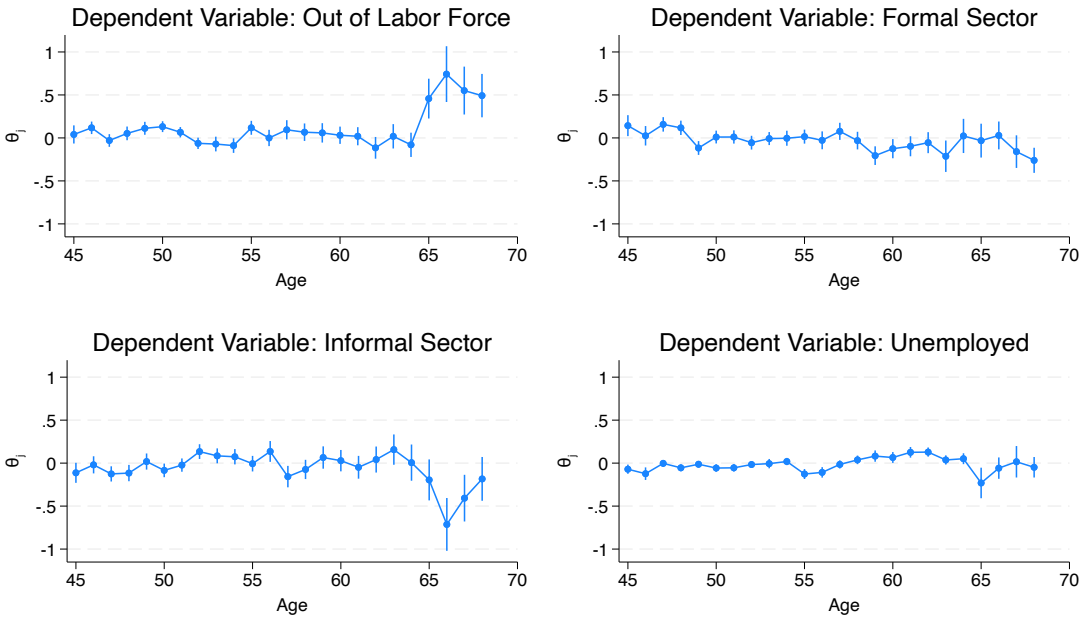
[8]We are unable to estimate the impact at age 69 for women due to a small sample size and lack of variation.

Figure 5: Impact of Lump Sum Withdrawal Option on Labor Force Status: Men



Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

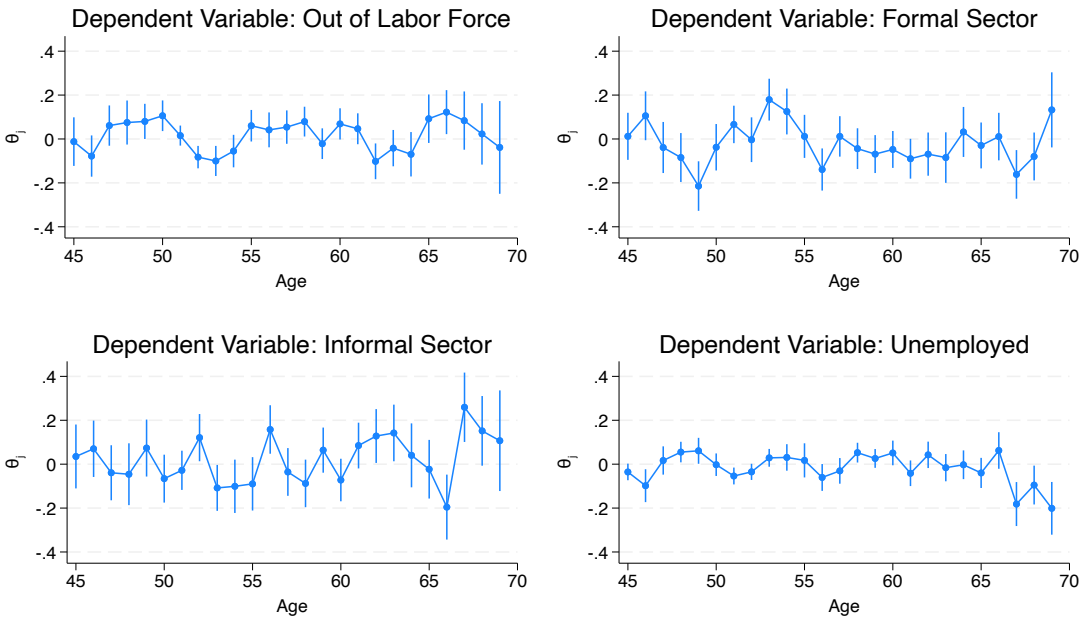
Figure 6: Impact of Lump Sum Withdrawal Option on Labor Force Status: Women



Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

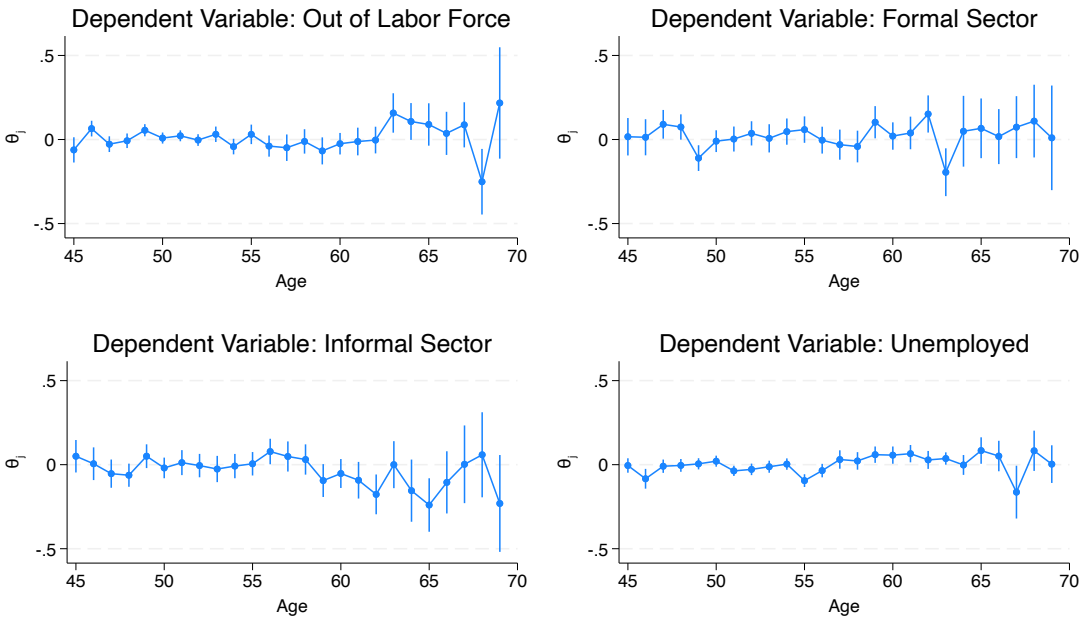
Figures 7 and 8 show results broken down by education level, a characteristic that is likely to be positively correlated with income and wealth. These figures suggest that the increase in formal employment prior to age 55 is concentrated among those with less education. The increase in retirement around ages 50, 55, and 65 are also larger in this group. In fact, there is no statistically significant impact on retirement at ages 55 or 65 for the more highly educated group. These results are consistent with the theoretical prediction that lump sum withdrawals have a larger impact on the labor supply behavior of liquidity-constrained individuals with lower income and wealth.

Figure 7: Impact of Lump Sum Withdrawal Option on Labor Force Status: Less than High School



Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

Figure 8: Impact of Lump Sum Withdrawal Option on Labor Force Status: High School or More

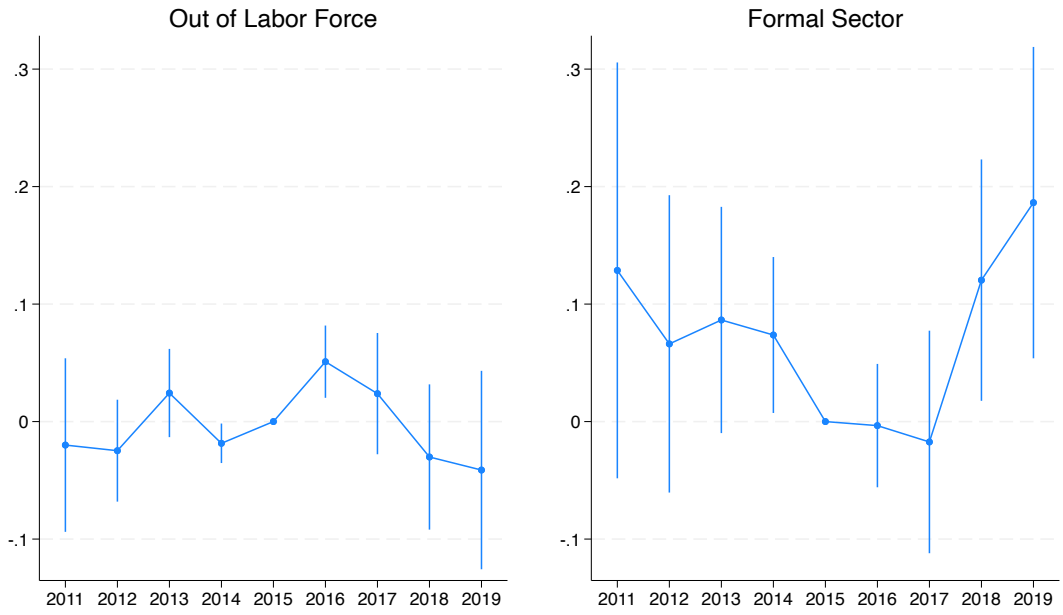


Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

Robustness

Interpreting our results causally requires that the treatment and control groups - those covered by the private pension system and those covered by the PAYG pension system - experience common trends in their labor force outcomes in the absence of the 2016 policy change. To examine the plausibility of this assumption, we perform two robustness checks. First, we estimate separate event studies for several three-year age groups: ages 49-51, ages 52-54, ages 55-57, and ages 65-67. We estimate these event studies using both retirement and formal work as dependent variables (as the key conclusions we have drawn relate to these variables). The indepedent variables include interactions between the private pension (treatment) indicator and a set of year dummies, as well as individual fixed effects. The coefficient on each treatment-year interaction term indicates the increase in the probability of the labor force outcome in the treatment group relative to the control group in the indicated year. If the policy causes shifts in labor force outcomes, we would expect these coefficients to become significant starting only in 2016. The age groups selected for the event studies are the ones that Figure 4 suggests are most affected by the lump sum withdrawal policy. Second, we re-estimate

Figure 9: Event Study: Ages 49-51

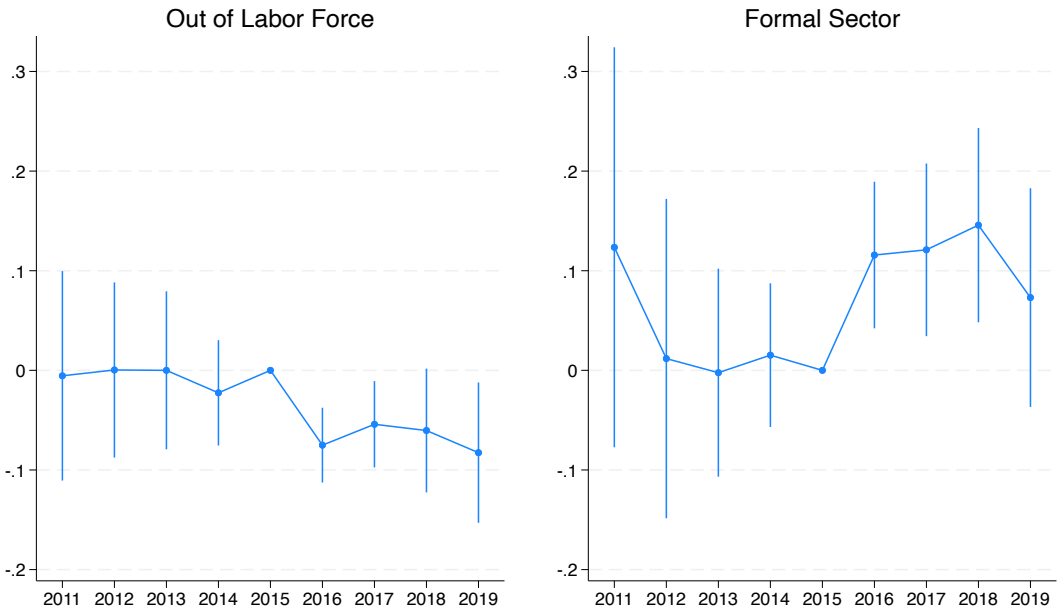


Figures depict event studies for indicated age group. Plotted points are coefficients on interactions between private pension system and year dummies. Standard errors clustered by individual. Regressions also include year dummies and individual fixed effects.

equation (3) with the addition of age- and pension-system-specific trends. That is, we add three-way interactions between the age dummies, the private pension indicator, and a linear time trend. These additional variables allow age-specific labor force outcomes to differ across the control and treatment groups by a linear trend. We present results in this section graphically. Full regression results are available upon request.

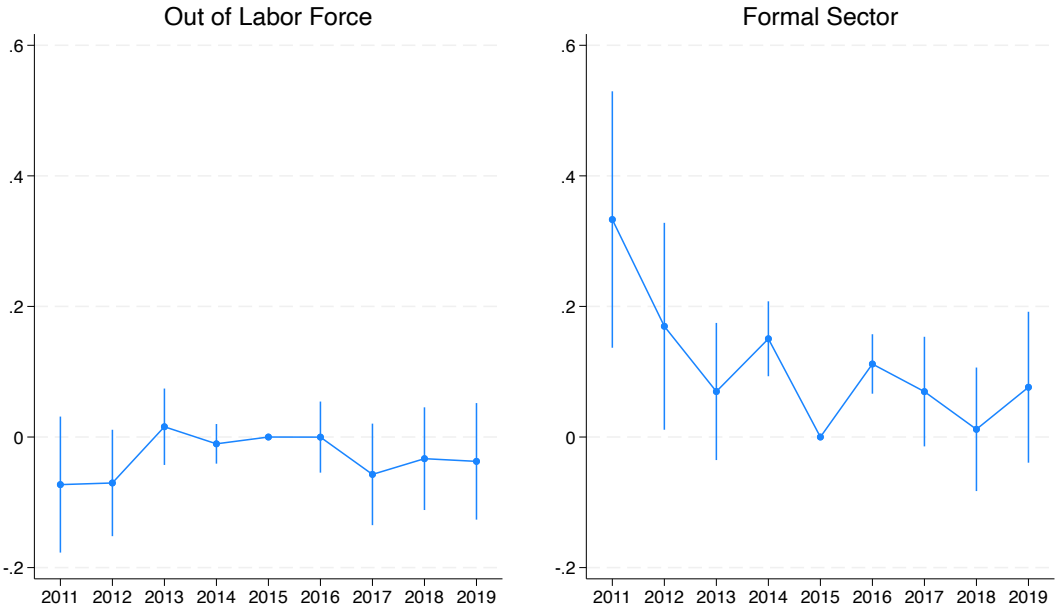
Figures 9-12 show the event study coefficients on the interactions between the private pension indicator and the year dummies. They illustrate the increase in the probability of the given outcome in the treatment group relative to the control group during the year indicated on the horizontal axis. The reference year is 2015, just before the policy went into effect. Figure 9 suggests that the probability of being retired at ages 49-51 increased in the treatment group relative to the control group in 2016; however, the increase may be temporary as it only shows up in this year. Figure 10 suggests a post-2016 shift towards formal sector work (and a corresponding decline in being out of the labor force) among those aged 52-54. This shift clearly appears to be associated with the policy; there are no pre-trends. In contrast to Figure 4, Figure 11 does not suggest a post-policy increase in the probability of being retired among the treatment group at ages 55-57. However, Figure 12 suggests that there is a post-policy

Figure 10: Event Study: Ages 52-54



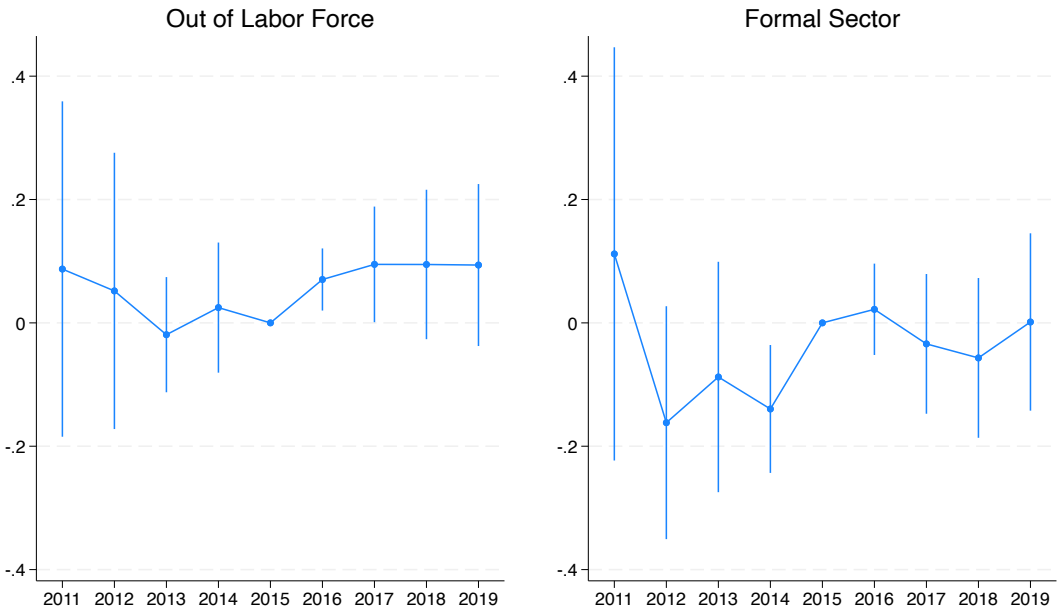
Figures depict event studies for indicated age group. Plotted points are coefficients on interactions between private pension system and year dummies. Standard errors clustered by individual. Regressions also include year dummies and individual fixed effects.

Figure 11: Event Study: Ages 55-57



Figures depict event studies for indicated age group. Plotted points are coefficients on interactions between private pension system and year dummies. Standard errors clustered by individual. Regressions also include year dummies and individual fixed effects.

Figure 12: Event Study: Ages 65-67

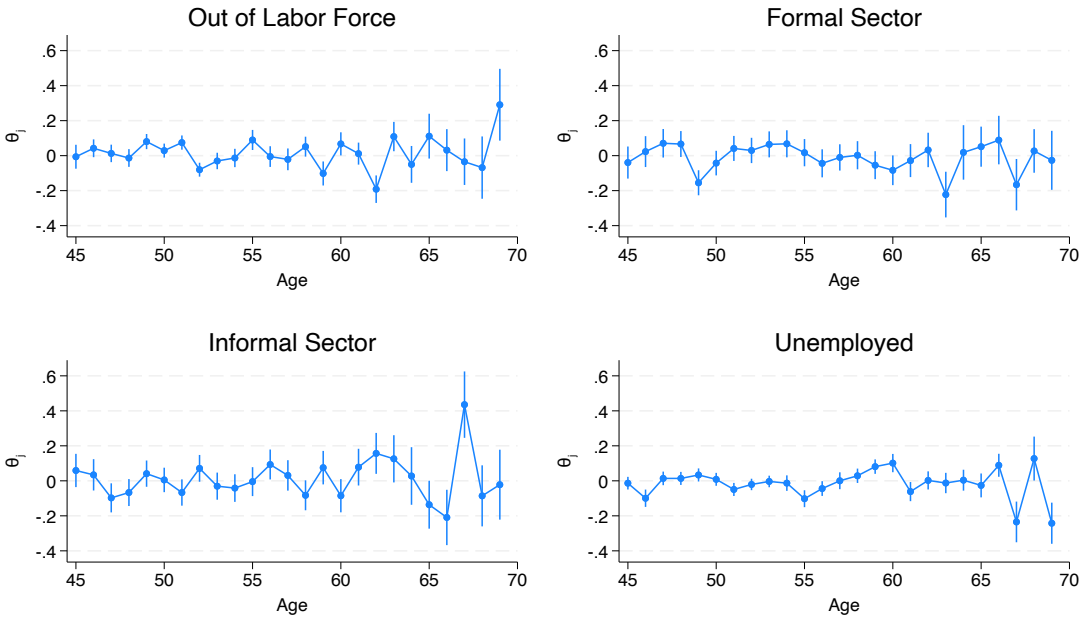


Figures depict event studies for indicated age group. Plotted points are coefficients on interactions between private pension system and year dummies. Standard errors clustered by individual. Regressions also include year dummies and individual fixed effects.

increase in the probability of being retired at ages 65-65 in the treatment group relative to the control group.

Finally, Figure 13 shows estimates of the same coefficients as Figure 4. However, these underlying regressions control for age-specific time trends through the inclusion of three-way interactions between the age dummies, a linear time trend, and the private pension indicator. The results in this figure are qualitiatively similar to those in Figure 4. In particular, we still observe a policy-associated increase in the probability of being retired around ages 50 and 55. There is also still an increase in the probability of being retired at age 65, although the coefficient is only significant at the 10 percent level. Finally, point estimates suggest an increase in formal employment at ages 53 and 54, although these are also only significant at the 10 percent level.

Figure 13: Impact of Lump Sum Withdrawal Option on Labor Force Status: Full Sample (with Age-Specific Time Trends)



Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3 and additionally control for three-way interactions between the age dummies, a linear time trend, and the private pension indicator.

5 Conclusion

While life annuities have insurance value, empirical evidence suggests that individuals often prefer actuarially equivalent lump sums. We have examined the impact of a lump sum pension payout option on labor supply decisions. In our theoretical model, liquidity constraints lead individuals to prefer lump sum payments. The model predicts that introducing a more valuable lump sum payout option alleviates liquidity constraints and accelerates retirement via an income effect. In addition, the lump sum payout option increase the attractiveness of the formal sector employment (which requires pension contributions) relative to informal sector employment (which does not require pension contributions). Empirical evidence from Peru supports these predictions. We have shown that the introduction of a lump sum payout option in 2016 increased the probability of being retired around key ages - 50 (early retirement age for women), 55 (early retirement age for men), and 65 (full retirement age for all workers) - for those affected by the policy relative to those not affected by the policy. We have also shown that the lump sum option increases formal sector employment just before age 50 for women and 55 for men. This result is consistent with a policy-induced increase in efforts to qualify for early retirement, which requires a history of recent pension contributions.

References

Alcaraz, C., Chiquiar, D., and Ramos-Francia, M. (2011). Wage differentials in mexico's urban labor market. *Economics Bulletin*, 31(3):2500–2508.

Bütler, M. and Teppa, F. (2007). The choice between an annuity and a lump sum: Results from swiss pension funds. *Journal of Public Economics*, 91(10):1944–1966. Special Issue published in cooperation with the National Bureau of Economic Research and Uppsala University: Proceedings of the Trans-Atlantic Public Economics Seminar on Public Policy and Retirement Behavior June 12-14 2006.

Cruz Saco, M. A. and Gil, M. (2021). The pension system in peru: Parallels and intersections. *International Journal of Social Welfare*, 30(3):316–329.

Fetter, D. K. and Lockwood, L. M. (2018). Government old-age support and labor supply: Evidence from the old age assistance program. *American Economic Review*, 108(8):2174–2211.

ILO (2022). International labour organization, modelled estimates database. https://ilostat.ilo.org/data/.

Liebman, J. B., Luttmer, E. F., and Seif, D. G. (2009). Labor supply responses to marginal social security benefits: Evidence from discontinuities. *Journal of Public Economics*, 93(11):1208–1223.

Maloney, W. F. (1999). Does informality imply segmentation in urban labor markets? evidence from sectoral transitions in mexico. *The World Bank Economic Review*, 13(2):275–302.

Maloney, W. F. (2004). Informality revisited. *World Development*, 32(7):1159–1178.

Mastrobuoni, G. (2009). Labor supply effects of the recent social security benefit cuts: Empirical estimates using cohort discontinuities. *Journal of Public Economics*, 93(11):1224–1233.

Maurer, R., Mitchell, O. S., Rogalla, R., and Schimetschek, T. (2018). Will they take the money and work? people's willingness to delay claiming social security benefits for a lump sum. *Journal of Risk and Insurance*, 85(4):877–909.

Maurer, R., Mitchell, O. S., Rogalla, R., and Schimetschek, T. (2021). Optimal social security claiming behavior under lump sum incentives: Theory and evidence. *Journal of Risk and Insurance*, 88(1):5–27.

Mitchell, O., Poterba, J. M., Warshawsky, M., and Brown, J. R. (1999). New evidence on the money's worth of individual annuities. *The American Economic Review*, 89(5):1299–1318.

Moreno, C. (2020). Mandatory savings, informality and liquidity constraints. *Economics Bulletin*, 40(4):3274–3295.

OECD (2019). *OECD Reviews of Pension Systems: Peru*. OECD Publishing. https://doi.org/https://doi.org/10.1787/e80b4071-en.

Rabaté, S. and Rochut, J. (2020). Employment and substitution effects of raising the statutory retirement age in france. *Journal of Pension Economics and Finance*, 19(3):293–308.

Saavedra, J. and Chong, A. (1999). Structural reform, institutions and earnings: evidence from the formal and informal sectors in urban peru. *The journal of development studies*, 35(4):95–116.

Saco, M. A. C., Seminario, B., Leiva, F., Moreno, C., and Zegarra, M. A. (2018). *El porvenir de la vejez: demografía, empleo y ahorro*. Fondo Editorial, Universidad del Pacífico.

Warner, J. T. and Pleeter, S. (2001). The personal discount rate: Evidence from military downsizing programs. *The American Economic Review*, 91(1):33–53.

Yaari, M. E. (1965). Uncertain lifetime, life insurance, and the theory of the consumer. *The Review of Economic Studies*, 32(2):137–150.

A Model Evaluation

A.1 Analytical Solution for Annuity Problem

The worker maximizes 1 by choosing the fraction of hours to work in the formal sector, h^f, the fraction of hours to work pre-retirement, L, and savings during retirement, a_3 and a_4.

The budget constraints for periods 3, 4 and 5 can be rewritten by using the simple annuity formula to write the pension payment for the three periods, P, as a function of the control variable, h^f:

$$P(h^f) = \frac{\rho}{(1-(1+\rho)^{-3})}[(1+\rho)(m_0 + xw_1^f h^f) + xw_2^f h^f]$$

In the above equation, the pension fund's rate of return is given by ρ and used to calculate the annuity that will be paid during 3 periods. Initial retirement wealth is m_0. Contributions during the first and second periods are also added to the account.

The maximization problem yields the following first-order condition for the share of hours in the formal sector, h^f:

1. FOC$_{h^f}$:

$$u'(c_1)[(1-x)w_1^f - w_1^i] + \beta u'(c_2)[(1-x)w_2^f - w_2^i] + \beta^2 u'(c_3)[(w_3^f - w_3^i)L + \frac{\partial P}{\partial h^f}] + \beta^3 u'(c_4)\frac{\partial P}{\partial h^f} + \beta^4 u'(c_5)\frac{\partial P}{\partial h^f} \geq 0$$

Using the fact that $\frac{(w_t^f - w_t^i)}{w_t^f} = \Omega_t$ (the wage gap between formal and informal jobs expressed as a percentage of formal wages), the first-order condition can be restated as:

$$u'(c_1)[(\Omega_1 - x)w_1^f] + \beta u'(c_2)[(\Omega_2 - x)w_2^f] + \beta^2 u'(c_3)[\Omega_3 w_3^f L] + \frac{\partial P}{\partial h^f}[\beta^2 u'(c_3) + \beta^3 u'(c_4) + \beta^4 u'(c_5)] \geq 0$$

If payroll contributions (x) are higher than the formal wage gap (Ω), supplying any formal sector work requires that the discounted marginal benefit from the pension P be big enough to compensate for the lost consumption during the working years.

The first-order condition for the proportion of hours worked during the third period (pre-retirement age) is as follows:

2. FOC$_L$:

$$\beta^2[u'(c_3)(h^f w_3^f + w_3^i - h^f w_3^i) - \phi] \geq 0$$

In this equation, ϕ is the disutility of working during period 3. Using Ω to represent the formal premium on wages, we can simplify the expression as:

$$u'(c_3)(\Omega_3 h^f w_3^f + w_3^i) \geq \phi$$

The first order conditions for a_3 and a_4 are as follows:

3. FOC$_{a_3}$:

$$-u'(c_3) + \beta u'(c_4)(1+r) \geq 0$$

or,

$$\frac{u'(c_3)}{u'(c_4)} \geq \beta(1+r)$$

4. FOC$_{a_4}$:

$$-u'(c_4) + \beta u'(c_5)(1+r) \geq 0$$

or,

$$\frac{u'(c_4)}{u'(c_5)} \geq \beta(1+r)$$

A.2 Analytical Solution for Lump Sum Problem

The worker maximizes 2 by choosing the share of hours to work in the formal sector, h^f, the fraction of hours to work in the period before retirement, L, and savings during periods 3 and 4, a_3 and a_4. We can express pension savings, m_2, in terms of previous pension contributions and rewrite the budget constraint for period 3 in terms of the decision variable h^f:

$$c_3 = [h^f w_3^f + (1-h^f)w_3^i]L - a_3 + (1+\rho)^2(m_0 + xh^f w_1^f) + (1+\rho)(xh^f w_2^f)$$

Inserting the budget constraints into the objective function 2, maximizing with respect to a_3, a_4, h^f, and L yields the following first-order conditions:

1. FOC$_{h^f}$:

$$u'(c_1)[(1-x)w_1^f - w_1^i] + \beta u'(c_2)[(1-x)w_2^f - w_2^i] +$$
$$\beta^2 u'(c_3)[(w_3^f - w_3^i)L + (1+\rho)^2 x w_1^f + (1+\rho)x w_2^f] \geq 0$$

Substituting $\Omega_t = \frac{(w_t^f - w_t^i)}{w_t^f}$, we obtain:

$$u'(c_1)(\Omega_1 - x)w_1^f + \beta u'(c_2)(\Omega_2 - x)w_2^f + \beta^2 u'(c_3)(\Omega_3 w_3^f L) +$$
$$\beta^2 u(c_3)[(1+\rho)^2 x w_1^f + (1+\rho)x w_2^f] \geq 0.$$

The first and second terms tell us that the share of formal labor supply (h^f) is impacted by the marginal utility of consumption in the first period multiplied by the net first-period gain from working in the formal sector, which is the difference between the

gain due to the formal wage gap (Ω) and the loss due to the illiquidity of the mandatory pension contribution (x). The third and fourth terms tell us the discounted marginal utility of consumption benefits from the formal sector wage premium and the lump sum pension benefit.

The first order condition for optimal hours to work pre-retirement age is as follows:

2. FOC$_L$:

$$u'(c_3)[w_3^f h^f + w_3^i(1-h^f)] \geq \phi$$

Here, the worker compares the marginal utility of additional consumption during the current period to the marginal disutility of work (ϕ). In contrast, when the pension system pays an annuity (P), the worker also takes into account the impact of current working hours on consumption during retirement via future pension benefits.

Finally, the first order conditions for a_3 and a_4 are the same as in the annuity pension.

3. FOC$_{a_2}$:

$$-u'(c_3) + \beta u'(c_4)(1+r) \geq 0$$

or,

$$\frac{u'(c_3)}{u'(c_4)} \geq \beta(1+r)$$

4. FOC$_{a_4}$:

$$-u'(c_4) + \beta u'(c_5)(1+r) \geq 0$$

or,

$$\frac{u'(c_4)}{u'(c_5)} \geq \beta(1+r)$$

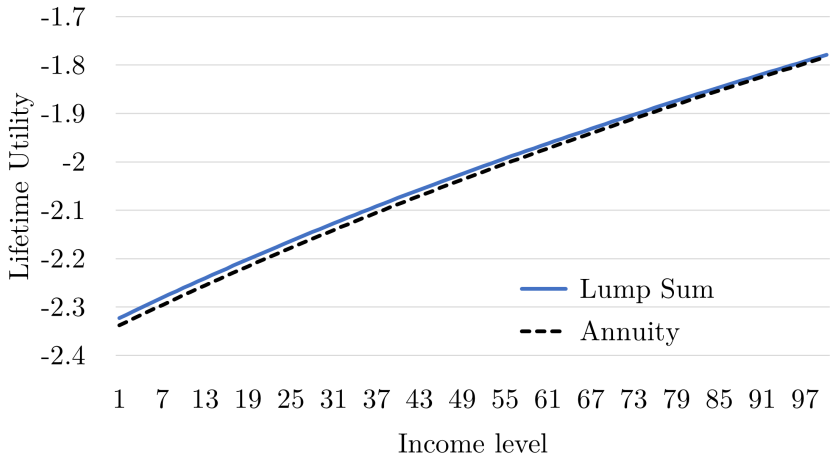
B Model Simulation

B.1 Simulation Parameters

Description	Parameter	Value
Time preference	β	0.5
CRRA Risk aversion	γ	2
Contribution to pension system (as % of earnings)	x	45%
Liquid returns	r	10%
Pension returns	ρ	10%
Wage gap between sectors	Ω	25%
Desutility of work	ϕ	[0.0005 0.0003]
Wages increase by period	$\%\Delta w_t$	10%

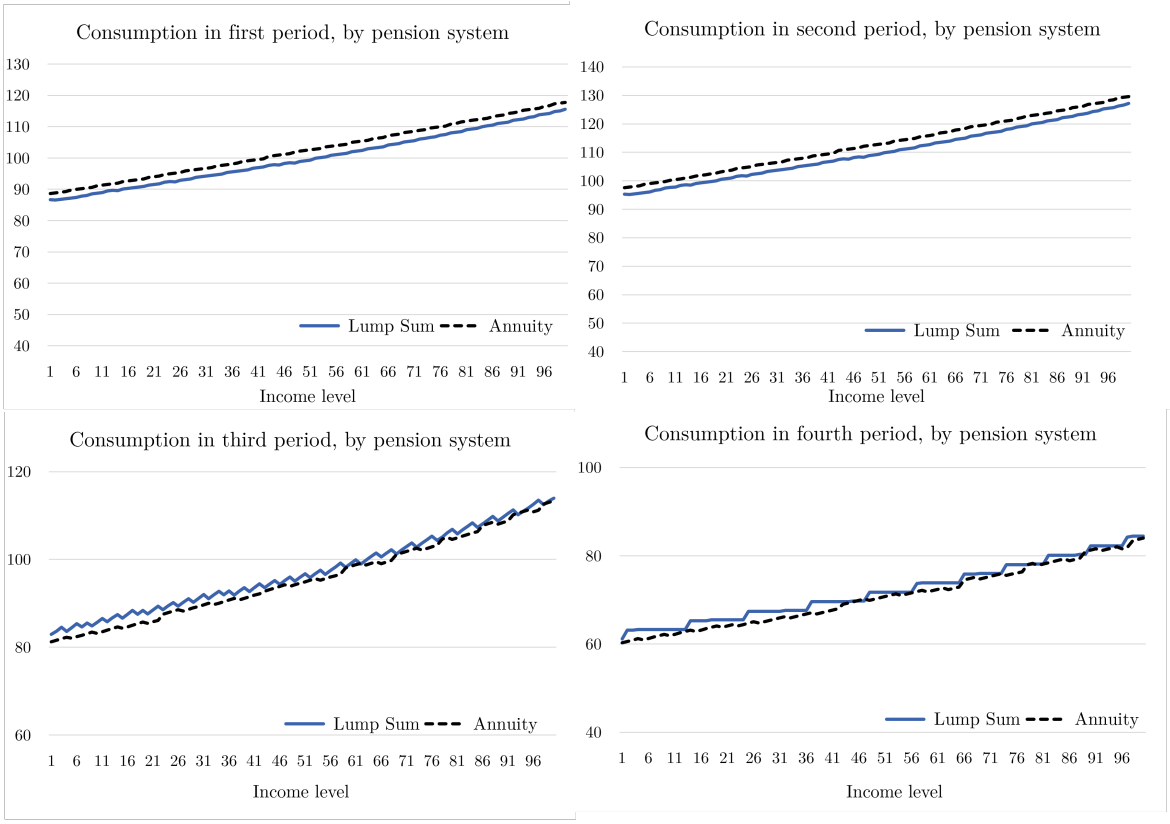
B.2 Lifetime utility results

Figure 14: Lifetime utility across income levels, by pension system



B.3 Consumption results

Figure 15: Consumption across income levels according to pension system



C Empirical Estimates

Tables 3 through 7 in this section show the point estimates and standard errors of θ_j from equation (3) for the full sample, men, women, those with less than a high school education, and those with a high school education or more. These point estimates and standard errors are depicted graphically in Figures 4 through 8 in the main text. Table 8 shows the pre-policy treatment group means, by age, of all the dependent variables. These means are depicted graphically in Figure 3 in the main text.

Table 3: Regression Estimates of θ_j: Full Sample

VARIABLES	Out of Labor Force	Formal Sector	Informal Sector	Unemployed
Private Pension x Age 45 x Post-Policy	-0.0234	0.0263	0.0297	-0.0326*
	(0.0336)	(0.0401)	(0.0416)	(0.0169)
Private Pension x Age 46 x Post-Policy	0.0297	0.0196	0.0416	-0.0910***
	(0.0237)	(0.0382)	(0.0389)	(0.0230)
Private Pension x Age 47 x Post-Policy	0.00969	0.0480	-0.0523	-0.00538
	(0.0228)	(0.0345)	(0.0351)	(0.0165)
Private Pension x Age 48 x Post-Policy	0.0281	0.0218	-0.0614*	0.0115
	(0.0226)	(0.0313)	(0.0334)	(0.0145)
Private Pension x Age 49 x Post-Policy	0.0548***	-0.120***	0.0457	0.0193
	(0.0200)	(0.0310)	(0.0323)	(0.0146)
Private Pension x Age 50 x Post-Policy	0.0398**	-0.00495	-0.0368	0.00198
	(0.0162)	(0.0274)	(0.0275)	(0.0139)
Private Pension x Age 51 x Post-Policy	0.0174	0.0359	-0.0108	-0.0425***
	(0.0149)	(0.0290)	(0.0297)	(0.0126)
Private Pension x Age 52 x Post-Policy	-0.0485***	0.00761	0.0671**	-0.0262*
	(0.0165)	(0.0301)	(0.0311)	(0.0135)
Private Pension x Age 53 x Post-Policy	-0.0229	0.0700**	-0.0539*	0.00678
	(0.0200)	(0.0306)	(0.0314)	(0.0135)
Private Pension x Age 54 x Post-Policy	-0.0431**	0.0758**	-0.0538	0.0212
	(0.0212)	(0.0319)	(0.0330)	(0.0171)
Private Pension x Age 55 x Post-Policy	0.0634***	0.0122	-0.0161	-0.0594***
	(0.0224)	(0.0307)	(0.0329)	(0.0201)
Private Pension x Age 56 x Post-Policy	-0.0119	-0.0411	0.109***	-0.0558***
	(0.0241)	(0.0313)	(0.0337)	(0.0180)
Private Pension x Age 57 x Post-Policy	-0.00539	0.00776	0.0117	-0.0141
	(0.0267)	(0.0320)	(0.0349)	(0.0192)
Private Pension x Age 58 x Post-Policy	0.0367	-0.0566*	-0.0189	0.0388**
	(0.0242)	(0.0328)	(0.0353)	(0.0173)
Private Pension x Age 59 x Post-Policy	-0.0349	0.00197	-0.000708	0.0336**
	(0.0260)	(0.0311)	(0.0349)	(0.0157)
Private Pension x Age 60 x Post-Policy	0.0206	-0.0153	-0.0523	0.0469**
	(0.0234)	(0.0291)	(0.0320)	(0.0184)
Private Pension x Age 61 x Post-Policy	0.0275	-0.0484	0.0137	0.00722
	(0.0257)	(0.0334)	(0.0373)	(0.0195)
Private Pension x Age 62 x Post-Policy	-0.0752***	0.0231	0.0119	0.0402**
	(0.0285)	(0.0363)	(0.0425)	(0.0199)
Private Pension x Age 63 x Post-Policy	0.0435	-0.146***	0.0921**	0.0103
	(0.0332)	(0.0448)	(0.0466)	(0.0185)
Private Pension x Age 64 x Post-Policy	-0.0446	0.0826*	-0.0408	0.00274
	(0.0381)	(0.0499)	(0.0546)	(0.0215)
Private Pension x Age 65 x Post-Policy	0.0853**	-0.0165	-0.0703	0.00161
	(0.0405)	(0.0448)	(0.0503)	(0.0257)
Private Pension x Age 66 x Post-Policy	0.138***	-0.00585	-0.172***	0.0392
	(0.0400)	(0.0424)	(0.0560)	(0.0305)
Private Pension x Age 67 x Post-Policy	0.0874*	-0.0997**	0.179***	-0.166***
	(0.0496)	(0.0488)	(0.0643)	(0.0394)
Private Pension x Age 68 x Post-Policy	-0.0909	-0.0463	0.152**	-0.0152
	(0.0569)	(0.0466)	(0.0664)	(0.0345)
Private Pension x Age 69 x Post-Policy	0.0982	0.0480	-0.0213	-0.125***
	(0.0762)	(0.0648)	(0.0771)	(0.0395)
Observations	53,115	53,115	53,115	53,115
R-squared	0.766	0.838	0.772	0.500

Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4: Regression Estimates of θ_j: Men

VARIABLES	Out of Labor Force	Formal Sector	Informal Sector	Unemployed
Private Pension x Age 45 x Post-Policy	-0.0849**	-0.104**	0.181***	0.00780
	(0.0364)	(0.0483)	(0.0581)	(0.0221)
Private Pension x Age 46 x Post-Policy	-0.0557*	0.0303	0.0902	-0.0648**
	(0.0291)	(0.0512)	(0.0625)	(0.0279)
Private Pension x Age 47 x Post-Policy	0.0417*	-0.0580	0.0195	-0.00321
	(0.0249)	(0.0541)	(0.0553)	(0.0276)
Private Pension x Age 48 x Post-Policy	-0.00612	-0.0631	0.00474	0.0645***
	(0.0217)	(0.0453)	(0.0458)	(0.0211)
Private Pension x Age 49 x Post-Policy	0.00364	-0.129***	0.0844*	0.0411*
	(0.0163)	(0.0451)	(0.0444)	(0.0220)
Private Pension x Age 50 x Post-Policy	-0.0320***	-0.0230	0.0239	0.0311
	(0.0116)	(0.0383)	(0.0361)	(0.0206)
Private Pension x Age 51 x Post-Policy	-0.0121	0.0361	0.00641	-0.0304**
	(0.0160)	(0.0425)	(0.0437)	(0.0154)
Private Pension x Age 52 x Post-Policy	-0.0476**	0.0456	0.0323	-0.0303*
	(0.0192)	(0.0421)	(0.0428)	(0.0179)
Private Pension x Age 53 x Post-Policy	-0.00618	0.121***	-0.124***	0.00929
	(0.0210)	(0.0445)	(0.0435)	(0.0134)
Private Pension x Age 54 x Post-Policy	-0.00145	0.114**	-0.139***	0.0262
	(0.0169)	(0.0469)	(0.0470)	(0.0246)
Private Pension x Age 55 x Post-Policy	0.0436	-0.00397	-0.0229	-0.0167
	(0.0265)	(0.0432)	(0.0473)	(0.0292)
Private Pension x Age 56 x Post-Policy	0.0154	-0.0874*	0.0847*	-0.0127
	(0.0279)	(0.0479)	(0.0458)	(0.0222)
Private Pension x Age 57 x Post-Policy	-0.0229	-0.0999**	0.114***	0.00864
	(0.0271)	(0.0431)	(0.0437)	(0.0247)
Private Pension x Age 58 x Post-Policy	0.0121	-0.0993**	0.0403	0.0468**
	(0.0287)	(0.0443)	(0.0457)	(0.0228)
Private Pension x Age 59 x Post-Policy	-0.0579**	0.0641*	-0.0151	0.00881
	(0.0276)	(0.0382)	(0.0420)	(0.0168)
Private Pension x Age 60 x Post-Policy	0.00816	-0.0168	-0.0390	0.0476**
	(0.0258)	(0.0349)	(0.0376)	(0.0214)
Private Pension x Age 61 x Post-Policy	0.0557*	-0.0441	0.0349	-0.0465**
	(0.0294)	(0.0414)	(0.0468)	(0.0230)
Private Pension x Age 62 x Post-Policy	-0.0583*	0.0558	0.000829	0.00164
	(0.0315)	(0.0452)	(0.0518)	(0.0258)
Private Pension x Age 63 x Post-Policy	0.0589*	-0.132**	0.0714	0.00157
	(0.0352)	(0.0512)	(0.0548)	(0.0243)
Private Pension x Age 64 x Post-Policy	-0.0113	0.0996*	-0.0670	-0.0213
	(0.0429)	(0.0572)	(0.0638)	(0.0262)
Private Pension x Age 65 x Post-Policy	0.00784	0.00353	-0.0676	0.0562**
	(0.0430)	(0.0510)	(0.0572)	(0.0282)
Private Pension x Age 66 x Post-Policy	0.0463	-0.00928	-0.0788	0.0417
	(0.0397)	(0.0494)	(0.0609)	(0.0361)
Private Pension x Age 67 x Post-Policy	0.0455	-0.0925	0.291***	-0.244***
	(0.0541)	(0.0563)	(0.0724)	(0.0444)
Private Pension x Age 68 x Post-Policy	-0.182***	0.0134	0.187**	-0.0190
	(0.0680)	(0.0556)	(0.0792)	(0.0431)
Private Pension x Age 69 x Post-Policy	-0.0321	0.174**	0.0249	-0.167***
	(0.0857)	(0.0695)	(0.0856)	(0.0490)
Observations	34,302	34,302	34,302	34,302
R-squared	0.718	0.825	0.777	0.503

Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5: Regression Estimates of θ_j: Women

VARIABLES	Out of Labor Force	Formal Sector	Informal Sector	Unemployed
Private Pension x Age 45 x Post-Policy	0.0404	0.143**	-0.113*	-0.0707***
	(0.0538)	(0.0621)	(0.0595)	(0.0273)
Private Pension x Age 46 x Post-Policy	0.118***	0.0252	-0.0199	-0.123***
	(0.0369)	(0.0577)	(0.0507)	(0.0371)
Private Pension x Age 47 x Post-Policy	-0.0297	0.158***	-0.125***	-0.00253
	(0.0375)	(0.0428)	(0.0451)	(0.0202)
Private Pension x Age 48 x Post-Policy	0.0528	0.117***	-0.116**	-0.0545***
	(0.0406)	(0.0426)	(0.0484)	(0.0201)
Private Pension x Age 49 x Post-Policy	0.112***	-0.117***	0.0183	-0.0129
	(0.0384)	(0.0409)	(0.0479)	(0.0196)
Private Pension x Age 50 x Post-Policy	0.131***	0.0103	-0.0845**	-0.0571***
	(0.0322)	(0.0381)	(0.0403)	(0.0218)
Private Pension x Age 51 x Post-Policy	0.0662**	0.0112	-0.0228	-0.0546**
	(0.0308)	(0.0393)	(0.0395)	(0.0218)
Private Pension x Age 52 x Post-Policy	-0.0627*	-0.0551	0.134***	-0.0163
	(0.0336)	(0.0407)	(0.0437)	(0.0197)
Private Pension x Age 53 x Post-Policy	-0.0710	-0.00748	0.0847*	-0.00617
	(0.0436)	(0.0385)	(0.0444)	(0.0278)
Private Pension x Age 54 x Post-Policy	-0.0892**	-0.00351	0.0741	0.0186
	(0.0431)	(0.0445)	(0.0454)	(0.0215)
Private Pension x Age 55 x Post-Policy	0.118***	0.0153	-0.00633	-0.127***
	(0.0413)	(0.0416)	(0.0462)	(0.0294)
Private Pension x Age 56 x Post-Policy	-0.000386	-0.0279	0.136**	-0.108***
	(0.0484)	(0.0529)	(0.0618)	(0.0310)
Private Pension x Age 57 x Post-Policy	0.0949*	0.0769	-0.157**	-0.0151
	(0.0569)	(0.0507)	(0.0636)	(0.0243)
Private Pension x Age 58 x Post-Policy	0.0666	-0.0308	-0.0736	0.0378
	(0.0519)	(0.0522)	(0.0571)	(0.0254)
Private Pension x Age 59 x Post-Policy	0.0589	-0.206***	0.0652	0.0819**
	(0.0575)	(0.0553)	(0.0663)	(0.0336)
Private Pension x Age 60 x Post-Policy	0.0311	-0.125**	0.0286	0.0654**
	(0.0512)	(0.0568)	(0.0633)	(0.0322)
Private Pension x Age 61 x Post-Policy	0.0196	-0.0969	-0.0485	0.126***
	(0.0537)	(0.0595)	(0.0677)	(0.0315)
Private Pension x Age 62 x Post-Policy	-0.115*	-0.0550	0.0417	0.128***
	(0.0644)	(0.0622)	(0.0771)	(0.0271)
Private Pension x Age 63 x Post-Policy	0.0190	-0.213**	0.157*	0.0368
	(0.0722)	(0.0932)	(0.0899)	(0.0272)
Private Pension x Age 64 x Post-Policy	-0.0801	0.0233	0.00558	0.0513
	(0.0720)	(0.101)	(0.107)	(0.0324)
Private Pension x Age 65 x Post-Policy	0.458***	-0.0313	-0.195	-0.231**
	(0.118)	(0.100)	(0.122)	(0.0906)
Private Pension x Age 66 x Post-Policy	0.742***	0.0292	-0.713***	-0.0584
	(0.166)	(0.0827)	(0.157)	(0.0634)
Private Pension x Age 67 x Post-Policy	0.551***	-0.159*	-0.407***	0.0157
	(0.142)	(0.0968)	(0.138)	(0.0934)
Private Pension x Age 68 x Post-Policy	0.492***	-0.261***	-0.183	-0.0483
	(0.129)	(0.0744)	(0.130)	(0.0608)
Private Pension x Age 69 x Post-Policy				
Observations	18,792	18,792	18,792	18,792
R-squared	0.796	0.866	0.748	0.513

Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6: Regression Estimates of θ_j: Less than High School

VARIABLES	Out of Labor Force	Formal Sector	Informal Sector	Unemployed
Private Pension x Age 45 x Post-Policy	-0.0120	0.0122	0.0351	-0.0354*
	(0.0564)	(0.0547)	(0.0742)	(0.0193)
Private Pension x Age 46 x Post-Policy	-0.0778	0.106*	0.0701	-0.0980**
	(0.0479)	(0.0567)	(0.0655)	(0.0382)
Private Pension x Age 47 x Post-Policy	0.0611	-0.0388	-0.0391	0.0168
	(0.0468)	(0.0594)	(0.0640)	(0.0329)
Private Pension x Age 48 x Post-Policy	0.0750	-0.0844	-0.0457	0.0552**
	(0.0511)	(0.0569)	(0.0719)	(0.0239)
Private Pension x Age 49 x Post-Policy	0.0801**	-0.214***	0.0735	0.0609**
	(0.0408)	(0.0576)	(0.0662)	(0.0302)
Private Pension x Age 50 x Post-Policy	0.106***	-0.0376	-0.0658	-0.00237
	(0.0356)	(0.0540)	(0.0557)	(0.0262)
Private Pension x Age 51 x Post-Policy	0.0155	0.0664	-0.0280	-0.0539***
	(0.0232)	(0.0435)	(0.0455)	(0.0195)
Private Pension x Age 52 x Post-Policy	-0.0826***	-0.00337	0.121**	-0.0350*
	(0.0260)	(0.0520)	(0.0548)	(0.0188)
Private Pension x Age 53 x Post-Policy	-0.100***	0.179***	-0.108**	0.0289
	(0.0349)	(0.0486)	(0.0533)	(0.0207)
Private Pension x Age 54 x Post-Policy	-0.0551	0.125**	-0.101	0.0307
	(0.0378)	(0.0532)	(0.0620)	(0.0308)
Private Pension x Age 55 x Post-Policy	0.0604*	0.0119	-0.0896	0.0173
	(0.0367)	(0.0500)	(0.0620)	(0.0397)
Private Pension x Age 56 x Post-Policy	0.0415	-0.139***	0.158***	-0.0605*
	(0.0405)	(0.0490)	(0.0563)	(0.0312)
Private Pension x Age 57 x Post-Policy	0.0541	0.0118	-0.0354	-0.0305
	(0.0388)	(0.0470)	(0.0555)	(0.0298)
Private Pension x Age 58 x Post-Policy	0.0792**	-0.0440	-0.0877	0.0525**
	(0.0346)	(0.0473)	(0.0553)	(0.0230)
Private Pension x Age 59 x Post-Policy	-0.0215	-0.0687	0.0641	0.0261
	(0.0357)	(0.0441)	(0.0524)	(0.0218)
Private Pension x Age 60 x Post-Policy	0.0687*	-0.0477	-0.0722	0.0511*
	(0.0363)	(0.0429)	(0.0494)	(0.0287)
Private Pension x Age 61 x Post-Policy	0.0466	-0.0899*	0.0848	-0.0415
	(0.0359)	(0.0463)	(0.0531)	(0.0298)
Private Pension x Age 62 x Post-Policy	-0.102**	-0.0690	0.128**	0.0425
	(0.0415)	(0.0502)	(0.0625)	(0.0307)
Private Pension x Age 63 x Post-Policy	-0.0417	-0.0847	0.142**	-0.0159
	(0.0422)	(0.0587)	(0.0658)	(0.0317)
Private Pension x Age 64 x Post-Policy	-0.0697	0.0321	0.0402	-0.00262
	(0.0516)	(0.0581)	(0.0743)	(0.0334)
Private Pension x Age 65 x Post-Policy	0.0924	-0.0294	-0.0230	-0.0399
	(0.0564)	(0.0533)	(0.0681)	(0.0350)
Private Pension x Age 66 x Post-Policy	0.122**	0.0109	-0.196***	0.0623
	(0.0511)	(0.0552)	(0.0755)	(0.0425)
Private Pension x Age 67 x Post-Policy	0.0838	-0.161***	0.259***	-0.182***
	(0.0677)	(0.0565)	(0.0807)	(0.0511)
Private Pension x Age 68 x Post-Policy	0.0231	-0.0796	0.152*	-0.0951**
	(0.0713)	(0.0556)	(0.0810)	(0.0451)
Private Pension x Age 69 x Post-Policy	-0.0384	0.133	0.107	-0.201***
	(0.108)	(0.0872)	(0.117)	(0.0613)
Observations	25,690	25,690	25,690	25,690
R-squared	0.761	0.837	0.774	0.489

Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: Regression Estimates of θ_j: High School or More

VARIABLES	Out of Labor Force	Formal Sector	Informal Sector	Unemployed
Private Pension x Age 45 x Post-Policy	-0.0618	0.0164	0.0503	-0.00481
	(0.0383)	(0.0568)	(0.0492)	(0.0219)
Private Pension x Age 46 x Post-Policy	0.0649***	0.0132	0.00564	-0.0838***
	(0.0238)	(0.0547)	(0.0497)	(0.0300)
Private Pension x Age 47 x Post-Policy	-0.0278	0.0903**	-0.0534	-0.00908
	(0.0238)	(0.0436)	(0.0429)	(0.0202)
Private Pension x Age 48 x Post-Policy	-0.00758	0.0744*	-0.0626*	-0.00419
	(0.0221)	(0.0384)	(0.0351)	(0.0194)
Private Pension x Age 49 x Post-Policy	0.0550***	-0.111***	0.0505	0.00510
	(0.0184)	(0.0391)	(0.0360)	(0.0170)
Private Pension x Age 50 x Post-Policy	0.00856	-0.00995	-0.0194	0.0208
	(0.0168)	(0.0330)	(0.0313)	(0.0167)
Private Pension x Age 51 x Post-Policy	0.0219	0.00277	0.0122	-0.0369**
	(0.0165)	(0.0379)	(0.0379)	(0.0155)
Private Pension x Age 52 x Post-Policy	-0.00333	0.0365	-0.00533	-0.0279
	(0.0177)	(0.0368)	(0.0355)	(0.0175)
Private Pension x Age 53 x Post-Policy	0.0311	0.00692	-0.0257	-0.0122
	(0.0234)	(0.0428)	(0.0398)	(0.0183)
Private Pension x Age 54 x Post-Policy	-0.0421*	0.0469	-0.00836	0.00355
	(0.0236)	(0.0398)	(0.0369)	(0.0172)
Private Pension x Age 55 x Post-Policy	0.0305	0.0589	0.00541	-0.0948***
	(0.0296)	(0.0401)	(0.0356)	(0.0194)
Private Pension x Age 56 x Post-Policy	-0.0391	-0.00392	0.0782**	-0.0352*
	(0.0321)	(0.0408)	(0.0387)	(0.0204)
Private Pension x Age 57 x Post-Policy	-0.0489	-0.0307	0.0488	0.0308
	(0.0402)	(0.0457)	(0.0457)	(0.0279)
Private Pension x Age 58 x Post-Policy	-0.0115	-0.0418	0.0308	0.0224
	(0.0370)	(0.0481)	(0.0459)	(0.0266)
Private Pension x Age 59 x Post-Policy	-0.0679*	0.103**	-0.0944*	0.0595**
	(0.0410)	(0.0489)	(0.0498)	(0.0249)
Private Pension x Age 60 x Post-Policy	-0.0251	0.0206	-0.0524	0.0569**
	(0.0327)	(0.0415)	(0.0439)	(0.0262)
Private Pension x Age 61 x Post-Policy	-0.0119	0.0389	-0.0924*	0.0655**
	(0.0420)	(0.0495)	(0.0556)	(0.0263)
Private Pension x Age 62 x Post-Policy	-0.00332	0.152***	-0.177***	0.0283
	(0.0405)	(0.0563)	(0.0604)	(0.0272)
Private Pension x Age 63 x Post-Policy	0.158***	-0.195***	0.000134	0.0367**
	(0.0598)	(0.0725)	(0.0713)	(0.0186)
Private Pension x Age 64 x Post-Policy	0.107*	0.0490	-0.155	-0.00164
	(0.0558)	(0.107)	(0.0944)	(0.0301)
Private Pension x Age 65 x Post-Policy	0.0894	0.0665	-0.240***	0.0841**
	(0.0643)	(0.0906)	(0.0812)	(0.0401)
Private Pension x Age 66 x Post-Policy	0.0365	0.0172	-0.105	0.0515
	(0.0654)	(0.0835)	(0.0944)	(0.0463)
Private Pension x Age 67 x Post-Policy	0.0874	0.0735	0.00231	-0.163**
	(0.0684)	(0.0940)	(0.118)	(0.0801)
Private Pension x Age 68 x Post-Policy	-0.251**	0.109	0.0589	0.0827
	(0.0995)	(0.110)	(0.129)	(0.0611)
Private Pension x Age 69 x Post-Policy	0.217	0.00988	-0.231	0.00333
	(0.169)	(0.159)	(0.147)	(0.0571)
Observations	24,771	24,771	24,771	24,771
R-squared	0.776	0.809	0.726	0.547

Coefficients indicate the post-policy increase in the dependent variable at each age for individuals covered by the private pension system compared to individuals covered by the PAYG pension system. Standard errors clustered by individual. Regressions include all variables shown in equation 3.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 8: Pre-Policy Mean Values of Dependent Variable: Individuals Covered by Private Pension

Age	Out of Labor Force	Formal Sector	Informal Sector	Unemployed
45	2.9%	66.7%	28.1%	2.3%
46	2.2%	69.3%	24.9%	3.5%
47	3.4%	65.8%	29.3%	1.4%
48	4.7%	67.7%	25.0%	2.7%
49	3.2%	69.9%	24.9%	2.0%
50	4.8%	63.1%	28.0%	4.1%
51	3.5%	59.0%	33.9%	3.5%
52	3.4%	65.8%	28.9%	1.9%
53	4.1%	62.1%	31.5%	2.3%
54	3.0%	62.4%	32.3%	2.3%
55	5.3%	66.4%	23.5%	4.9%
56	7.1%	63.1%	26.3%	3.5%
57	4.5%	69.1%	23.1%	3.3%
58	6.5%	62.3%	30.4%	0.8%
59	9.4%	58.8%	31.5%	0.2%
60	5.8%	52.8%	40.5%	1.0%
61	7.0%	54.6%	33.4%	5.0%
62	10.4%	53.0%	33.1%	3.6%
63	12.0%	58.3%	29.3%	0.4%
64	17.6%	44.7%	34.2%	3.5%
65	14.0%	52.5%	30.7%	2.8%
66	12.8%	45.6%	41.6%	0.0%
67	16.8%	34.7%	33.7%	14.7%
68	42.0%	25.0%	31.8%	1.1%
69	34.9%	27.0%	38.1%	0.0%

Authors' calculations based on household data from ENAHO. See text for details.