Regulation by Public Options: Evidence from Pension Funds*

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September 8, 2026

Abstract

We study the equilibrium welfare effects of using state-owned enterprises (SOEs) to discipline market power. We estimate a dynamic equilibrium model of Uruguay's individual capitalization pension system, where a high-quality SOE competes with private firms in the presence of worker inertia. We find that a SOE lowers equilibrium fees and increases investment returns. Replacing it with a private firm would more than double its fee and raise private firms' fees by 8 percent. Reducing inertia mitigates but does not offset privatization. Comparing policy instruments, we show that direct price regulation yields higher welfare gains than competition through an SOE.

JEL Classification: L51, N2, H4, L21

Key words: competition, state-owned firms, pension funds, regulation

*We thank Dante Amengual, Ines Berniell, Greg Buchak, Rob Clark, Jan De Loecker, Juan Dubra, Gautam Gowrisankaran, Michael Grubb, Diego Jiménez Hernández, Charlie Murry, Nicola Pavanini, Richard Sweeney, Theodore Papageorgiou, Jo Van Biesebroeck, and Frank Verboven for their valuable comments and suggestions, and Nicolas Malfetano for excellent research assistance. This research was funded by the María Viñas Fund of the National Agency for Research and Innovation of Uruguay (ANII) FMV 3 2024 1 180876.

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1 Introduction

Governments sometimes rely on State-Owned Enterprises (SOEs) to enhance competition and regulate markets. In the market for Pension Fund Administrators (PFAs), where firms charge workers a management fee in exchange for investing their contributions, weak competition has led to high fees and reduced workers' net savings (OECD, 2018). As several countries use this institutional design[1], concerns over low retirement benefits have sparked policy debates on whether alternative policies can mitigate market power and improve workers' outcomes. This paper examines the welfare effects of using a public option —a SOE that competes with private firms in a market— as a regulatory or competition-enhancing instrument in the market for PFAs.

The argument in favor of introducing public options[2] is that, because they are not pure profit-maximizers, they can compete more aggressively with private firms by charging lower fees, thereby increasing workers' savings. However, while the participation of public options can contribute to solving market failures, the existing literature shows how the equilibrium welfare effects of this policy are *a-priori* uncertain (Kang, 2022). Market segmentation, price-increasing competition, and inefficient provision (Hastings et al. (2017), Chen and Riordan (2008), Duggan and Scott Morton (2006)) can negatively affect the welfare of market participants instead of increasing it (Jiménez-Hernández and Seira (2021), Atal et al. (2024), Fonseca and Matray (2022)). Whether the public option outperforms alternative policies in raising workers' savings or not is an empirical question.

In this paper, we study the welfare consequences of the participation of a state-owned enterprise (SOE) in the Uruguayan market for Pension Fund Administrators (PFAs), where three private firms and a public option compete. Using rich administrative data, we estimate consumer preferences and firms' marginal costs for the market in which forward-looking PFAs compete to enroll workers and manage their savings. In Uruguay, PFAs charge a single management fee to administer and invest workers' social security contributions until retirement, as part of the defined-contribution retirement subsystem[3]. We

[1] In Latin America, these systems were introduced decades ago, and most of them are still in place: Chile (1980), Peru (1993), Colombia (1994), Uruguay (1996), Bolivia (1997), Mexico (1997), El Salvador (1998), Costa Rica (2001), Dominican Republic (2003), Nicaragua (2004), Ecuador (2004).

[2] Except where specifically noted, we will use the terms state-owned enterprises and public options interchangeably throughout the paper.

[3] PFAs participate in the defined-contribution subsystem while workers are active in the labor market. Once

analyze three distinct equilibria, driven by two policy shifts: a change in the SOE's shareholder preferences in 2005 and the introduction of a cap on management fees in 2020. We use the estimated model to conduct counterfactual policy evaluations.

We develop and estimate a dynamic model of demand and supply in the market for pension fund administrators. On the demand side, we specify a two-stage decision model that captures the inertia and other frictions typically observed in workers' enrollment choices. In the first stage, individuals choose a pension fund administrator using a discrete choice framework in the tradition of Berry (1994); Berry et al. (1995). The parameters in our model represent the combined individual preferences with the influence of firms' sales forces[4]. At enrollment, workers behave as long-horizon decision makers: they choose the firm that maximizes the discounted net present value of expected retirement income, taking observed fees and average returns as constant until retirement (Luco, 2019). In subsequent periods, already-enrolled workers may receive an awareness shock (Ho et al., 2017) that temporarily increases attention to alternatives. When the shock is sufficiently large, individuals re-optimize and switch to their preferred available option; otherwise, they remain with their incumbent administrator.

On the supply side, we use a dynamic model of forward-looking firms that compete for enrollees by setting fees and mean portfolio returns, with no possibility of fee or return discrimination between new and existing cohorts. Private firms maximize the discounted net present value of economic profits, while the public option considers both profits and workers' savings in its objective function. Since workers already enrolled exhibit inertia and in each period new cohorts are small relative to the existing stock of enrollees, firms face an investing-harvesting trade-off (Beggs and Klemperer, 1992). Furthermore, given the observed stability in management fees and return differentials in the periods we study, we assume that equilibrium outcomes are consistent with a stationary, "no-sales" Nash-Bertrand equilibrium (Farrell and Klemperer, 2007).

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they retire, insurance companies pay retirement benefits in the form of annuities, based on the retiree's age and accumulated savings. The defined-contribution subsystem is part of the broader retirement system, which also includes a defined-benefit (pay-as-you-go) subsystem.

[4]This assumption is closely related to the approach adopted in the pharmaceutical literature that estimates discrete choice models of demand at the prescription level. In this literature, the estimated utility parameters are interpreted as reflecting a combination of patients' preferences and physicians' prescribing decisions, recognizing that physicians act as agents who internalize clinical considerations, patient benefits, and institutional constraints. As a result, demand parameters do not represent purely patient tastes, but rather a composite object shaped by both patients and physicians. See, among others, Crawford and Shum (2005), Duggan and Scott Morton (2010), and Ching and Ishihara (2012).

We use detailed administrative data provided by the Uruguayan social security administration, *Banco de Previsión Social*. The data consists of a panel of a representative sample of workers who made enrollment decisions between 1996 and 2020. We observe monthly data on gross wages, basic employer characteristics, spells in and out of the formal labor market, PFA enrollment decisions, and the enrollment mechanism, along with basic demographics (sex and date of birth). We complement these data with publicly available market-level information on market shares, management fees, investment returns, switchers, sales force agents, and PFAs' financial statements.

For the estimation of the first stage of the demand model, we estimate a conditional logit model that allows worker heterogeneity in fee and return sensitivities based on wage quartiles and whether they have access to an outside option[5]. To estimate preferences, we exploit the fact that fees and returns are common for all enrollees within a firm, while management costs and the potential accumulated savings from an enrollment decision vary across individuals, due to differences in gross wages (Hastings et al., 2017). Our estimates show that higher-wage workers are more sensitive to management fees than to returns, and that, on average, make enrollment decisions that deliver higher savings relative to those of low-wage workers. These findings are consistent with evidence that financial literacy is positively correlated with income (Lusardi, 2008). For the second stage, we use market-level data to estimate a probit model for the first stage of the decision model, where the probability of being aware and switch depends on the gap between the fees and returns of private firms and those of the SOE[6].

We use estimated preferences and the assumption that firms set fees and mean returns to maximize the discounted net present value of their objective function to recover marginal enrollment costs and investment costs. In contrast to the previous literature that studied this market assuming zero marginal costs (Hastings et al., 2017; Luco, 2019; Illanes, 2016), we estimate positive enrollment marginal costs, aligned with the variable payment per enrollee that sales force agents receive from PFAs in practice. Additionally, we leverage the existence of a minimum rate of return regulation and use estimated preferences and the risk of capitalization that firms face to estimate the variable cost of obtaining investment returns for their enrollees. Finally, to recover the non-profit motives of the public

[5]This depends on their wage level.

[6]This is consistent with what we observe in the data. We modify this assumption in our counterfactual simulations.

option, we assume its enrollment marginal cost is in line with that of private firms, since marginal cost and the conduct parameter cannot be separately identified in this case.

We conduct counterfactual policy evaluations to quantify the equilibrium welfare effects of the public option and assess the role of alternative regulatory instruments. Given the presence of choice frictions, we compute welfare as the expected value of savings at retirement age. We consider two main counterfactuals. First, we simulate the privatization of the SOE by converting it into a private firm with standard profit motives and similar cost structures. We analyze this counterfactual under different market structures (e.g. reassigning market shares) to evaluate the effects of a non-naïve privatization. We also explore how the effects of privatization change when it is complemented with a demand-side policy that reduces workers' inertia. Second, we examine the effects of strengthening the SOE's non-profit motives and compare the results with the effects of introducing a cap on management fees—a regulatory tool implemented in Uruguay in 2020 and commonly used in other pension systems.

The privatization counterfactual shows that the SOE contributes to reducing market fees and increasing workers' savings. Eliminating it would result in a 44% increase in average fees and a 3% decrease in mean returns, leading to a 6.7% decline in expected retirement savings for a representative worker. These effects are more pronounced for former SOE enrollees, who experience a 150% increase in fees and a drop of over 11.1% in savings. The complementary demand-side policy we simulate is one in which workers become more responsive to fee differences. Although increased sensitivity improves overall savings and reduces fees, the degree of responsiveness required to fully offset the effects of privatization is unrealistically high. Moreover, this combination still creates winners and losers, with former SOE enrollees being worse off.

In the second counterfactual, we explore the consequences of increasing the non-profit motives of the SOE and study the distributive profile of the policy relative to a cap on management fees. We find that raising non-profit motives increases market segmentation, leaving low-wage workers enrolled in private firms worse off due to higher equilibrium fees caused by the incentive to harvest on lower elasticity stayers. When compared with the cap on management fees introduced in 2020, the cap outperforms the non-profit motives in terms of aggregate savings and equity: it increases savings for all workers, especially the lowest earners, and narrows the savings gap between the ratio of SOE and

private firm enrollees from 91.3% to 98%.

In summary, an oligopoly with a public option competing alongside three private firms delivers welfare gains by lowering fees and raising returns relative to an oligopoly with four private firms, particularly for the SOE's own enrollees. Demand-side policies can enhance competition but are unlikely to fully compensate for the privatization of the SOE. Furthermore, strengthening the SOE's non-profit motives can raise savings for its own enrollees, but also exacerbate market segmentation and inequality. By contrast, a cap on management fees improves savings across the board—especially for low-income workers—and promotes convergence in outcomes between private and public enrollees.

In this paper, we contribute to two strands of the literature. First, we contribute to the empirical literature that analyzes the welfare effects of state-owned enterprises (Fonseca and Matray, 2022; Jiménez-Hernández and Seira, 2021; Atal et al., 2024; Handbury and Moshary, 2021; Curto et al., 2019; Busso and Galiani, 2019; Cunha et al., 2019). In this context, we contribute by evaluating the equilibrium effects of a public option on welfare in a market with forward-looking, single-product firms that possess market power, in an environment where workers place a high valuation on the SOE. We show that the presence of the SOE benefits not only workers enrolled in it but also those enrolled in private PFAs, due to increased competition, lower fees, and higher savings, relative to a privatization scenario in which four private firms compete. However, using its non-profit motives more aggressively also raises market segmentation and can leave low-wage workers enrolled in private firms worse off.

Second, we contribute to the literature that studies the regulation of the market of pension fund administrators in individual capitalization retirement systems (Hastings and Tejeda-Ashton (2008), Hastings et al. (2017), Illanes (2016), Luco (2019)). In this case, different from previous papers, we observe a public option in action, instead of estimating its effects as a counterfactual (Hastings et al. (2017). Moreover, the changes in the regulatory environment and in shareholders' preferences allow us to understand how the welfare effects of the public option change when the institutional configuration also changes. Furthermore, we leverage the financial regulation to endogenize the returns that firms obtain when investing workers' savings. This makes our analysis more comprehensive than previous studies on the topic by dealing with the two main outcomes that matter for workers' retirement benefits: fees and returns.

2 Institutional Environment

2.1 Overview of the Retirement System

In 1996, Uruguay reformed its retirement system by introducing a defined-contribution subsystem based on individual capitalization to complement the existing defined-benefit (pay-as-you-go) system. While the latter is administered by the social security administration, *Banco de Previsión Social* (BPS), and is mandatory for all workers[7], the former is mandatory only for high-wage workers. However, in practice, most active workers participate in the defined-contribution subsystem and have an individual account in a PFA. This subsystem is partitioned into two. Before retirement, workers' contributions to individual savings accounts are managed and invested by PFAs, financial institutions regulated by the Central Bank (BCU). After retirement, an insurance company pays an annuity based on the worker's age at retirement and accumulated savings[8].

2.2 Worker Enrollment and Contributions

Enrollment in a pension fund administrator is optional for workers earning less than USD 1,535 a month[9] and mandatory for those earning more. If they are not already enrolled when they first cross this threshold, they have two months to choose a PFA. If they do not, the social security administration assigns one by default[10]. Enrollment outside this mechanism requires contact with sales force agents employed by PFAs.

Workers contribute a fixed 15% of their gross wages to social security (with no contributions required on earnings above USD 4,605)[11]. The distribution of these contributions between the defined-benefit subsystem administered by the Social Security Administration (SSA-DB) and the defined-contribution subsystem administered by pension fund admin-

[7] With the exception of small groups covered by special retirement subsystems.

[8] Pension fund administrators do not participate in this segment.

[9] Expressed in real US Dollars of April 2021. Thresholds are adjusted yearly according to a Nominal Average Wage Index.

[10] Until 2014, the assignment was made by lottery in proportion to firms' market share. Since then, accounts are assigned to the two firms with the lowest management fees, unless the gap between them exceeds 20%. In that case, default affiliations are made only to the firm with the lowest fee. In practice, this enrollment mechanism accounts for 10–12% of new enrollments each year, and since 2014 the SOE has been the sole beneficiary.

[11] Employers' contributions (also a share of workers' gross wages) go exclusively to the defined-benefit subsystem.

istrators (PFA-DC) depends on a worker's gross monthly wage and whether they choose to apply Article 8 of Law 16.713. For enrollees earning less than USD 1,535, if they do not opt for Article 8, 100% of their contribution goes to the defined-benefit subsystem[12]. If they do opt for Article 8, the contribution is split equally between SSA-DB and PFA-DC for income up to this threshold.

If a worker earns more than USD 1,535, their contribution is automatically split between SSA-DB and PFA-DC, regardless of whether they choose to apply Article 8. However, the specific distribution across subsystems depends on this choice. With Article 8, contributions from USD 1,535 to USD 2,303 go to SSA-DB, and those from USD 2,303 to USD 4,605 go to PFA-DC. Without it, 100% of contributions above USD 1,535 are allocated to the defined-contribution subsystem. In practice, only 0.4% of eligible workers have not opted into Article 8.

PFAs receive workers' monthly gross contributions, from which they pay a disability and survivor insurance premium on behalf of the worker[13] and deduct a management fee. The remaining amount is credited to the worker's individual account in the PFA and invested by this institution in legally authorized assets.

2.3 PFAs' Market Structure and Regulation

There are four active firms in the market for pension fund administrators: three private firms and one public option. The SOE operates under the same rules as private firms, but its shareholders are other state-owned public institutions. It has been active since the inception of the system in 1996, with ownership divided among BROU (a state-owned commercial bank, 51%), BPS (37%), and BSE (a state-owned insurance company, 12%)[14]. The private segment of the market originally included five firms, but reached its current structure after four firms merged into two in 2001.

Firms charge management fees for their services. Until 2008, they were allowed to charge both a fixed fee (a flat monetary amount) and a variable fee (a percentage of the gross contribution). Since then, only a single variable fee is permitted. PFAs are not allowed

[12] See the right bar of Figure A.1.

[13] Also as a share of the gross wage. The premium is set by a monopolist state-owned insurance company as a share of workers' gross contributions. The differences between premiums across PFAs are negligible.

[14] BROU: Banco de la República Oriental del Uruguay and BSE: Banco de Seguros del Estado.

to price discriminate, so all enrollees are charged the same fee. In 2018, Parliament introduced a cap on fees, setting it at 1.5 times the lowest fee in the market. This cap was fully implemented in 2020, following a two-year transition period.

Firms invest workers' savings in legally authorized assets and manage investment portfolios based on the age of each enrollee. Unlike in other individual capitalization systems, workers in Uruguay cannot choose how their savings are allocated across funds. Until 2014, each PFA operated a single investment fund. A second fund was introduced that year, and since then, the allocation between the two has been determined entirely by the enrollee's age.

Firms are required to provide a minimum level of investment return to their enrollees. By law, PFAs must cover any shortfall using their own capital when their rate of return falls below a specified threshold. This threshold, which varies with the overall level of returns, is defined as the lower of: 1) 2%, or 2) the system's average return minus 200 basis points (bp). The average is calculated by weighting each firm's return by the value of the assets under management.

Finally, workers may switch between PFAs, provided they have made at least six months of contributions at the one they wish to leave. Unlike initial enrollment, switching cannot be done through a sales force agent; instead, it requires an in-person procedure at the PFA's office. Although this requirement has been simplified in recent years, switching rates remain relatively low compared to other Latin American countries with capitalization systems.

3 Data and Descriptive Statistics

3.1 Data Sources

We combine several data sources on workers' characteristics and choices in the pension system, along with PFAs' financial statements and data on fees, sales force agents, and portfolio rates of return. First, we use a novel database of administrative records collected by BPS for a representative random sample of workers, covering the period from the market's inception in 1996 through 2020. The dataset is a monthly panel of worker records containing information on wages, employer characteristics, demographics (date of birth,

sex), and PFA enrollment decisions (enrollment mechanism and date, selected PFA, and an indicator for whether the worker ever switched). We complement this data with publicly available market-level data published by the Central Bank on market shares, fees, investment returns, contributions, switchers, and sales force agents for the 1996–2022 period. Finally, we use firms' financial statements for 2001–2020, which are also publicly available on the regulator's website.

3.2 Summary Statistics and Enrollment Patterns

We begin by summarizing the characteristics of the worker sample and enrollment behavior over time. In Table 1 we show the descriptive statistics of the random sample of workers. The median entry age to the formal labor market is 23.2 years, and the median age at enrollment is 24.9 years. Also, conditional on enrollment and excluding mandatory enrollees, 75% of workers enroll within the first two years of entering the labor market[15].

Table 1: WORKERS' SAMPLE SUMMARY STATISTICS

Individuals	125,453
Gender (female)	0.48
Age when entering the market (median)	23.2
Age when enrolling (median)	24.9
Gross wage (median, USD)	834
Share with enrollment gross wage above threshold (USD 1,535)	0.15
Outside option (conditional on gross wage below USD 1,535)	0.26

Notes. The Table reports descriptive statistics for selected demographics for the available sample. Average 1996-2020. UYU expressed in US$ 2017.

The median gross wage was USD 834, and 15% of workers earned gross wages above the first contribution threshold when entering the labor market. Among individuals whose wage eventually exceeded the mandatory enrollment threshold, 24% enrolled by default. Finally, among those who were not required to enroll (i.e., with gross wages below the first threshold), 74% voluntarily chose to save in an individual account within the capitalization sub-system. Beyond individual-level characteristics, several market-level patterns provide insight into the structure and dynamics of competition among PFAs.

[15]See Figure A.3 in the Appendix

3.3 Market Dynamics and Stylized Facts

We now turn to market-level dynamics, highlighting key patterns that inform the structure of our empirical model. Individual capitalization retirement systems evolve in two phases: an initial stage with mostly unenrolled workers and intense competition for new enrollees[16], and a later stage with a large stock of existing enrollees and a smaller inflow. This paper focuses on the latter phase, beginning in 2002 when new enrollees dropped below 10% of the total.

In Table 2, we present descriptive statistics at the market level for the average year in the period we study. The average number of enrolled workers is 1,146,540, while the average cohort of new enrollees entering the formal labor market is 63,317, representing 5.5% of the stock. Additionally, the average number of switchers per year is low. Notably, the switching rate (0.31%) is even lower than those observed in similar regimes in other Latin American countries[17]. Low switching rates in this market have been documented and analyzed in previous studies (Luco (2019), Illanes (2016)). Furthermore, conditional on switching, most enrollees leave private firms and switch to the public option (95%). Workers leaving the public option or switching from one private firm to another are almost nonexistent.

Table 2: MARKET SUMMARY STATISTICS

	Average Year	% Enrollees
Enrollees	1,146,540	
New enrollees	63,317	5.52%
Switchers	3,497	0.31%
Switchers towards SOE (95%)	3,322	
Switchers towards PF (5%)	175	

Notes. Average during period of analysis. Net switchers on average per year.

During the period analyzed in the paper, we identify three distinct market equilibria. These arose from structural changes, including a shift in the preferences of the public option's shareholders following the 2005 change in government, and the introduction of

[16] A model for firms' competition in this period is proposed in Hastings et al. (2017).

[17] See https://www.aiosfp.org/ for detailed information on the percentage of switchers over affiliates by country.

a cap on market fees[18]. The shift in shareholder preferences led to lower fees, with clear effects on accounting profits. While we acknowledge that economic profits are the relevant concept for firm behavior and guide the analysis in the following sections, we highlight accounting profits due to their marked variation over time, which helps distinguish the three stationary equilibria we characterize in our supply and demand model.

- **Equilibrium 2002-2005: Relatively high SOE fee, no cap on management fees.** During this period, the public option charged slightly lower fees than private firms but achieved similar accounting profits, as measured by Return on Equity (ROE).

- **Transition 2006-2013: SOE reduces its fee, no cap on management fees.** In 2006, the SOE began reducing its fee —a shift in behavior that we argue reflects a change in the preferences of its shareholders, as documented in transcripts from public shareholder meetings. The policy aimed to benefit workers by allowing fee reductions as long as the ROE of the SOE remained above a minimum threshold set by the majority shareholder.[19].

- **Equilibrium 2014-2017: Low SOE fee, no cap on management fees.** The SOE continued to operate under the same shareholder mandate, but ROE became a binding constraint on further fee reductions. Compared to the first equilibrium, the fee of the SOE was cut by half, while private PFAs reduced theirs only slightly. As a result, during this period, the ROE of private PFAs increased, while that of the public option declined from 40% to 12%. This provides preliminary descriptive evidence of a shift in the SOE behavior. However, in our model, we do not impose this behavioral change ex ante; rather, we recover it from the data.

- **Transition 2018-2019: Low SOE fee, progressive implementation of a cap on management fees.** Between 2018 and 2019, the regulator implemented a transition phase that allowed firms to adjust from pre-regulation fee levels to the new legal maximum. Once fully implemented, the cap limited fees to no more than 50% above the lowest fee in the market. The discussion surrounding the potential introduction of

[18]These equilibria are depicted in gray in Figure 3.

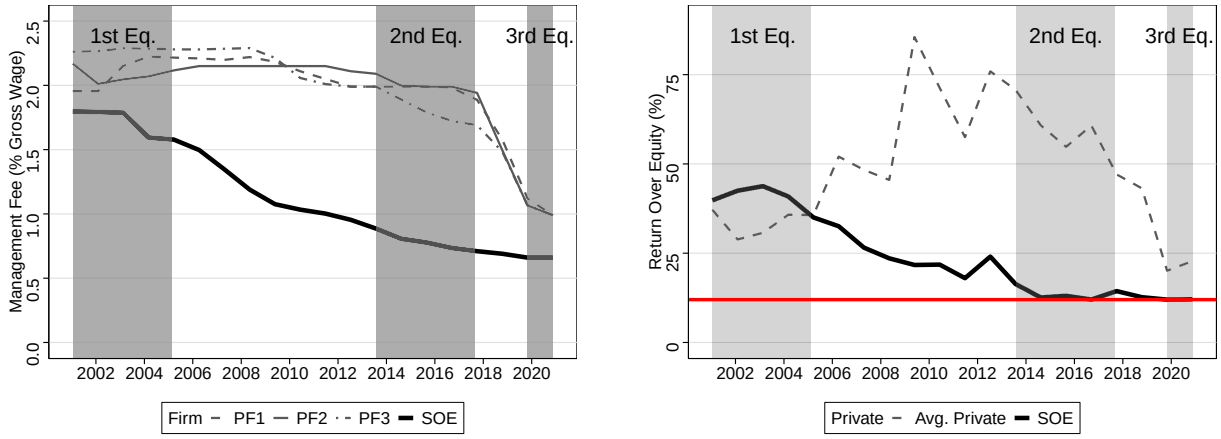
[19]Shareholders' meeting for fiscal year 2017: *"(...) distributable profits stood at a ROE of 14.4%, exceeding the minimum requirement of 12% established by the majority shareholder." (...) "it is requested to continue with the fee reduction policy (...)"*

this cap began in December 2017, so it does not affect our analysis of the earlier period. The reduction in PFA fees observed during this phase is attributed to the new regulation. Since 2019, private PFAs have charged fees equal to the legal maximum.

- **Equilibrium 2020: Low SOE fee, fully implemented cap on management fees.** The cap on management fees led to a new equilibrium in which private PFAs' fees fell by half compared to the 2014–2017 average, and their ROE declined from approximately 60% to 20%.

Figure 1: Management Fee and Firms' Accounting Profits

(a) Management Fee (% Gross Wage) (b) Accounting Profits (ROE, %)



Note. Management fee as a share of the gross wage component relevant for social security contributions to the defined-contribution subsystem. The Return Over Equity is the ratio between distributed profits in t and equity in $t-1$. The red line represents the minimum acceptable ROE imposed by the main shareholder on the SOE. Shaded areas indicate the 3 equilibrium periods: 2002-2004, 2014-2017, and 2020.

Within each equilibrium period, the fees of private PFAs remain relatively stable and show little difference between them. Additionally, Figure A.2 shows that the share of old workers evolves without significant variation over time. The public option is the market leader, with nearly 40% of total enrollees. There is also heterogeneity in market shares across the wage distribution, with the SOE capturing a larger share among higher-wage workers[20]. In fact, the public option is not the leading firm among low-wage workers.

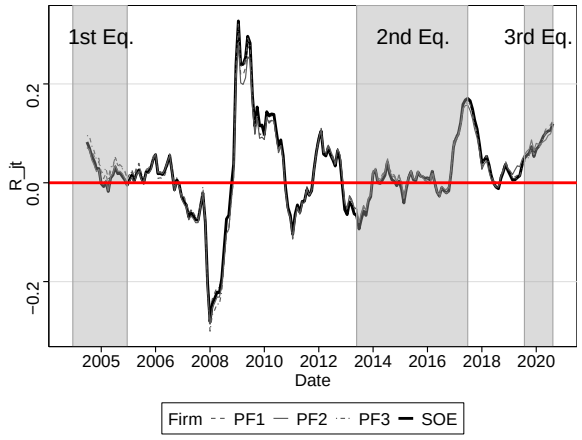
To complete the description of firms' characteristics, Figure 3 shows the evolution and distribution of the real annual rate of return that firms generate for enrollees by investing

[20]See shares by income bracket in Table A.1 in the Appendix.

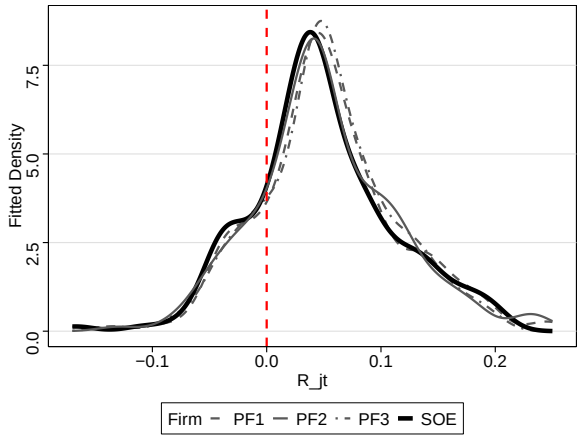
their savings. Two main patterns emerge. First, returns are highly correlated over time[21]. Based on informal discussions with PFA managers and regulators, this correlation reflects both regulatory constraints —such as limits on the types and proportions of financial assets PFAs may hold— and behavioral responses. On the behavioral side, firms face a minimum rate of return regulation intended to protect workers from under-performance. In practice, firms respond by closely replicating each other's portfolios, resulting in similar returns.

Figure 3: Investment Real Returns (1 Yr)

(a) Investment Returns (Monthly Series)



(b) Investment Returns (Fitted Density)



Note. Real returns calculated as nominal returns deflated by the Consumer Price Index. Real gross wages grew 2.7% on average during the same period.

Second, some private firms are slightly more successful at generating higher returns. While short-term rankings fluctuate, certain private PFAs have consistently delivered superior performance[22]. Leveraging this fact, we use the minimum rate of return regulation to estimate firms' variable costs of "producing" those returns. Finally, regarding the sales force, the public option has the larger number of agents, with approximately 35%, a share that is stable between the three periods[23].

[21] The lowest correlation coefficient in 1 Yr. real returns between any two firms during this period was 0.98.
[22] Importantly, whether these performance differences are sufficient to offset fee disparities is a question we examine in Section A.2.5.
[23] In Table A.2 of Appendix A.2 we show the average share by firm in each period

4 Model

The model characterizes the competition between forward-looking firms in the oligopolistic market for Pension Fund Administrators to enroll workers and invest their social security contributions. Given the observed inertia in workers' initial enrollment decisions, we develop a model based on the literature on dynamic competition with switching costs (Beggs and Klemperer, 1992), where firms face an invest-harvest trade-off due to the presence of both new and existing consumers each period.

4.1 Workers

Workers' enrollment decisions d_{ijt} are the result of a two-stage decision process that repeats every period t and characterizes the choices of consumers with inertia and inattention, in the spirit of Ho et al. (2017). In the first stage, workers make the decision of which firm to choose, assuming that they will always stay enrolled with the same firm. The preferences in this first stage are a combination of consumer preferences and the persuasion by the sales force. In the second stage, consumers may receive an awareness shock that "wakes them up" and makes them go through the problem of deciding where to enroll. In this second stage, conditional on being aware, workers move to their best option.

4.1.1 Enrollment Decision

For enrollment decisions we use a demand system in the tradition of Berry (1994), Berry et al. (1995). Workers make discrete choices between the $\mathcal{J}$ firms available at time t, and when available[24], a non-enrollment outside option -indexed by 0-. Worker i chooses the firm j that maximizes her indirect utility u_{ijt}, represented by an index function that depends on the management cost C_{ijt}, the potential stock of savings S_{ijt}, the number of sales force agents sf_{jt}, firm η_j and time-variant market characteristics ζ_t , and unobserved

[24]For workers with a gross monthly wage above USD 1,535 enrollment in a PFA is mandatory. For workers below that threshold, it is not, but more than 75% of workers enroll in one during the first two years of entering the labor market. Furthermore, enrollment is a terminal state. Once enrolled, a worker can switch between PFAs but cannot leave the market.

idiosyncratic preferences ϵ_{ijt}.

$$u_{ijt} = \underbrace{\theta \times C_{ijt}(\{w_{ik}\}_t^{t^r}, f_{jt})}_{\text{NPV}_i \text{ of Management Cost}} + \underbrace{\gamma_S \times S_{ijt}(\{w_{ik}\}_t^{t^r}, \mu_{jt})}_{\text{NPV}_i \text{ of Savings}} + \underbrace{\gamma_{SF} \times sf_{jt} + \eta_j + \zeta_t}_{\text{Common Components}} + \epsilon_{ijt} \tag{1}$$

Since we assume that workers initially believe they are making a permanent decision, the management cost and the potential savings stock are monetary net present value terms that depend on the flow of workers' gross wages $\{w_{ik}\}_t^{t^r}$, fees $\{f_{jk}\}_t^{t^r}$, and returns $\{\mu_{jk}\}_t^{t^r}$ between enrollment at t and retirement at t^r. We assume that workers believe that the fees and returns of period t will remain constant until retirement. However, we assume that they have better information about the path that their own wages will follow in the future and that they discount the future according to a common factor δ. Note that even though fees and returns are common for all enrollees, the management cost and the potential savings stock are worker-specific. Cost and savings terms are calculated as follows:

$$C_{ijt} = \sum_{k=t}^{k=t^r} \delta^{k-t} f_{jt} w_{ik}, \tag{2}$$

$$S_{ijt} = \tau^{ssc} \sum_{k=t}^{k=t^r} \delta^{k-t} w_{ik} \times (1 + (\mu_{jt} - \bar{\mu}_t))^{t^r - k} \tag{3}$$

Furthermore, we allow workers to have different sensitivities for each term (θ, γ_S), as one can be more salient than the other at the decision stage. In this sense, the savings stock measures the potential monetary gains (or losses) from selecting a firm with returns μ_{jt} above (or below) the market average $\bar{\mu}_t$, scaled by the social security contribution rate τ^{ssc}, with $f_{jt} \in [0, \tau^{ssc}]$. We also assume that the sales force deployed by each firm in the market sf_{jt}, on top of affecting the main parameters (θ, γ_S), can also shift the mean utility with sensitivity γ_{SF}. Finally, we assume that unobserved idiosyncratic preferences are distributed Type One Extreme Value. The individual choice probabilities pr_{ijt} are given by the following expression:

$$pr_{ijt}\big(\{w_{ik}\}_t^{t^r}, \mathbf{f}_t, \boldsymbol{\mu}_t\big) = \frac{\exp[\theta C_{ijt} + \gamma_S S_{ijt} + \gamma_{SF} sf_{jt} + \eta_j + \zeta_t]}{1 + \sum_k \exp[\theta C_{ikt} + \gamma_S S_{ikt} + \gamma_{SF} sf_{kt} + \eta_k + \zeta_t]} \tag{4}$$

4.1.2 Awareness

Once enrolled with a firm, consumers may wake up and face again the problem of deciding where to enroll. A worker's awareness is represented by a binary random variable A_{ijt}, which takes the value 1 if the worker is aware and 0 otherwise. For workers entering the labor market for the first time (i.e., potential new enrollees), we assume full awareness; thus, they make a choice consistent with the model described in the previous subsection. In contrast, workers who enrolled before the period t (old enrollees) receive an awareness shock ε_{ijt} each period. When this shock exceeds a threshold ($\varepsilon_{ijt} \geq \bar{\varepsilon}_{ijt}$), the worker re-optimizes. We assume that the shock follows a standard normal distribution $\varepsilon_{ijt} \sim \mathrm{N}(0,1)$. The probability of awareness aw_{ijt} depends on a fixed effect of the firm υ_j and a dummy variable that indicates whether the simplified switching procedure introduced in 2013 is in effect (Post_{2013}):

$$aw_{ijt} = \Phi(\beta_0 + \beta_1 \times (f_{jt} - f_{SOE,t}) + \beta_3 \times (\mu_{jt} - \mu_{SOE,t}) + \beta_4 \times \text{Post}2013 + \upsilon j) \tag{5}$$

Consistent with what we observe in the data[25], in the baseline model we work under the assumption that conditional on receiving a shock that makes them re-optimize, workers decide to move to the state-owned enterprise. Therefore, only old enrollees in a private firm may re-optimize in the baseline model. Furthermore, this is the reason why the cumulative distribution function that calculates the probability of being aware aw_{ijt} is a function of the difference between the fees and returns of private firms relative to those of SOE. Notice that while being aware and switching from a private PFA to the SOE are equivalent in this model, we revisit this assumption in our counterfactual scenarios[26].

4.2 Firms

In the model, oligopolistic, forward-looking firms compete to enroll workers and manage their social security contributions. The strategic behavior of firms manifests in two strategic variables: management fees (f_j) and the mean of the portfolio returns (μ_j).[27]

[25] See Section 3 for additional details.

[26] In those cases, workers that re-optimize do choose according to the model in Subsection 4.1.1 first stage model we stated in the previous section.

[27] While we allow the sales force to influence the enrollment probability, in the model we treat it as non-strategic.

Since firms can charge only a single management fee and enrolled workers exhibit inertia, firms face an investing-harvesting trade-off Beggs and Klemperer (1992). On the one hand, firms have incentives to "harvest" by charging a high fee to profit from their existing base of enrollees. On the other hand, by charging a lower fee, they have incentives to "invest" in obtaining a higher market share of new workers that will remain enrolled between t and t^r –with high probability –and therefore to make more profits from them in the future.

The model captures a second trade-off related to the portfolio returns that firms obtain from investing workers' savings. On the one hand, obtaining higher returns is good for firms for two reasons. First, because returns attract workers and increase revenues through enrollment decisions. Second, because higher returns reduce the probability of capitalization, and therefore firms' expected costs associated with the minimum rate of return regulation. On the other hand, achieving higher returns is costly. Consistent with optimal portfolio theory, we assume that firms can control the mean return of their portfolio through their asset allocations, but that a higher return exposes them to higher risk. We take advantage of the institutional environment to estimate the implicit cost of generating portfolio returns.

4.2.1 Revenues

Firms obtain revenues each period t by charging a management fee f_{jt} to their enrollees, expressed as a share of their gross wage[28]. The fee affects the choices of new and old enrollees according to the decision model of Section 4.1. We work with a stationary model of the labor market and re-express choice probabilities as monetary shares that aggregate across workers[29]. These shares depend on choice probabilities pr_{ijt}, but re-weight workers according to their wages w_{it}, consistent with the fact that firms obtain higher revenues by enrolling higher wage workers.

In the stationary model of the labor market, the mass of wages of new workers is a fixed fraction α of the aggregate wage mass M_t. Under these assumptions, we express expected revenues as the management fee multiplied by the sum of two components: 1) the share of

[28]Because the social security contribution rate is fixed (15%) and the management fee is deducted from these contributions, the fee can be also expressed as a share of the social security contributions ($f_{jt}/0.15$). Furthermore, this implies that workers pay for this service only when they are active in the labor market and have a formal job.

[29]See Appendix A.3.2 for additional details.

the wage mass from new enrollees, $s^n_{jt}(\mathbf{f}_t, \boldsymbol{\mu}_t)$, applied to αM_t, representing workers entering the labor market; and 2) the share of the wage mass from existing enrollees, $s^o_{jt}(\mathbf{f}_t, \boldsymbol{\mu}_t)$, applied to $(1-\alpha)M_t$, accounting for continuing workers net of those who retire, where the share of old enrollees is predetermined at the beginning of the period and depends on current fees and returns only through contemporaneous switching decisions. Furthermore, for the case of private firms, revenues also consider the probability that old enrollees in firm j may become aware and leave to enroll in the SOE[30]. The following equation describes private firms' expected revenues each period.

$$\mathbb{E}\big[Y_{jt}\big] = f_{jt} \times \Big(\underbrace{\alpha\, M_t\, s^n_{jt}(\mathbf{f}_t, \boldsymbol{\mu}_t)}_{\text{New Workers' Wages}} + \underbrace{(1-\alpha)\, M_t\, s^o_{jt}(\mathbf{f}_t, \boldsymbol{\mu}_t)\,(1 - aw_{jt}(\mathbf{f}_t, \boldsymbol{\mu}_t))}_{\text{Old Workers' Wages}} \Big) \tag{6}$$

For the SOE the revenue equation is given by the following equation:

$$\begin{aligned} \mathbb{E}\big[Y_{jt}\big] = f_{jt} \times \Big(& \underbrace{\alpha\, M_t\, s^n_{jt}(\mathbf{f}_t, \boldsymbol{\mu}_t)}_{\text{New Workers' Wages}} + \underbrace{(1-\alpha)\, M_t\, s^o_{jt}(\mathbf{f}_t, \boldsymbol{\mu}_t)}_{\text{Old Workers' Wages}} \\ & + \underbrace{\sum_{\forall k \neq j} \big((1-\alpha)\, M_t\, s^o_{kt}(\mathbf{f}_t, \boldsymbol{\mu}_t) \times (aw_{kt}(\mathbf{f}_t, \boldsymbol{\mu}_t)) \big)}_{\text{Workers from Private Firms}} \Big) \end{aligned} \tag{7}$$

In Appendix A.3.4 and A.3.5, the revenue equations in net present value are derived.

4.2.2 Costs

Firms incur economic costs from their regular business activities and from complying with the regulations in place. The model considers the variable costs of 1) enrolling new workers, 2) obtaining portfolio returns, and 3) complying with the regulations regarding 3.1) the minimum rate of return that firms must achieve for enrollees and, 3.2) the equity they must put aside and invest mirroring the portfolio that enrollees have.

The cost of enrolling new workers is a variable cost related to the payments that firms make to their sales force agents as a reward when they bring in new enrollees. In practice, this payment is tied to the "value" of the new enrollee in terms of the wage, the expected

[30]Consistently, these switchers represent additional revenues for the SOE. So the revenues equation for the SOE includes all the consumers that are aware and, therefore, move to the SOE each period.

density of future contributions, etc. To better reflect this feature, in the model the marginal cost of enrolling an additional worker depends on the wage of the new enrollee: we express the cost as the product of the enrollment probability $pr_{ijt}(f_t, \mu_t)$, the wage of the new enrollee w_{it}^n, and a firm-time specific cost per dollar CPD_{jt}.

Firms also incur a variable cost $f(\mu_{jt}|\kappa_j)$ to achieve the mean return μ_{jt} for their enrollees. This cost is related to optimal portfolio theory and reflects the increasing volatility risk firms must manage when seeking higher mean returns. This is a reduced-form mechanism that summarizes the economics of an efficient frontier without risk-free assets Markowitz (1952). Furthermore, based on what we observe in the data, we allow firms to have different investment abilities, as summarized by the firm-specific parameter κ_j.

Firms benefit from higher returns not only because they increase the enrollment probability, but also because they can reduce -ceteris paribus- the expected cost of capitalization. The regulation requires firms to compensate workers with their own equity when realized returns R_{jt} fall below a threshold $r_{min,t}$. The threshold $r_{min,t}$ is the minimum between 2% and the average return of the market minus 2%: $r_{\text{min},t} = \min\{\bar{R}_t - 2\%; 2\%\}$. See Appendix A.3.6 for details. Since both returns are random variables, the economic cost associated with this risk is determined by their joint distribution.[31] When this event occurs ($R_{jt} \leq r_{min,t}$), the capitalization cost depends on the gap between the realized returns and the stock of workers' savings managed by firm j (PSF_{jt}, Pension Savings Fund).

Finally, to further incentivize firms to achieve good returns for enrollees while simultaneously mitigating the moral hazard of investing others' money, the regulation requires firms to invest their own equity, mirroring the asset portfolio they select for enrollees. The required equity investment is a fixed fraction (0.5%) of the total stock of savings they manage (PSF_{jt}). This regulation imposes an opportunity cost on firms by constraining their portfolio allocations along multiple dimensions, including asset type, origin, and credit rating, among others, thereby limiting their ability to allocate their equity freely. We calculate this cost using the benchmark rate of return r_t^* that would be obtained from an unconstrained allocation.

Taken together, the elements of the expected cost of firm j in period t described previously

[31] See Appendix A.3.6 for details of this probability distribution.

are summarized in the following equation:

$$\begin{aligned}\mathbb{E}\big[C_{jt}\big] &= \underbrace{\sum_{i_{c=t}} pr_{ijt}(\mathbf{f}_t, \boldsymbol{\mu}_t) \cdot w_{it} \cdot CPD_{jt}}_{\text{Enrollment Cost of New Workers}} + \underbrace{f(\mu_{jt}|\kappa_j)}_{\text{Investment cost}} \\ &+ \underbrace{\mathbb{E}\Big[\big|(r_{\text{min,t}} - R_{jt})\big| \times \text{PSF}_{jt} | (R_{jt} < r_{\text{min,t}})\Big]}_{\text{Expected Capitalization Cost}} + \underbrace{\mathbb{E}\Big[0.5\% \cdot (r_t^* - R_{jt}) \cdot \text{PSF}_{jt}\Big]}_{\text{Expected Opp. Cost of Firm } j\text{'s Equity}}\end{aligned} \tag{8}$$

4.2.3 Firm Problem and Equilibrium

We solve the problem of the firm using the elements related to workers' preferences and firms' revenues and costs described above. We assume that firms play a dynamic, full information, simultaneous move game each period. In the game, firms set the sequences of management fees $\{\mathbf{f}_{jk}\}_t^T$ and mean returns $\{\mu_{jk}\}_t^T$ between t and a terminal period T, that maximize the present discounted value of their objective function $\mathcal{W}(\{\mathbf{f}_{jk}, \mu_{jk}\}_t^T)_{jt}$.

For private firms, the objective function considers only economic profits ($\mathbb{E}\big[V(\mathbf{f}, \mu)_{jt}\big]$), whereas for the state-owned enterprise, it incorporates a weighted sum of profits and the stock of its enrollees' savings. We denote the weight on workers' savings as Non-Profit Motives (NPM), represented by the parameter λ, with the remaining weight on profits given by $(1 - \lambda)$.

$$\mathcal{W}(\{\mathbf{f}_k, \mu_k\}_t^T)_{jt} = (1-\lambda) \underbrace{\left(\mathbb{E}\Big[V(\{\mathbf{f}_k, \mu_k\}_t^T)_{jt}\Big]\right)}_{\text{NPV Profits}} + \lambda \underbrace{\left(\mathbb{E}\Big[\text{Savings}(\{\mathbf{f}_k, \mu_k\}_t^T)_{jt}\Big]\right)}_{\text{NPV Workers' Savings}} \tag{9}$$

$$\begin{aligned}&1)\ \ \mathbb{E}\big[V(\mathbf{f}, \mu)_{jt}\big] &&= \sum_{k=t}^{k=T} \beta^{k-t} \mathbb{E}\big[\pi_{jk}\big] = \sum_{k=t}^{k=T} \beta^{k-t} \mathbb{E}\big[Y_{jk} - C_{jk}\big] \\ &2)\ \ \mathbb{E}\Big[\text{Savings}(\mathbf{f}, \mu)_{jt}\Big] &&= \sum_{k=t}^{k=T} \beta^{k-t} \mathbb{E}\big[\sum_i \sum_{l=k}^{l=k+(t_i^r - t)} w_{il}(\tau^{ssc} - f_{jl}) \prod_{l}^{l=k+(t_i^r-t)} (1 + R_{jl})\big]\end{aligned}$$

We work under the assumption that observed fees and mean returns constitute a pure-strategy, stationary "no-sales" Nash equilibrium of the game, in the spirit of Farrell and Klemperer (2007). This implies that equilibrium fees and mean returns are constant in every period k between t and T: $\{\mathbf{f}_k^*, \mu_k^*\}_t^T = (\mathbf{f}_t^*, \boldsymbol{\mu}_t^*)$. Firms know the distribution of the

preference shocks (ϵ) and awareness (ε) shocks that workers receive but not their realizations. The timing of events is as follows. First, firms choose simultaneously fees and mean returns to maximize their objective function. Afterwards, workers observe their preference and awareness shocks and decide.

5 Estimation and Results

5.1 Demand

5.1.1 Specification Details

We estimate workers' demand of Subsection 4.1.1 following Hastings et al. (2017). In order to allow for flexible preference heterogeneity, we estimate conditional logit models separately for five demographic brackets (b) using workers' micro data. First, we divide the population into those with and without an outside option. For those with an outside option, we further classify individuals into four quartiles based on the distribution of gross wages. For individuals without one, we construct a single group. Therefore, the vector of sensitivity parameters $\{\theta^b, \gamma_S^b, \gamma_{SF}^b\}$ and the firm η_j^b and time ζ_t^b fixed effects are specific for each bracket b.

To compute the net present values of the management cost $C_{ijt(i)}$ and of the potential savings stock S_{ijt}, we assume that workers are active in the labor market for 40 years before retirement. Additionally, for the wage w_{ik} we use the average wage over workers' life cycle $w_i = \frac{1}{40}\sum_l^{l+40} w_{il}$. To estimate this wage, we first regress observed wages against age and age-squared, and then compute the average wage consistent with the estimated wage curve[32]. Finally, to calculate the stock of potential savings S_{ijt}, we assume that the mean return rate μ_{jt} is equal to the average 12-month return during the year before the enrollment decision.

For the stage of Subsection 4.1.2, we use a probit model to estimate the awareness probability. Since we only have aggregate switchers' data at the firm level, we use data from the entire period for which we have information (2002-2020).

[32]See Appendix A.4.1 for details.

5.1.2 Identification

The identification of the cost and savings stock sensitivities $\{\theta^b, \gamma_S^b\}$ is based on the fact that fees and returns are plausibly exogenous. We extend Hastings et al. (2017), who use a similar argument for the identification of the cost sensitivity. In our setting, firms set national fees and have single portfolios for their enrollees, but costs and potential savings are worker-specific and vary with gross wages and spells in the formal labor market. This individual-level variation of the costs and benefits that every PFA delivers, even among individuals with similar demographic characteristics, gives us arguably exogenous variation to estimate the target parameters. The identification of the sales force shifter is based on changes in the relative share of sales force, given the presence of market characteristics that vary over time. The identification of the other parameters follows the standard identification arguments.

5.2 Results

We estimate the conditional logit model by maximum likelihood separately for workers in each bracket b. In Figure 5 we summarize the results by displaying the median elasticity to the management cost C_{ijt} and the potential savings stock S_{ijt} for individuals in each estimation bracket. We calculate these using estimated parameters, observed fees and returns, and workers' characteristics[33].

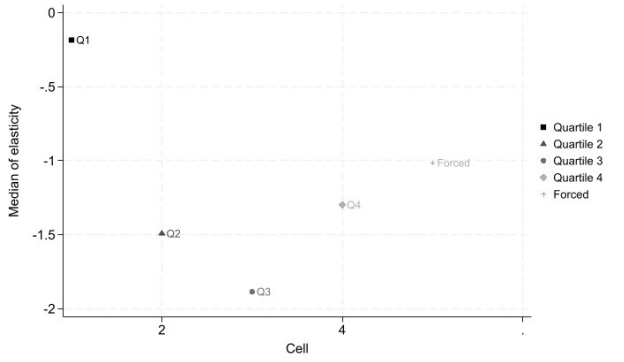
The estimates show that higher-wage individuals are more elastic than lower-wage ones with respect to changes in the management cost[34], but this pattern reverses for the savings component. In particular, the correlation between the wage level and the sensitivity to the management cost is in line with the previous literature on individual capitalization pension systems in other Latin American countries (Hastings and Tejeda-Ashton, 2008; Hastings et al., 2017), and on financial literacy (Lusardi, 2008).

Furthermore, while both terms are monetary metrics, management costs appear to be more salient than potential savings to workers when making enrollment decisions. This is reflected in the magnitude difference between the estimated elasticities of both terms. Considering the differences in management fees that exist between private firms and the

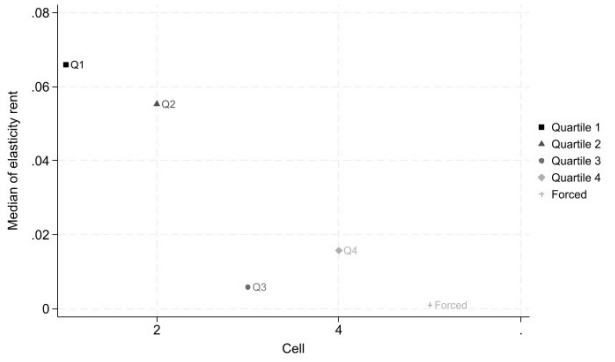
[33]Demand estimates are presented in Tables A.4 of the Appendix.
[34]In Figure A.7 we show the management fee elasticities in each period.

Figure 5: Median Elasticity by bracket

(a) Management Cost



(b) Potential Savings



Note. Within-bracket median PFA elasticity, all periods. Elasticities are calculated using observed fees, mean returns, and gross wages.

SOE, the estimates are consistent with the fact that higher wage workers enroll disproportionately more in the SOE than low wage workers[35]. This pattern is relevant for understanding the welfare implications of alternative regulations and market configurations.

We estimate the second-stage awareness probit with maximum likelihood[36]. In the baseline model, the results imply that an increase of one standard deviation in the fee differential ($f_{jt} - f_{SOE,t}$) raises the probability of leaving firm j to the SOE by 9 p.p. Similarly, an increase of one standard deviation in the mean return differential ($\mu_{jt} - \mu_{SOE,t}$) reduces the probability of leaving firm j to the SOE by 2 p.p.

We now use the system of first-order conditions with respect to fees and mean returns from firms' problem, the estimated demand, and market level data to recover the vector of enrollment cost per dollar (CPD_{jt}), the parameters of the investment cost function (κ_j) and the weight related to the state-owned enterprise Non-Profit Motives (λ).

5.3 Enrollment Marginal Cost and Non-Profit Motives

We recover the cost per dollar of enrolling a worker with average wage w_i in two different periods: 2002–05 and 2014–17. As described in Section 3.3, we interpret these as

[35]See Figure A.8 in Appendix A.4

[36]In Table A.3 of the appendix we display the estimation outcome.

two stationary equilibrium, reflecting the change in shareholder preferences on the SOE's board in 2005. In Table 3 we show the enrollment marginal cost for the first two equilibrium and the three private firms. For private firms, we estimate enrollment marginal costs of enrolling an average wage enrollee to be between $\$10$ and $\$30$ in the first period, and between $\$40$ and $\$67$ in the second.

Table 3: Enrollment Marginal Cost and Non-Profit Motives

	Average CPD (USD)				SOE NPM ($\hat{\lambda}$)
Equilibrium	PF 1	PF 2	PF 3	SOE ($\lambda = 0$)	(Max. MC_{PF})
2002-05	10	29	21	-275	0,63
2014-17	45	67	40	-394	0,86

Note: Cost of enrolling a new worker with the average gross monthly wage, inflation-adjusted USD (2017).

It is not possible to separately identify the cost per dollar CPD and non-profit motives λ for the state-owned enterprise. As shown in Table 3, ignoring non-profit motives would require accepting a negative marginal enrollment cost to rationalize the observed equilibrium variables under the implicit pure profit-maximizing behavior. Given that firms in this market incur variable costs when enrolling additional individuals, this scenario seems unlikely. As discussed above, the marginal cost in this market is mainly associated with paying sales force agents to enroll new workers entering the labor market[37] [38]. Therefore, we proceed by assuming that the marginal cost of the SOE is equal to the marginal cost of the less efficient private firm (PF 2)[39]. The direct implication of this assumption is that non-profit motives effectively increased between the first and the second equilibrium.

[37] Although we do not directly observe the variable wage component that sales force workers receive per affiliation, we approximate it using data on sales force productivity (measured as the ratio of monthly new enrollees per firm to the number of sales agents), aggregated wage payments, and the minimum wage established in collective agreements. For 2017, this calculation implies an average variable wage of USD 63 per enrollee, a figure close to our estimated marginal enrollment cost. Appendix A.6 describes the calculation in detail. Appendix A.5 compares the implied profit structure with that observed in the accounting data.

[38] The increase in the CPD from one period to the next is consistent with the context of strong wage growth in Uruguay.

[39] Tables A.7 and A.8 report robustness checks assuming that the SOE's marginal cost equals that of the most efficient private firm and the average marginal cost across private firms, respectively. The results are qualitatively unchanged.

5.4 Investment Cost

The remaining unobservable primitive we recover is the vector of parameters κ that controls the variable investment cost that firms pay to obtain units of portfolio returns. We parameterize the cost function as $f(\mu_{jt}|\kappa_j) = \exp(\kappa_j \cdot \mu_{jt})$. In this case, different from the enrollment marginal cost, we assume that firms have a time-invariant ability to obtain those returns. In Table 4 we display the mean return, the expected capitalization probability consistent with observed returns and the minimum rate of return regulation, and the estimated κ for each firm.

Table 4: Investment Cost

Variable	PF 1	PF 2	PF 3	SOE
μ_j^*	1.64	1.00	1.44	1.33
$\mathbb{E}[\Pr(\text{Cap})_j]$	1.1%	1.5%	1.7%	0.3%
$\hat{\kappa_j}$	944	1,518	1,090	1,128

This table reports the parameters used to characterize the investment cost of each pension fund administrator. μ_j^* denotes the mean observed portfolio return for firm j. $\mathbb{E}[\Pr(\text{Cap})_j]$ is the expected probability that the fund must capitalize in order to comply with the minimum return regulation. $\hat{\kappa}_j$ is the estimated parameter governing the investment cost function $f(\mu_{jt}|\kappa_j) = \exp(\kappa_j \mu_{jt})$. The calculations use the observed portfolio weights ω = [0.18; 0.09; 0.16; 0.57], the observed standard deviations of returns for each asset class σ = [0.089; 0.088; 0.095; 0.094], and the observed pairwise correlation between asset returns $\rho_{jk} = 0.9$.

Notice how the equilibrium effect of the regulation results in smaller firms having a higher capitalization probability, and this occurs despite obtaining higher returns on average. Due to its size, the SOE has the lowest probability (0.3%), which is about one-third the probability of the private firm that achieves the highest mean return (1.1%). Therefore, the fact that some private firms achieve higher returns for their enrollees while facing higher capitalization probabilities is, in our model, consistent with a lower cost to generate those returns and a lower value of $\hat{\kappa}$.

6 Counterfactuals

We use our estimates about preferences and marginal costs to understand the value of the public option and the effect of the regulation on fees in the market. In particular, we analyze two counterfactuals. In the first one, we substitute the public option with a private firm that resembles the other private options. Here, we try to capture the value of the public option by comparing the observed market equilibrium with an alternative configuration with private PFAs only. In the second, we analyze how far the observed equilibrium was from a benchmark where fees were set such that PFAs have zero economic profits. We separate the analysis into two periods: 2014-2017 and 2020, to account for the effects of the introduction of the fee regulation in the latter period.

6.1 Privatization

The privatization counterfactual involves simulating the equilibrium we would observe in an oligopoly with four private firms, rather than the one we observe with three private firms and one public option. The approach we follow implies asking *"what if the SOE is sold to a private investor, a new board takes over, and all enrollees are informed about the change?"*. To do so, we must address how privatization affects certain demand and supply side aspects of our model.

6.1.1 Implementation Details

In the case of supply, we consider changes in non-profit motives and in harvesting incentives due to a large pre-existing base of enrollees. In the first case, in the counterfactual firms care only about economic profits, so we set the value of the parameter that summarizes non-profit motives in the public option to zero ($\lambda = 0$). In the second, we deal with the sizable harvesting incentives by redistributing the share of old enrollees among all four firms[40].

In the case of demand, we consider how the privatization affects the awareness probability (first stage) and the enrollment decision (second-stage). For the probability that

[40]The public option is the largest firm, so only setting non-profit motives to zero would imply a massive increase in the equilibrium fee of this firm. In the main specification, we redistribute the old enrollees of the SOE in equal parts among all four private firms.

worker i enrolled in firm j becomes aware[41], we assume that the chance of receiving a large attention shock and re-optimize is now a function of the differences between firm j's fee and mean return, and their associated market averages[42]. For the enrollment decision, we change the estimated intrinsic mean valuation η^b_{SOE} that workers have for the public option, and replace it with the average valuation they have for private firms $\overline{\eta_j}^b$. These changes in the two-stage decision problem imply that awareness and switching are not equivalent events anymore [43]. Furthermore, for enrollees that decide to switch, we assume that the firm pays the enrollment marginal cost CPD.

6.1.2 Privatization Results

The counterfactual indicates that, in equilibrium, the public option reduces fees, increases portfolio returns, and raises the expected savings of all workers. In our preferred specification,[44] the privatization of the SOE would increase average fees by 44% and reduce average returns by 3% (4 bp), relative to the stationary equilibrium in 2014–17. This implies that the expected savings at retirement for a new worker who enrolls in the new market equilibrium and remains active for forty years would decrease by 6.7%, on average. In contrast, the profits of the four firms more than double. We present these results in Table 5, where we decompose the effects of the different implementation assumptions we adopt.

[41] We retain the assumption that new workers are aware with certainty.

[42] In the baseline, this probability was a function of the difference between private firms' fees and mean returns relative to those of the SOE. More importantly, awareness and switching coincided, but now they do not.

[43] For old enrollees, being aware and switching from a private firm to the SOE were equivalent events in the baseline model. This was motivated by the switching pattern that we observe in the data (See Table 2).

[44] Consistent with the specification details described in the previous section. In Table A.9 of the appendix, we present the effects when we assume efficiency gains motivated by the privatization of the SOE. The main conclusions are similar.

Table 5: Privatization - Oligopoly with Four Private Firms

	Fees f_j^* (% Gross Wage)		Returns μ_j^* 1Yr (%)		$\mathbb{E}[\pi_t]$ (US$ Mill.)		$\mathbb{E}[\text{Savings}]^*$ (US$ '000)	
	PFs	SOE	PFs	SOE	PF (Tot.)	SOE	PFs	SOE
Baseline Equilibrium (Avg. 2014/17)	1.94	0.80	1.36	1.33	60.17	26.72	**40.75**	**44.59**
Counterfactual								
1) $\rightarrow \hat{\lambda} = 0$	1.90	4.66	1.35	0.99	56.39	164.77	40.80	28.26
2) $\rightarrow \hat{\lambda} = 0 \ + \ s_{SOE}^{old} = s_j^{old} = 0.25$	2.11	2.70	1.35	1.29	103.87	44.50	40.05	37.29
3) $\rightarrow$ 2) $+ \ \eta_{SOE} = \bar{\eta}_{pf}$	2.10	2.20	1.35	1.32	103.51	35.66	**40.08**	**39.36**

* Mean savings for a worker facing equilibrium f^* and μ^* for 40 years. PF averages are weighted by enrollment shares s_j. Awaking probability is a function of the difference between a firm's fee and the market average. When consumers awake, they meet the sales force (as in the first choice). Marginal costs apply every period.

In terms of heterogeneity, while the direction of the changes is common across firms, the magnitude of the effects is not. For workers enrolled in the SOE, privatization implies a 150% increase in fees and a 4.5% (6 bp) reduction in the return rate, which together reduce the expected savings of the average worker by 11.1%. The magnitudes are more modest in the case of private firms: privatization results in an average increase in fees of 8% and a 1.5% (2 bp) reduction in the mean return rate, with an associated 1.7% decrease in workers' savings. Overall, the results show that competition in the market is modest and that the benefits delivered by the SOE's non-profit motives are largely concentrated among its own enrollees. The combination of a modest demand sensitivity to fee differences —which sometimes leads enrollees to select dominated options— and the absence of strong entry incentives for new firms[45] implies that the privatization of the SOE would reduce savings.

6.2 Inattention

A typical argument against supply-side regulations is that demand-side policies can make the market more competitive through changes in consumer behavior. To examine whether such policies could offset the negative effects of privatization in this market, we simulate the effects of a policy that reduces inertia. To conduct this analysis, we increase the sensitivity of enrollees to the difference between the fee of their current option j and the market average, which, in the context of our model, implies an increase in the parameter β_1.

As displayed in Table 6, results show that reducing inattention would increase competi-

[45] In Appendix A.7.2 we analyze these incentives in more detail.

tion and benefit all enrollees. Because old enrollees are more likely to re-optimize when a firm charges a fee above the market average, harvesting incentives are moderated, and therefore, the equilibrium fees of all firms are lower in equilibrium. However, for this to compensate for the negative effects of privatization, the increase in β_1 must be sizable. For the average fee to decrease by 27.5% and the stock of savings to increase by 5.4%, the sensitivity must increase by a factor of four.

Table 6: Privatization + Demand-Side Policy

	Fees f_j^* (% Gross Wage)		Returns μ_j^* 1Yr (%)		$\mathbb{E}[\pi_t]$ (US$ Mill.)		$\mathbb{E}$[Savings]* (US$ '000)	
	PFs	SOE	PFs	SOE	PF (Tot.)	SOE	PFs	SOE
Baseline Equilibrium (Avg. 2014/17)	1.94	0.80	1.36	1.33	60.17	26.72	**40.75**	**44.59**
Privatization ($\hat{\lambda} = 0 \ + \ s_{SOE}^{old} = s_j^{old} = 0.25$)	2.11	2.7	1.35	1.29	103.87	44.5	**40.05**	**37.29**
Counterfactual (Privatization + ↑ Sensitivity)								
$2 \times \hat{\beta}_1$	1.86	1.81	1.35	1.28	90.6	28.9	40.97	40.39
$3 \times \hat{\beta}_1$	1.66	1.64	1.35	1.28	80.27	25.79	41.72	41.06
$4 \times \hat{\beta}_1$	1.49	1.48	1.35	1.29	71.57	23.05	**42.35**	**41.66**

* Mean savings for a worker facing equilibrium f^* and μ^* for 40 years. PF averages are weighted by s_j.

Furthermore, even if a demand-side policy could effectively achieve this, the combination of privatization and inattention reduction policies would still create winners and losers relative to the baseline environment with three private firms and one public option. Note that while the former implies higher savings for the enrollees of private firms, it leaves enrollees in the former SOE worse off.

Due to the fact that demand-side policies have not been able to reduce equilibrium fees substantially in this market before, we consider the required increase to compensate for the privatization negative effects for workers to be unlikely. Looking from a different angle, it is highly likely that the public option increases retirement savings for everyone, at the same time that it creates winners and losers among the pool of workers who participate in the market. For this reason, we explore now how it performs relative to another common policy in this market: a cap on the management fee.

6.3 Regulation by public options

Having shown that a public option with non-profit motives increases workers' savings relative to an oligopolistic market with only private firms, we now examine how far such motives can go as an instrument to improve equilibrium outcomes for workers. We also compare these outcomes with those achieved under a cap on management fees. This is motivated by the fact that many countries rely on fee caps as a regulatory instrument in the market of pension fund administrators, and that we observe the consequences of their introduction in the case we study.

In our baseline specification, we found that the reduction of the management fee of the SOE observed between the first equilibrium (2002-05) and the second (2014-17) was consistent with an increase in its non-profit motives (the weight the SOE assigns to workers' savings in its objective function) from 0.63 to 0.86. Accordingly, in this counterfactual, we use the second equilibrium as baseline ($\lambda = 0.86$), and increase the SOE's non-profit motives to match two potential targets: (1) an extreme case with a zero management fee (free provision), and (2) a less extreme case with an equilibrium fee that implies zero economic profits. In Table 7 we display these results and compare them with the observed equilibrium after the cap on fees was introduced.

Table 7: Non-Profit Motives and Cap on Management Fees

	Fees f_j^* (% Gross Wage)		Returns μ_j^* 1Yr (%)		$\mathbb{E}[\pi_t]$ (US$ Mill.)		$\mathbb{E}$[Savings]* (US$ '000)	
	PFs	SOE	PFs	SOE	PF (Tot.)	SOE	PFs	SOE
Baseline Equilibrium (Avg. 2014/17)	1.94	0.80	1.36	1.33	60.17	26.72	**40.75**	**44.59**
Counterfactual: Non-Profit Motives λ								
$\lambda: f_{SOE} = 0$	2.03	0.00	1.34	1.34	62.75	-2.85	**40.27**	**47.56**
$\lambda: \mathbb{E}[\pi_{SOE}] = 0$	1.95	0.61	1.36	1.34	60.47	0.00	**40.68**	**45.29**
Cap on Fees								
Observed Equilibrium (2020)	0.99	0.66	1.36	1.33	27.84	22.14	**44.27**	45.13

* Mean savings for a worker facing f^* and μ^* for 40 years. PF averages are weighted by enrollees' s_j.

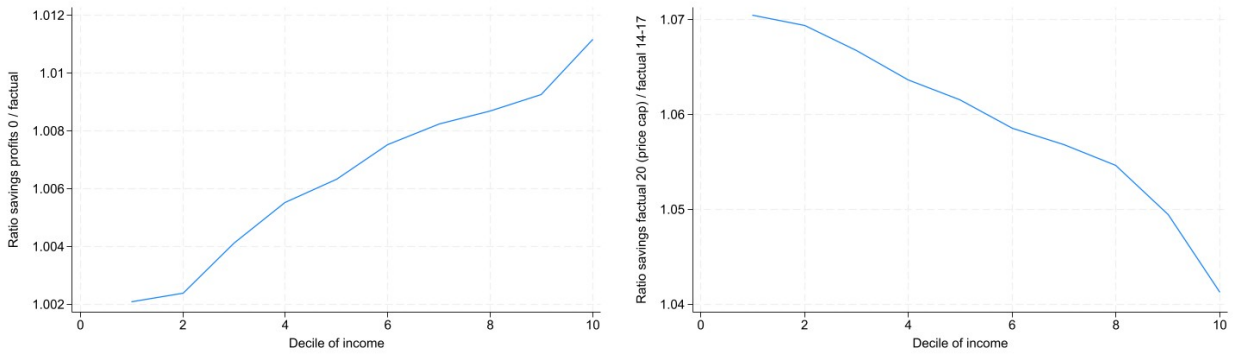
Though magnitudes differ across targets, the main effect of raising non-profit motives is to increase market segmentation. In both cases, private firms raise their equilibrium fees in response to the reduction in the SOE's fee. High-wage workers have greater elasticity to changes in management costs ($C_{ijt}(f_{jt}, w_{it})$), so even if they are equally likely as

lower-wage workers to receive an attention shock, they are still more likely to switch to the SOE when f^*_{SOE} decreases. As a result, the pool of enrollees that remain in private firms becomes more inelastic, and harvesting incentives increase, as reflected in higher management fees relative to the baseline equilibrium.

The previous result suggests that using non-profit motives to enhance competition may have redistributive consequences and exacerbate wage inequality in retirement. Figure 6a illustrates the aggregate equilibrium effect on savings when non-profit motives are set to achieve the zero-profits target, relative to the baseline. The fact that the savings of low-wage workers remain almost unchanged reflects a net effect: lower savings for low-wage workers who stay in private firms are fully offset by higher savings for those who enroll in the SOE.

Figure 6: Savings at Retirement by Wage Decile - Counterfactual vs Baseline

(a) Non-Profit Motives ($\lambda_{\mathbb{E}[\pi_{SOE}]=0}$) (b) Cap on Management Fees



Note: "Baseline" stands for the 2014-17 stationary equilibrium before the introduction of the cap. The figure shows the policy effects at the market level, aggregating enrollees of private firms and the public option.

6.3.1 Cap on Management Fees

Finally, we compare the welfare effects of non-profit motives with those of introducing a cap on management fees. This policy was implemented in 2020 following a two-year transition period and has been adopted by other regulators worldwide to increase workers' net savings. We simulate the policy as designed by the Uruguayan regulator: the maximum management fee cannot exceed 1.5 times the lowest fee in the market,[46] which in

[46] As the SOE had the lowest management fee, this design may, in theory, give the SOE an incentive to lower its fee to the point where private firms incur losses and exit the market. However, since neither the SOE

our case corresponds to the SOE.

In our model, the equilibrium effects of the cap are ambiguous. On the one hand, the policy limits the harvesting incentives of private firms and may reduce fees across all firms, including the public option. On the other hand, it reduces the fee gap of private firms with respect to the SOE, and thus reduces the likelihood that workers in private firms receive an attention shock that triggers re-optimization. Additionally, as the cap alters enrollment decisions and market shares, the resulting effect on mean returns is also uncertain.

The results show that the cap increases savings for all workers, with relatively larger gains for low-wage workers. More importantly, while private firms now charge the maximum allowed fee, differences in expected savings across firms shrink, primarily because returns are—marginally—higher in private firms. Before the cap, an average worker enrolled in a private firm was expected to accumulate 91.3% of the savings she would have earned in the SOE. After the cap, this figure rises to 98%.

7 Final comments

This paper examines the welfare consequences of introducing a state-owned enterprise in the market of pension fund administrators to compete with private firms. This market is usually characterized by workers' inertia in enrollment decisions and low sensitivity to fees and returns, features that translate into high management fees. Using rich data on workers' enrollment decisions, we estimate a demand and supply model where forward-looking firms compete to enroll workers and the SOE maximizes an objective function that considers profits and non-profit motives. We then use the model to evaluate counterfactual policies in this market.

First, we simulate a privatization scenario in which the SOE is replaced by a private firm with standard profit motives and cost structures. We also explore whether a demand-side policy that reduces inattention among workers can offset the negative effects of privatization, finding that although such a policy increases competition and savings, it requires unrealistically high workers responsiveness to fee differentials to fully compensate for

nor the regulator aims to establish a monopolistic public option, we abstract from this possibility.

the replacement of the public option. Next, we assess how enhancing the SOE's non-profit motives affects outcomes, showing that stronger non-profit behavior reduces fees and raises savings for its own enrollees but also increases market segmentation and inequality. Finally, we compare this intervention with the introduction of a cap on management fees—a policy implemented in Uruguay in 2020 and used in other pension systems—which proves more effective at increasing savings across the board and narrowing gaps between public and private enrollees, especially benefiting low-wage workers.

Our findings suggest that creating a public option with high not-for-profit motives helps to increase workers' savings through lower fees and higher returns. However, due to moderate demand elasticities to fees and the lack of entry of new competitors, the presence of the public option is not enough to meet the increase in savings that the cap on management fees generates for workers. In the environment we study, the combination of a public option with a cap on fees seems to perform better than an alternative regulation aiming at privatizing and reducing workers' inertia.

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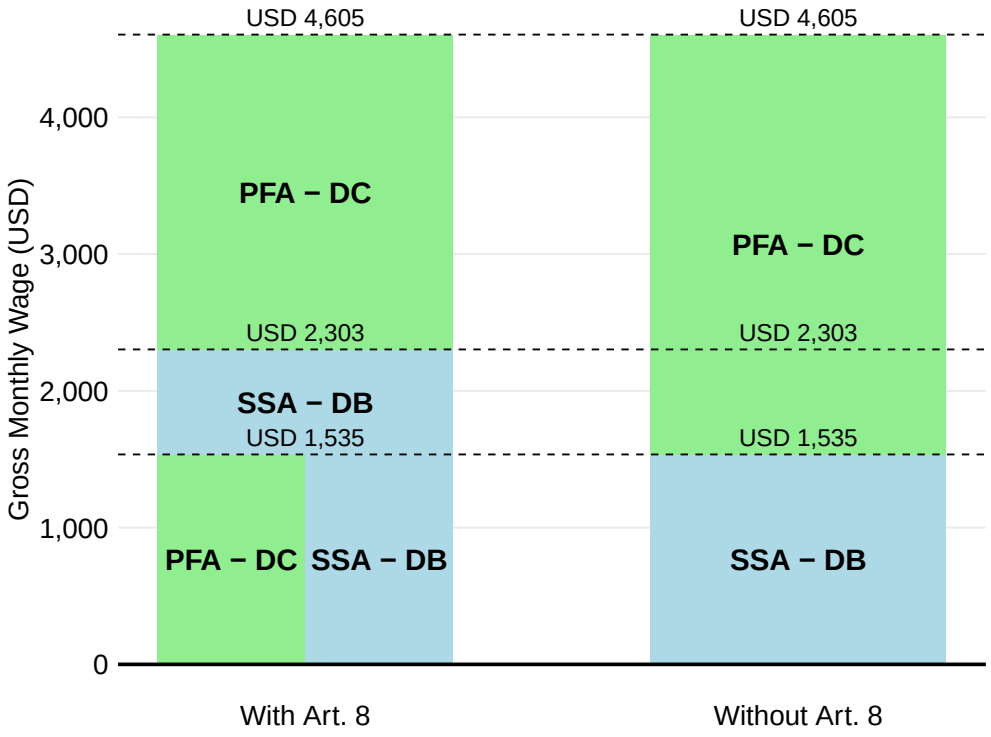
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A Appendix

A.1 Gross Wage Distribution for Contributions

Figure A.1: Gross Wage Distribution for Social Security Contributions



Note. PFA-DC: Pension Fund Administrator - Defined Contribution subsystem, SSA-DB: Social Security Administration - Defined Benefit subsystem. Expressed in real US Dollars of April 2021. Thresholds are adjusted yearly according to a Nominal Average Wage Index. Contributions to each subsystem are calculated as 15% of the gross wage allocated to each subsystem.

A.2 Additional Descriptive Information

A.2.1 Market Shares

Figure A.2: MARKET SHARE BY FIRM - ALL ENROLLEES

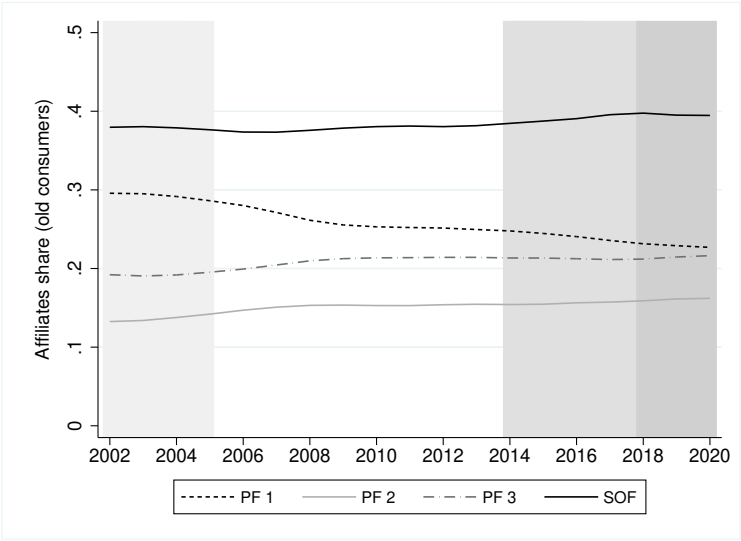


Table A.1: MARKET SHARE BY FIRM, GROSS WAGE QUARTILE AND PERIOD - NEW ENROLLEES

	PF 1	PF 2	SOE	PF 3
Period 2002-2005				
Quartile 1	25.32	27.68	16.61	30.40
Quartile 2	19.08	25.55	23.41	31.97
Quartile 3	18.09	23.85	35.22	22.83
Quartile 4	16.41	15.77	49.95	17.87
Forced	10.84	15.66	53.01	20.48
Period 2014-2017				
Quartile 1	25.02	30.01	20.63	24.34
Quartile 2	22.72	26.39	21.89	29.00
Quartile 3	19.92	22.80	27.66	29.63
Quartile 4	14.62	21.49	37.74	26.15
Forced	7.63	9.16	59.54	23.66
Period 18-20				
Quartile 1	23.85	24.24	26.53	25.38
Quartile 2	18.83	24.11	21.66	35.40
Quartile 3	22.53	19.91	25.26	32.31
Quartile 4	20.42	17.08	35.21	27.29
Forced	7.55	1.89	86.79	3.77

Notes. For each level of gross wages we display the average share of new enrollees by PFA. The quartiles are composed of workers whose wages are below the compulsory enrollment threshold.

A.2.2 Sales Force

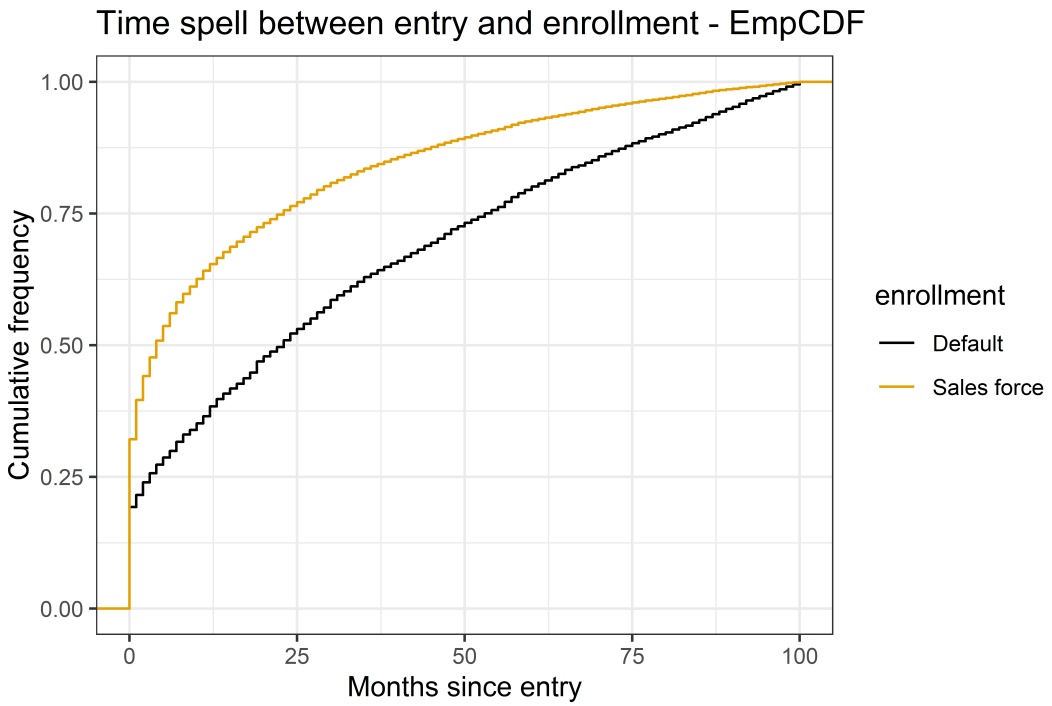
Table A.2: SALES FORCE AGENTS - SHARE BY FIRM AND PERIOD

Period	Firm			
	PF 1	PF 2	SOE	PF 3
2002-2005	0.21	0.24	0.35	0.21
2014-2017	0.22	0.15	0.36	0.27
2018-2020	0.24	0.15	0.36	0.25

Notes. Average share of total.

A.2.3 Enrollment Time

Figure A.3: LABOR MARKET ENTRY AND PFA ENROLLMENT

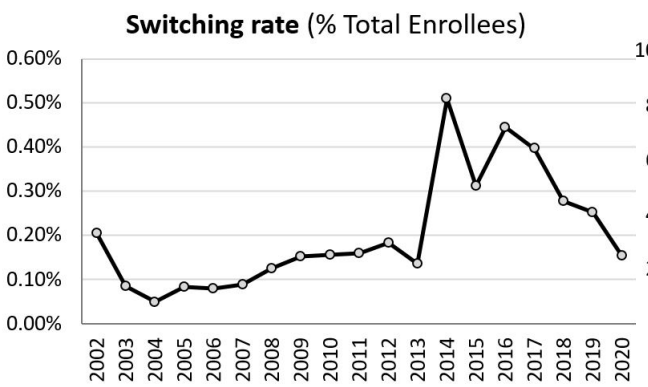


Note. Yellow curve: empirical cumulative distribution function of time spell between entry and enrollment for individuals voluntarily enrollment. Black curve: cumulative distribution function of time spell between entry to the labor market and enrollment for individuals enrolled by default (mandatory enrollment).

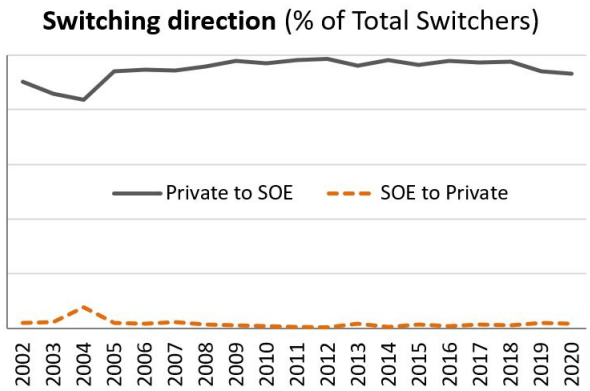
A.2.4 Switching Rates

Figure A.4: Switching Patterns

(a) Equilibrium 2014-17, Before cap



(b) Equilibrium 2020, After cap



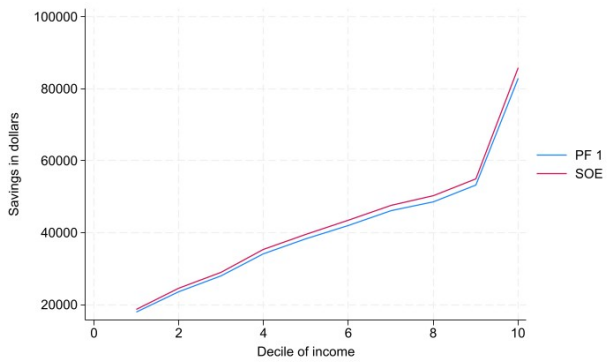
A.2.5 Expected Savings

Based on (1) the low switching rates, (2) the almost unanimous switching direction from private firms to the public option, (3) the lower fees charged by the public option relative to private firms, and (4) the superior investment performance of some private firms, we study the expected level of savings under the two most common enrollment strategies: (1) single-firm enrollment, where the worker remains with the same PFA until retirement, and (2) switch-once, where the worker initially enrolls in the low-fee public option and later switches to a higher-return private firm.

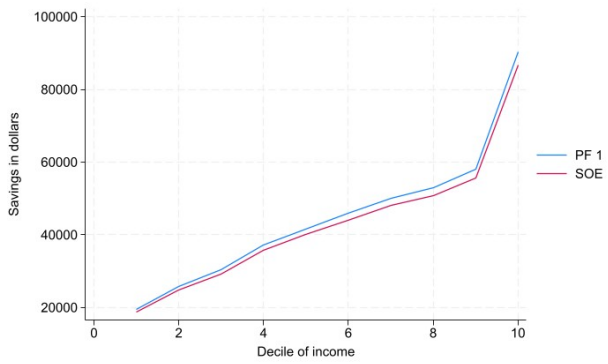
The expected savings at retirement under the first strategy are shown in Figure A.5, comparing outcomes before the introduction of the cap on management fees (A.5a) and after (A.5b). In both cases, we compare enrollment in the public option to enrollment in the private firm with the highest observed returns in our sample.

Figure A.5: Expected Savings by PFA and Period, Public Option vs Best Private Firm

(a) Equilibrium 2014-17, Before cap



(b) Equilibrium 2020, After cap



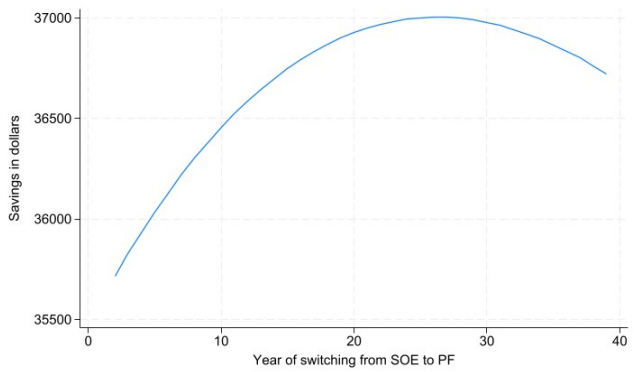
Importantly, before the introduction of the cap, differences in returns were not sufficient to offset the fee advantage of the public option, regardless of the worker's gross wage level. These results suggest that enrolling in a private firm was a "mistake" under the 2014–2017 configuration. However, after the cap was introduced, this result changes: the best-performing private firm is now able to compensate for the higher fee it charges by delivering superior returns.

Second, given that most workers switch firms at most once, we explore an alternative switch-once strategy in which the worker begins with the low-fee public option and switches later to a high-return private firm. The intuition behind this strategy is that early in the contribution period—when the accumulated savings are still low—differences in fees matter more than differences in returns for growing the savings stock. As the savings accumulate, the return on investment becomes more influential, making a switch to a higher-return private firm potentially beneficial.

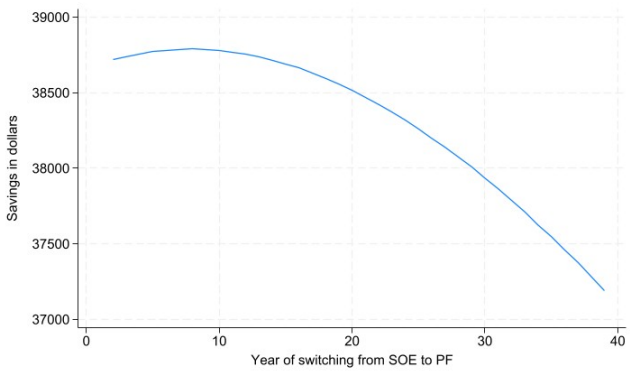
We find that, before the introduction of the cap on management fees, the optimal time to switch was approximately 28 years after entering the system. After the cap was introduced, this optimal switching point dropped to 9 years for the average worker. These results are illustrated in Figure A.6.

Figure A.6: Optimal Switching Timing: Public Option to Best Private Firm

(a) Equilibrium 2014-17, Before cap



(b) Equilibrium 2020, After cap



A.3 Model

A.3.1 Labor Market

We use a stationary model of the labor market where the mass of wages of new workers is a fixed fraction α of the aggregate wage mass M_t, and the probability of retirement is deterministic and constant. We make the following assumptions:

1 Retirement probability: Workers remain active in the labor market for forty years and then retire. Accordingly, we assume a constant retirement probability of 0 for the first forty periods and 1 thereafter.

2 Workers and firms consider the average gross wage over the life cycle, w_{it}, when solving their optimization problems[47].

3 Each year t, a new cohort of equal size, preferences, and gross wages enters the labor market.

[47]See Appendix A.4.1 for details on the estimation procedure and results.

4 The wage mass M_t is constant each period $M_t = M$. Therefore, the wage mass of the new cohort is equal to the wage mass of the cohort who retires.

A.3.2 Revenues

In each period there are new and old workers who earn gross wages w_{it}^n and w_{it}^o, respectively. The total wage mass M_t aggregates over the distribution of each group:

$$M_t = \int_{i_n} w_{it}^n dF_{i_n} + \int_{i_o} w_{it}^o dF_{i_o} = M_{t,n} + M_{t,o} \tag{10}$$

As we assume cohorts are of equal size, we write the wage mass of new and old cohorts of workers as $M_{t,n} = \alpha M_t$ and $M_{t,o} = (1-\alpha)M_t$. Then, we can express firm expected revenues (before switchers are taken into account) as:

$$\mathbb{E}[Y_{jt}] = \int_{i_n} pr_{ijt}(w_{it}^n, \mathbf{f}_t, \boldsymbol{\mu}_t)\ w_{it}^n\ dF_{i_n} + \int_{i_o} pr_{ijt}(w_{it}^o, \mathbf{f}_t, \boldsymbol{\mu}_t)\ w_{it}^o\ dF_{i_o} \tag{11}$$

$$= \alpha M_t \underbrace{\int_{i_n} pr_{ijt}(w_{it}^n, \mathbf{f}_t, \boldsymbol{\mu}_t) \frac{w_{it}^n}{\alpha M_t} dF_{i_n}}_{s_{jt}^n(\mathbf{f}_t, \boldsymbol{\mu}_t)} + (1-\alpha) M_t \underbrace{\int_{i_o} pr_{ijt}(w_{it}^o, \mathbf{f}_t, \boldsymbol{\mu}_t) \frac{w_{it}^o}{(1-\alpha)M_t} dF_{i_o}}_{s_{jt}^o(\mathbf{f}_t, \boldsymbol{\mu}_t)} \tag{12}$$

This equation is consistent with the revenue equation 6 and show the re-weighting of choice probabilities. Under our labor market assumptions, we re-express these probabilities as revenue shares, with higher-wage enrollees being relatively more valuable to firms than lower-wage ones. Note also that we use the same probability for new and existing enrollees, consistent with our assumption of equal preferences across cohorts (conditional on a life-cycle wage level).

A.3.3 SOE Revenues

In the baseline model, the SOE receives revenues not only from its original enrollees (new and old) but also from old enrollees switching from private PFAs. For this reason, we adjust Equation 6 as follows:

$$\mathbb{E}\big[Y_{SOE,t}\big] = f_{SOE,t} \times \Bigg[\underbrace{\underbrace{\Big(\alpha\, M_t\, s^n_{SOE,t}(\mathbf{f}_t, \boldsymbol{\mu}_t)}_{\text{New Workers' Wages}} + \underbrace{(1-\alpha)\, M_t\, s^o_{SOE,t}(\mathbf{f}_t, \boldsymbol{\mu}_t)\Big)}_{\text{Old Workers' Wages}}}_{\text{Original Enrollees}} + \underbrace{\sum_{j_{PF}} (1-\alpha)\, M_t\, s^o_{jt}(\mathbf{f}_t, \boldsymbol{\mu}_t)\, aw_{jt}(\mathbf{f}_t, \boldsymbol{\mu}_t)}_{\text{Incoming Switchers}} \Bigg] \tag{13}$$

Importantly, notice that we assume that no one is leaving the SOE by removing the awareness probability from the old-workers' term, and that it captures all enrollees leaving the group of private firms $\mathcal{J}_{PF}$.

A.3.4 Net Present Value of Expected Revenues of private firm j:

In this section, we start with the individual-level revenue equation, then we present the net present value equation for revenues, and specify a series of assumptions made to transition to working at an aggregate level.

Y_{jt} are the revenues for a private firm j in period t:

$$\begin{aligned} \mathbb{E}\big[Y_{jt}\big] \;=\; & f_j.\Big(\underbrace{\sum_{i_{c=t}} w^n_{it}.pr_{ij}(\mathbf{f}, \boldsymbol{\mu}).\mathbb{1}_{(t-40\leq c\leq t)}}_{\text{New workers}} \\ & + \underbrace{\sum_{i_{c<t}} w^o_{it}.\mathbb{1}(d_{i_{c<t}} = j_{t-1}).\mathbb{1}_{(t-40\leq c\leq t)}.(1-sw(\mathbf{f}, \boldsymbol{\mu}))}_{\text{Old workers}} \Big) \end{aligned} \tag{14}$$

f_j represents the management fee of firm j. i_c are individuals of cohort c. $i_{c=t}$ are individuals who enter to the market in t, while $i_{c<t}$ are individuals of old cohorts who enter until $t-1$. μ_j is the yearly expected return. w^n_{it} and w^o_{it} are the yearly computable wage of the new and old individuals, pr_{ij} the probability for individual i of choosing firm j, which for new consumers depends on the vector of fees and returns. The old consumers have already chosen a firm, so $\mathbb{1}(d_{i_{c<t}} = j)$ takes the value 1 if the individual $i_{c<t}$ chooses firm j and 0 in another case. $\mathbb{1}_{(t-40\leq c\leq t)}$ is a dummy with the value 1 if the individual is from a cohort between $t-40$ and t and 0 in other cases[48]. aw is the aware probability.

Y_{SOEt} are the revenues for the SOE in period t:

$$\begin{aligned}\mathbb{E}\big[Y_{SOE_t}\big] &= f_j.\Big(\underbrace{\sum_{i_{c=t}} w^n_{it}.pr_{ij}(\mathbf{f},\boldsymbol{\mu}).\mathbb{1}_{(t-40\leq c\leq t)}}_{\text{New workers}} + \underbrace{\sum_{i_{c<t}} w^o_{it}.\mathbb{1}(d_{i_{c<t}} = SOE_{t-1}).\mathbb{1}_{(t-40\leq c\leq t)}}_{\text{Old workers}} \\ &+ \underbrace{\sum_{i_{c<t}} w^o_{it}.\mathbb{1}(d_{i_{c<t}} \neq SOE_{t-1}).\mathbb{1}_{(t-40\leq c\leq t)}.sw(\mathbf{f},\boldsymbol{\mu})}_{\text{Switchers from PF}}\Big)\end{aligned} \quad (15)$$

Given assumptions (2) and (3) of the appendix A.3.1, the net present value of revenues of firm j in period t expressed as a summation of cohorts is:

[48]This is related to the deterministic retirement probability assumption.

$$
\begin{aligned}
E(NPVY_{jt}) \;=\; & f_j.\Bigg(\underbrace{\sum_{i_{c=t}} pr_{ij}(\mathbf{f},\boldsymbol{\mu}).w_i^n.\sum_{l=t}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\leq c\leq t)}.(1-aw(\mathbf{f},\boldsymbol{\mu}))^{l-t}}_{\text{New workers in } t\text{, from } t \text{ to } T} \\
& + \underbrace{\sum_{i_{c=t+1}} pr_{ij}(\mathbf{f},\boldsymbol{\mu}).w_i^n.\sum_{l=t+1}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\leq c\leq t)}.(1-aw(\mathbf{f},\boldsymbol{\mu}))^{l-t-1}}_{\text{New workers in } t+1\text{, from } t+1 \text{ to } T} \\
& + \;\ldots \\
& + \underbrace{\sum_{i_{c=T}} pr_{ij}(\mathbf{f},\boldsymbol{\mu}).w_i^n.\sum_{l=T}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\leq c\leq t)}.(1-aw(\mathbf{f},\boldsymbol{\mu}))^{l-t-(T-t)}}_{\text{New workers in } T\text{, from } T \text{ to } T} \\
& + \underbrace{\sum_{i_{c<t}} \mathbb{1}(d_{i_{c<t}}=j_{t-1}).w_i^o.\sum_{l=t}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\leq c\leq t)}.(1-aw(\mathbf{f},\boldsymbol{\mu}))^{l-t+1}}_{\text{Old workers from } t \text{ to } T}\Bigg)
\end{aligned}
\tag{16}
$$

Given assumption (1), the probability of retirement in each period is the same for all individuals within a cohort, therefore the third term of each sum does not depend on i and we call the terms as in $\sum_{l=t}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\leq c\leq t)}.(1-aw(\mathbf{f},\boldsymbol{\mu}))^{l-t}$ as $\gamma(\mathbf{f},\boldsymbol{\mu})'s$:

$$
\begin{aligned}
E(NPVY_{jt}) \;=\; & f_j.\Bigg(\underbrace{\sum_{i_{c=t}} p_{ij}(\mathbf{f},\boldsymbol{\mu}).w_i^n.\gamma_t(\mathbf{f},\boldsymbol{\mu})}_{\text{New workers in } t\text{, from } t \text{ to } T} + \underbrace{\sum_{i_{c=t+1}} p_{ij}(\mathbf{f},\boldsymbol{\mu}).w_i^n.\gamma_{t+1}(\mathbf{f},\boldsymbol{\mu})}_{\text{New workers in } t+1\text{, from } t+1 \text{ to } T} + \\
& \ldots \;+\; \underbrace{\sum_{i_{c=T}} p_{ij}(\mathbf{f},\boldsymbol{\mu}).w_i^n.\gamma_T(\mathbf{f},\boldsymbol{\mu})}_{\text{New workers in } T\text{, from } T \text{ to } T} + \underbrace{\sum_{i_{c<t}} \mathbb{1}(d_{i_{c<t}}=j_{t-1}).w_i^o.\gamma_o(\mathbf{f},\boldsymbol{\mu})}_{\text{Old workers from } t \text{ to } T}\Bigg)
\end{aligned}
\tag{17}
$$

We denote $W_t^n(\mathbf{f}, \boldsymbol{\mu}) = (\gamma_t(\mathbf{f}, \boldsymbol{\mu}) + ... + \gamma_T(\mathbf{f}, \boldsymbol{\mu}))$ and $W_t^o(\mathbf{f}, \boldsymbol{\mu}) = \gamma_o(\mathbf{f}, \boldsymbol{\mu})$:

$$\begin{aligned} E(NPVY_{jt}) &= f_j.\Bigg(\sum_{i_{c=t}} p_{ij}(\mathbf{f}, \boldsymbol{\mu}).w_i^n.W_t^n(\mathbf{f}, \boldsymbol{\mu}) \\ &+ \sum_{i_{c<t}} \mathbb{1}(d_{i_{c<t}} = j_{t-1}).w_i^o.W_t^o(\mathbf{f}, \boldsymbol{\mu})\Bigg) \end{aligned} \tag{18}$$

Now call M the total mass of gross wages affected to the individual capitalization subsystem in period t, and α the share of that mass of wage that comes from new cohort. So $\sum_{i_{c=t}} w_i^n = \alpha M$ and $\sum_{i_{c<t}} w_i^o = (1-\alpha)M$.

We multiply and divide every term by the mass of wage of new and old, and call $s_j^n = \sum_{i_{c=1}} \frac{p_{ij}(\mathbf{f},\boldsymbol{\mu}).w_{it}^n}{\sum_{i_{c=t}} w_i^n}$ and $s_j^o = \sum_{i_{c<t}} \frac{\mathbb{1}(d_{i_{c<t}}=j_{t-1}).w_{it}^o}{\sum_{i_{c<t}} w_i^o}$, so we get:

$$E(NPVY_{jt}) = f_j.\Bigg(s_j^n(\mathbf{f}, \boldsymbol{\mu}).\alpha.M.W_t^n(\mathbf{f}, \boldsymbol{\mu}) + s_j^o.(1-\alpha).M.W_t^o(\mathbf{f}, \boldsymbol{\mu})\Bigg) \tag{19}$$

where M is the total mass of gross wages affected to the individual capitalization subsystem in period t, and α the share of that mass of wage that comes from new cohort. $W_t^n(\mathbf{f}, \boldsymbol{\mu})$ and $W_t^o(\mathbf{f}, \boldsymbol{\mu})$ are weights of new and old consumers in net present value. The shares $s_j^n(\mathbf{f}, \boldsymbol{\mu})$ and s_j^o of new and old workers are compound terms that depend both on the workers' enrollment decisions in current and previous periods, as well as on weights associated with the importance of individual gross wages in the aggregated wage mass. This reflects the fact that richer individuals have a higher positive impact on PFAs' revenues than poorer ones through the one-to-one connection between revenues and gross wages.

The formula is similar to the revenue equation in period t, but the weight of the new cohorts is much greater. On one hand, this is because the new cohorts contribute for a longer period before retiring. On the other hand, it is because a new cohort enters every year, while the stock of old cohorts diminishes.

A.3.5 Net Present Value of Expected Revenues of SOE:

$$
\begin{aligned}
E(NPVY_{SOEt}) \;=\; & f_j.\Bigg(\underbrace{\sum_{i_{c=t}} p_{ij}(\mathbf{f},\boldsymbol{\mu}).w_i^n.\sum_{l=t}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\le c\le t)}}_{\text{New workers in } t\text{, from } t \text{ to } T} \\
& + \underbrace{\sum_{i_{c=t}} w_{it}^n.\mathbb{1}(d_{i_{c=t}}\neq SOE_t).\sum_{l=t+1}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\le c\le t)}.aw(\mathbf{f},\boldsymbol{\mu}).(1-aw(\mathbf{f},\boldsymbol{\mu}))^{l-t-1}}_{\text{Switchers of cohort } t \text{ from } t \text{ to } T} \\
& + \underbrace{\sum_{i_{c=t+1}} p_{ij}(\mathbf{f},\boldsymbol{\mu}).w_i^n.\sum_{l=t+1}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\le c\le t)}}_{\text{New workers in } t+1\text{, from } t+1 \text{ to } T} \\
& + \underbrace{\sum_{i_{c=t+1}} w_{it}^n.\mathbb{1}(d_{i_{c=t+1}}\neq SOE_{t+1}).\sum_{l=t+2}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\le c\le t)}.aw(\mathbf{f},\boldsymbol{\mu}).(1-aw(\mathbf{f},\boldsymbol{\mu}))^{l-t-2}}_{\text{Switchers of cohort } t+1 \text{ from } t+1 \text{ to } T} \\
& + \ldots \\
& + \underbrace{\sum_{i_{c=T}} pr_{ij}(\mathbf{f},\boldsymbol{\mu}).w_i^n.\sum_{l=T}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\le c\le t)}}_{\text{New workers in } T\text{, from } T \text{ to } T} \\
& + \underbrace{\sum_{i_{c<t}} w_{i}^o.\mathbb{1}(d_{i_{c<t}}= SOE_{t-1}).\sum_{l=t}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\le c\le t)}}_{\text{Old workers from } t \text{ to } T} \\
& + \underbrace{\sum_{i_{c<t}} w_{it}^o.\mathbb{1}(d_{i_{c<t}}\neq SOE_{t-1}).\sum_{l=t}^{T}\beta^{l-t}.\mathbb{1}_{(t-40\le c\le t)}.aw(\mathbf{f},\boldsymbol{\mu}).(1-aw(\mathbf{f},\boldsymbol{\mu}))^{l-t}}_{\text{Switchers old from } t \text{ to } T} \Bigg)
\end{aligned}
\tag{20}
$$

A.3.6 Expected Capitalization Cost

For period t, the expected capitalization cost of firm j depends on the Pension Savings Fund (PSF_{jt})[49], and on the realization of firm-specific and average market returns R_{jt} and $\bar{R}_t$. Even though the PSF_jt also is a function of R_{jt}, for simplicity we assume that the capitalization cost is based on the stock before R_{jt} realizes.

[49]This represents the value of the assets under management.

By law, the minimum rate of return $r_{\text{min},t}$ that pension fund administrators must secure their enrollees is the minimum between: 1) 2%, and 2) $\bar{R}_t - 2\%$[50]. To calculate the expected cost we work with the support of r_{min}:

$$\mathbb{E}[\text{Cap. Cost}]_{jt} = \int_{\text{supp}(r_{\text{min}})} \left(\int_{-\inf}^{r_{\text{min},t}} \text{PSF}_{jt} \cdot (r_{\text{min},t} - R_{jt}) \cdot f(R_{jt}, \bar{R}_t) d\text{R} \right) d\text{F}(r_{\text{min}}) \tag{21}$$

Notice that when $\bar{R} \geq 4\%$, the minimum rate is 2%, while when $\bar{R} < 4\%$, the minimum rate is $\bar{R} - 2\%$. Then, the capitalization cost of firm j as a function of the distributions of $\bar{R}$ and R_j is:

$$\begin{aligned}
\mathbb{E}[\text{Cap. Cost}]_{jt} &= \Bigg(\underbrace{\int_{-\inf}^{4\%} \int_{-\inf}^{\bar{R}-2\%} \text{PSF}_{jt} \cdot (\bar{R}_t - 2\% - R_{jt}) \cdot f(R_j, \bar{R}) \text{dRd}\bar{R}}_{E(\text{Cap Cost}|\bar{R} \leq 4\%)_{jt}} \Bigg) \cdot F_{\bar{R}}(4\%) \\
&+ \Bigg(\underbrace{\int_{4\%}^{\inf} \int_{-\inf}^{2\%} \text{PSF}_{jt} \cdot (2\% - R_{jt}) \cdot f(R_j, \bar{R}) \text{dRd}\bar{R}}_{E(\text{Cap Cost}|\bar{R} \geq 4\%)_{jt}} \Bigg) \cdot (1 - F_{\bar{R}}(4\%)) \\
&= \left(\int_{-\inf}^{4\%} \int_{-\inf}^{\bar{R}-2\%} \text{PSF}_{jt} \cdot (\bar{R}_t - 2\% - R_{jt}) \cdot f(R_j, \bar{R}) \text{dRd}\bar{R} \right) \cdot F_{\bar{R}}(4\%) \\
&+ \left(\int_{4\%}^{\inf} \int_{-\inf}^{2\%} \text{PSF}_{jt} \cdot (2\% - R_{jt}) \cdot f(R_j, \bar{R}) \text{dRd}\bar{R} \right) \cdot (1 - F_{\bar{R}}(4\%))
\end{aligned}$$

To work with this term, we assume that R_j follows a Normal distribution with $R_j \sim \mathcal{N}(\mu_j, \sigma_j^2)$ and therefore, the average return also follows a normal distribution $\bar{R} \sim \mathcal{N}(\bar{\mu}, \bar{\sigma}^2)$ with $\bar{\mu} = \sum_j \omega_j \mu_j$ and $\bar{\sigma}^2 = \sum_j \sum_j \omega_j \omega_k \sigma_{jk} = \omega' \Sigma \omega$. Furthermore, given that both R_j and $\bar{R}$ are Normal random variables, the joint distribution $f(R_j, \bar{R})$ has the following expres-

[50] $\bar{R}_t$ is the average of R_{jt} across PFAs', weighted by a vector ω that sum to 1 and depends on the PSF_{jt} of each firm: $\bar{R}_t = \sum_j \omega_{jt} R_{jt}$ with $\omega_{jt} = \frac{PSF_{jt}}{\sum_j PSF_{jt}}$

sion:

$$f(R_j, \bar{R}) = \frac{1}{2\pi\sigma_{R_j}\sigma_{\bar{R}}\sqrt{1-\rho^2}} \tag{22}$$
$$\cdot \exp\left\{-\frac{1}{2\left(1-\rho^2\right)}\left[\left(\frac{R_{jt}-\mu_j}{\sigma_{R_j}}\right)^2+\left(\frac{\bar{R}_t-\mu_{\bar{R}}}{\sigma_{\bar{R}}}\right)^2-2\rho\frac{\left(R_{jt}-\mu_{R_j}\right)\left(\bar{R}_t-\mu_{\bar{R}}\right)}{\sigma_{R_j}\sigma_{\bar{R}}}\right]\right\}$$

A.4 Estimation

A.4.1 Life Cycle Gross Wage

Our database contains payroll data between 1996 and 2020 for a random sample of 125,000 workers, drawn from the universe of active workers. We observe each worker's monthly wage during this period. To construct an estimate of workers' wages over their life cycle, we proceed as follows:

1 We calculate an earnings curve over the working life cycle for the economy by regressing annual wages on age and age squared. Because our sample includes workers at different career stages, it captures individuals nearing retirement in 1996 as well as new entrants to the labor market.

2 We apply this earnings curve to each worker used to estimate demand —specifically, those who entered the labor market for the first time between 2002 and 2020— using their observed salary in the year of entry.

3 We compute the average wage for each worker over their working life cycle.

A.4.2 1^{st} Stage - Estimation Results

Table A.3: Switching Probability From PF to SOE

	(1)
Gap $(\mu_{jt} - \mu_{SOE,t})$	-5.893***
	(0.473)
Gap $(f_{jt} - f_{SOE,t})$	52.02***
	(2.671)
Dummy 2013 reform	0.374***
	(0.00515)
PF 1	0.0649***
	(0.00620)
PF 2	-0.900***
	(0.0334)
PF 3	0.0528***
	(0.00581)
Constant	-3.046***
	(0.00786)

Notes. Probit model. Estimation of equation 5. Period: 2002-2020.

A.4.3 2^{nd} Stage - Additional Results

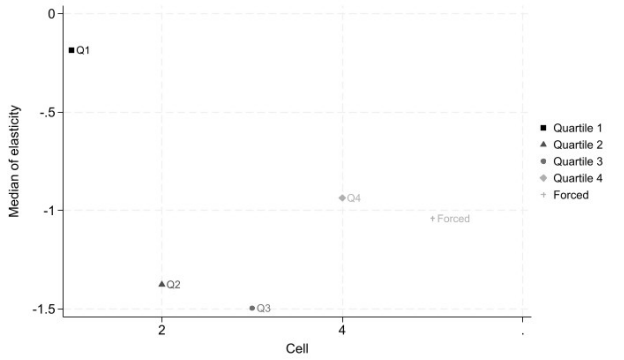
Table A.4: Conditional logit estimations

	(1)	(2)	(3)	(4)	(5)
NPV Management Cost	-2.03e-06***	-1.23e-05***	-1.32e-05***	-8.34e-06***	-1.73e-06***
	(5.10e-07)	(4.50e-07)	(4.05e-07)	(2.87e-07)	(5.04e-07)
NPV Savings	8.65e-07***	5.24e-07***	4.69e-08	1.15e-07	3.66e-08
	(2.16e-07)	(1.26e-07)	(9.12e-08)	(7.81e-08)	(1.00e-07)
PF 1	-0.970***	1.441***	3.648***	3.427***	-2.139***
	(0.129)	(0.154)	(0.182)	(0.244)	(0.325)
PF 2	-1.050***	1.468***	3.784***	3.650***	-2.001***
	(0.133)	(0.158)	(0.186)	(0.246)	(0.321)
SOE	-1.287***	0.997***	3.740***	4.260***	-0.625*
	(0.148)	(0.160)	(0.182)	(0.244)	(0.328)
PF 3	-0.998***	1.693***	3.863***	3.616***	-1.492***
	(0.128)	(0.153)	(0.181)	(0.243)	(0.308)
Bracket of income	Quartile 1	Quartile 2	Quartile 3	Quartile 4	Forced
Observations	62,595	69,685	72,140	52,745	7,220

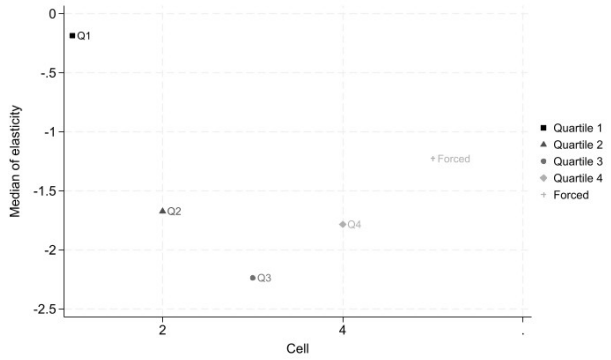
Notes: Conditional logit estimation by bracket of income. Controls: number of sales force agents sf_{jt}, firm fixed effects η_j and market fixed effects (year x inside option) ζ_t. Standard errors reported in parentheses. For hypothesis testing we use p-values with significance levels: ***p $<$ 0.01, **p $<$ 0.05, *p $<$ 0.1.

Figure A.7: Median Management Cost Elasticity by Bracket and Period

(a) Period 2002-05



(b) Period 2014-17

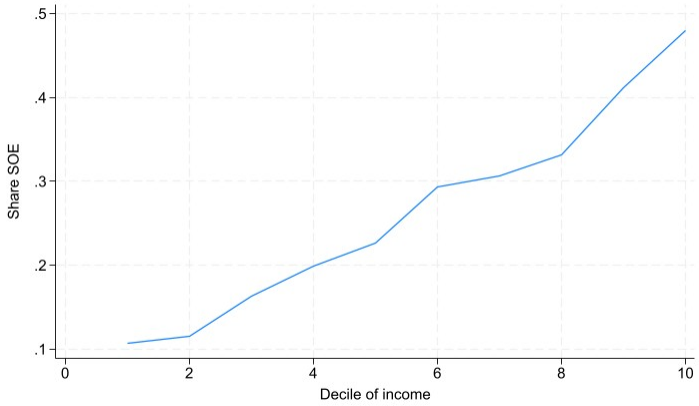


Note. Within-bracket median elasticity with respect to the management fee by period. Elasticities are calculated using observed fees, mean returns, and gross wages.

A.4.4 Enrollment Probability and Income

The results described in Section 5 are consistent with the fact that higher-wage workers enroll with higher probability in the public option. This explains why, despite having a market share of enrollees of approximately 40%, the SOE receives close to 55% of monthly gross contributions in the subsystem. In Figure A.8 we display the predicted enrollment probability to the public option by gross wage decile, as implied by the model.

Figure A.8: SOE Enrollment Probability by Wage Decile



Note. Median probability by gross wage decile as predicted by the model for the period 2014-17.

A.5 Estimated and Accounting Profits Structure

This appendix details the various components of the estimated revenue and cost structure of the firms and compares them with the information reported in the financial statements.

The Table A.5 presents the estimated revenues and a disaggregation of variable costs into three components: affiliation costs (linked to the sales force), investment-related costs, and regulation-related costs (which include expected capitalization costs and the expected opportunity cost associated with the special reserve).

In the Table A.6 we present information derived from the financial statements. It can be observed that accounting revenues and estimated revenues are very similar. Regarding

Table A.5: ESTIMATED REVENUES AND COSTS

	Sum of PF	SOE	Total
Revenue	66.18	29.08	95.26
Variable Costs	6.16	2.36	8.52
Sales force	1.45	1.24	2.69
Investment	0.56	0.12	0.68
Regulation	4.15	1.00	5.15

Notes. Average 2014-2017. Expressed in US$ Millions Dollars 2017. To compute these estimated costs, we use the corresponding parameters from the estimates, together with the observed average values over the 2014–2017 period for either sales force intensity or the rate of return, and convert the results to millions of 2017 U.S. dollars. For example, to calculate the SOE's investment cost, we compute: $\exp(\kappa_j \cdot \mu_{j14-17})/1000000/dollar_{2017} = \exp(1128 \cdot 0.0133618)/1000000/28,635$.

costs, the estimated variable costs account for 16% of the total costs, and 21% of the pre-tax costs. The remaining component corresponds to the firms' fixed costs.

Based on these two tables, it is possible to assess the weight of the sales force within the firms' cost structure. In relation to variable costs, the sales force accounts for 32%, while in relation to total pre tax costs, it is 7 %.

It is not possible to determine the expenditure on each component of variable costs from the financial statements. However, using the sample of employment histories, we find that during the 2014–2017 period, the average monthly salary of a sales agent was US$2,658. Sales force compensation includes both a fixed and a variable component; what we are capturing here is the variable component. Based on the estimated aggregate cost of new affiliations derived from the model and the known size of the sales force, we estimate that the variable wage component per agent was US$1,429.

In Uruguay, sectoral minimum wages are established through collective bargaining, and there is a specific bargaining group for PFA employees (Group 11, Subgroup 1.3). While

Table A.6: FIRMS'S FINANCIAL STATEMENT

	Sum of PF	SOE	Total
Revenue	63.96	36.26	100.22
Costs	29.48	23.89	53.37
Wage	13.11	9.84	22.95
Administration_cost	2.22	0.80	3.02
Commercial_cost	0.97	1.17	2.14
IT_cost	2.08	1.26	3.34
Customer_Service	1.07	0.83	1.90
Other_costs	1.77	4.93	6.70
Taxes	8.26	5.06	13.32

Notes. Average 2014-2017. Expressed in US$ Millions Dollars 2017.

the agreement does not set a variable wage, it does set a minimum wage for the sales force (US$513), which we take as a proxy for the fixed component. This yields an estimated total average salary of US$1,942. This estimate should be considered a lower bound of the actual salary, as firms may pay higher fixed wages due to factors such as tenure or individual performance. Therefore, there is consistency between the information from administrative records and the estimates derived from the model.

A.6 Sales force average variable payments per enrollee

We define the wage mass of the sale force of firm j in month t as:

$$W_{jt} = L_{jt}^{sf}(w_{jt}^{fixed} + Aff_{jt} \times w_{jt}^{variable}) \tag{23}$$

being L_{jt}^{sf} the sales force, w_{jt}^{fixed} the average fixed wage, Aff_{jt} the average number of affiliates through sales force and $w_{jt}^{variable}$ the average variable wage.

We observe L_{jt}^{sf}, W_{jt} and Aff_{jt}. Regarding w_{jt}^{fixed}, we construct the following proxy. As mentioned before, in Uruguay, the minimum wage by sector is set through collective bargaining and there is a specific negotiation group for PFAs' employees (group 11, Sub-

group 1.3). The negotiation does not set the variable salary. However, the minimum wage set in the negotiation for the sales force (US$ 513 dollars) is taken as a proxy for the fixed-wage component, so the results obtained are an upper bound of the variable wage component.

A.7 Counterfactual

A.7.1 Additional results.

Table A.7: Privatization - Oligopoly with Four Private Firms. SOE with minimum marginal cost of PF.

	Fees f_j^* (% Gross Wage)		Returns μ_j^* 1Yr (%)		$\mathbb{E}[\pi_t]$ (US$ Mill.)		$\mathbb{E}[\text{Savings}]^*$ (US$ '000)	
	PFs	SOE	PFs	SOE	PF (Tot.)	SOE	PFs	SOE
Baseline Equilibrium (Avg. 2014/17)	1.94	0.80	1.36	1.33	60.18	27.22	40.75	44.61
Counterfactual								
1) $\rightarrow \hat{\lambda} = 0$	1.90	4.49	1.35	1.10	56.54	158.7	40.83	29.58
2) $\rightarrow \hat{\lambda} = 0 \ + \ s_{SOE}^{old} = s_j^{old} = 0.25$	2.11	2.37	1.34	1.32	103.97	39.00	40.03	38.75
3) $\rightarrow$ 2) $+ \ \eta_{SOE} = \bar{\eta}_{pf}$	2.10	1.89	1.34	1.35	103.79	30.54	40.04	40.73

Notes: Similar to Table 5, but assuming that the marginal cost of the SOE is equal to the marginal cost of the most efficient private firm. [*] Mean savings for a worker facing equilibrium f^* and μ^* for 40 years. PF averages are weighted by enrollment shares s_j. Awaking probability is a function of the difference between a firm's fee and the market average. When consumers awake, they meet the sales force (as in the first choice). Marginal costs apply every period.

Table A.8: Privatization - Oligopoly with Four Private Firms. SOE with average marginal cost of PF.

	Fees f_j^* (% Gross Wage)		Returns μ_j^* 1Yr (%)		$\mathbb{E}[\pi_t]$ (US$ Mill.)		$\mathbb{E}[\text{Savings}]^*$ (US$ '000)	
	PFs	SOE	PFs	SOE	PF (Tot.)	SOE	PFs	SOE
Baseline Equilibrium (Avg. 2014/17)	1.94	0.80	1.36	1.33	60.18	27.02	40.75	44.60
Counterfactual								
1) $\rightarrow \hat{\lambda} = 0$	1.90	4.56	1.35	1.07	56.49	161.25	40.82	29.09
2) $\rightarrow \hat{\lambda} = 0 \ + \ s_{SOE}^{old} = s_j^{old} = 0.25$	2.11	2.50	1.34	1.31	103.9	41.10	40.04	38.20
3) $\rightarrow$ 2) $+ \ \eta_{SOE} = \bar{\eta}_{pf}$	2.10	2.00	1.34	1.34	103.62	32.44	40.06	40.22

Notes: Similar to Table 5, but assuming that the marginal cost of the SOE is equal to the marginal cost of the average private firm. [*] Mean savings for a worker facing equilibrium f^* and μ^* for 40 years. PF averages are weighted by enrollment shares s_j. Awaking probability is a function of the difference between a firm's fee and the market average. When consumers awake, they meet the sales force (as in the first choice). Marginal costs apply every period.

Table A.9: Privatization - Oligopoly with Four Private Firms. Ex SOE efficiency gains.

	Fees f_j^* (% Gross Wage)		Returns μ_j^* 1Yr (%)		$\mathbb{E}[\pi_t]$ (US$ Mill.)		$\mathbb{E}[\text{Savings}]^*$ (US$ '000)	
	PFs	SOE	PFs	SOE	PF (Tot.)	SOE	PFs	SOE
Baseline Equilibrium (Avg. 2014/17)	1.94	0.80	1.36	1.33	60.17	26.72	**40.75**	**44.59**
Counterfactual								
1) $\rightarrow \hat{\lambda} = 0$	1.90	4.47	1.35	1.24	56.67	158.11	40.85	30.56
2) $\rightarrow \hat{\lambda} = 0 \ + \ s_{SOE}^{old} = s_j^{old} = 0.25$	2.12	2.34	1.35	1.57	104.17	38.92	40.04	41.08
3) $\rightarrow$ 2) $+ \ \eta_{SOE} = \bar{\eta}_{pf}$	2.11	1.86	1.35	1.60	104.11	30.44	40.04	43.22

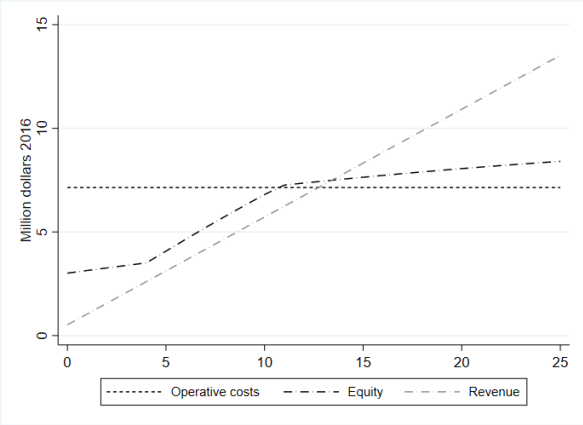
Notes: We impose on the former SOE the marginal costs and κ of the most efficient private firm. [*] Mean savings for a worker facing equilibrium f^* and μ^* for 40 years. PF averages are weighted by enrollment shares s_j. Awaking probability is a function of the difference between a firm's fee and the market average. When consumers awake, they meet the sales force (as in the first choice). Marginal costs apply every period.

A.7.2 (Lack of) Entry Incentives

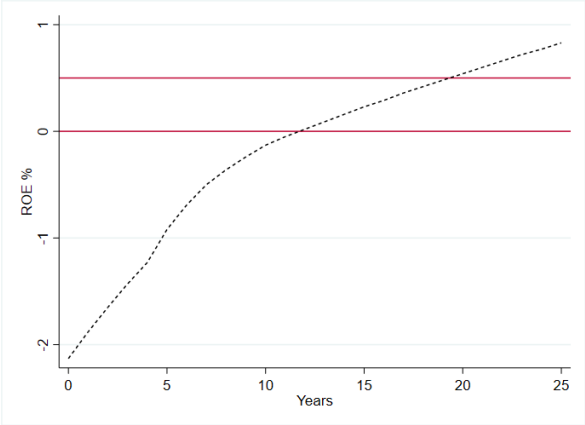
As shown in Figure A.9a, a new pension fund administrator entering the market under conditions similar to those observed historically would take approximately 12 years to achieve a positive return on equity (ROE), and around 19 years to reach an ROE of 50%—a level comparable to that of incumbent firms. This slow trajectory is primarily driven by high fixed operating costs. Investment management requires a similar organizational scale, whether the fund is small or large, while sales force and marketing expenses are aimed at acquiring new customers and are largely unaffected by the number of current enrollees.

Unlike the early days of the system —when all firms competed to enroll a large, untapped pool of existing workers— new entrants today can only target new cohorts of labor market entrants, making the growth of a sufficiently large customer base slower and more costly than during the system's inception.

(a) Revenues, Costs and Equity



(b) Return-Over-Equity



Note: This figure shows the evolution of revenues, costs, equity, and return on equity after entry.