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PRODUCT CHOICE UNDER GOVERNMENT REGULATION: THE CASE OF CHILE'S PRIVATIZED PENSION SYSTEM*

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Chile's individual retirement pension accounts system has been a model for many countries. To limit the riskiness of pension investments, Chile required pension fund managers to deliver returns that are not more than 2% below the industry average. We develop and estimate a model of the pension investment market that allows us to study the impact of minimum return regulation. We find that the regulation leads to higher demand for risky investments, creates incentives to offer riskier portfolios, and leads to higher management fees. However, the regulation also stimulates balance accumulation that ultimately reduces the reliance on government support.

1. INTRODUCTION

The United States and many European countries are considering how best to reform their pay-as-you-go social security systems. Demographic trends indicate rising numbers of pensioners per worker and pending insolvency of many social security systems. The kinds of reforms being considered include increasing the required social security contribution per worker, raising the standard retirement age, or overhauling the system by transiting to a private retirement accounts system. Chile has been at the forefront of pension reforms, having switched to a private retirement accounts system 25 years ago. Numerous other Latin American and South American countries followed suit, building on the Chilean model. These include (with years of adoption in parentheses): Peru (1993), Colombia (1994), Argentina (1994), Uruguay (1996), Bolivia (1997), Mexico (1997), El Salvador (1998), Costa Rica (2001), the Dominican Republic (2003), Nicaragua (2004), and Ecuador (2004).[2]

The proposed plans for pension reform in the United States and in Europe have many features in common with Chile's pension system. They outline a system under which workers are mandated to contribute a percentage of their income to their pension account, which is managed by money manager(s) (either a government owned company or a competitive industry of money managers). The government serves as a last resort guarantor, supplementing pension income

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[2] Cogan and Mitchell (2003) discuss prospects for funded individual defined contributions account pensions in the United States.

if pension accumulations are insufficient upon retirement (below prespecified minimal level) either because of low income or unfavorable investment returns. All these features are present in the Chilean pension fund system, called the *Administradoras de Fondos de Pensiones* (AFPs). Specifically, workers are mandated to contribute 10% of their earnings to a retirement account. Contributing workers receive a minimum pension benefit guarantee from the government.

Several important concerns have been raised about this type of individual retirement accounts system. The first is that government obligations can be large, particularly in years with unfavorable market returns. Second, the government guarantee of minimal support may induce moral hazard problems by providing incentives for consumers with low income to choose risky investment options. If the system is run by a competitive industry, then money managers may offer products to meet this riskier demand.

To insulate consumers from excessive risk, individual retirement accounts pension systems usually incorporate features designed to limit the riskiness of the portfolios offered. In some cases, there may be restrictions on the investment options that pension fund managers are allowed to offer. In other cases, the burden of guaranteed pension support may be shifted in part from the government toward the industry by requiring that the pension managers guarantee a certain level of return. For example, the Chilean government required pension fund management firms to guarantee a return on their enrollees' investments that is within 2 percentage points of the industry average.

This article investigates how this type of minimum return regulation affects the pension fund industry's operation. To this end, we estimate an equilibrium model of demand and supply in the pension investment market and use the model to study the effects of regulation under alternative scenarios. The question of whether and to what extent such regulations protect a privatized retirement accounts system from excessive risk taking is pertinent not only for Chile but also for the many other countries (listed above) that operate similar retirement account systems and for any country considering a move to a privatized account system. Our analysis also provides general insights into the consequences of minimum return guarantees in the context of a competitive money management industry.

The model we develop is a three-stage model of industry competition and consumer choices. In the first stage, the firms participating in the market simultaneously decide which portfolios to offer. In the second stage, the firms observe competitors' portfolio choices and simultaneously decide on the fees that they charge their consumers. In the third stage, consumers choose pension management firms to manage their pension accumulations, portfolio returns realize, and profits accrue. We argue that in the absence of other incentives, the minimal return regulation induces pension managers to choose riskier portfolios relative to the choices they would make in the absence of regulation. However, the specific features of the demand (consumer heterogeneity) may work to enhance or mitigate these incentives in a competitive environment. Specifically, the joint distribution of risk preferences, price sensitivity, accumulated balance, and income in the population plays an important role in determining the overall regulation impact. Also, changes in products offered to the market, in fee structures, and in consumer choices induced by the regulation will affect pension accumulation and may therefore have important welfare implications. For example, if the regulation leads to riskier investments, we would expect to see an increase in the variability of consumers' balances, perhaps accompanied by an increase in accumulated average balances. Depending on the magnitude of these effects, the minimum return regulation may work to facilitate balance accumulation and decrease reliance on government pension support. Empirical analysis is needed to fully assess the effect of such regulation on the market operation.

Our empirical analysis combines data from multiple sources. First, we have administrative data on contributions and fund choices from 1981 to 2004 from the pension fund regulatory agency. These data were merged with longitudinal household survey data gathered in 2002 and 2004. Thus, we analyze microlevel data on individual characteristics, wealth levels, and pension fund choices. Additionally, we obtained data series on portfolios' returns and fees charged by funds as well as accounting cost data.

Descriptive analysis reveals that consumer heterogeneity plays an important role in this market. For example, evidence that different firms attract different types of consumers can be seen in the fact that the pension management firm that attracts the highest share of enrollees does not have the highest share of balance under management; that is, this company tends to attract individuals with relatively low average balances. Indeed, preferences for risk and for residual income that drive consumer's choices likely vary across demographic groups, and AFP firms can exploit this heterogeneity to segment the market. We capture this feature of the environment by rationalizing the observed demand for pension managing services through an indirect utility function where the risk preferences and price sensitivity depend in a flexible way on consumers' demographics.

As in many other developing countries, the Chilean economy is characterized by a substantial informal sector. Descriptive analysis reveals that many individuals participating in the pension system spend almost half of their working time in the informal sector and, during these periods, do not contribute to their pension account. For this reason, we also incorporate in our model individuals' decisions whether to work in the formal or in the informal sector.

We find that consumers' risk preferences and price sensitivity vary with demographics. Interestingly, consumers in this market are quite risk averse, which suggests that concerns about excessive demand for risky products may not be justified. The estimated level of risk aversion is comparable to the levels that have been estimated for other markets, for example, the market for car insurance.[3]

Our estimated model fits the data well. In particular, using a single set of firm fixed effects, the model rationalizes market shares of various pension managers with respect to the number of enrollees, balance under management, and contributions in the population of informal and formal sector workers. A large part of the model fit is accounted for by the systematic part of the model instead of the unobservable error terms. Unlike other studies of differentiated products markets, we have access to detailed data on firms' costs. We use these data to estimate the pension managers' cost function directly, instead of exploiting optimality of firms' pricing decisions as is more standard in the differentiated products literature. An advantage of this approach is that it allows us to recover the model primitives without having to impose a particular model of pricing and competition in the estimation.

We use the estimated parameters characterizing the demand and supply side of our market to conduct counterfactual analysis of the impact of the minimal return regulation on the industry and on consumers.[4] We find that given the market returns in our data, minimal return regulation incentivizes firms to move toward riskier portfolios relative to those that would be chosen in the absence of regulation. Specifically, the risk of the safest portfolio offered in the market increases substantially. We isolate the effects associated with the two channels through which regulation impacts the market: (i) It directly affects consumer choices by offering them protection from downside risk, and (ii) it imposes additional costs on the pension management firms, which is tied to their performance relative to that of competitors. The first component effectively shifts consumer demand toward moderately risky products. This induces the industry to substantially increase the risk of the safest portfolio offered while reducing the risk of the riskiest portfolio. The second component has dual effects. On the one hand, it introduces complementarities in firms' portfolio choices. On the other hand, the regulation imposes additional costs on the industry that results in an increase in the fees charged for pension management services. The relative impact of these two effects appears to depend on the degree of protection from downside risk offered to consumers by the regulation. Specifically,

[3] See Cohen and Einav (2007) for the review of the levels of consumer risk aversion documented in different settings.

[4] In this analysis, we study the impact of minimal return regulation holding constant other features of the market. In reality, however, this regulation was implemented in combination with some other restrictions on the operation of portfolio managers. In the analysis below, we investigate the combined impact of the minimal return regulation and one such restriction, an upper bound on the riskiness of the assets that the money managers were allowed to include in their portfolios. We find that the imposition of portfolio restrictions can reduce the impact of the minimal return regulation.

we find that changes in the set of portfolios offered in the market are sensitive to the regulation restrictiveness.

We evaluate the overall impact of regulation by investigating resulting pension balance accumulations under alternative regulatory regimes. We find that balance variability at the time of retirement increases under the regulation. However, the higher variance is accompanied by an increase in balance accumulations, on average, that substantially decreases reliance on government pension support relative to the case without regulation. The important channel through which regulation achieves this effect is by offering consumers protection from downside risk, which makes them willing to invest in riskier portfolios and, in turn, facilitates balance accumulation. With the regulation, fees are higher, offsetting somewhat the beneficial impact on consumer welfare, particularly for lower income subgroups. But for those with higher income, the overall impact of the regulation on consumer welfare is positive.

Previous research on Chile mainly examined the impact of pension reforms on the macroeconomy, capital markets, and aggregate savings.[5] It found substantial benefits of moving to a private retirement accounts system in promoting the development of well-functioning capital markets and in stimulating economic growth. Recently, several papers have analyzed consumer choices in the context of the Chilean pension system (see Joubert, 2015, and Luco, 2013) as well as market competition and the impact of industry structure and regulation on consumer welfare for Chile and similar markets (Hastings et al., 2015). This article is also related to the recent literature analyzing industry competition when firms choose both prices and the characteristics of the products they offer, for example, Fan (2013), Draganska et al. (2009), and Eizenberg (2014).

The article is organized as follows: Section 2 provides some background information on the Chilean private accounts system. Section 3 describes the consumer's choice problem and outlines the oligopolistic model of the firms' price and portfolio decisions. Section 4 discusses expected consequences of the minimal return regulation. Section 5 describes the data, and Section 6 presents estimation strategy. Section 7 summarizes the empirical results, and Section 8 discusses empirical implications of the minimal return regulation. Section 9 concludes.

2. INDUSTRY DESCRIPTION

The Chilean individual pension accounts system was established in 1981 as an alternative to the "pay-as-you-go" system that existed at that time. Workers close to retirement age were given a choice of remaining in the old system (called the INP system) or moving to the new AFP system, whereas new workers were required to affiliate with the new system.[6]

A competitive industry was established to manage the pension accumulations of Chilean workers. From its inception, the industry was heavily regulated. Only companies with a proven track record in money management were licensed to manage pension investments. These companies were required to limit their operation to managing pension accumulations and were not allowed to be involved in other money management activities. The industry initially attracted a large number of firms (up to 20–25 firms in various years), but gradually the number of firms declined due to exits and mergers.[7] Toward the end of the 1990s, there were eight firms. During the first 20 years, every pension manager was restricted to offer a single portfolio to his or her

[5] Many have written on the Chilean pensions system (e.g., Cheyre, 1988; Iglesias and Acuña, 1991; Baeza et al., 1995). Some of the literature is summarized in Mesa et al. (2006).

[6] To encourage transfers, workers who opted for the new system received a 12.6% increase in net income (the new contribution rate plus commissions or fees), and the benefits accrued under the old system were recognized through the issuing of a recognition bond.

[7] In each case, the exit was organized as a merger with one of the existing AFPs. The clients of an existing AFP were transferred to its merging partner, though the clients could easily switch funds afterward.

customers. Starting in 2000, however, they were allowed to offer four alternative portfolios, which differed according to the riskiness of the investment.[8]

Under the individual accounts system, Chilean workers are mandated to contribute 10% of their earnings into their pension account on a regular basis. Those participating in the system are guaranteed pension support provided by the government should their accumulations fall short of a prespecified minimum. Workers are required to place all their pension accumulations with a single pension manager, which, during the period we study, effectively restricts them to placing their whole balance in a single investment portfolio.[9] The rules governing switching between money managers changed several times over the years, but beginning in 1984 investors could switch funds without incurring monetary costs. The government facilitates dissemination of information about the performance, fees, and the composition of portfolios managed by various AFP firms. Specifically, a quarterly brochure is circulated, which reports these details. It is available in local pension authority offices or can be ordered by mail or downloaded from a government Web site.

Pension managers charge fees for their services. Initially, the fee was a three-part nonlinear tariff consisting of a fixed fee, a variable fee proportional to the participant's contribution, and a fee proportional to the participant's balance. Some companies initially also charged fees for withdrawal of funds, but in 1984, the government passed a regulation to disallow fees on the balance or on withdrawal. This regulation was introduced in part to avoid the depletion of balances for nonworkers stemming from fees. Currently, most pension managers charge a two-part tariff consisting of a fixed fee and a fee that is proportional to the participant's contribution.

When the private accounts system was established, the government exerted control over the investment choices. Initially, pension investments could only be held in government bonds, but over time the options expanded to include stocks and to allow a higher degree of foreign investments. Importantly, to reduce the riskiness of the system, the government imposed a minimal return regulation that shifted part of the costs of the guaranteed pension support toward the industry. This regulation required that pension managers deliver a real return above a threshold equal to 2 percentage points below the industry average, making the firms responsible for covering low return realizations with their own capital. The analysis in this article focuses on this minimal return regulation, because this type of regulation regularly appears in proposals for pension system design considered by various countries.

3. MODELING FRAMEWORK

We next outline our model of industry competition, which is a game that describes firms' pricing and portfolio decisions.

3.1. *Discussion of Modeling Choices.* The primary aim of this article is to understand how return regulation in the context of a competitive industry affects outcomes, specifically with regard to products offered and pricing. A secondary aim is to compare outcomes under alternative regulatory regimes. To this end, we need to be able to solve the game under different competitive environments. For tractability, we consider a setting where individuals take only one year annual payoffs into account when choosing firms to manage their pension balances and pension management firms take one year of profitability into account when deciding on portfolios and fees.

Although this assumption on the time horizon is somewhat restrictive, we believe that it is a good approximation to the reality of the Chilean market. First, during the time covered in our data, the Chilean regulatory environment was undergoing frequent changes. The competitive

[8] Each of these instruments has a targeted age group. An investor's contributions are allocated by default into an age-appropriate fund unless he/she chooses otherwise.

[9] This restriction was relaxed in 2008.

landscape was changing from year to year, with multiple firms merging or exiting the market annually. Second, the competitive decisions were made in the presence of inflation and fairly significant stock market fluctuations. It is quite likely that firms in the market mostly pursued short-term goals in their decision making. Indeed, we know from the data that as the regulatory restrictions were relaxed, pension managers responded by revising their portfolios. Similarly, consumers could surely not anticipate how the industry landscape would change several years down the road. They could also freely switch firms from year to year with no monetary cost, which could likely lead them to base decisions mainly on short-term market conditions.

As noted above, the short-term framework is convenient for tractability. However, we also believe that it does not greatly impact the estimated model parameters given our estimation approach (the details are presented later). Dynamic considerations would suggest that consumer choices reflect life-cycle decisions as to what kind of investment is appropriate for what age. We capture the dependence on age in our framework by allowing consumers' price sensitivity and risk aversion to depend in a flexible way on consumers' demographics. It is also notable that consumer decisions are limited to the choice of fund instead of the choice of how much to save/invest. Therefore, their choices consider intertemporal substitution of consumption only to a very limited degree.[10] A more subtle consideration is that the choice of money manager today may impact the likelihood of having a certain balance and thus whether it will be optimal to switch to a different portfolio a few years from now. We believe that in reality, Chilean consumers were not much motivated by such considerations because of the rapidly changing industry landscape that made it difficult to predict which portfolios and fee structures would be available in the future. On the supply side, our estimation approach exploits available data on operational costs, allowing recovery of firms' cost functions without having to specify an optimization framework underlying firms' decisions.

Another potential concern is whether consumers are sufficiently financially literate to make optimal investment decisions. A large body of research documents that consumers, especially those with low education levels, often have difficulties making complex financial decisions.[11] In light of this evidence, one might ask whether we would expect to see optimal consumer choices. This is, of course, an empirical question. Econometric analysis will determine whether observed consumer choices can be rationalized within the framework of rational decision making that we develop and estimate in this article. We accommodate some potential suboptimality of consumer choices by allowing for switching costs. Specifically, switching costs may prevent consumers from choosing an optimal (in the absence of such costs) portfolio in a given period. Similar to Handel (2013), we assume that consumers are myopic in that they do not anticipate the impact of their choices today on their future.

3.2. *The Market for Retirement Investment.* At time t, there are J_t pension managing firms (AFP) in the market. Each AFP offers a single investment portfolio summarized by a parameter $\beta_{j,t}$ that corresponds to the portfolio's CAPM beta. In the spirit of mutual fund separation theorem, the return of AFP j's portfolio, $R_{j,t}$, is a random variable, and the moments of return's distribution are determined by $\beta_{j,t}$. More specifically, the portfolio's performance is linked to the realization of the market return, $R_{m,t}$, distributed as $N(\mu_{m,t}, \sigma^2_{m,t})$, and the risk-free return, $r_{0,t}$, available at that period so that $R_{j,t} = r_0 + \beta_{j,t}(R_m - r_0)$.[12]

If the market is subject to a minimum return requirement, such that AFP are required to deliver a return that is no lower than δ percentage points relative to the average return of all

[10] The majority of the population does not have any additional investments/savings beyond the pension fund. Those who do, as a rule, tend to work in the formal sector, so that the crowding out of pension investment does not arise.

[11] For a summary of findings in this area see, for example, Lusardi and Mitchell (2007).

[12] In the model presented in this section, $r_{0,t}$ is a constant, and thus the variation in $R_{j,t}$ is induced solely by the variation in $R_{m,t}$. In reality, a portfolio's performance also contains a stochastic component, $\epsilon_{j,t}$, which is not perfectly correlated with the market so that $\text{Var}(R_{j,t} | R_{m,t} = r_m) = \sigma_{\epsilon_j}$. The econometric model we estimate incorporates this feature.

pension management funds annually, then AFP j's return in period t from the consumer's point of view is given by

$$\tilde{R}^r_{j,t}(\delta) = \max\left\{\bar{R}_t - \delta, R_{j,t}\right\} \text{ with } \bar{R}_t := \frac{\sum_{j=1}^{J} R_{j,t}}{J}.$$

The firms charge fees for their services. We denote by $p_{j,t}$ the fee charged by firm j at time t. We assume, in accordance with the features of the Chilean market, that the fee structure is nonlinear, that is, $p_{j,t} = (p^0_{j,t},\ p^1_{j,t})$, where $p^0_{j,t}$ is the fixed fee charged on the annual basis, and $p^1_{j,t}$ is the proportional fee charged per contribution amount.

3.3. *Consumer Demand.* Consumers choose whether to be employed in the formal or informal sector and also choose a pension fund to manage their pension savings. The choice of employment sector, among other things, will have implications for whether an individual actively contributes to his pension account. Of course, pension investment is only one of many factors influencing individuals' decisions about whether to work in the formal or informal sectors. Other considerations include relative earnings opportunities in the two sectors, the potential for tax evasion in the informal sector, and access to public health insurance and other benefits associated with having a formal sector job. We capture these considerations in the model by allowing for earned income (after tax) to be different in the two sectors and by incorporating a utility component capturing the benefits/costs associated with working in each sector. We allow this component to depend on an individual's demographic characteristics. We begin by discussing the implications of employment in each sector for pensions.

3.3.1. *Formal sector.* If individual i chooses to be employed in the formal sector, he is characterized by a tuple $(Y_{1,i,t}, y_{i,t}, B_{i,t})$, where $Y_{1,i,t}$ is the income he earns in the formal sector, $y_{i,t}$ is the amount that he contributes to a pension account in a given period, and $B_{i,t}$ is a balance in the pension account accumulated in previous years (if he is new to the market, then $B_{i,t} = 0$).

Let $p_{i,j,t}$ denote the fee individual i would pay to AFP j if he chooses to allocate his pension savings with this firm. Specifically,

$$p_{i,j,t} = p^0_{jt} + y_{i,t} p^1_{j,t}.$$

Further, let $w_{1,i,t}$ denote the balance in individual i's pension account at the beginning of period t if he chooses formal sector employment. Then,

$$w_{1,i,t} = B_{i,t} + y_{i,t}.$$

Finally, let $\tilde{Y}_{1,j,i,t}$ denote the after-tax residual income of individual i who chooses to be employed in the formal sector that he retains after making the contribution $y_{i,t}$ to his pension account and after paying management fees to the AFP j:[13]

$$\tilde{Y}_{1,j,i,t} = Y_{1,i,t} - y_{i,t} - p_{i,j,t}.$$

An individual's utility associated with choosing formal sector employment and AFP j to manage his retirement wealth is given by

$$U_{1,j,i,t} = w_{1,i,t}\tilde{R}^r_{j,t} - \gamma_{i,t}\left(w_{1,i,t}\tilde{R}^r_{j,t}\right)^2 + \tau_{i,t}\tilde{Y}_{1,j,i,t} + \eta\mathbf{1}(j_{t-1} \neq j) + \xi_{0,i,t} + \xi_{j,t} + \epsilon_{1,j,i,t}, \tag{1}$$

where $\gamma_{i,t} > 0$ denotes a parameter that affects individual i's coefficient of risk aversion and $\tau_{i,t} > 0$ denotes a parameter that affects individual i's elasticity of substitution between current

[13] We account for the Chilean tax schedule that was in effect at the time of the data collection.

and retirement consumption. In the remainder, we will refer to τ as the price sensitivity and to γ as the risk aversion parameter. The unobservable component of consumer i's preferences is captured by $\epsilon_{1,j,i,t}$, $\xi_{j,t}$ captures the unobserved AFP-specific fixed effect, and $\xi_{0,i,t}$ captures the benefit/cost associated with working in the formal sector. The parameter η captures costs of switching from one AFP to another.

3.3.2. *Informal sector.* If an individual chooses to be employed in the informal sector, he does not make contributions to the pension fund, $y_{i,t} = 0$.[14] However, he may be affiliated with the pension investment system if he has accumulated balances from previously working in the formal sector. If this is the case, he has to decide on an AFP to manage his balance. The utility from choosing AFP j is given by

$$U_{0,j,i,t} = w_{0,i,t}\tilde{R}^r_{j,t} - \gamma_{i,t}\left(w_{0,i,t}\tilde{R}^r_{j,t}\right)^2 + \tau_{i,t}Y_{0,i,t} + \eta\mathbf{1}(j_{t-1} \neq j) + \xi_{j,t} + \epsilon_{0,j,i,t}, \tag{2}$$

where $w_{0,i,t} = B_{i,t}$ and $Y_{0,i,t}$ is the income he earns in the informal sector. We assume here that an individual does not pay the income tax when he is employed in the informal sector.

3.3.3. *Consumer choice.* An individual chooses an alternative that delivers the highest expected utility level. The expected utility associated with the choice $(0, j)$ is given by

$$E[U_{0,j,i,t}] = w_{0,i,t}E\left[\tilde{R}^r_{j,t}\right] - \gamma_{i,t}w^2_{0,i,t}E\left[(\tilde{R}^r_{j,t})^2\right] + \tau_{i,t}Y_{0,i,t} + \eta\mathbf{1}(j_{t-1} \neq j) + \xi_{j,t} + \epsilon_{0,j,i,t},$$

whereas the expected utility associated with choice $(1, j)$ is given by

$$E[U_{1,j,i,t}] = w_{1,i,t}E\left[\tilde{R}^r_{j,t}\right] - \gamma_{i,t}w^2_{1,i,t}E\left[(\tilde{R}^r_{j,t})^2\right] + \tau_{i,t}\tilde{Y}_{1,j,i,t} + \eta\mathbf{1}(j_{t-1} \neq j) + \xi_{0,i,t} + \xi_{j,t} + \epsilon_{1,j,i,t}.$$

The case where an individual has never previously worked in the formal sector and is thus unaffiliated with the pension system has to be considered separately. Such an individual is choosing between entering the formal workforce and choosing a pension management company for his mandatory pension contributions or working in the informal sector and remaining unaffiliated. The expected utility associated with entering the formal sector and choosing a particular AFP firm is given by

$$E[U_{1,j,i,t}] = w_{1,i,t}E\left[\tilde{R}^r_{j,t}\right] - \gamma_{i,t}w^2_{1,i,t}E\left[(\tilde{R}^r_{j,t})^2\right] + \tau_{i,t}\tilde{Y}_{1,j,i,t} + \xi_{0,i,t} + \eta^0 + \xi_{j,t} + \epsilon_{1,j,i,t},$$

where $w_{1,i,t} = y_{i,t}$ and η^0 captures any costs associated with entering for the first time. The expected utility from staying unaffiliated is given by

$$E[U_{0,0,i,t}] = \tau_{i,t}Y_{0,i,t} + \epsilon_{0,0,i,t}.$$

To understand the forces driving individuals' decisions in this market, let us first consider choices conditional on the sector of employment. Once the sector of employment is fixed, then the individual's income, contribution level, and the fees he would pay for various AFPs are fixed as well. The individual's AFP choice reflects his preferences over the risk versus expected return trade-off as well as his preference over possibly increasing his utility associated with retirement investment at the expense of reducing residual income by the pension management fee amount. If, in addition, an individual chooses his employment sector, then he still takes into account the trade-off between the risk and expected return, but he also considers the possibility of earning the return and taking risk on a smaller amount. This is because he does not contribute to his pension plan if he chooses to work in the informal sector. He may earn less in informal

[14] Consumers have the option of making voluntary contributions even if unemployed or employed in the informal sector, but it is very rare for them to do so. That is why we abstract away from this possibility in our model.

sector employment, but he will avoid contributing and paying fees to the pension fund as well as paying income taxes. There may be additional benefits/costs associated with employment in the formal/informal sector that likely differ across demographic groups.

Formally, let us denote the vector of variables characterizing individual i in this setting by $z_{i,t}$ so that $z_{i,t} = \{Y_{0,i,t}, Y_{1,i,t}, B_{i,t}, \gamma_{i,t}, \tau_{i,t}, \xi_{0,i,t}, \epsilon_{i,t}\}$. We assume that $z_{i,t}$ is distributed according to $F_t(\cdot)$ in the population at the time t. The sets of consumers choosing various alternatives are defined as follows:

$$M_{(0,j),t}(p_t, R_t) = \{z_{i,t} : B_{i,t} > 0 \text{ and } E[U_{0,j,i,t}] \geq E[U_{k,l,i,t}] \ \forall\ k = 0, 1,\ l = 1, \ldots, J\}$$
$$M_{(1,j),t}(p_t, R_t) = \{z_{i,t} : B_{i,t} > 0 \text{ and } E[U_{1,j,i,t}] \geq E[U_{k,l,i,t}] \ \forall\ k = 0, 1,\ l = 1, \ldots, J\} \cup$$
$$\{z_{i,t} : B_{i,t} = 0, \text{ and } E[U_{1,j,i,t}] \geq \max\{E[U_{1,l,i,t}],\ E[U_{0,0,i,t}]\} \ \forall\ l = 1, \ldots, J\}.$$

The total number of consumers served by AFP j is given by

$$D^N_{j,t}(R_t, p_t) = \int_{M_{(1,j),t} \cup M_{(0,j),t}} dF_t(z_{i,t}).$$

The balance these consumers invest with AFP j is

$$D^B_{j,t}(R_t, p_t) = \int_{M_{(1,j),t}} (B_{i,t} + y_{i,t}) dF_t(z_{i,t}) + \int_{M_{(0,j),t}} B_{i,t} dF_t(z_{i,t}),$$

while the contributions deposited by these consumers in period t are given by

$$D^C_{j,t}(R_t, p_t) = \int_{M_{(1,j),t}} y_{i,t} dF_t(z_{i,t}).$$

3.4. *Industry Competition.* We model industry competition as a two-stage game. In the first stage, AFPs simultaneously choose their portfolio composition, characterized by a choice of β, which determines the portfolio returns in a given period. In the second stage, AFPs observe chosen portfolios and simultaneously choose prices. Thereafter, the rate of return on the market portfolio is realized, interest is paid on consumers' retirement wealth, and AFPs' profits accrue.

In traditional industrial sectors, production is fully summarized by the quantity produced or in a service sector by the number of customers served. In this industry, however, the firm's output is multidimensional: It is summarized both by the number of affiliates enrolled with the company and by the balance (brought in by the affiliates) that the company manages. For this reason, we explicitly allow the cost function $C_{j,t}(\cdot, \cdot)$ reflecting firms' technology to depend on the number of customers served, $D^N_{j,t}(R_t, p_t)$, and on the total balance under management, $D^B_{j,t}(R_t, p_t)$. The cost function may exhibit economies of scale in either or both arguments.

Minimal return regulation imposes additional (regulatory) costs on the firms in the industry. The regulation requires that each AFP guarantee a return on the balance it manages to be no lower than δ percentage points below the industry average. In practical terms, this means that the company may have to use its own funds to bring the return to the required level. It thus has to incur an additional expected cost of

$$C^{reg}_{j,t}\left(R_{j,t}, R_{-j,t}, D^B_{j,t}\right) = (R_{j,t} - \bar{R}_t + \delta) \times D^B_{j,t} \times 1(R_{j,t} < \bar{R}_t - \delta),$$

where $\bar{R}_t = \frac{1}{J}\sum_j R_{j,t}$. Thus, the total cost faced by a firm participating in this market is

$$C_{j,t}\left(D^N_{j,t}, D^B_{j,t}\right) + C^{reg}_{j,t}\left(R_{j,t}, R_{-j,t}, D^B_{j,t}\right).$$

In period t, the expected profit of fund j that chooses a portfolio characterized by $\beta_{j,t}$ and a fee schedule $p_{j,t}$ when the competing AFP firms choose portfolios characterized by $(\beta_{-j,t},\ p_{-j,t})$ is given by

$$E_{R_t|\beta_t}[\Pi_{j,t}(p_t, R_t(\beta_t))|\beta_t, I_t] = E_{R_t|\beta_t}\big[p^0_{j,t}D^N_{j,t}(R_t(\beta_t), p_t) + p^1_{j,t}D^C_{j,t}(R_t(\beta_t), p_t)$$
$$-C(D^N_{j,t}(R_t(\beta_t), p_t),\ D^B_{j,t}(R_t(\beta_t), p_t)) - C^{reg}_{j,t}(R_t(\beta_t), D^B_{j,t}(R_t(\beta_t), p_t))|\beta_t, I_t\big].$$

Here, we explicitly recognize the dependence between the AFP's return (i.e., the return's distribution) and AFP's choice of the portfolio's β. Specifically, we use interchangeably R_t and $R_t(\beta_t)$ to denote the vector of AFPs' returns at time t. The expectation is taken with respect to the distribution of returns as a function of the choice of β and the information available at the beginning of period t (such as previous realizations of market return).

It is important to emphasize that the regulatory penalty is assessed relative to the average performance of the firms in the industry. This feature further enhances strategic interdependence of the firms in this market. A given firm's costs depend on the portfolio choices made by other firms in the market not only through the share and the composition of the demand this firm is able to attract, but also through the regulatory surcharge this firm may have to pay on the balance it attracts.

A strategy of firm j in this setting consists of two components: The first component, $\beta_{j,t} \in [0,1]$, characterizes the riskiness of the portfolio that the firm offers to its customers, whereas the second component, $p_{j,t}(.) : [0,1]^{J_t} \to \mathcal{R}_+ \times [0,1]$, summarizes the contingency fee schedule that the firm would use under various configurations of the set of portfolios that the other firms in the market may choose to offer.

The equilibrium of this game is characterized by the vector of portfolios and fee schedules, $(\beta^\star_t,\ p^\star_t(\cdot))$, such that for each firm j, its equilibrium fee schedule maximizes firm j's expected profit for all possible realizations of β_t and given the fee structures chosen by competitors:

$$p^\star_{j,t}(\beta_t) = \arg\max E\left[\Pi_{j,t}(p^\star_{j,t}(\beta_t), p^\star_{-j,t}(\beta_t), R_{j,t}(\beta_{j,t}), R_{-j,t}(\beta_{-j,t}))|\beta_t\right],\ \forall j \in J_t \text{ and } \forall \beta_t;$$

and firm j's equilibrium portfolio choice summarized by β maximizes firms' expected profit given the portfolios chosen by the competitors:

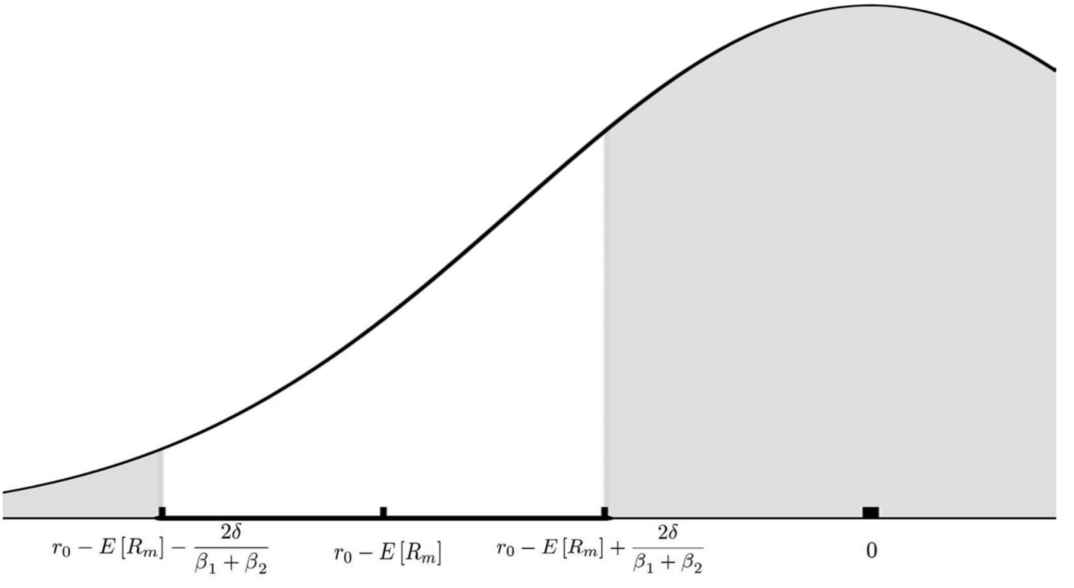
$$\beta^\star_{j,t} = \arg\max E\left[\Pi_{j,t}(p^\star_{j,t}(\beta_{j,t}, \beta^\star_{-j,t}), p^\star_{-j,t}(\beta_{j,t}, \beta^\star_{-j,t}), R_{j,t}(\beta_{j,t}), R_{-j,t}(\beta^\star_{-j,t}))\right],\ \forall j \in J_t.$$

The existence of an equilibrium in such a two-stage game is investigated in Caplin and Nalebuff (1991), where it is shown that an equilibrium of such a game exists but may not be unique. We take the possibility of nonuniqueness into account in both our empirical and counterfactual analyses.

The expression in (2) for the expected profit highlights the key feature of this environment, that is, that the firm's choices determine the distribution of product characteristics offered to consumers. As discussed below, this has important implications for the minimal return regulation.

4. THE IMPACT OF MINIMAL RETURN REGULATION

To understand the impact of the regulation, let us first consider the case of the two AFP firms competing in the market. If these firms choose portfolios characterized by β_1 and β_2, then the returns on these portfolios are given by $R_1 = r_0 + \beta_1(R_m - r_0)$ and $R_2 = r_0 + \beta_2(R_m - r_0)$, correspondingly, with $\bar{R} = r_0 + \bar{\beta}(R_m - r_0)$ and $\bar{\beta} = (\beta_1 + \beta_2)/2$. Consider the case when $\beta_1 \geq \beta_2$, so firm 1 offers the riskier portfolio. Recall that above we assumed the market returns are normally distributed with mean μ_m and variance σ^2_m. The probability of firm 1 not falling below



NOTES: This figure illustrates the probability of not incurring regulatory penalties under the minimal return regulation in the case of two firms and $\beta_1 > \beta_2$. Specifically, the shaded area on the right reflects the probability that firm 1 will not incur a regulatory penalty, whereas the shaded area on the left reflects the probability that firm 2 will not be subject to the penalty.

FIGURE 1

THE PROBABILITY OF NOT INCURRING A PENALTY UNDER MINIMAL RETURN REGULATION

the threshold δ specified by the regulation is[15]

$$\Pr(R_1 - \bar{R} \geq \delta) = 1 - \Phi\left(\frac{1}{\sigma_m}\left(\frac{2\delta}{\beta_1 - \beta_2} + r_0 - \mu_m\right)\right).$$

Similarly, for firm 2, it is

$$\Pr(R_2 - \bar{R} \geq \delta) = \Phi\left(\frac{1}{\sigma_m}\left(-\frac{2\delta}{\beta_1 - \beta_2} + r_0 - \mu_m\right)\right).$$

As seen in Figure 1, the probability of incurring the regulation penalty is higher for firm 2, which offers the safer portfolio. Thus, the minimum return regulation creates incentives for AFPs to offer riskier portfolios relative to their competitors. Specifically, in the setting with two firms, each AFP would prefer to be the one to offer the riskiest portfolio in the absence of other considerations. The incentives are not as strong when more than two firms are present, but it is still strongly preferable not to have the safest portfolio in the market. These incentives are stronger, all other things equal, when the market return is higher and market return volatility is lower.

In the presence of market competition, however, there are other important considerations. First, the cost imposed by the regulation on the firm is proportional to the total balance under

[15] In a realistic framework with $\mathrm{Var}(R_{j,t}|R_{m,t} = r_m) \neq 0$, these probabilities could be rewritten conditional on realizations of $\epsilon_{1,t}$ and $\epsilon_{2,t}$ (or on $\tilde{\epsilon}_t = \epsilon_{1,t} - \epsilon_{2,t}$):

$$\Pr(R_1 - \bar{R} \geq \delta | \, \epsilon_{1,t}, \epsilon_{2,t}) = 1 - \Phi\left(\frac{1}{\sigma_m}\left(\frac{\tilde{\epsilon}+\delta}{\beta_1 - \bar{\beta}} + r_0 - \mu_m\right)\right),$$

$$\Pr(R_2 - \bar{R} \geq \delta | \, \epsilon_{1,t}, \epsilon_{2,t}) = \Phi\left(\frac{1}{\sigma_m}\left(\frac{\tilde{\epsilon}-\delta}{\beta_1 - \bar{\beta}} + r_0 - \mu_m\right)\right).$$

The comparison we presented above holds for every realization of $\tilde{\epsilon}$, and thus all the conclusions hold as well.

the firm's management. Therefore, if individuals who carry a high balance tend to have low risk aversion, then the incentives for choosing a riskier portfolio may be mitigated or even reversed.

Additionally, if the return regulation is combined with fee structure regulation, then such regulation introduces a potential wedge between the costs and the fee revenue. As previously noted, in Chile, AFP firms are allowed to charge fees on contributions but not on balances. If individuals who have high income (and therefore pay high fees, because fees are proportional to contributions that are equal to 10% of income) are also the ones with high balances, the firms may use pricing to mitigate the costs of high balances imposed by the return regulation. If, on the other hand, high contribution individuals are not the ones with high balances and are also highly risk averse, then direct profitability incentives may outweigh the incentives imbedded in minimal return regulation and may induce AFPs to prefer to offer safe portfolios. This analysis underscores that the regulation impact depends on the population distribution of consumer characteristics.

5. DATA

We have access to administrative data provided by the pension fund regulatory agency, which contain individual-level histories of contributions, accumulated balances, and fund choices for a random sample of the Chilean population, covering the years 1981–2004. These data were merged with information from longitudinal household survey data from the 2002 *Historia Laboral y Seguridad Social (HLLS)* survey and the 2004 *Enquesta de Proteccion Social (EPS)* follow-up survey. Thus, the data set additionally contains information on demographics, work history, income, and health. The resulting merged data set covers 12,246 individuals. We also have access to the data on the performance of pension managers' portfolios and the fees charged by pension managers as well as accounting cost data.

Our analysis focuses on the second decade of the pension system operation, which corresponds to the time period when the system achieved relative stability but before the wave of significant changes that were implemented starting from 2001 and for the next several years. For the reasons explained in the next section, we use data for four years (1992, 1995, 1998, 2000) in the empirical analysis. Table 1 describes individuals in our sample for these years. As can be seen, the population differs very little in terms of demographics across the years, indicating that the population in the Chilean pension system was fairly stable during the period of time studied. In any given year of our sample, roughly 60% of individuals are male and an average person is 35 years old (37 in the year 2000 sample). Individuals range from 18 to 55 years old with 25%–75% quantile range corresponding to ages between 27 and 41 (29–45 in the sample corresponding to year 2000). An average individual has more than secondary school but less than high school education, with approximately 10% having a college degree.

The sample clearly ages in terms of the number of years individuals are associated with the pension system as we go from 1992 to 2000. Specifically, an average individual in 1992 spent 86 months (approximately 7 years) in the system, whereas an average individual in 2000 sample spent 137 months (approximately 11 years) there. The time in the system varies significantly within the sample (between 50 months or 4.5 years to 138 months or 11.5 years in the year 1992 sample and 82 months or 6.7 years to 230 months or 19.8 years in the year 2000 sample). Interestingly, an average individual contributes to his pension account only about half of the time he spends in the pension system. This is because many individuals find participation in the formal sector to be costly (they have to contribute 10% of their income to the pension fund, to pay AFP fees, to pay income taxes, etc.). On the other hand, they do care about having funds to support their retirement, so they move between sectors to balance these considerations. The relationship between the number of months in the system and the number of months actively contributing varies in the data, with 10% of individuals contributing 80% of the time or more and 10% of individuals contributing 25% of the time or less. A median individual contributes approximately 40% of the time. This pattern underscores the potential significance of formal sector participation decisions in analyzing effects of pension regulations.

TABLE 1
SUMMARY STATISTICS

Variable	Mean	Std. Dev.	25%	50%	75%	90%
Year 1992; number of observations: 6,153						
Age	34.66	10.26	27	33	41	49
Male	0.62	0.48	0	1	1	1
Education (y)	9.39	9.52	8	11	12	15
Months in system	85.72	40.73	50	87	130	138
Months contributing	48.62	38.46	15	40	76	109.6
Annual income (mln CLP)	1.344	1.344	0.543	0.888	1.553	2.890
Annual income ($)	4,361	4,362	1,761	2,882	5,041	9,378
Pension balance (mln CLP)	1.015	2.441	0.116	0.372	1.039	2.378
Pension balance ($)	3,294	7,921	375	1,209	3,373	7,719
Year 1995; number of observations: 7,312						
Age	35.18	9.85	27	34	42	50
Male	0.59	0.49	0	1	1	1
Education (y)	9.71	8.29	8	11	12	15
Months in system	108.68	53.55	62	109	155	183
Months contributing	59.40	49.02	17	47	94	137
Annual income (mln CLP)	2.295	2.142	1.007	1.638	2.744	4.615
Annual income ($)	5,975	5,576	2,622	4,266	7,145	12,016
Pension balance (mln CLP)	1.888	3.594	0.265	0.785	2.053	4.396
Pension balance ($)	4,915	9,357	691	2,043	5,344	11,447
Year 1998; number of observations: 7,435						
Age	35.52	9.70	28	34	42	50
Male	0.58	0.49	0	1	1	1
Education (y)	9.87	8.30	8	12	12	15
Months in system	120.69	60.03	71	121	171	206.4
Months contributing	66.45	54.63	19	53	105	152
Annual income (mln CLP)	2.761	2.429	1.218	2.000	3.405	5.600
Annual income ($)	6,603	5,811	2,913	4,783	8,143	13,391
Pension balance (mln CLP)	2.373	4.162	0.371	1.049	2.588	5.667
Pension balance ($)	5,675	9,952	888	2,508	6,188	13,551
Year 2000; number of observations: 8,322						
Age	37.52	11.11	29	36	45	53
Male	0.57	0.50	0	1	1	1
Education (y)	9.91	8.63	8	12	12	15
Months in system	136.63	67.17	82	139	193	230
Months contributing	73.24	60.80	20	59	116	168
Annual income (mln CLP)	2.957	2.708	1.360	2.035	3.502	6.246
Annual income ($)	5,664	5,188	2,606	3,899	6,710	11,966
Pension balance (mln CLP)	3.235	5.455	0.521	1.463	3.543	7.679
Pension balance ($)	6,197	10,451	997	2,802	6,787	14,710

NOTE: This table summarizes the demographic composition of the sample population across the years in the data. The annual income and pension balance are reported in contemporaneous pesos (CLP) and in U.S. dollars deflated to reflect the dollar value in the year 2000.

Average annual income is growing over time and is approximately $5,500–$6,000. At the 90th percentile, annual income is as high as $ 9,000–$13,000. The average accumulated balance changes over the years. It is equal to approximately 1 mln CLP (or $3,294) in 1992 and 3.235 mln CLP ($5,675) in 2000.

Table 2 breaks down the sample into age groups using the 1998 data. Summary statistics indicate that younger cohorts are better educated, with an average individual having 11 years of schooling (i.e., almost high school education). The oldest cohort (50–65 years old) has 8.12 years of schooling (i.e., just secondary school education). Not surprisingly, the mean and the variance of the income distribution increases with age. Interestingly, the fraction of time in the system during which the individual is actively contributing increases across age groups with

TABLE 2
SUMMARY STATISTICS

	Mean	Std. Dev.	25%	50%	75%	90%
Age: 20–30 years; number of observations: 2,223						
Education (years)	11.12	6.47	10	12	13	15
Months enrolled	69.14	33.88	42	68	94	116
Months contributed	33.29	26.62	12	27	50	73
Annual income (mln CLP)	2.319	1.818	1.201	1.817	2.812	4.386
Annual income ($)	5,546	4,348	2,873	4,346	6,725	10,489
Pension balance (mln CLP)	0.578	0.958	0.141	0.365	0.762	1.292
Pension balance ($)	1,381	2,292	337	873	1,821	3,091
Age: 30–40 years; number of observations: 2,714						
Education (years)	9.91	9.55	8	12	12	15
Months enrolled	131.74	47.26	99	137	164	195
Months contributed	69.42	48.84	26	66	107	137
Annual income (mln CLP)	2.834	2.348	1.282	2.073	3.631	5.608
Annual income ($)	6,777	5,614	3,066	4,957	8,682	13,411
Pension balance (mln CLP)	2.025	2.481	0.635	1.342	2.495	4.273
Pension balance ($)	4,842	5,932	1,519	3,208	5,966	10,218
Age: 40–50 years; number of observations: 1,635						
Education (years)	8.89	8.82	7	10	12	14
Months enrolled	157.61	56.35	120	176	206	210
Months contributed	93.45	60.67	38	95	147	176
Annual income (mln CLP)	3.093	2.680	1.205	2.177	3.955	6.825
Annual income ($)	7,396	6,409	2,882	5,206	9,457	16,321
Pension balance (mln CLP)	4.090	5.316	0.937	2.414	5.059	9.566
Pension balance ($)	9,780	12,712	2,242	5,773	12,099	22,876
Age: 50–65 years; number of observations: 765						
Education (years)	8.12	6.94	5	8	12	14
Months enrolled	163.94	54.47	127	192	209	210
Months contributed	101.96	64.38	41	107	160	187
Annual income (mln CLP)	3.217	3.221	1.167	2.155	4.037	7.656
Annual income ($)	7,693	7,704	2,791	5,154	9,654	18,310
Pension balance (mln CLP)	5.371	7.482	1.142	2.860	6.303	12.800
Pension balance ($)	12,845	17,892	2,730	6,840	15,073	30,609

NOTE: This table summarizes the 1998 subsample of the data by age cohorts. The annual income and pension balance are reported in contemporaneous pesos (CLP) and in U.S. dollars deflated to reflect the dollar value in the year 2000.

the youngest contributing the least and oldest the most. Thus, individuals are heterogeneous in many ways that may impact their pension investment decisions. This heterogeneity may be taken into account by the industry when it decides what portfolios to offer and what fees to charge.

Tables 3–4 summarize the characteristics of the pension management industry for the years used in estimation. In the beginning (year 1992), the industry contains a large number of firms (20), most of which were small. The number of firms decreases to 16 firms in 1996 and then to eight firms in 1998 and 2000. A few very small firms exit the market, whereas the rest of the firms merge with competitors. Seven firms remained in the market throughout the whole time period: Provida, Habitat, Santa Maria, Summa (later renamed as Summa Bassander), Cuprum, Planvital, and Magister.

Table 3 summarizes the fees and the returns of the different firms. As previously noted, the firms in this market use nonlinear pricing where they charge a fixed and a percentage fee on a monthly basis. The percentage fee is applied to the contribution amount an individual deposits into his account. By regulation, firms are prohibited from charging fees on balances. In fact, they are also prohibited from charging any fee (even the fixed fee) on nonactive accounts, that is, in the months when individual is not actively contributing to his account. As the table indicates, the percentage fees vary somewhat among firms, but they become more similar toward the end of the sample. In contrast, the fixed fee component varies significantly across firms. Some firms

TABLE 3
SUMMARY STATISTICS: AFPS

	1992	1996	1998	2000
Fees				
Monthly percentage fee, mean	3.18	2.96	2.64	2.44
Monthly percentage fee, std. dev.	0.36	0.23	0.10	0.21
Monthly fixed fee (CLP), mean	159.82	280.00	431.25	573.57
Monthly fixed fee (CLP), std. dev.	108.85	468.66	269.43	301.17
Monthly fixed fee ($), mean	0.519	0.710	0.994	1.099
Monthly fixed fee ($), std. dev.	0.353	1.188	0.621	0.577
Returns				
Inflation	1.115	1.075	1.039	1.043
Bond	1.054	1.061	1.096	1.054
Annual market return	1.230	1.046	0.842	0.929
Annual returns, mean	1.191	1.052	1.031	1.093
Annual returns, std. dev.	0.024	0.016	0.013	0.011
Volatility of returns, mean	0.027	0.017	0.022	0.056
Volatility of returns, std. dev.	0.016	0.016	0.026	0.044

NOTE: This table summarizes fees charged by AFPs, the realized AFPs' annual returns, and the realized volatility of returns. The fees are reported in contemporaneous Chilean Pesos (CLP) and in U.S. dollars adjusted for inflation to reflect the dollar value in the year 2000. We compute standard deviations of returns using monthly return data over an 18-month window. To summarize market return, we use IPSA index that reflects annual return for the basket of 40 shares that are traded most frequently in the market in a given quarter. Risk-free rate is constructed as an average of the interest rates for the instruments issued by the Central Bank of Chile.

such as Cuprum (or Habitat until 1996) do not charge a fixed fee, whereas in other cases, the fixed fee of one firm may be twice as high as the fee of another firm (e.g., Provida and Santa Maria in 1992 or Provida and Habitat in 2000). In general, fixed fees constitute around 1%–2% of the individual's contribution, whereas the total fees (percentage plus fixed) add upto about 4%–5% of the contribution.

Table 3 summarizes AFPs' performance. It also reports other variables related to investment decisions in these years. First, the beginning of the 1990s is characterized by high levels of inflation (about 10% annually) that declined toward the end of the decade. As a result, even when the nominal returns appear high, real returns are actually very modest or even fall below the inflation rate. Next, the portfolios chosen by individual AFPs are clearly less risky than the market portfolio. In a good stock market year (e.g., 1992), the market portfolio outperforms the AFPs portfolios, whereas in bad years (e.g., 1995, 1998), the funds fare better than the market portfolio. Finally, the variation in AFPs performances is small, indicating that portfolios are quite similar. This feature may arise in part because of the return regulation implemented during this period. It makes precise estimation of individuals' risk aversion quite challenging. Nevertheless, some variation in the returns is present, and, in the individuals' decision making, it is amplified by differences in the size of individuals' accumulated pension savings. Thus, for some individuals, the differences in costs of choosing different AFPs can be quite substantial. We observe that individuals pay nontrivial fixed fees to choose funds such as Provida or Santa Maria when they could enroll in another fund for a much lower fee. Clearly, some firms are considered more attractive than others. Of course, firms' attractiveness may not be solely related to the returns or their different fee structures. We address this empirical question in subsequent sections when we estimate the parameters of the indirect utility function.

Finally, Table 4 summarizes AFPs' market shares in terms of the number of enrollees and in terms of the balance under the management. The table also indicates when an AFP firm was absorbed by another firm (mergers). As the table shows, the industry is quite concentrated. Most of the enrollees and of the balance (85%) are concentrated in the top five firms, with the top three firms accounting for 70% of both. An interesting feature of this market is that allocation of individuals across funds is characterized by a modest degree of sorting. For example, Provida captures from 35% to 41% of the market in terms of the number of enrollees in 1995 through

TABLE 4
SUMMARY STATISTICS: MARKET SHARES

	Enrollees			
	1992	1995	1998	2000
System	4,434,795	5,320,913	5,966,143	6,280,191
Provida	0.290	0.356	0.396	0.416
Habitat	0.181	0.173	0.237	0.246
Santa Maria	0.220	0.228	0.169	0.162
Summa	0.075	0.080	0.059	0.061
Cuprum	0.026	0.060	0.060	0.061
Planvital	0.023	0.043	0.037	0.037
Magister	0.016	0.011	0.014	0.015
Proteccion	0.012	0.014	0.027	Provida
Union	0.075	0.079	Provida	
Concordia	0.034	0.026	Planvital	
El Libertador	0.022	Provida		
	Assets			
System (mln CLP)	2,695,580	2,961,928	3,149,755	3,196,991
Provida	0.307	0.254	0.277	0.312
Habitat	0.151	0.142	0.240	0.248
Santa Maria	0.182	0.177	0.121	0.131
Summa	0.073	0.122	0.119	0.094
Cuprum	0.096	0.176	0.151	0.151
Planvital	0.018	0.023	0.021	0.023
Magister	0.019	0.014	0.014	0.017
Proteccion	0.037	0.054	0.059	Provida
Union	0.045	0.043	Provida	
Concordia	0.026	0.017	Planvital	
El Libertador	0.021	Provida		

NOTE: This table reports the markets shares of various AFPs in terms of the number of individuals affiliated with a given company and in terms of the assets under the management based on economy-wide data on enrollment provided by the pension fund regulatory agency. The total system assets are reported in millions of Chilean Peso. Only the firms with market shares above 0.5% are included in the table. AFP "Summa" was renamed "SummaBassander" starting 1998. A number of companies were acquired by other AFP. We note the name of acquiring company wherever appropriate.

2000 but only 25%–30% of balances. At the same time, Summa attracts only 8%–6% of enrollees, but they bring in 12%–9% of the market balance. This indicates that Provida attracts people with slightly lower balances on average relative to Summa. It is not surprising that such sorting exists. Indeed, the pricing in this market is related to individual contribution levels and hence to income; this feature alone may induce the kind of sorting that we observe in the data if income is correlated with the balance. In addition, individuals' decisions about where to allocate their balances are driven by their price sensitivity and potentially also by risk aversion, both of which may depend on individuals' demographics and income. Clearly, the impact of these factors on individuals' decision making (and therefore on the firms' decision making) has to be taken into account to understand the potential impact of the minimum return regulation on this market.

6. ESTIMATION METHODOLOGY

This section describes how we estimate the parameters of consumer indirect utility functions and the industry cost structure. The estimation procedure consists of two steps. In the first step, we estimate AFPs' βs from historical data on returns using a variant of the Capital Asset Pricing Model (CAPM), and then, in the second step, we use the estimated βs to recover consumer preferences and firms' cost structure. The methods used to estimate the AFPs' βs and the parameters of the distributions of returns are described in detail in Appendix A.1. We take the two-step nature of our estimator into account in estimating the variance of the estimated coefficients.[16]

6.1. *Demand Estimation.* We first describe the parameterization of the model and then summarize details of the estimation procedure.

6.1.1. *Parameterization.* The demand side of the model represents individuals' choices among multiple discrete alternatives (employment sector k and AFP j to manage pension savings at time t). Consumers' indirect utility derived from alternative options was described in Section 3. The econometric model can be written as

$$u_{(k,j),i,t} = X_{k,j,i,t}\theta_{0,i,t} + \eta\mathbf{1}(j_{i,t-1} \neq j) + \mathbf{1}(k=1)X_{4,i,t}\theta_4 + \xi_{j,t} + \epsilon_{(k,j),i,t},$$

where $X_{k,j,i,t}$ denotes $(X_{1,k,j,i,t}, X_{2,k,j,i,t}, X_{3,k,j,i,t})$ such that, in the context of the model outlined in Section 3: $X_{1,j,i,t} = w_{i,t}\tilde{R}^r_{j,t}$, $X_{2,j,i,t} = -w^2_{i,t}E[(\tilde{R}^r_{j,t})^2]$, $X_{3,j,i,t} = -\tilde{Y}_{k,j,i,t}$ and $X_{4,i,t}\theta_4 = \xi_{0,i,t}$; $\theta_{0,i,t}$ denote a vector of coefficients $(\theta_1, \theta_{2,i,t}, \theta_{3,i,t})$.[17] Thus, the model allows for multiple random coefficients (which capture individuals' risk aversion and price sensitivity) and AFP-specific fixed effects.

The model specification naturally implies that the coefficient in front of the expected return should be equal to one. This allows us to estimate the standard deviation of the ϵ term instead of normalizing it to one as is traditional in discrete choice models. Hence, $\theta_1 = \frac{1}{\sigma_\epsilon}$, $\theta_{2,i,t} = \frac{\gamma_{i,t}}{\sigma_\epsilon}$, $\theta_{3,i,t} = \frac{\tau_{i,t}}{\sigma_\epsilon}$. To incorporate observed determinants of preference heterogeneity, we allow the means of the random coefficients to depend on individuals' characteristics:

$$\theta_{2,i,t} = g_2(Z_{2,i,t};\omega_2) + \sigma_{\theta,2}\tilde{\theta}_{2,i,t},$$
$$\theta_{3,i,t} = g_3(Z_{3,i,t};\omega_3) + \sigma_{\theta,3}\tilde{\theta}_{3,i,t},$$

where $\tilde{\theta}_{2,i,t}$ and $\tilde{\theta}_{2,i,t}$ are standard normal random variables; $Z_{2,i,t}$ and $Z_{3,i,t}$ are vectors of consumer demographics such as age, education, gender, marital status, income, etc., with dimensions $1 \times m_2$ and $1 \times m_3$, respectively. In estimation, we impose that $g_p(Z_{p,i,t};\omega_p) = \exp(Z_{p,i,t}\omega_p)$, for $p = 2, 3$, to ensure that the means of θ_2 and θ_3 are nonnegative.

We further allow for the sector-specific nested structure of $\epsilon_{(k,j),i,t}$. Specifically, we assume that the joint distribution of $\{\epsilon_{(k,j),i,t}\}_{(k,j)}$ follows a Generalized Extreme Value joint cumulative distribution function such that

$$F_\epsilon\left(\epsilon_{(0,1),i,t}, \dots, \epsilon_{(0,J),i,t}, \epsilon_{(1,1),i,t}, \dots, \epsilon_{(1,J),i,t}\right) = \exp\left(-\sum_{k=0}^{k=1}\left(\sum_{j=1}^{j=J}\left(e^{-\epsilon_{(k,j),i,t}}\right)^{1/\rho_k}\right)^{\rho_k}\right).$$

Here, ρ_k is a function of correlation between $\epsilon_{(k,j_1),i,t}$ and $\epsilon_{(k,j_2),i,t}$. More specifically, $\rho_k = \sqrt{1 - Corr(\epsilon_{(k,j_1),i,t}, \epsilon_{(k,j_2),i,t})}$. It can also be viewed as related to unobserved benefit/cost associated with working in the formal/informal sector.

To simplify notation, denote by $X_{i,t}$ the matrix of right-hand-side variables that includes $X_{k,j,i,t}$ for all the alternatives (k, j). The nested structure implies that[18]

$$\Pr\left(k|X_{i,t}, \tilde{\theta}_{0,i,t}\right) = \frac{\exp\left(X_{4,k,i,t}\theta_4 + \rho_k I_k\left(X_{i,t}, \tilde{\theta}_{0,i,t}\right)\right)}{\sum_{m=0}^{m=1}\exp\left(\exp\left(X_{4,m,i,t}\theta_4 + \rho_m I_m\left(X_{i,t}, \tilde{\theta}_{0,i,t}\right)\right)\right)},$$

[16] We use formulas given in chapter 36 from Newey and McFadden (2016).

[17] We use Chile's tax schedule for the year 2000 to adjust individuals' incomes in the formal sector for income tax deductions. Notice that the pension contribution and AFP fees are subtracted before income taxes are deducted.

[18] For details, see Amemiya (1985).

$$\Pr\left(j|k, X_{i,t}, \tilde{\theta}_{0,i,t}\right) = \frac{\exp\left(\left(X_{k,j,i,t}\theta_{0,i,t} + \xi_j\right)/\rho_k\right)}{\sum_{j'=1}^{j'=J} \exp\left(\left(X_{k,j',i,t}\theta_{0,i,t} + \xi_{j'}\right)/\rho_k\right)},$$

where $I_{i,k}(X_{i,t}, \tilde{\theta}_{0,i,t}) = \ln(\sum_{j=1}^{j=J} \exp((X_{k,j,i,t}\theta_{0,i,t} + \xi_j)/\rho_k))$.

Then, the joint probability of choosing AFP j and formal sector work can be decomposed as

$$\Pr((k, j)|X_{i,t}) = \int \Pr(k|X_{i,t}, \tilde{\theta}_{0,i,t}) \Pr(j|k, X_{i,t}, \tilde{\theta}_{0,i,t}) d\Phi(\tilde{\theta}_{0,i,t}). \tag{3}$$

Here, $\Phi(.)$ is the cumulative distribution function of a standard normal distribution.

Thus, the full vector of model coefficients is given by

$$\theta = (\theta_1, \omega_2, \omega_3, \theta_4, \eta, \eta^0, \sigma_{\theta_2}, \sigma_{\theta_3}, \sigma_\epsilon, \rho_0, \rho_1, \xi_1, \dots, \xi_J).$$

6.1.2. *Identification.* The argument for identification of the model parameters is standard and relies on the variation in the variables entering on the right-hand side of the indirect utility function across alternatives and across individuals. We assume that portfolio choice and prices (fee structure) are exogenous conditional on the included AFP-specific fixed effects. Recall that the term corresponding to the expected wealth has a coefficient equal to one. Following the argument in Berry and Haile (2011), the variation in this variable identifies stochastic elements of the model such as the variances of the random coefficients in front of the quadratic utility term and the disposable income term as well as variance of the ϵ. Model parameters other than switching costs can be identified from one year of data on the individuals who are entering the pension market for the first time. Consumer choices in other years may deviate from those implied by consumer preferences recovered from the first year of data due to the switching costs and because of the changes in firms' fixed effects. Because we observe $J^2 - 1$ differences in market shares and need to infer $J + 1$ numbers from these deviations, the switching costs are overidentified.

6.1.3. *Generalized Method of Moments (GMM) estimation procedure.* The structure of our data differs from the type of data typically used in the analysis of differentiated products markets. Specifically, we have only a small number of alternatives from which individuals choose. At the same time, we have access to a very large number of individual-level transactions, with indirect utilities that naturally depend on the variables that change across individuals and alternatives. This leads us to use the GMM estimation method developed in McFadden (1989) instead of the procedures developed by Berry et al. (1995, 2004), which are now fairly standard in the analysis of differentiated products markets. We use multiple years of data in estimation. However, we do not use consecutive years to reduce possible dependence in individual-specific random coefficients.[19]

We recover the parameter vector using the moment conditions characterizing, for a given year and a sector of employment: (i) the market share of each AFP, (ii) the proportion of individuals switching AFP firms in any given year, (iii) the expected end-of-period retirement wealth given the optimal choice of AFP by individual, (iv) the expectation of the quadratic term in indirect utility function multiplied by the variables included in the mean of the individual-specific coefficient in front of the quadratic term given the optimal choice of AFP, (v) the second moment of quadratic term given the optimal choice of AFP, (vi) the expectation of residual income net of contribution and fees given the optimal choice of AFP, and (vii) the second moment of residual income net of contribution and fees given the optimal choice of AFP.[20]

[19] Implicitly, we are assuming that any correlation in preferences across years is captured by the observable components of the random coefficients.

[20] The formal expressions for the moments are shown in Appendix A.2.

6.2. *Cost Function Estimation.* Most studies of differentiated products markets infer firms' costs using the first-order condition for the optimality of firms' prices. In contrast, we have access to annual data on firms' operational costs, which allows us to recover the cost structure directly from the data. One advantage of making using of explicit cost data is that a specific structure of industry competition need not be imposed in estimation. For this reason, our assumption about AFPs pursuing short-term profitability goals when deciding on their portfolios and prices will not influence the estimates characterizing the AFPs' cost structure. Another advantage is that we are able to consider rich specifications that allow for potential scale effects associated both with the number of customers served and the total balance under the management.

We estimate the cost function using a flexible "translog" functional form where the costs depend on the number of customers ($D^N_{j,t}$) and the total balance of the AFP j's customers ($D^B_{j,t}$). Specifically, we assume that

$$\ln\left(C\left(D^N_{j,t}, D^B_{j,t}\right)\right) = Y(t) + \tau_1 \ln\left(D^N_{j,t}\right) + \tau_2 \ln\left(D^B_{j,t}\right) + \tau_3\left(\ln\left(D^N_{j,t}\right)\right)^2 + \tau_4\left(\ln\left(D^B_{j,t}\right)\right)^2 + \tau_5 \ln\left(D^N_{j,t}\right)\ln\left(D^B_{j,t}\right) + \nu_j + \eta_{j,t},$$

where $Y(t)$ is a flexible trend component and ν_j is an unobserved fixed effect for each AFP. The τ parameters are estimated using standard panel data methods.

7. ESTIMATION RESULTS

This section describes the estimation results.[21] When interpreting the findings, it is useful to remember that, in our setting, individuals' choices reflect multiple considerations. First, when choosing an AFP to manage their pension balance, individuals are guided by their risk versus expected return preferences. Second, individuals weigh expected gains in retirement wealth associated with a given AFP choice against any reduction in income from subtracting the AFP's fees. Both considerations depend on individuals' accumulated retirement wealth and after tax disposable income.[22]

The later trade-off also drives the choice of the employment sector. When choosing a sector, individuals take into account that income may be lower/higher in the informal sector, and that they do not need to contribute part of their income to the pension account or pay fees to the pension fund in the informal sector and any additional costs/benefits associated with informal/formal sector employment, summarized by $\xi_{0,i,t}$ in our model.[23] Individuals who put higher weight on income relative to retirement wealth are more likely to prefer the informal sector. The preference for various components is likely to vary across demographic groups. Below, we summarize the estimated relationship between preferences and demographics.

Our estimates reflect preferences of individuals in our sample as revealed through their choices. Of course, an individual who selects a risky portfolio may also do so because of a lack of understanding about risk. This does not pose a problem for our estimation, because we expect industry decisions to be based on revealed preferences regardless of the underlying mechanisms. Thus, the preferences that we recover are an appropriate basis for our counterfactual analysis.

[21] We have also estimated a simplified (reduced-form) discrete choice model that projects individuals' choices on the portfolio characteristics (expected return and variance for individuals' investment and residual income after fees for a given AFP) and takes as given the observed employment sector choice. We allow for AFP fixed affects to capture such things as AFP's marketing strategy, the use of the sales force, and overall customer service. The coefficients associated with various portfolio characteristics depend on individuals' demographics. The results are presented and discussed in Appendix A.3.

[22] Specifically, among the two individuals with the same utility coefficients, an individual with higher balance will obtain higher utility from the retirement accumulations. Further, an individual with higher income will make a larger contribution and will derive higher utility from the retirement wealth component everything else equal.

[23] For some demographic groups, the disposable income in the informal sector may be higher due to the potential for tax evasion.

TABLE 5
PARAMETERS OF INDIRECT UTILITY FUNCTION

	Quadratic Wealth Term		Residual Income Term	
	Parameter	Std. Error	Parameter	Std. Error
Constant	-5.445^{***}	0.043	-1.705^{***}	0.048
$30 \leq$ age < 45, education < 8	2.056^{***}	0.003	-1.681	39.26
$45 \leq$ age, education < 8	0.970^{***}	0.006	-2.385^{***}	0.078
Age < 30, $8 \leq$ education < 12	-0.745^{**}	0.387	1.389^{***}	0.181
$30 \leq$ age < 45, $8 \leq$ education < 12	1.232^{***}	0.007	1.156^{***}	2.108
$45 \leq$ age, $8 \leq$ education < 12	-1.694^{***}	0.012	-0.715^{***}	0.128
Age < 30, $12 \leq$ education	-2.766^{***}	0.003	-2.683^{***}	0.614
$30 \leq$ age < 45, $12 \leq$ education	0.512^{***}	0.072	-0.253	0.249
$45 \leq$ age, $12 \leq$ education	1.612^{***}	0.745	-0.239^{***}	0.027
Male	-0.373^{***}		-0.337	8.312
Married	-5.780^{***}	0.013	-2.125	16.374
Married female, education < 8	-0.948^{***}	0.059	2.337^{***}	0.032
Married female, $8 \leq$ education < 12	1.855^{***}	0.237	-1.919	7.441
$5 \leq$ experience < 10	-1.260^{***}	0.61		
$10 \leq$ experience	1.85	1.27		
\$3,000 $\leq$ income $<$ \$8,000	-0.529^{***}	0.172	-2.367	6.625
\$8,000 $\leq$ income	1.263	1.223	-0.748	7.337
log (std. deviation of random coefficient)	-1.386^{***}	0.01	-0.526^{***}	0.121
Std. deviation of random coefficient*	0.04	–	0.07	–
Linear wealth term/inverse of σ_ϵ	0.423^{***}	0.003		

NOTE: This table shows the estimated indirect utility coefficients on the linear and quadratic wealth terms. Age, education, and experience are measured in years. The income variable corresponds to an individual's annual income. This variable and individual's balance are measured in thousands of dollars. The "Std. Deviation of Random Coefficient*" reflects the value of the standard deviation after it is multiplied by $\frac{1}{\theta_1}$ to impose normalization that the coefficient in front of the linear term is equal to one. *** and ** indicate statistical significance at 1% and 5%, respectively.

7.1. *Parameter Estimates.* The estimated parameters of the indirect utility function are reported in Tables 5–8. These parameters can be divided into three groups. The first group consists of the coefficient in front of the linear wealth term (expected AFP return multiplied by pension wealth) and the parameters used to construct the coefficient in front of the quadratic term (the second moment of the AFP return multiplied by the squared pension wealth). The second group consists of coefficients on residual income (income after subtracting contribution amount and fees), which also reflects an individual's price sensitivity. The third group is the set of parameters that captures the value of formal sector employment.

We begin by considering the first group. Recall that (after imposing natural normalization) the coefficient in front of the linear wealth term is the inverse of the standard deviation of the ϵ term. We estimate the standard deviation of ϵ to be equal to 2.36, which on average constitutes approximately 30% of the variation in indirect utility.

The parameters associated with the quadratic term reveal that this term plays an important role in decision making. Most of these parameters, including the standard deviation of the random coefficient, are precisely estimated. The estimated coefficients associated with the quadratic term vary across demographic groups. The standard deviation of the random coefficient is small, which indicates that heterogeneity in the degree of risk aversion is well captured by the observed demographic variables.

Beyond this, the estimated parameters are somewhat difficult to interpret. Recall that to calculate the value of the coefficient in front of the quadratic term, for example, for a male who is not married, is between 30 and 45 years of age, has less than eight years of education, low experience, and low income, we need to compute the linear index $Z_{2,i}\omega_2 = -5.445 + 2.056 - 0.373$ for such an individual, exponentiate it, and then multiply it by $\sigma_\epsilon = \frac{1}{0.423}$, which results in $\exp(-5.445 + 2.056 - 0.373)/0.423 = 0.055$. To not subject the reader to this task, we compute

TABLE 6
IMPLIED VALUES OF COEFFICIENTS IN THE INDIRECT UTILITY FUNCTION

	Coefficient in Front of	
	Quadratic Term	Residual Income Term
Age < 30, education < 8	0.006	0.432
$30 \leq$ age < 45, education < 8	0.047	0.080
$45 \leq$ age, education < 8	0.016	0.040
Age < 30, $8 \leq$ education < 12	0.003	0.956
$30 \leq$ age < 45, $8 \leq$ education < 12	0.021	0.830
$45 \leq$ age, $8 \leq$ education < 12	0.001	0.211
Age < 30, $12 \leq$ education	0.001	0.030
$30 \leq$ age < 45, $12 \leq$ education	0.010	0.556
$45 \leq$ age, $12 \leq$ education	0.030	0.548

NOTE: This table shows the coefficients in front of the quadratic wealth term and in front of the residual income term for an unmarried man from several demographic groups defined in terms of age and education. The reported coefficient is an average for of the coefficients for individuals in the data who belong to the specified group.

the values of the coefficient in front of the quadratic term for several demographic groups and report them in Table 6. The numbers reported in the table are the average of corresponding coefficients for the unmarried males in different age–education cells where the average is taken over the income, balance, and experience levels. We additionally provide a more intuitive interpretation of this coefficient below, where we investigate individuals' risk aversion implied by the estimated values of the utility function coefficients.

Table 6 also reports estimated parameters associated with the residual income term. Again, the parameters are precisely estimated and indicate that price sensitivity differs across demographic groups. Also, the standard deviation of the random coefficient is very small, which shows that differences across individuals are well explained by the demographic variables. The table indicates that individuals with the lowest level of educational attainment exhibit low price sensitivity, except for the youngest age category, for which price sensitivity is higher and comparable to that of college educated individuals.

These findings may reflect the fact that individuals with lower education levels spend a lot of time in the informal sector, so they rarely pay fees. They are also more likely to rely on government old-age support (welfare) in their retirement. In contrast, the observed price sensitivity of highly educated individuals probably reflects a more systematic approach to plan selection. These individuals pay more attention to fees and returns of different AFP firms.

The group with medium-range education levels is very price sensitive. These are individuals who have nontrivial balances and therefore have a lot to gain from pension investment, but they also tend to work frequently in the informal sector. The estimated coefficient associated with residual income may reflect, in part, their preference for informal sector work (where they avoid contributing to their pension account and can more easily evade taxes).

7.2. *Implied Risk Aversion.* Table 7 reports the implied measures of individuals' risk aversion based on the estimates reported in Table 5. Specifically, we report the average coefficients of absolute and relative risk aversion for different demographic groups. The magnitudes of these coefficients are generally consistent with values obtained by other studies (see Cohen and Einav, 2007, for a summary). The estimated risk aversion varies with individuals' demographics. Individuals with lower education levels are the least risk averse and, for this education group, risk aversion declines with age. In contrast, for individuals with higher education levels, risk aversion tends to be higher and to increase with age.

The table also reports a lottery interpretation, which helps to get a sense of the magnitudes of the estimated degree of risk aversion. Specifically, we consider a lottery where an individual

TABLE 7
IMPLIED MEASURES OF RISK AVERSION

	Absolute Risk Aversion	Relative Risk Aversion	Lottery Interpretation
Education < 8, age < 30	1.16×10^{-2}	1.67×10^{-2}	\$72.5
Education < 8, $30 \leq$ age < 45	1.47×10^{-2}	6.47×10^{-2}	\$42.2
Education < 8, $45 \leq$ age	5.36×10^{-4}	4.53×10^{-4}	\$98.5
$8 <$ education < 12, age < 30	1.45×10^{-2}	2.40×10^{-2}	\$74.7
$8 <$ education < 12, $30 \leq$ age < 45	1.47×10^{-2}	3.50×10^{-2}	\$42.2
$8 <$ education < 12, $45 \leq$ age	1.48×10^{-2}	4.87×10^{-2}	\$39.6
$12 <$ education, age < 30	1.25×10^{-2}	4.34×10^{-2}	\$56.4
$12 <$ education, $30 \leq$ age < 45	1.37×10^{-2}	4.89×10^{-2}	\$50.0
$12 <$ education, $45 \leq$ age	1.39×10^{-2}	6.01×10^{-2}	\$45.1

NOTE: This table characterizes the levels of risk aversion implied by the estimated parameters for several demographic groups. The coefficients of the absolute and relative risk aversion are computed according to the standard formulas, that is, $ARA = -\frac{u''(w)}{u'(w)}$ and $RRA = -\frac{x \times u''(w)}{u'(w)}$ with $w = B + y$. The last column considers a lottery where an individual may win a \$100 (approximately 50,000 peso) or lose \$x with equal probability. We report an average amount \$x for which individuals from a given demographic group are indifferent between participating in this lottery or staying out.

may win \$100 (approximately 50,000 peso) or lose \$ x with equal probability. We compute the values of x for which individuals are indifferent between taking this lottery up or not. The last column of Table 7 reports the average values of x for different demographic groups.

To interpret the results, note that a risk-neutral individual should be willing to participate in the lottery where he has an equal chance of losing \$100 or winning \$100. Similarly, an individual who is not very risk averse would be willing to participate in the lottery where he may lose an amount that is somewhat smaller but close to \$100 or win \$100 with equal probability. In contrast, an individual who is significantly risk averse requires a compensation for taking the risk, that is, he would only take the lottery if he expects to win more than he might have to lose (when chances of losing or winning are equal). As seen in the last column of Table 7, individuals with higher levels of education are quite risk averse; they would only be willing to participate in the lottery when the amount they might lose is quite low (\$40 for the high school graduates or \$50 for the college-educated group) relative to the amount they might win (\$100).

7.3. *Additional Value of Formal Sector Participation.* Table 8 reports the estimated parameters characterizing the value associated with formal sector employment. The estimates reveal expected regularities: The value of formal sector employment is increasing with education and age. Recall that we assumed a nested logit structure in modeling sector choice. We find that the ϵ error terms associated with the same sector choices are highly correlated. This indicates that unobserved costs/benefits associated with different sectors play an important role.

Finally, we estimate that the cost of switching AFP in this setting is approximately equal to \$200. This indicates that individuals in this market perceive switching as being quite costly. For this reason, switching is economically justified only for individuals with high balances who can gain sufficient amounts from the 1 or 2 percentage points difference in funds' returns.[24]

7.4. *Model Fit.* We summarize the model fit in Table 9, which compares the AFP market shares, predicted on the basis of the estimated parameters, to the market shares observed in the data. We consider the AFP market shares in terms of numbers of enrollees but also in terms of

[24] We also investigated robustness of our estimates to the assumption of the homogeneous switching costs. We find that individuals with low-education/low-income levels tend to have higher switching costs relative to highly educated/high-income individuals. The estimates for other parameters are relatively invariant to whether the specification allows for switching cost heterogeneity. The results are reported in the Online Appendix to the article.

TABLE 8
INDIRECT UTILITY FUNCTION: ADDITIONAL VALUE OF FORMAL SECTOR PARTICIPATION

	Parameter	Std. Error	Adjusted
Age $<$ 30, education $<$ 8	0.063	0.782	0.139
30 $\leq$ age $<$ 45, education $<$ 8	0.350	2.874	0.773
45 $\leq$ age, education $<$ 8	0.880***	0.028	1.943
Age $<$ 30, 8 $\leq$ education $<$ 12	0.941***	0.141	2.077
30 $\leq$ age $<$ 45, 8 $\leq$ education $<$ 12	1.052***	0.140	2.322
45 $\leq$ age, 8 $\leq$ education $<$ 12	1.594***	0.441	3.519
Age $<$ 30, 12 $\leq$ education	1.501*	1.071	3.313
30 $\leq$ age $<$ 45, 12 $\leq$ education	1.677***	0.274	3.709
45 $\leq$ age, 12 $\leq$ education	2.046***	0.036	4.517
Male	−0.426***	0.045	−0.940
Married	0.814***	0.090	1.797
Married female, education $<$ 8	−1.464***	0.018	−3.232
Married female, 8 $\leq$ education $<$ 12	−0.738***	0.015	−1.629
ρ_1	0.625******	0.042	
ρ_2	0.794******	0.016	
Switching Cost, η	0.089***	0.008	0.21
Entry Cost for New Affiliates, η_0	0.153***	0.008	0.36

NOTE: This table shows the estimated indirect utility from the formal sector employment. Age, education, and experience are measured in years. The last column reflects the values of the parameters after they are multiplied by $\frac{1}{\theta_1}$, a normalization imposed so that the coefficient in front of the linear term is equal to one. The indirect utility is measured in thousands of dollars. *** and * indicate statistical significance at 1% and 10%, respectively.

TABLE 9
PREDICTED SHARES

	Formal Sector		Informal Sector	
	Actual Shares	Predicted Shares	Actual Shares	Predicted Shares
Share of the number of enrollees				
Provida	0.253	0.237	0.152	0.158
Santa Maria	0.148	0.116	0.104	0.139
Habitat	0.107	0.106	0.091	0.102
Cuprum	0.055	0.042	0.013	0.009
Planvital	0.025	0.026	0.025	0.012
Summa	0.015	0.030	0.002	0.001
Magister	0.008	0.024	0.004	0.000
Share of funds under management				
Provida	0.227	0.248	0.049	0.042
Santa Maria	0.214	0.226	0.037	0.036
Habitat	0.229	0.236	0.038	0.020
Cuprum	0.132	0.101	0.016	0.010
Planvital	0.030	0.029	0.005	0.002
Summa	0.022	0.034	0.001	0.000
Magister	0.009	0.010	0.002	0.002

NOTE: This table characterizes the fit of the model to the data in terms of the shares of the number of enrollees and the pension investment captured by different firms. Each entry describes the average (across years) share of a given group in the total population; for example, the average share in the data of individuals who are in formal sector and have chosen Provida is equal to 0.253.

the total balance under the management and the numbers of new contributions (not reported in the article). It is quite challenging to achieve good fit for these measures. Recall that our framework includes only one set of AFP fixed effects, whereas the market shares we aim to fit pertain to several different dimensions of the data. Additionally, the balance and contribution shares are not explicitly targeted in estimation.

TABLE 10
BREAKDOWN OF THE MODEL FIT

Full Model	0.001
No AFP fixed effects	0.130
+ no random coefficients	0.131
+ no logit errors	0.320

NOTE: In this table, we investigate contribution of various model component to the model's performance in terms of fit to the data. Specifically, we report what fraction of the average sum of squared empirical moments, $\frac{1}{NT}\sum_{i,t}\sum_k \hat{m}_{k,i,t}^2$, is accounted for by the average sum of squared differences between the moment conditions predicted out of the model and empirical moments, $\frac{1}{NT}\sum_{i,t}\sum_k (m_{k,i,t}(\hat{\theta}^{est}) - \hat{m}_{k,i,t})^2$, under the estimated values of the parameters and when various components of the econometric model are shut down.

Our results indicate that the estimated model achieves a reasonably good fit to the market shares data. The fit is not perfect, however. For individuals in the formal sector, the model somewhat overpredicts the share of Summa and Magister and underpredicts shares of Santa Maria. For individuals in the informal sector, it overpredicts shares of Santa Maria and underpredicts shares of Planvital. However, the overall performance is quite good. The model also delivers a good fit in terms of the shares of the balance under the management and in terms of the shares of new contributions (not shown in the table).

In Table 10, we investigate the contribution of various model components to the performance in terms of model fit. In this analysis, we report the fraction of the average sum of squared empirical moments, $\frac{1}{NT}\sum_{i,t}\sum_k \hat{m}_{k,i,t}^2$, accounted for by the average sum of squared differences between the moment conditions based on the estimated model and empirical moments, $\frac{1}{NT}\sum_{i,t}\sum_k (m_{k,i,t}(\hat{\theta}^{est}) - \hat{m}_{k,i,t})^2$, when various components of the econometric model are shut down. Here i, t, and k enumerate individuals, years, and moment conditions correspondingly; $\hat{m}_{k,i,t}$ denotes the value of an empirical moment condition, whereas $m_{k,i,t}(\hat{\theta}^{est})$ denotes a theoretical model condition evaluated at the estimated parameter vector.

We find that AFP fixed effects play an important but limited role in explaining individual fund choices (they explain for 13% of the sum of squared empirical moments). At the same time, logit random errors contribute importantly to explaining individual choices (they explain 19% of the sum of squared empirical moments). This indicates that some variables influencing individuals' decisions are not observable. The contribution of the random coefficient component in the indirect utility coefficients is negligible.

7.5. *Cost Function.* To estimate the translog cost function, we use yearly observations on AFP operational costs for 20 years of market operation. The majority of coefficients are statistically significant and have the expected sign. Table 11 reports the estimated coefficients that indicate that the average cost per affiliate is an increasing function of the balance per affiliate:

$$\log C - \log N = 0.584(\log B - \log N) - 0.3(\log B - \log N)^2.$$

The estimated AFP fixed effects are not statistically significant at conventional levels except in two cases, which indicates that costs of AFPs are largely symmetric across firms.

8. COUNTERFACTUAL ANALYSIS

We next investigate the implications of minimal return regulation on the operation of the market under different scenarios. That is, we use the estimated demand and cost function parameters to study the effect of minimal return regulation on the choice of products offered in this market and on consumer welfare. This requires resolving the industry competition game under alternative scenarios.

TABLE 11
COST FUNCTION

	Coefficients	Std. Errors
log(Affiliates)	0.515	0.196***
log(Assets)	0.517	0.039***
log(Affiliates)^2	+0.029	0.009***
log(Assets)^2	−0.031	0.011***
log(Affiliates) log(Assets)	−0.062	0.021***
Provida	−0.097	0.066
Santa Maria	0.063	0.123
Habitat	−0.082	0.096
Cuprum	−0.236	0.066***
Planvital	0.024	0.062
Summa	0.083	0.090
Magister	−0.253	0.061***
Dependent variable: log(C)		
The analysis incorporates a quadratic time trend.		

NOTE: ***indicates statistical significance at 1%.

8.1. *Implementation Details.* This task proves to be challenging, because there are conflicting incentives driving AFP firms' decisions. First, the estimated cost function implies that the average cost per enrollee depends on the average balance per person. This implies that the firm will aim to achieve an optimal relationship between the number of enrollees and the total balance they bring to the firm. Second, the regulation of fees in this market ties firm's revenue to the number and income of contributing consumers, whereas the costs are associated with all customers carrying balances. These compositional effects present challenges to the equilibrium's existence and uniqueness, which makes solving such games nontrivial.

To make progress, we simplify the setting in the counterfactual analysis. Specifically, we restrict the set of firms competing in the market to the three firms capturing the largest market shares in terms of the number of enrollees and the balance under the management (their combined market shares constitute 70% of the market).[25] This assumption significantly reduces the dimensionality of the problem and facilitates numerical analysis.

Additionally, we introduce some smoothing into the problem by assuming that each firm chooses among a finite number of possible values of β (the portfolio choice) where each possible choice of β has associated with it a firm-specific private cost. This means that the equilibrium portfolio choices are probabilistic from a competitor's point of view. It is well known that in the two-stage models with firms competing on product characteristics in the first stage and then on prices in the second stage, multiple equilibria may occur. However, it remains unclear how prevalent this phenomenon is in practice. The existing empirical studies, for example, typically find only a single equilibrium. We allow for the possibility of multiple equilibria in our analysis and indeed document an instance of two equilibria under one of the specifications considered.[26] In most specifications, however, only a single equilibrium is found.

In the analysis presented below, we fix the number of firms to three and thus abstract from firms' participation decisions. On the basis of the recorded profit, we expect that some of the firms would exit the market if they had such an option. Our assumption that the number of firms is fixed is motivated in part by data limitations. We have data only for a relatively short time series of a single market. Any information on firms' participation decisions under the circumstances would be imprecise. We leave the analysis of participation decisions until the time when better information on entry costs and scrap values is available. Further, to keep things

[25] We adjust the market size accordingly. Specifically, we use individuals in our sample to simulate demand under different regulatory scenarios and use the population sampling weights to obtain the market-level demand. These weights are further adjusted to take into account the fact that we are working with 70% of the market.

[26] We find them by using multiple starting points when solving the industry competition game.

tractable, we ignore switching costs in the counterfactual analysis. Future work may investigate how industry may exploit this source of inertia embedded in consumer decisions.

Our primary objective is to understand the potential impact of the minimal return regulation on the market. We focus on the most important features of the market, recognizing that some other existing regulations could interact with the minimum return regulation. For example, the Chilean government imposed some restrictions that limited the types of assets that AFPs were allowed to use for investment purposes, which effectively imposed an upper bound on the riskiness of portfolios that could be offered in the market (effectively, β was restricted to be below 0.25). The restrictions were gradually relaxed over time. To explore the mechanism through which minimal return regulation may impact the market, we opted to present here the results for the case when βs are allowed to be as high as 1, which is a restriction traditionally imposed in institutional investment. However, we also explore the impact of the minimum return regulation under alternative upper bound restrictions on β in Table A.2. If the riskiness of portfolios is severely restricted, then the effect of minimum regulation will be smaller.

We outline the details of the empirical framework used to compute equilibria below.

8.1.1. *Details of empirical framework used to compute equilibria.* As previously noted, we set the number of firms competing in the market to three ($J = 3$). We allow each firm to choose a point on the grid of possible values of β: $\Omega_K = (\bar{\beta}_1, \bar{\beta}_2, \dots, \bar{\beta}_K)$, with the options assumed to be the same for all firms. A firm is characterized by a vector of private costs associated with choosing each grid point, $\nu_{j,t} = (\nu_{1,j,t}, \dots, \nu_{K,j,t})$, where vector components are independent and distributed according to a normal distribution with mean zero and standard deviation σ_ν.

A firm chooses β from the set of feasible points for a given realization of private costs. Firm j's private type is K-dimensional at a given point in time. Therefore, firm j's strategy is a mapping: $\tau_\beta : R^K \longrightarrow \Omega_K$, which indicates which value from the finite set of grid points the firm should play for a given realization of fixed costs $\nu \in R^K$. Integrating over the distribution of private costs results in a vector of probabilities with which firm j chooses a particular grid point in equilibrium, $\lambda_{j,t} = (\lambda_{j,t,1}, \dots, \lambda_{j,t,K})$. In this setting, firm j's strategy is stochastic from a competitors' point of view, because the competitor cannot observe the realization of firms j's private costs. Competitors' beliefs about firm j's strategy are therefore summarized by a probability distribution $\lambda_{j,t}$ over the grid of possible β-values.[27]

As described in the model section, the firms observe competitors' portfolio choices when they choose their prices. The equilibrium of this game is therefore summarized by a collection of probability distributions over the β-grid and the collection of pricing functions that specify the price the firm charges when different combinations of portfolios are realized in the market:

$$(\lambda^\star_{j,1}, \dots, \lambda^\star_{j,K}; p^\star_1(\beta_1, \beta_{-1}), \dots, p^\star_J(\beta_J, \beta_{-J})).$$

Denote by $\pi_j(\beta_j, \beta_{-j}; p_j, p_{-j})$ the profit that accrues to firm j if it chooses portfolio characterized by β_j and charges price p_j, whereas its competitors choose portfolios characterized by λ_{-j} and charge prices according to pricing functions p_{-j}. Then, the ex ante expected profit is given by

$$\Pi_j(\beta_{k_j}, \lambda_{-j}, p_j, p_{-j}; \nu_j) = \sum_{k_{-j}} \left[\left(\pi_j(\beta_{k_j}, \beta_{k_{-j}}; p_j(\beta_{k_j}, \beta_{k_{-j}})) + \nu_{k_j} \right) \prod_{i \neq j} \lambda_{k_i} \right].$$

We set $K = 6$, $\beta_1 = 0$, $\beta_K = 1$, and $\sigma_\nu = 0.5$ in simulations. The robustness of the results to the number of possible β points, K, and to the variance of private costs, σ_ν, is explored in the

[27] The results of the counterfactual analysis in Tables 12–14 are summarized in terms of the expected value of $\beta_{j,t} = \tau_\beta(\nu_{j,t})$, which is computed using the equilibrium vector of probabilities $\lambda_{j,t}$. The expected values of the prices, profits, and other variables are computed in a similar way.

TABLE 12
IMPACT OF REGULATION: FIXED SECTOR OF EMPLOYMENT

Firm		Expected			Market Shares		
		β	Price	Profit	Participants	Balance	Contributions
No regulation							
1	1	0.02	1.42	409.19	70.04%	80.44%	82.5%
	2	0.21	1.76	175.85	1.34%	1.17%	1.6%
	3	0.6	1.41	356.07	28.63%	18.41%	15.9%
2	1	0.07	1.32	217.4	70.04%	80.44%	81.5%
	2	0.27	1.65	138.03	1.34%	1.17%	1.2%
	3	1	1.32	−14.74	28.63%	18.41%	17.3%
Regulation: $\delta = 0$							
	1	0.36	1.85	435.35	44.79%	41.11%	40.5%
	2	0.6	4.82	965.43	15.09%	34.22%	36.4%
	3	0.79	2.16	1,146.29	40.13%	24.64%	23.1%
Regulation: $\delta = 0.02$							
	1	0.2	1.96	757.48	54.81%	73.91%	76.0%
	2	0.4	17.44	5.59	0%	0%	0.0%
	3	1	1.91	1,003.03	45.19%	26.04%	24.0%

NOTE: This table characterizes the impact of the minimal return regulation in a setting where consumers' sector of employment is exogenously determined. The values of β, prices, and profits reflect expectations computed with respect to the distribution λ characterizing equilibrium choices of β. The variable price reflects the fee paid by an individual who contributes \$10. The price is measured in dollars, whereas the profit is measured in tens of thousands of dollars.

Online Appendix. We verify that the results are not particularly sensitive to the values of these parameters. The number of equilibria also remains unchanged.

8.2. *The Impact of Regulation.* We now turn to our analysis of the minimal return regulation impact. We present the results for the distribution of the market return observed in our data (7% is average over the years).[28] Although our ultimate goal is to study the impact of the regulation in the most realistic setting, where individuals may choose between employment sectors, we start with a simpler setting to build intuition. Specifically, we first consider the case when the sector of employment is fixed and thus individual's income levels, contribution levels, and fee payments to invest with various AFPs are fixed as well.

8.2.1. *Fixed employment sector.* In this analysis, we assume that the distribution of consumers' characteristics (their balances, income, and risk aversion) and their allocation to the formal and informal sectors are as observed in the data. We then compute the equilibrium vector of portfolios and fees for (i) the case when there is no minimal return regulation, (ii) the case when minimal return regulation with $\delta = 0$ is imposed, and (iii) the case when minimal return regulation with $\delta = 0.02$ (Chilean case) is imposed. The results are reported in Table 12.

As the table shows, for the case without the regulation, we find two equilibria. In the first one, the AFPs offer a diverse set of portfolios that span the spectrum of possible CAPM β's from very safe (close to zero correlation with the market portfolio) to quite risky (high correlation with the market portfolio). The enrollees are mostly distributed between the safest and the riskiest portfolio, with the safest portfolio attracting by far the largest share of enrollees. Relative to other AFPs, the AFP offering the safest portfolio attracts older individuals, who tend to have both higher income and higher balances. This is indicated by the fact that the market share of this portfolio in terms of balance and in terms of new contributions exceeds its market share in terms of enrollees. The medium-risk portfolio attracts only a small share of consumers. It manages to stay profitable by charging fees that exceed those charged by other firms. The second

[28] In the online Appendix, we explore robustness to alternative market return distributions.

equilibrium appears less plausible, because in this equilibrium, one of the firms obtains negative profit and the overall industry profitability is much lower.[29]

Under the scenario when AFPs are required to guarantee an average (among AFPs) return or above ($\delta = 0$), the portfolios offered in the market become more similar and the whole vector of returns moves toward riskier options. Among other things, the position of the safest portfolio offered in the market corresponds to a significantly higher level of risk relative to the no regulation scenario. The consumers are more uniformly distributed across firms, with a large share of consumers investing in the two riskiest portfolios. Recall that in the case with no regulatory restrictions, some similar portfolios were offered but they attracted a smaller share of consumers. This enrollment change reflects the fact that the minimum return regulation reduces individuals' risk aversion by protecting customers from potential downside risks. We investigate this effect in greater detail below. The allocation of consumers toward riskier options mitigates the regulation costs borne by the industry, because the balance that the AFP with the safest portfolio (which is the one most exposed to the risk of regulatory penalties) manages is reduced. Another important consequence of the regulation is that it induces an increase in fees (around 30% increase on average) to compensate for the expected cost that the regulation imposes on firms.

Under the minimum return regulation that was actually implemented in Chile ($\delta = 0.02$), the selection of portfolios offered by AFPs also shifts toward riskier options. However, the diversity in the set of portfolios offered is greater relative to the case when $\delta = 0$. As was the case in the no regulation case, the medium-risk portfolio attracts a small share of customers and compensates for lower enrollment by charging high fees. However, the profitability of the medium-risk portfolio is less successful than when there is no regulation. It is likely that this AFP would exit the market if that option were available. The distribution of consumers across firms is similar to that observed under the "no regulation" case. However, a larger share (relative to "no regulation" case) of consumers prefers the riskiest portfolio, because the guarantee of a minimum return effectively insures their downside risk. The later effect reduces the burden of regulation borne by the firm offering the safest portfolio.

8.2.2. *Decomposing the effect of regulation.* The minimal return regulation impacts the market through two channels. First, it partially protects consumers from downside risks and therefore makes them more apt to choose riskier portfolios among those offered. Second, it imposes additional costs, which are proportional to the balance under the management, on the firms participating in the market. The logic outlined in Section 3 suggests that these two effects may work to enhance the incentives embedded in the minimal return regulation or to diminish them. We investigate their relative importance by resolving the model while shutting down one of these channels in turn. The results are reported in Table 13.

Let us first consider the case when $\delta = 0$ and for the case where the regulation protects consumers but imposes no additional costs on firms. In this case, the risk of the safest portfolio is considerably increased, but the portfolios offered in the market are closer to each other relative to the "no regulation case." Among other things, the risk of the riskiest portfolio is reduced. This outcome arises because the regulation that offers risk protection increases the number of consumers who prefer moderately risky products. This, in turn, makes it profitable to saturate this part of the product space instead of offering a more diverse set of products in the equilibrium.

In contrast, under the case where the regulation does not offer protection to consumers but instead only imposes costs on the firms in the event of low performance, the movement of consumers toward riskier products does not arise naturally. This type of regulation leads to

[29] Interestingly, a firm in this market may not be able to avoid negative profit through the choice of fee. Even if the fee is high, a firm may still attract individuals from the informal sector who are exempt from paying fees. Thus, firms can be in a situation of incurring costs but not being able to collect fees to generate revenue. Further, the firm may not be able to avoid these consumers even through a choice of β, because β is limited from above by one.

TABLE 13
DECOMPOSING THE IMPACT OF REGULATION UNDER FIXED EMPLOYMENT SECTOR

	Expected			Market Shares		
Firm	β	Price	Profit	Participants	Balance	Contributions
Regulation, consumer protection only: $\delta = 0$						
1	0.29	1.75	120.85	35.14%	43.38%	40.6%
2	0.44	1.35	169.28	42.39%	41.2%	41.6%
3	0.5	2.8	66.16	22.48%	15.49%	17.8%
Regulation, consumer protection only: $\delta = 0.02$						
1	0.2	2.53	645.72	18.01%	52.79%	42.2%
2	0.4	1.44	230.63	43.24%	24.1%	29.1%
3	1	1.42	177.76	38.76%	23.22%	28.6%
Regulation, no consumer protection: $\delta = 0$						
1	0.4	5.17	605.22	17.62%	52.19%	41.6%
2	0.6	1.63	291.61	40.15%	22.99%	28.4%
3	1	1.6	375.85	42.27%	24.87%	30.1%
Regulation, no consumer protection: $\delta = 0.02$						
1	0.2	3.1	737.11	54.98%	74.11%	67.7 %
2	0.44	9.91	0.5	0%	0%	0%
3	1	1.94	1,089.41	45.02%	25.87%	32.3%

NOTE: This table decomposes the impact of the minimal return regulation in a setting where consumers employment sector is exogenous. The values of β, prices, and profits reflect expectations computed with respect to the distribution λ characterizing equilibrium choices of β. The variable price reflects the fee paid by an individual who contributes \$10. The price is measured in dollars, whereas the profit is measured in tens of thousands of dollars.

two effects: (i) It is profitable to offer a diverse set of portfolios that targets different types of consumers; and (ii) the safest portfolio charges high fees, which, on the one hand, allow it to finance its risk exposure associated with the regulation and, on the other hand, steers consumer demand toward other portfolios. As a result, imposing the regulation only on firms without providing consumer protection results in much higher fees and an overall riskier set of portfolios.

Similar effects arise under the regulatory restriction where $\delta = 0.02$. However, the consumer protection awarded in this case as well as the probability of firms incurring a regulation penalty is lower in this case and all the effects are weaker. To summarize, when the sector of employment is fixed, the protection awarded by the regulation reduces consumer risk aversion and induces the industry to offer riskier portfolios but also mitigates the cost of regulatory penalties to the industry and in this way controls the level of fees charged by firms.

8.2.3. *Extension to allow endogenous sector of employment.* Having built the intuition for industry competition when the employment sector is fixed, we now turn to the analysis of the full model where individuals can opt out of contributing to their pension accounts and paying fees by choosing informal sector work. The results of this analysis are summarized in Table 14. The most noticeable difference relative to the case with the exogenous employment sector is that the ability of individuals to choose the employment sector results in a degree of sorting of individuals on risk across sectors.[30] Specifically, individuals with low risk aversion are attracted to formal sector work because their preference for riskier portfolios also makes them wish to invest more instead of less. Of course, many individuals also choose the formal sector for other reasons, such as higher paying jobs for certain demographic groups. The additional sorting induced by employment sector choice motivates the industry to offer riskier products relative to the case with a fixed employment sector: The risky portfolio is now more lucrative because it attracts fee-paying customers.

[30] The allocation of individuals across sectors in the fixed employment sector analysis corresponds to the allocation observed in the data, which reflects the market equilibrium under additional regulatory restrictions ($\beta_j \leq 0.25$).

TABLE 14
IMPACT OF REGULATION: ENDOGENOUS SECTOR OF EMPLOYMENT

Formal Sector	Firm	Expected β	Expected Price	Expected Profit	Market Shares Participants	Market Shares Balance	Market Shares Contributions
No regulation							
65%	1	0	1.02	187.58	50.18%	47.59%	28.4%
	2	0.24	1.25	14.46	12.11%	11.46%	1.8%
	3	1	1.02	223.15	32.22%	35.5%	69.8%
Regulation: $\delta = 0$							
69%	1	0.62	1.39	220.15	39.61%	25.08%	13.1%
	2	0.85	5.02	281.9	7.87%	30.14%	0%
	3	1	1.34	859.02	52.53%	44.84%	86.9%
Regulation: $\delta = 0.02$							
68%	1	0.17	2.45	188.93	15.36%	17.22%	2.9 %
	2	0.27	2.9	429.2	37.54%	39.12%	9.7 %
	3	1	1.31	641.42	47.06%	43.68%	87.4%

NOTE: This table characterizes impact of the minimal return regulation in a setting where consumers sector of employment is endogenously determined. The values of β, prices, and profits reflect expectations computed with respect to the distribution λ characterizing equilibrium choices of β. The variable price reflects the fee paid by an individual who contributes \$10. The price is measured in dollars, whereas the profit is measured in tens of thousands of dollars.

Continuing with the analysis of the regulation effects, under $\delta = 0$ or $\delta = 0.02$, an expected consequence of the regulation is that it reallocates consumers toward riskier portfolios. Due to the sorting, the safest portfolio attracts a large share of individuals choosing the informal sector (who do not pay fees), and thus the firm offering the safest portfolio collects relatively low-fee revenues. This results in a higher fee schedule (relative to exogenous participation case) and encourages consumers to shift toward riskier portfolio choices, as the AFPs try to minimize the probability of incurring regulatory penalties. Finally, the regulation is associated with a modest increase in the probability that a worker chooses the formal employment sector.

8.3. *Economic Impact.* To assess the economic importance of the minimal return regulation for pension fund accumulations and government budgets, we perform the following "back-of-the-envelope" calculations. First, we simulate a sample of workers entering the pension market in the same year, setting the age at which individuals enter the job market to be equal to the median age observed in the data for each corresponding education level. We maintain the proportions of different educational levels as observed in the data. We consider both the case of the fixed employment sector and the case of endogenous employment sector for comparison purposes.

In the fixed employment sector case, we also replicate the distribution of individuals (conditional on education) across formal/informal sectors as in the data. Each simulated individual is "endowed" with a draw from the income distribution corresponding to his demographics, which changes over time in a manner observed in the data.

We further fix the distribution of market returns and the risk-free rate at the levels observed in the data and simulate balance growth for these individuals over a 40-year time span. We then allow these individuals to retire at the age of 60. At this point, the accumulated pension balance is converted into an annuity, which corresponds to expected survival for 10 years subsequent to retirement (consistent with Chilean life expectancy tables.).[31] Individuals who draw an annuity below \$1,000 are eligible for government support. We compute the mean and variance of the pension balance distribution, and the probability of government support for different quantiles of the initial income distribution. We repeat this exercise under different regulation scenarios.

[31] We have considered a few alternative scenarios concerning the balance withdrawal, including one where individuals can keep their money invested after retirement, withdrawing 10% annually. All the scenarios produce qualitatively similar results.

TABLE 15
WELFARE STATISTICS

	Fixed Sector				Endogenous Sector			
	25%	50%	75%	90%	25%	50%	75%	90%
No regulation								
Balance, mean	11.2	21.1	40.9	81.8	6.19	12.34	27.4	56.2
Balance, std. dev.	2.09	2.72	4.05	7.95	1.56	3.20	7.8	15.8
Probability of support	0.27	0.00	0.00	0.00	0.52	0.24	0.06	0.00
Average consumer surplus	1.08	1.64	2.84	5.36	1.05	1.33	1.74	3.23
Regulation: $\delta = 0$								
Balance, mean	13.9	24.3	46.8	93.5	12.9	24.6	48.3	98.7
Balance, std. dev.	2.65	3.83	5.73	11.7	2.97	4.67	8.80	17.75
Probability of support	0.12	0.01	0.00	0.00	0.16	0.01	0.00	0.00
Average consumer surplus	1.16	1.77	3.08	5.87	1.16	1.78	3.14	6.06
Regulation: $\delta = 0.02$								
Balance, mean	13.0	24.4	45.7	91.7	13.0	24.9	48.4	98.7
Balance, std. dev.	2.92	4.42	6.34	12.4	3.20	5.64	10.6	21.2
Probability of support	0.13	0.00	0.00	0.00	0.18	0.00	0.00	0.00
Average consumer surplus	1.16	1.79	3.04	5.80	1.15	1.78	3.17	6.06

NOTES: This table reports the moments of the pension balance distribution, probability of government support, and an average per period disposable income for a set of workers entering market in the same year with the initial income draws equal to different quantiles of income distribution.

Table 15 reports the results. The reported numbers correspond to the fixed income levels (fixed at the quantiles of income distribution). The variation in final balances and in disposable income arises for multiple reasons: (i) individual heterogeneity in risk aversion and price sensitivity associated with demographics other than income, which leads them to choose different AFPs, and (ii) uncertainty associated with the realizations of the market and AFP returns. As seen in the table, the regulation results in higher mean and variance of pension balances.

Specifically, the average balance almost doubles for all income quantiles under the full model. Recall that the participation margin is not greatly affected; that is, participation in the formal sector does not substantially increase under the regulation. However, in the presence of regulation, individuals place their balances in riskier portfolios, which earn higher returns on average, even in years when they may be working in the informal sector. In contrast, in the world without the regulation, the individuals who decide to work in the informal sector (and to allocate their funds into the safest portfolio offered) collect very low rates of return. The impact of the regulation is most striking for individuals with low levels of education and therefore lower income who tend to spend a larger portion of their working life in the informal sector.

The regulation significantly reduces the probability of receiving government old-age pension support. Specifically, in the absence of regulation, individuals in the lowest two income quantiles require support with very high probability (52% and 24%). With the regulation, the second lowest quantile does not require any support, whereas the probability of relying on government support for the lowest quantile is substantially reduced to 16% and 18% for $\delta = 0$ and $\delta = 0.02$. Recall that under the regulation (either $\delta = 0$ or $\delta = 0.02$), consumers pay higher fees relative to the case of no regulation. Our results indicate that consumers gain from regulation in terms of average accumulated balance and thus in terms of postretirement consumption. We use our utility measure as a way to capture the net effects for the consumers. We find that, on average, per period utility is somewhat higher under regulation, with larger gains accruing to the individuals with higher income levels. These regularities are also present in the model with a fixed employment sector. However, the magnitudes of the effects are smaller. The ability of individuals to choose the employment sector amplifies the impact of the regulation on this market.

To summarize, the regulation induces individuals to invest their wealth in riskier portfolios. This increases volatility in the individuals' accumulated balances, but it also drives up the average accumulated balance. In the end, the higher average balance accumulation reduces the probability of relying on government old-age pension support and increases the average expected utilities of consumers.

9. CONCLUSIONS

This article studies the impact of minimal return regulation on the operation of the pension investment market in the context of Chile's individual investment account pension system. As a point of departure, we show that such regulation unambiguously provides incentives for the industry to choose riskier investments relative to the case without the regulation if the minimal return is tied to average firm performance. However, the joint distribution of consumers' pension accumulations, income, and risk preferences may either mitigate or enhance these incentives. Our empirical results show that riskier pension investments result in higher volatility of pension accumulations but also higher expected pension balance levels. The welfare consequences of the minimum return regulation depend on the relative magnitude of these two effects.

To assess the empirical magnitudes, we estimate an equilibrium model characterizing the demand and supply of the Chilean pension investment product market. We find that consumer characteristics play an important role in determining the overall regulation impact on the market. Specifically, individuals with high balances are not necessarily actively contributing, and they tend to have lower income due to age cohort effects. Because of the restrictions that limit the types of fees that can be charged, pension managers may find it difficult to cover the management costs of the balances that they attract with fee revenues. Furthermore, we find that the majority of the working age population is quite risk averse.

Our results show that on the supply side, regulation results in firms offering a riskier set of portfolios and charging higher pension management fees. On the demand side, the regulation leads consumers to demand riskier products. As a result, individuals' pension balances around the age of retirement are characterized by higher variability than they would be in the absence of minimum return regulation. However, the balance is also a higher mean, and the increase in mean is sufficiently large to substantially reduce the proportion of individuals relying on government old-age pension support. These outcomes depend somewhat on the restrictiveness of the regulatory policy, which means that policy parameters should be carefully calibrated for a specific market to achieve desired outcomes.

The regulation impacts the market primarily through two channels: (i) It protects consumers from downside risk and thus makes them more willing to invest into risky portfolios, and (ii) it imposes additional costs on industry. We find that the first component contributes significantly toward facilitating balance accumulation. First, it ensures that individuals are willing to place their balance with an AFP offering risky portfolios that, in turn, incentivizes the industry to offer such portfolios. Second, it mitigates the regulatory cost borne by the industry by reducing the share of balance managed by the safest portfolio. However, in the circumstances when the later effect is weak, the industry offsets regulatory costs by increasing fees.

To summarize, the minimum return regulation is able to deliver an increase in balance accumulations and a reduction in reliance on government support. We believe that this article makes the first step in the analysis of minimal return and fee regulations and, more generally, of policies that implement peer-related performance incentives. We hope that our findings will motivate further research in this area.

APPENDIX

A.1. *Estimating the Distributions of Returns.* We use data on AFP returns to estimate $E[R_{j,t}]$ and $\mathrm{Var}[R_{j,t}]$. In particular, we use a diagonal VEC model as described in Bolleslev (1988). We model a univariate process governing evolution of $R_{j,t}$ as

$$\Delta R_{j,t} = b_j + \epsilon_{j,t},$$

where variance of $\epsilon_{j,t}$ follows an ARCH-GARCH (1,1) process and $\Delta R_{j,t}$ is defined as $\Delta R_{j,t} = R_{j,t} - r_{0,t}$ with $r_{0,t}$ representing risk-free return. More specifically,

$$\sigma^2_{\epsilon_j;t} = \gamma_{j,0} + \gamma_{j,1}\epsilon^2_{j,t-1} + \gamma_{j,2}\sigma^2_{\epsilon_j;t-1}.$$

To obtain $E[\tilde{R}_{j,t}]$ and $\text{Var}[\tilde{R}_{j,t}]$ that enter consumer's expected utility function, we estimate a bivariate GARCH model that describes joint evolution of $R_{j,t}$ and $\bar{R}_t = \frac{\sum_j R_{j,t}}{J_t}$. Under this specification,

$$\Delta R_{j,t} = b_j + \epsilon_{j,t},$$
$$\Delta \bar{R}_t = b_0 + \epsilon_{0,t},$$

where the elements of variance–covariance matrix of $\epsilon_{j,t}$ and $\epsilon_{0,t}$ follow a VEC (1,1) process.[32] More specifically,[33]

$$\sigma^2_{\epsilon_j;t} = \gamma_{j;0} + \gamma_{j;1}\epsilon^2_{j,t-1} + \gamma_{j;2}\sigma^2_{\epsilon_j;t-1},$$
$$\sigma^2_{\epsilon_0;t} = \gamma_{0;0} + \gamma_{0;1}\epsilon^2_{0,t-1} + \gamma_{0;2}\sigma^2_{\epsilon_0;t-1},$$
$$\sigma_{\epsilon_j,\epsilon_0;t} = \gamma_{j,0;0} + \gamma_{j,0;1}\epsilon_{j,t-1}\epsilon_{0,t-1} + \gamma_{j,0;2}\sigma_{\epsilon_j,\epsilon_0;t-1}.$$

We then use the estimated coefficients of this process to compute the estimates for $E[\tilde{R}_{j,t}]$ and $\text{Var}[\tilde{R}_{j,t}]$ taking into account that $\tilde{R}_{j,t} = \max\{R_{j,t}, \bar{R}_t - \delta\}$.

We also compute a time-varying CAPM beta using the same bivariate technique as above.

$$\Delta R_{j,t} = b_j + \epsilon_{j,t},$$
$$\Delta R_{m,t} = b_m + \epsilon_{m,t},$$

where $\epsilon_t = (\epsilon_{j,t}, \epsilon_{m,t})$ is distributed according to $N(0, H_t)$ and the elements of the variance–covariance matrix are given by

$$\sigma^2_{\epsilon_j;t} = \alpha_{j;0} + \alpha_{j;1}\epsilon^2_{j,t-1} + \alpha_{j;2}\sigma^2_{\epsilon_j;t-1},$$
$$\sigma^2_{\epsilon_m;t} = \alpha_{m;0} + \alpha_{m;1}\epsilon^2_{m,t-1} + \alpha_{m;2}\sigma^2_{\epsilon_m;t-1},$$
$$\sigma_{\epsilon_j,\epsilon_m;t} = \alpha_{j,m;0} + \alpha_{j,m;1}\epsilon_{j,t-1}\epsilon_{m,t-1} + \alpha_{j,m;2}\sigma_{\epsilon_j,\epsilon_m;t-1}.$$

We use the estimated coefficients of this model to compute $\hat{\beta}_{j,t} = \frac{\hat{\sigma}_{\epsilon_j,\epsilon_m;t}}{\hat{\sigma}_{\epsilon_j;t}\sigma_{\epsilon_m;t}}$, which characterizes the portfolio choice decision in our model.

A.2. *Moment Conditions.* This section reports formal expressions for the moment conditions used in the estimation.

$$\Pr(i \text{ chooses } (0, j)) \quad \forall j = 1, \dots, J, \text{ and } t \in \{t_1, \dots, t_T\},$$
$$\Pr(i \text{ chooses } (1, j)) \quad \forall j = 1, \dots, J, \text{ and } t \in \{t_1, \dots, t_T\},$$
$$\Pr(j_{i,t-1} \neq j_{i,t})$$

[32] Here, $\Delta \bar{R}_t = \bar{R}_t - r_{0,t}$.

[33] Alternatively, we could have estimated a full system of joint evolution of all funds returns and then used inferred covariance structure to derive $E[\tilde{R}_{j,t}]$ and $\text{Var}[\tilde{R}_{j,t}]$. We choose the former approach since it requires a smaller number of coefficients to be computed at a time. This maximizes the precision of our estimates of interest.

$$\Pr(A_{i,t-1} \neq A_{i,t})$$
$$E[X_{1,j,i,t} \times 1(i \text{ chooses } (0, j))] \quad \forall t \in \{t_1, \dots, t_T\},$$
$$E[X_{1,j,i,t} \times 1(i \text{ chooses } (1, j))] \quad \forall t \in \{t_1, \dots, t_T\},$$
$$E[Z_{2,m,i,t} X_{2,i,j} \times 1(i \text{ chooses } (0, j))] \quad \forall m = 1, \dots, m_2, \text{ and } t \in \{t_1, \dots, t_T\},$$
$$E[Z_{2,m,i,t} X_{2,i,j} \times 1(i \text{ chooses } (1, j))] \quad \forall m = 1, \dots, m_2, \text{ and } t \in \{t_1, \dots, t_T\},$$
$$E[X_{2,i,j}^2 \times 1(i \text{ chooses } j)] \quad \forall t \in \{t_1, \dots, t_T\}$$
$$E[Z_{3,m,i,t} X_{3,i,j} \times 1(i \text{ chooses } (0, j))] \quad \forall m = 1, \dots, m_3, \text{ and } t \in \{t_1, \dots, t_T\},$$
$$E[Z_{3,m,i,t} X_{3,i,j} \times 1(i \text{ chooses } (1, j))] \quad \forall m = 1, \dots, m_3, \text{ and } t \in \{t_1, \dots, t_T\},$$
$$E[X_{3,i,j}^2 \times 1(i \text{ chooses } j)] \quad \forall t \in \{t_1, \dots, t_T\}$$
$$\Pr(i \text{ chooses } (1, j)) \quad \forall t \in \{t_1, \dots, t_T\},$$
$$E[Z_{4,m,i,t} \times 1(i \text{ chooses } (1, j))] \quad \forall m = 1, \dots, m_4, \text{ and } t \in \{t_1, \dots, t_T\},$$

where $A_{i,t}$ is an indicator variable that is equal to 1 if individual i is affiliated with a pension system (has a nonzero pension balance) at time t and is equal to 0 otherwise. In the context of our setting, the event $(A_{i,t-1} \neq A_{i,t})$ occurs only if $A_{i,t-1} = 0$ and $A_{i,t} = 1$.

A.3. *The Results of Simplified Discrete Choice Model.* This section presents the estimation results for a discrete choice model that projects individuals' choices on the portfolio characteristics (expected gross return and variance of individuals' investment, and residual income after fees for a given AFP), taking the sector of employment as given. The AFP fixed effects are included to capture such things as AFPs' marketing strategy, the use of the sales force, and overall customer service. We allow the coefficients associated with various portfolio characteristics to depend on individuals' demographics.

The estimated parameters are summarized in Table A.1. The estimated coefficients should be interpreted in the same way as the estimated parameters of the baseline model (with endogenous sector of employment). The results indicate that AFP characteristics play an important role in individual's choices and that the coefficients of corresponding to portfolio characteristics depend on individual's demographics in a nontrivial way. However, the values of coefficients often differ from those documented for the full model. This is because such descriptive analysis ignores potential endogeneity of the individual's sector of employment, whereas the full model takes it into account. The considerations shaping individuals' choice of the sector include the trade-off of accumulating larger retirement wealth versus retaining higher residual income by withholding contribution to the pension account and not paying management fees that can be achieved by employment in the informal sector. Because the importance of such considerations varies across demographic groups, the estimates of the parameters are affected to a different degree by allowing for employment sector choice. One way to look at this is to see that additional benefits/costs associated with formal sector is an omitted variable in the descriptive regression. If the sector of employment is endogenous, this variable is correlated both with the size of the individual's contribution and with the fees he pays for AFP services. This would induce substantial bias into the estimates of the parameters associated with preferences for risk and price sensitivity.

A.4. *The Impact of the Restriction on the Range of β Values.* The Chilean government imposed a number of restrictions that severely limited the minimum return regulation policy. Specifically, during the time period considered in the article, the set of assets AFPs were allowed to use for investment was very limited. This effectively imposed an upper bound on riskiness of portfolios that could be offered in the market (effectively, βs were restricted to

TABLE A.1
DISCRETE CHOICE REGRESSION FOR THE EXOGENOUS EMPLOYMENT SECTOR MODEL

	Quadratic Wealth Term		Residual Income Term	
	Parameter	Std. Error	Parameter	Std. Error
Constant	-3.143^{***}	0.021	-4.857^{***}	0.765
$30 \leq$ age < 45, education < 8	-1.555^{***}	0.002	0.323	0.43
$45 \leq$ age, education < 8	0.272^{***}	0.02	3.223^{***}	1.34
Age < 30, $8 \leq$ education < 12	-0.842^{***}	0.02	-0.552^{***}	0.21
$30 \leq$ age < 45, $8 \leq$ education < 12	-1.123^{***}	0.01	-0.450^{***}	0.07
$45 \leq$ age, $8 \leq$ education < 12	-0.859^{***}	0.001	1.468^{***}	0.03
Age < 30, $12 \leq$ education	1.089^{***}	0.004	1.420	1.02
$30 \leq$ age < 45, $12 \leq$ education	0.164^{***}	0.01	-1.099^{***}	0.23
$45 \leq$ age, $12 \leq$ education	-0.996^{***}	0.012	1.846^{***}	0.02
Male	-1.005^{***}	0.52	-0.205^{***}	0.04
Married	0.102^{***}	0.12	-1.556	1.21
Married female, education < 8	2.741^{***}	0.11	4.038^{***}	0.22
Married female, $8 \leq$ education < 12	0.662^{***}	0.23	1.987	2.01
$5 \leq$ experience < 10	-1.720^{***}	0.43		
$10 \leq$ experience	0.260^{***}	0.03		
$\$3,000 \leq$ income $< \$8,000$	-2.330^{***}	0.13	-0.249	1.54
$\$8,000 \leq$ income	-2.344^{***}	0.12	1.010	1.21
log (std. deviation of random coefficient)	-1.795^{***}	0.43	-0.682^{***}	0.275
Std. deviation of random coefficient***	0.0009	–	0.002	–
Linear wealth term/inverse of σ_ϵ	0.423^{***}	0.003		
Switching costs, η				

NOTE: This table shows the estimates produced by the descriptive discrete choice regression. Age, education, and experience are measured in years. The income variable corresponds to an individual's annual income. This variable and individual's balance are measured in thousands of dollars. The "Std. Deviation of Random Coefficient*" reflects the value of the standard deviation after it is multiplied by $\frac{1}{\theta_1}$ to impose normalization that the coefficient in front of the linear term is equal to one. ***indicates statistical significance at 1%.

TABLE A.2
RESTRICTION ON THE RANGE OF β VALUES: FULL MODEL

	$\beta \leq 0.25$ Average		$\beta \leq 0.5$ Average		$\beta \leq 0.75$ Average	
Firms	Beta	Price	Beta	Price	Beta	Price
No regulation						
1	0.00	1.01	0.00	1.01	0.06	1.02
2	0.05	1.43	0.10	1.27	0.30	2.05
3	0.16	0.99	0.50	1.01	0.40	1.01
Regulation: $\delta = 0.02$						
1	0.00	1.20	0.00	1.36	0.15	1.36
2	0.06	1.01	0.13	1.06	0.45	2.89
3	0.16	1.00	0.67	1.07	0.85	1.31

be below 0.25). Table A.2 summarizes a simulation analysis where we explore the impact of minimum return regulation of the market under several alternative upper bound restrictions on β. This analysis indicates that if the riskiness of portfolios is severely limited from above, the regulation has only a negligible effect. The effect only becomes nonnegligible when βs are allowed to be quite high.

A.5. *The Role of the Informal Sector.* Here, we explore the role of the informal sector in determining impact of the minimal return regulation. In this analysis, we recompute an

TABLE A.3
IMPACT OF REGULATION: ELIMINATING THE INFORMAL SECTOR

		Informal Sector			
	Firms	Beta	With Price	Beta	Without Price
No Regulation					
1	1	0.02	1.42	0.02	1.22
	2	0.21	1.76	0.16	1.37
	3	0.60	1.41	0.54	1.21
2	1	0.05	1.32		
	2	0.25	1.64		
	3	1.00	1.32		
Regulation: $\delta = 0$					
	1	0.36	1.85	0.26	1.49
	2	0.60	4.82	0.37	1.71
	3	0.79	2.16	0.63	1.55
Regulation: $\delta = 0.02$					
	1	0.20	1.96	0.13	1.46
	2	0.40	17.45	0.24	4.73
	3	1.00	1.91	0.77	1.41

NOTE: This table investigates the role of the informal sector in determining the impact of the minimal return regulation in a setting where consumers' sector of employment is exogenously determined. The values of β, prices, and profits reflect expectations computed with respect to the distribution λ characterizing equilibrium choices of β. The variable price reflects the fee paid by an individual who contributes \$10. The price is measured in dollars, whereas the profit is measured in tens of thousands of dollars.

equilibrium of the game under the three regulatory regimes, reallocating all informal sector workers into the formal sector. The results of this analysis are presented in Table A.3.

As expected, elimination of the informal sector leads to lower price levels. This is not surprising, since in this setting, all workers are contributors, which increases revenue for a given fee schedule. This, in turn, allows firms to charge lower prices. A little less obvious is the fact that elimination of the informal sector also mitigates the incentives embedded into the minimal return regulation to offer riskier portfolios. The reason is similar to the one found earlier in connection to the protection of consumers against downside risk. Specifically, in the setting without an informal sector, it is easier for the firm to ensure profitability despite regulatory exposure through the fee revenue. Hence, the incentives to escape penalties by offering riskier products or by charging higher fees are lower.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table 1: Switching Costs Differ by Income Level (Specification 1)
Table 2: Switching Costs Differ by Education Group (Specification 2)
Table 3: Omitting year 1998 in estimation (Specification 3)
Table 4: Equilibrium under Alternative Specifications
Table 5: Robustness: σ_v
Table 6: Robustness to Assumption on n_g
Table 7: Robustness to the Distribution of Market Return: Fixed Sector of Employment
Table 8: Robustness to the Distribution of Market Return: Endogenous Sector of Employment

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