

Product Choice under Government Regulation: The Case of Chile's Privatized Pension System *

Elena Krasnokutskaya[†] Yiyang Li[‡] Petra E. Todd[§]

May 22, 2017

Abstract

Chile's long-running individual retirement pension accounts system has been a model for many countries in the world. To limit the riskiness of pension investments, Chile introduced a minimum return regulation that required pension fund management firms to deliver returns that are not more than two percent below of the industry average. This paper develops and estimates an equilibrium model of the pension market and uses the model to understand how minimum return regulation affects this industry. We find that the regulation leads to higher consumer demand for riskier investment products and creates incentives for pension managers to offer riskier portfolios. Hence, contrary to the original intent, such regulation results in higher overall riskiness of pension investments. Moreover, the cost imposed on the industry by this regulation leads to higher pension management fees. Nevertheless, we find that the regulation stimulates balance accumulation which, despite higher risk, ultimately reduces reliance upon government pension support.

Keywords: return regulation, pension market, endogenous product characteristics

JEL Classification: D22, E26, D14, G11, H55

*We thank Ludwig Ressner, formerly of Munich University, for his contribution to an early draft of the paper. In addition, we thank David Bravo, Jere Behrman, Olivia Mitchell, Sven Rady, and Markus Reisinger for helpful discussions. We are grateful to Jose Ruiz and Viviana Velez-Grajales for help in collecting the pension fund cost and return data series and in understanding pension fund fees and regulations. Solange Bernstein of the AFP regulatory agency provided helpful assistance in understanding the structure and coding of the administrative dataset and Javiera Vasquez Nunez was very helpful in the preparation of the datasets. We also thank Chao Fu, Clement Joubert, Edith Liu and Naoki Wakamori for able research assistance at various points over the course of this project. Elena Krasnokutskaya and Petra Todd gratefully acknowledge financial support from a Michigan Retirement Research Center grant (#UM-0917) and National Science Foundation grant (#0922405). The collection of the EPS dataset used in this project was funded in part by NIH R01-543250 (P.E. Todd, PI).

[†]Johns Hopkins University, ekrasnok@jhu.edu

[‡]Johns Hopkins University, ellen.liyiyang@gmail.com

[§]University of Pennsylvania, petratodd@gmail.com

1 Introduction

The United States and many European countries are currently 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. Chile has been at the forefront of pension reforms, having switched to a private retirement accounts system twenty five 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).¹

The proposed plans for pension reform in the US and in Europe have many features in common with Chile's current pension system. They outline a system under which all workers are mandated to contribute a pre-specified part 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 if pension accumulations are insufficient upon retirement (below pre-specified 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 pension 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 by pension fund managers. 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 towards the industry by requiring that the pension managers guarantee a certain level of return. For example, the Chilean government required

¹Cogan and Mitchell (2003) discuss prospects for funded individual defined contributions account pensions in the United States.

pension fund management firms to guarantee a return on their enrollees' investments which is within two percentage points of the industry average.

This paper 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 a potentially important role in determining the overall impact of the regulation. 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 1981-2004 from the pension fund regulatory agency. These data were merged with a longitudinal household survey data gathered in 2002 and 2004. Thus, we analyze micro-level data on individual characteristics, wealth levels and pension fund choices. Additionally, we obtained data series on portfolios' returns, 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 the 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, Chilean economy is characterized by a substantial informal sector. Descriptive analysis reveals that many individuals participating in the pension system tend to 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 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 indeed 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.² Our estimated model fits the data well. In particular, it 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, using a single set of firms' fixed effects. We also show that a large part of the model fit is accounted for by the systematic part of the model. 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 the standard in the differentiated products literature. This 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. We find that given the market returns in our data, minimal return regulation incentivizes firms to move towards 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

²See Cohen and Einav (2007) for the review of the levels of consumer risk aversion documented in different settings.

downside risk, and (ii) it imposes additional costs on the firms in the industry, which is tied to their performance relative to that of competitors. The first component effectively shifts consumer demand towards 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 one hand, it introduces complementarities in firms' portfolio choices. On the other hand, the regulation imposes additional costs on the industry that motivates 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, we find that changes in the set of portfolios offered in the market are sensitive to the restrictiveness of regulation.

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 of regulation on consumer welfare, particularly for lower income subgroups. But for those with higher income, the overall regulation impact on consumer welfare is positive.

Previous research on Chile mainly examined the impact of pension reforms on the macro-economy, capital markets and aggregate savings.³ 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 undertaken analysis of consumer choices in the context of Chilean pension system (see Joubert (2015) and Luco (2013)) as well as analysis of market competition and the impact of industry structure and regulation on consumer welfare for Chile and similar markets (Hastings, Hortacsu, and Syverson (2015)). This paper is also related to the recent literature analyzing industry competition when firms choose both prices and the characteristics of the products they offer, e.g. Fan (2013), Draganska, Mazzeo, and Seim (2009), and Eizenberg (2014).

The paper is organized as follows. Section two provides some background information on the Chilean private accounts system. Section three describes the consumer's choice problem and outlines the oligopolistic model of the firms' price and portfolio decisions. Section four discusses expected consequences of the minimal return regulation. Section five describes the data and section

³Many have written on the Chilean pensions system (e.g. Cheyre (1988), Iglesias and Acuña (1991), and Baeza, Margozzini, and Arroyo (1995)). Some of the literature is summarized in Mesa, Bravo, Behrman, Mitchell, and Todd (2006).

six presents estimation strategy. Section seven summarizes the empirical results and Section eight discusses empirical implications of the minimal return regulation. Section nine 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, while new workers were required to affiliate with the new system.⁴

A competitive industry was established to manage the pension accumulations of Chilean workers. From its inception, the industry was heavily regulated. Only companies with 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.⁵ Towards the end of the 1990s, there were 8 firms. During the first twenty years, every pension manager was restricted to offer a single portfolio to their customers. Starting in 2000, however, they were allowed to offer four alternative portfolios, which differed according to the riskiness of the investment.⁶

Under the individual accounts system, Chilean workers are mandated to deposit 10% of their earnings into their pension account on a regular basis. Those participating in the system are guaranteed government pension support should their accumulations fail short of a pre-specified 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.⁷ 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 website.

⁴To encourage transfers, workers who opted for the new system received a 12.6 percent 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.

⁵In each case, the exit was organized as a merger with one of the existing AFPs. The clients of an exiting AFP were transferred to its merging partner, though the clients could easily switch funds afterwards.

⁶Each 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.

⁷This restriction was relaxed in 2008.

Pension managers charge fees for their services. Initially, the fee was a three part non-linear 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 which shifted part of the costs of the guaranteed pension support towards the industry. Specifically, this regulation required that pension managers deliver a real return above the threshold equal to two percentage point below the industry average, making the firms responsible for covering low realizations of returns with their own capital. The analysis in this paper focuses on this minimal return regulation since it regularly appears in the proposals for pension system design considered by various countries.

3 Modeling Framework

This section outlines our model of industry competition, which is a game that describes firms' pricing and portfolio decisions.

3.1 Discussion of Modeling Choices

This paper primarily aims to understand how regulation 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 only one year profitability into account when deciding on their portfolios and fees.

Although this approach is restrictive, we believe that it nevertheless approximates the reality of the Chilean market. First, during the time covered in our data, the Chilean regulatory environment was undergoing constant changes. The competitive 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 revised their portfolios to reflect the most recent regulations. Similarly, consumers could likely 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 likely led them to base their decisions mainly on the 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 rather the choice of how much to save/invest and therefore involve intertemporal substitution of consumption only to a very limited degree.⁸ 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 different portfolio a few years from now. We believe that in reality Chilean consumers were not 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 important consideration 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.⁹ In light of this evidence, one might ask whether we would expect to see optimal consumer choices in this market. 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 paper. We accommodate some potential sub-optimality 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.

⁸The majority of 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.

⁹For a summary of findings in this area see, for example, Lusardi and Mitchell (2007).

3.2 The Market for Retirement Investment

At time t there are J_t pension managing firms (AFP) present in the market. Each AFP offers a single investment portfolio summarized by a parameter $\beta_{j,t}$ which 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, portfolio's performance is linked to the realization of the market return, $R_{m,t}$, distributed as $N(\mu_{m,t}, \sigma_{m,t}^2)$, and the risk free return, $r_{0,t}$, available at that period so that $R_{j,t} = r_{0,t} + \beta_{j,t}(R_{m,t} - r_{0,t})$.¹⁰

If the market is subject to a minimum return requirement such that AFP are required to deliver a return which is no lower than δ percentage points relative to the average return of all pension management funds annually then AFP j 's return in period t from consumer' point of view is given by

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

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 non-linear, i.e. $p_{j,t} = (p_{j,t}^0, p_{j,t}^1)$ where $p_{j,t}^0$ is the fixed fee charged on the annual basis, and $p_{j,t}^1$ is the proportional fee charged per contribution amount.

3.3 Consumer Demand

The 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 individual's 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 formal 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.

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

¹⁰In this stylized model $r_{0,t}$ is a constant and thus the variation in $R_{j,t}$ is induced solely by the variation in $R_{m,t}$. In reality, portfolio contains a stochastic component, $\epsilon_{j,t}$, which is not perfectly correlated with the market so that $Var(R_{j,t} | R_{m,t} = r_m) = \sigma_{\epsilon_j}$. Our econometric model incorporates this feature.

that he contributes to pension account in a given period, and $B_{i,t}$ is a balance in 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,

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

Further, let $w_{1,i,t}$ denote the balance in individual's i 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 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 :

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

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

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

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 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 formal sector. The parameter η captures costs of switching from one AFP to another.

Informal Sector. If an individual chooses to be employed in the informal sector, he does not make contributions to the pension fund, $y_{i,t} = 0$.¹¹ 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

¹¹Consumers 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.

AFP j is given by

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

where $w_{0,i,t} = B_{i,t}$, and $Y_{0,i,t}$ is the income he earns in the informal sector.

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

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

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

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

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 formal workforce and thus choosing a pension management company for his pension mandatory pension contributions or working in the informal sector and remaining unaffiliated with pension system. The expected utility associated with entering the formal sector and choosing a particular AFP firm is given by

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

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 individual's 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 an individual also 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 if he chooses to work

in the informal sector. He may earn less in the informal sector, but he will not be required to contribute to the pension fund and will not pay fees. 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:

$$\begin{aligned} M_{(0,j),t}(p_t, R_t) &= \left\{ z_{i,t} : B_{i,t} > 0 \text{ and } E[U_{0,j,i,t}] \geq E[U_{k,l,i,t}] \forall k = 0, 1, l = 1, \dots, J \right\} \\ M_{(1,j),t}(p_t, R_t) &= \left\{ z_{i,t} : B_{i,t} > 0 \text{ and } E[U_{1,j,i,t}] \geq E[U_{k,l,i,t}] \forall k = 0, 1, l = 1, \dots, J \right\} \\ &\quad \left\{ z_{i,t} : B_{i,t} = 0, \text{ and } E[U_{1,j,i,t}] \geq \max\{E[U_{1,l,i,t}], E[U_{0,0,i,t}]\} \forall l = 1, \dots, J \right\} \end{aligned}$$

Then the total number of consumers served by AFP j is then given by

$$D_{j,t}^N(R_t, p_t) = \iint_{M_{(1,j),t} \cup M_{(0,j),t}} dF_t(z_{i,t}).$$

The balance these consumers invest with AFP j is given by

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

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

$$D_{j,t}^C(R_t, p_t) = \iint_{M_{(1,j),t}} y_{i,t} dF_t(z_{i,t}).$$

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 multi-dimensional: 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, $D_{j,t}^N(R_t, p_t)$, and on the total balance under the management, $D_{j,t}^B(R_t, p_t)$. 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

$$C_{j,t}^{reg}(R_{j,t}, R_{-j,t}, D_{j,t}^B) = (R_{j,t} - \bar{R}_t + \delta) \times D_{j,t}^B \times 1(R_{j,t} < \bar{R}_t - \delta),$$

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 given by

$$C_{j,t}(D_{j,t}^N, D_{j,t}^B) + C_{j,t}^{reg}(R_{j,t}, R_{-j,t}, D_{j,t}^B)$$

In period t , the expected profit of fund j that chooses 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

$$\begin{aligned} E_{R_t|\beta_t}[\Pi_{j,t}(p_t, R_t(\beta_t))|\beta_t, I_t] &= E_{R_t|\beta_t}[p_{j,t}^0 D_{j,t}^N(R_t(\beta_t), p_t) + p_{j,t}^1 D_{j,t}^C(R_t(\beta_t), p_t) - \\ &- C(D_{j,t}^N(R_t(\beta_t), p_t), D_{j,t}^B(R_t(\beta_t), p_t)) - C_{j,t}^{reg}(R_t(\beta_t), D_{j,t}^B(R_t(\beta_t), p_t))|\beta_t, I_t]. \end{aligned} \quad (3)$$

Here we explicitly recognize the dependence between the AFP's return (i.e., the return's distribution) and AFP's choice of 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, because 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 firm offers to its customers, whereas the second component, $p_{j,t}(\cdot) : [0,1]^{J_t} \rightarrow \mathcal{R}_+ \times [0,1]$, 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, $(\beta_t^*, p_t^*(.))$ 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:

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

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

$$\beta_{j,t}^* = \arg \max E[\Pi_{j,t}(p_{j,t}^*(\beta_{j,t}, \beta_{-j,t}^*), p_{-j,t}^*(\beta_{j,t}, \beta_{-j,t}^*), R_{j,t}(\beta_{j,t}), R_{-j,t}(\beta_{-j,t}^*))], \forall j \in J_t.$$

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 game exists but may not be unique. We take the possibility of non-uniqueness into account both in our empirical and counterfactual analyses.

The expression in (3) for the expected profit highlights the key feature of this environment, i.e. that the firm's choices determine the distribution of product characteristics offered to consumers. This has important implications for the minimal return regulation as discussed below.

4 The Impact of Minimal Return Regulation

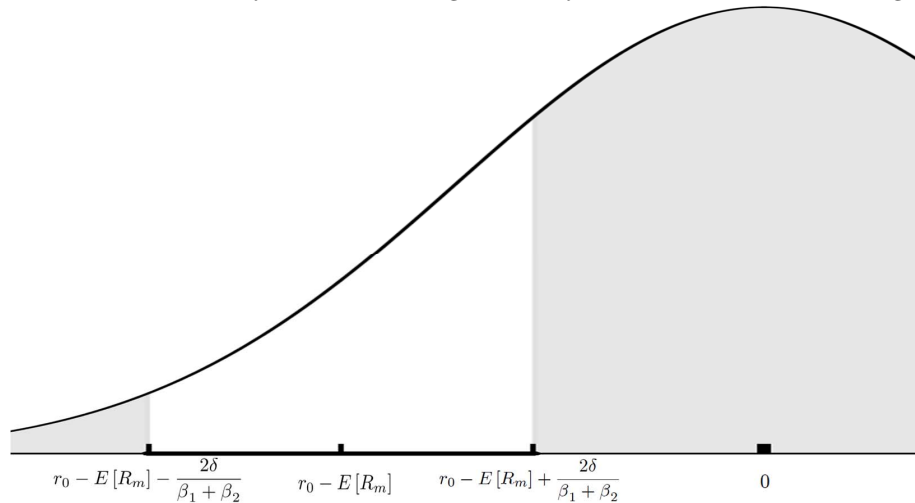
To understand the impact of the regulation, let us first consider the case of the two AFP firms competing in the market. If these firms choose portfolios characterized by β_1 and β_2 , then the returns on these portfolios are given by $R_1 = r_0 + \beta_1(R_m - r_0)$ and $R_2 = r_0 + \beta_2(R_m - r_0)$, 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_m^2 . The probability of firm 1 not falling below the threshold δ specified by the regulation is:¹²

¹²In a realistic framework with $Var(R_{j,t} | R_{m,t} = r_m) \neq 0$ these probabilities could be re-written conditional on realizations of $\epsilon_{1,t}$ and $\epsilon_{2,t}$ (or on $\tilde{\epsilon}_t = \epsilon_{1,t} - \epsilon_{2,t}$):

$$\begin{aligned} \Pr(R_1 - \bar{R} \geq \delta | \epsilon_{1,t}, \epsilon_{2,t}) &= 1 - \Phi\left(\frac{1}{\sigma_m} \left(\frac{\tilde{\epsilon}_t + \delta}{\beta_1 - \bar{\beta}} + r_0 - \mu_m\right)\right) \\ \Pr(R_2 - \bar{R} \geq \delta | \epsilon_{1,t}, \epsilon_{2,t}) &= \Phi\left(\frac{1}{\sigma_m} \left(\frac{\tilde{\epsilon}_t - \delta}{\beta_1 - \bar{\beta}} + r_0 - \mu_m\right)\right). \end{aligned}$$

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

Figure 1: The Probability of not Incurring a Penalty under Minimal Return Regulation



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

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

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 the figure, 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 a number of other important considerations. First, the cost imposed by the regulation on the firm is proportional to the total balance under the firm's management. Therefore, if individuals who carry 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 fixed at 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 AFP's 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 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 *Encuesta de Proteccion Social(EPS)* follow up survey. Thus, the dataset additionally contains information on demographics, work history, income, and health. The resulting merged dataset 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 focusses on the second decade of the operation of the pension system, which corresponds to the period of time 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 27-41 (29 to 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

Table 1: Summary Statistics

Variable	Mean	Std. Dev.	25%	50%	75%	90%
Year 1992; number of observations: 6153						
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: 7312						
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: 7435						
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: 8322						
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

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 US dollars deflated to reflect the dollar value in the year 2000.

Table 2: Summary Statistics

	Mean	Std. Dev.	25%	50%	75%	90%
Age: 20y -30y; number of observations: 2,223						
Education (y)	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: 30y -40y; number of observations: 2,714						
Education (y)	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	1,3411
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: 40y -50y; number of observations: 1,635						
Education (y)	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: 50y-65y; number of observations: 765						
Education (y)	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

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 US dollars deflated to reflect the dollar value in the year 2000.

months (approximately 7 years) whereas an average individual in 2000 sample spent 137 months (approximately 11 years) in the system. 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 year 2000 sample). Interestingly, an average individual contributes only about half of the time he spends in the pension system. Such regularity likely arises because many individuals find participation in formal sector to be very 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 time. This regularity underscores the potential significance of formal sector participation decisions in analyzing effects of pension regulations.

Average annual income is growing over time and is approximately equal to \$5500-\$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 1mln 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 youngest contributing the least and oldest the most. This analysis underscores the fact that individuals are heterogeneous in many ways that may impact their pension investment decisions and 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 industry managing pension investments during the years we use in estimation. In the beginning (year 1992), the industry contains a large number of firms (20), most of which are very small. The number of firms decreases over the years to 16 firms in 1996 to 8 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 pension managing firms. As mentioned earlier, the firms in this market use non-linear pricing where they charge a fixed and a percentage fee on monthly basis. The percentage fee is applied to the contribution amount an individual deposits into his account. As previously noted, 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 non-active accounts, i.e., 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 towards the end of the sample. In contrast, the fixed fee component varies significantly across

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

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 US 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 months window. To summarize market return we use IPSA index which reflects annual return for the basket of 40 shares which 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.

firms. Some firms such Cuprum (or Habitat till 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 to 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) which declines towards 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. Specifically, 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,

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

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.

some variation in the returns is present and, in the individuals' decision-making, it is amplified by the size of individual's accumulated pension savings. Thus, for some individuals the differences in costs of choosing different AFPs can be quite substantial. We observe that individuals pay non-trivial 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, firm's 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%) is concentrated in the top 5 firms with 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 2000 but only 25% to 30% of balances. At the same time, Summa attracts only 8% to 6% of enrollees but they bring in 12% to 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 individual's 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 from the data. The estimation procedure consists of two steps. In the first step, we estimate AFPs' β s from historical data on returns using a variant of the Capital Asset Pricing Model (CAPM) model and then, in the second step, we use the estimated β s to recover consumer preferences and firms' cost structure. The methods used to estimate the AFPs' β s and the parameters of the distributions of returns are described in detail in Appendix A. We take the two-step nature of our estimator into account in estimating the variance of the estimated coefficients.¹³

6.1 Demand Estimation

We begin by discussing parameterization of the model and then summarize details of the estimation procedure.

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

¹³We use formulas given in Chapter 36 from Newey and McFadden (2016).

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

Notice that 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 methods. 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.

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

where $\tilde{\theta}_{2,i,t}$ and $\tilde{\theta}_{3,i,t}$ 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 GEV joint cumulative distribution function such that

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

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

To simplify notation, denote by $X_{i,t}$ the matrix of right-hand-side variables which includes

$X_{k,j,i,t}$ for all the alternatives (k, j) . The nested structure implies that¹⁴

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

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

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:

$$\Pr((k, j)|X_{i,t}) = \int \left(\Pr(k|X_{i,t}, \tilde{\theta}_{0,i,t}) \Pr(j|k, X_{i,t}, \tilde{\theta}_{0,i,t}) d\Phi(\tilde{\theta}_{0,i,t}) \right). \quad (4)$$

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

Thus, the full vector of model coefficients is now given by

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

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 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 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 over-identified.

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 among 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) rather than the procedures developed by Berry, Levinsohn,

¹⁴For details see Amemiya (1985).

and Pakes (1995) and Berry, Levinsohn, and Pakes (2004), which are now fairly standard in the analysis of differentiated products markets.¹⁵ We use multiple years of data in estimation. However, we do not use consecutive years to reduce possible dependence in individual-specific random coefficients.¹⁶

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 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, (vii) the second moment of residual income net of contribution and fees given the optimal choice of AFP.¹⁷

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. The advantage of such approach is that a specific structure of industry competition need not be imposed in estimation. Specifically, this means that the assumption about AFP's pursuing short term profitability goals when deciding on their portfolios and prices does not impact the quality of our estimates characterizing the AFPs' cost structure. Further, due to this data feature we are able to consider rich specifications which allow for the 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 depends on the number of customers ($D_{j,t}^N$) and the total balance of the AFP j 's customers ($D_{j,t}^B$). Specifically, we assume that

$$\begin{aligned} \ln(C(D_{j,t}^N, D_{j,t}^B)) &= Y(t) + \tau_1 \ln(D_{j,t}^N) + \tau_2 \ln(D_{j,t}^B) + \tau_3 (\ln(D_{j,t}^N))^2 + \\ &\quad + \tau_4 (\ln(D_{j,t}^B))^2 + \tau_5 \ln(D_{j,t}^N) \ln(D_{j,t}^B) + \nu_j + \eta_{j,t}, \end{aligned}$$

¹⁵The main reason is that the procedures in Berry, Levinsohn, and Pakes (1995) and Berry, Levinsohn, and Pakes (2004) rely on the large number of products being offered in the market. In our setting this is unnecessary and also infeasible.

¹⁶Implicitly, we are assuming that any correlation in preferences across years is captured by the observable components of the random coefficients.

¹⁷The formal expressions for the moments are shown in Appendix B.

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.¹⁸ When interpreting the findings, it is useful to remember that, in our setting, individuals' choices reflect several considerations. First, when choosing an AFP to manage their pension balance individuals are guided by their risk versus expected return preferences. Further, individuals weigh expected gains in the retirement wealth associated with a given AFP choice (plus AFP's fixed effect) against any reduction in residual income after subtracting the AFP's fees. Both considerations depend on individual's accumulated retirement wealth and his disposable (after tax) income.¹⁹ The later trade off also drives the choice of the sector of employment. Indeed, when choosing a sector individuals take into account that disposable income may be lower/higher in the informal sector, that they do not need to give up 10% of their income as a pension fund contribution and that they do not have to pay fees to AFP in the informal sector as well as additional costs/benefits associated with formal sector, summarized by $\xi_{0,i,t}$ in our model.²⁰ Specifically, those individuals who put higher weight on the residual income relative to the retirement wealth are likely to prefer the informal sector. The strength of preference for various components is likely to vary across demographic groups. Below we summarize the estimated relationship between the preferences and demographics in the population of Chilean workers affiliated with pension system.

Our estimates reflect preferences of individuals in our sample as revealed through their choices. The estimates obtained may capture an individual's risk preference but could also partly reflect a lack of understanding about risk or response inertia. This is not a problem for the estimation, because we would 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.

¹⁸We have also estimated a simplified (reduced-form) discrete choice model which projects individuals' choices on the portfolio characteristics (expected return and variance for individual's investment, and residual income after fees for a given AFP) and takes as given the observed employment sector choice. We allow for AFP fixed effects 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 individual's demographics. The results are presented and discussed in Appendix C.

¹⁹Specifically, 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 larger contribution and will derive higher utility from the retirement wealth component everything else equal.

²⁰For some demographic groups the disposable income in informal sector maybe 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 ≤ Age < 45, Education < 8	2.056***	0.003	-1.681	39.26
45 ≤ Age, Education < 8	0.970***	0.006	-2.385***	0.078
Age < 30, 8 ≤ Education < 12	-0.745**	0.387	1.389***	0.181
30 ≤ Age < 45, 8 ≤ Education < 12	1.232***	0.007	1.156***	2.108
45 ≤ Age, 8 ≤ Education < 12	-1.694***	0.012	-0.715***	0.128
Age < 30, 12 ≤ Education	-2.766***	0.003	-2.683***	0.614
30 ≤ Age < 45, 12 ≤ Education	0.512***	0.072	-0.253	0.249
45 ≤ Age, 12 ≤ 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 ≤ Education < 12	1.855***	0.237	-1.919	7.441
5 ≤ Experience < 10	-1.260***	0.61		
10 ≤ Experience	1.85	1.27		
\$3000 ≤ Income < \$8000	-0.529***	0.172	-2.367	6.625
\$8000 ≤ 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		

The 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 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.

Parameter Estimates. The estimated parameters of the indirect utility function are reported in Tables 5-8. These parameters belong to 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, which also reflects an individual's price sensitivity. The third group of parameters captures the value of formal sector employment.

We begin by discussing the parameters related to 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 indirect utility.

The parameters associated with the quadratic term reveal that this term plays an important

Table 6: Implied Values of Coefficients in Indirect Utility Function

	Coefficient in front of	
	Quadratic Term	Residual Income Term
Age < 30, Education < 8	0.006	0.432
30 ≤ Age < 45, Education < 8	0.047	0.080
45 ≤ Age, Education < 8	0.016	0.040
Age < 30, 8 ≤ Education < 12	0.003	0.956
30 ≤ Age < 45, 8 ≤ Education < 12	0.021	0.830
45 ≤ Age, 8 ≤ Education < 12	0.001	0.211
Age < 30, 12 ≤ Education	0.001	0.030
30 ≤ Age < 45, 12 ≤ Education	0.010	0.556
45 ≤ Age, 12 ≤ Education	0.030	0.548

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.

role in individuals' decision-making. Most of these parameters, including the standard deviation of the random coefficient, are precisely estimated. The estimates also indicate that the coefficient in front of the quadratic term importantly varies across demographic groups. Furthermore, the standard deviation of the random coefficient is very small, which indicates that individual's degree of risk aversion is captured well by demographics.

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 individual 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 individual, exponentiate it and then multiply it by $\sigma_\epsilon = \frac{1}{0.423}$ which obtains $\exp(-5.445 + 2.056 - 0.373)/0.423 = 0.055$. To not subject the reader to this task, we compute the values of the coefficient in front of the quadratic term for several groups that often appear in the data 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 and experience levels. We 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.

Similar considerations apply to the estimated parameters associated with the residual income term. Indeed, most of 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 indicates the differences across individuals are well explained by the differences in their

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

This paper 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, i.e. $ARA = -\frac{u''(w)}{u'(w)}$ 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.

demographics. As above, we report the estimated values of the coefficient in front of the residual income term for several groups which are prominent in the data in Table 6. 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 comparable to that of college educated individuals.

These findings reflect the fact that individuals with lower education levels spend a lot of time in the informal sector, so they rarely pay fees and therefore do not make a lot of effort to minimize the fees they are paying. They are also more likely to rely on the welfare system in their retirement. The price sensitivity observed for younger age individuals probably reflects stronger preference for informal sector employment at this age. 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 to returns.

The group with medium range education levels is revealed to be very price sensitive. These are individuals with nontrivial balances, who thus have a lot to gain from pension investment, but who also tend to work frequently in the informal sector. Thus, the coefficient associated with residual income reflects their preference for the informal sector where they retain 10% of their income (the mandatory pension contribution amount in the formal sector) and possibly also increased opportunities for tax evasion.

Implied Risk Aversion. Table 7 reports the implied measures characterizing 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

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 ≤ Age < 45, Education < 8	0.350	2.874	0.773
45 ≤ Age, Education < 8	0.880***	0.028	1.943
Age < 30, 8 ≤ Education < 12	0.941***	0.141	2.077
30 ≤ Age < 45, 8 ≤ Education < 12	1.052***	0.140	2.322
45 ≤ Age, 8 ≤ Education < 12	1.594***	0.441	3.519
Age < 30, 12 ≤ Education	1.501*	1.071	3.313
30 ≤ Age < 45, 12 ≤ Education	1.677***	0.274	3.709
45 ≤ Age, 12 ≤ 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 ≤ 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

The table shows the estimated indirect utility's from the formal sector employment. The age, education, and experience are measured in years. The last column reflects the values of the parameters after they are multiplied by $\frac{1}{\theta_1}$ to impose normalization that the coefficient in front of the linear term is equal to one. The indirect utility is measured in thousands of dollars.

of these coefficients are generally consistent with values obtained by other studies (see Cohen and Einav (2007) for a summary). The estimated risk aversion generally varies with individual's demographics.

We find that individuals with lowest levels of education appear to be the least risk averse and risk aversion actually declines with age. In contrast, the risk aversion of individuals with higher levels of education increases with age. Individuals with the highest levels of education appear to be somewhat more risk averse than individuals with a high school education.

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 may win a \$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 so computed values of x for several demographic groups.

To interpret the results please notice that a risk neutral individual should be willing to participate in the lottery where he has an equal chance of losing a \$100 or winning a \$100. Similarly, an individual who is not very risk averse would be willing to participate in the lottery where he may lose an amount which is somewhat smaller but close to a \$100 or win a \$100 with equal

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

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, e.g., the average share in the data of individuals who are in formal sector and have chosen Provida is equal to 0.253.

probability. In contrast, an individual who is significantly risk averse requires a compensation for taking the risk, i.e. 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). For example, individuals with higher levels of education are quite risk averse since 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).

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. These estimates imply that switching is economically justified only for individuals with high balances who

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

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.

can gain sufficient amounts from the one or two percentage points difference in funds’ returns.²¹

Model Fit. We summarize the fit of the model to the data 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 the total balance under the management and the numbers of new contributions (not reported in the paper). It is quite challenging to achieve good fit for these measures. Recall that our framework allows for only one set of AFP fixed effects, whereas the market shares we consider reflect the fit along several different dimensions of the data. Additionally, the balance and contribution shares are not explicitly targeted in the estimation.

Our results indicate that the model achieves a reasonably good fit to the data. However, the fit is not perfect: the model somewhat over-predicts the share of Summa and Magister, under-predicts shares of Santa Maria for the individuals in the formal sector, and over-predicts shares of Santa Maria and under-predicts shares of Planvital for individuals in informal sector. 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).

Finally, we investigate the contribution of various model components to the model’s performance in terms of 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

²¹We have also investigated robustness of our estimates to the assumption of the homogeneous switching costs among the individuals in the population. 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 very similar to the specifications with the homogeneous switching costs. The results are reported in the Online Appendix to the paper.

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(<i>C</i>)		

Note: The analysis also incorporates quadratic time trend.

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.

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. The estimated specification very closely resembles a cost function where the average cost per affiliated is an increasing function of the balance per affiliate:

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

Note that AFP fixed effects are not statistically significant except in two cases, which indicates that costs of AFPs are largely symmetric.

8 Counterfactual Analysis

In this section, we investigate the implications of minimal return regulation on the operation of the market under several relevant scenarios.

8.1 Implementation Details

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. Specifically, we re-solve the industry competition game under a variety of scenarios. This task proves to be quite 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 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).²² 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 in the setting where each possible choice of β is associated with a firm-specific private cost. This means that the equilibrium portfolio choices are probabilistic from the competitors' 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. It, however, 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 specification that we consider.²³ We report these equilibria. In most specifications, however, only a single equilibrium is found.

In the analysis presented below, we fix the number of firms and thus abstract away from firms' participation decisions. On the basis of the recorded profit, we expect that some of the firms

²²We 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.

²³We find them by using multiple starting points when solving the industry competition game.

would exit the market if they had such an option. This research approach is motivated by the data limitations. Indeed, 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 highly imprecise. We therefore leave the analysis of participation decisions until the time when better information on entry costs and scrap values is available.

Our objective in this paper is primarily to understand the potential impact of the minimal return regulation on the market. We focus on the most important features of the market, but we recognize 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 s were 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 in the paper the results for the case when β s 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 several alternative upper-bound restrictions on β in Table 17 in the Appendix. If the riskiness of portfolios is severely limited, then the minimum regulation has a smaller effect.

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

Details of Empirical Framework Used to Compute Equilibria. As noted above, we set the number of firms competing in the market to be equal to three ($J = 3$). We allow each firm to choose a point on the grid of possible values of β : $(\beta_1, \beta_2, \dots, \beta_K)$, assumed to be the same for all firms. Further, a firm is characterized by a vector of private costs associated with 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 grid points for a given realization of private costs. In this setting, firm j 's strategy is stochastic from a competitors' point of view because they cannot observe the realization of firm's j private costs. Competitors' beliefs about firm j 's strategy are therefore summarized by a probability distribution over the grid of possible β values, $\lambda_j = (\lambda_{j,1}, \dots, \lambda_{j,K})$. As described in the model section, the firms observe competitors' portfolio choices when they choose their prices. So the equilibrium of this game is summarized by a collection of probability distributions over the β -grid, and the collection of pricing functions which specify the price the firm charges when different combinations of portfolios are realized in the market:

$$(\lambda_{j,1}^*, \dots, \lambda_{j,K}^*; p_1^*(\beta_1, \beta_{-1}), \dots, p_J^*(\beta_J, \beta_{-J})).$$

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 , while 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 our results to the number of possible β points, K , and to the variance of private costs, σ_ν , is explored in the Online Appendix. We verify that the results are not particularly sensitive to the values of these parameters. In particular, the number of equilibria remains unchanged.

8.2 The Impact of Regulation

We now turn to our analysis of the impact of minimal return regulation. We present the results for the case of the distribution of the market return observed in our data (7% which is average over the years).²⁴ 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 for the results. Specifically, we first consider the case when the sector of employment is fixed and thus individual's income, the level of contributions and the fees that he would pay to various AFPs are fixed as well.

Fixed Sector of Employment. 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 is as observed in the data. We then compute equilibrium vector of portfolios and fees for (a) the case when there is no minimal return regulation, (b) the case when minimal return regulation with $\delta = 0$ is imposed, and (c) 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 market portfolio) to quite risky (high correlation with 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. Further, 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 through the fact that the market share

²⁴In the Online Appendix we explore the robustness of our conclusions to the alternative market return distributions.

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	1146.29	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	1003.03	45.19%	26.04%	24.0%

This table characterizes impact of the minimal return regulation in a setting where consumers sector of employment is exogenously determined. The values of β , prices and profits reflects 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.

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 very small share of consumers. It manages to stay profitable by charging fees that exceed those charged by other firms. The second equilibrium appears to be less plausible, because in this equilibrium one of the firms obtains negative profit and the overall industry profitability is much lower.²⁵

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 towards riskier options. Among other things, the position of the safest portfolio offered in the market corresponds to significantly higher level of risk relative to the scenario with no regulation. The consumers are more uniformly distributed across firms and a large share of consumers reallocates to the two riskiest portfolios. Recall that in the case with no regulatory restrictions similar portfolios were offered but attracted a much smaller share of consumers. The change in enrollment reflects the fact that minimum return regulation reduces individuals' risk aversion by protecting customers from potential downside of taking risks. We investigate this effect in greater detail below. Reallocation of consumers towards riskier options mitigates the cost

²⁵Interestingly, a firm in this market may not be able to avoid negative profit through the choice of fee. Even if fee is high, a firm may still attract individuals from informal sector who do are exempt from paying fees. Thus, firms can be in a situation of incurring costs but not being able to collect any revenue. Further, the firm may not be able avoid these consumers even though a choice of β since β is limited from above by one.

Table 13: Decomposing the Impact of Regulation under Fixed Sector of Employment

Firm	Expected			Market Shares		
	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	1089.41	45.02%	25.87%	32.3%

This table decomposes the impact of the minimal return regulation in a setting where consumers sector of employment is exogenous. The values of β , prices and profits reflects 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.

of the regulation born by the industry since the balance under the management of the AFP with the safest portfolio (which is the one most exposed to the risk of regulatory penalties) is reduced. Further, an important consequence of the regulation is that it induces an increase in fees (around 30% increase on average) to compensates for the expected cost the regulation imposes on the firms.

Under the minimum return regulation that was actually implemented in Chile ($\delta = 0.02$), the selection of portfolios offered by AFPs also shifts towards 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 only a small share of customers and compensates for this by charging high fees. However, the profitability of the medium risk portfolio is less successful than when there is no regulation and it is likely that this AFP would exit the market if such an 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 minimum return effectively insures their downside risk. The later effect reduces the burden of regulation born by the firm offering the safest portfolio.

Decomposing the Effect of Regulation. The minimal return regulation impacts the market through two channels. First, it partially protects consumers from downside risks and thus makes them more prone to choose riskier portfolios among those offered in the market. 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 re-solving 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 cost on firms. Notice that 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 which offers risk protection increases the number of consumers who prefer moderately risky products, which 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 regulation which does not offer protection to the consumers but imposes costs on the firms, the re-allocation of consumers towards riskier products does not arise naturally. This leads to two effects: (a) it is profitable to offer diverse set of portfolios which targets different segments of consumers; (b) the safest portfolio charges very high fees, which, on one hand, allow it to finance its risk exposure associated with the regulation and, on the other hand, re-allocate demand to other portfolios. As a result the regulation without the consumer protection component results in much higher fees and 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 probability of incurring regulation penalty by firms are 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 the industry.

Endogenous Sector of Employment. Having built the intuition for industry competition when the individuals’ sector of employment is fixed, we now turn to the analysis of the full model. In this more realistic setting, individuals may choose between the sectors of employment, which allows them to additionally choose whether to contribute to the pension balance in a given period and whether to pay a fee.

The results of this analysis are summarized in Table 14. The most noticeable difference relative

Table 14: Impact of Regulation: Endogenous Sector of Employment

Formal Sector	Firm	Expected			Market Shares		
		β	Price	Profit	Participants	Balance	Contributions
No Regulation							
65%	1	0	1.02	187.58	50.18%	47.59%	28.4%
	2	0.2	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	0.6	1.39	220.15	39.61%	25.08%	13.1%
	2	0.8	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	0.14	2.45	188.93	15.36%	17.22%	2.9 %
	2	0.2	2.9	429.2	37.54%	39.12%	9.7 %
	3	1	1.31	641.42	47.06%	43.68%	87.4%

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 reflects 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.

to the case with the fixed 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.²⁶ Specifically, individuals with low risk aversion are attracted to formal sector, because their preference for riskier portfolios also makes them wish to invest more rather than less. Of course, many individuals also choose the formal sector due to additional benefits (such as greater availability of high paying jobs for certain demographic groups). The sorting motivates the industry to offer riskier products relative to the case with the fixed employment sector: the risky portfolio is now more lucrative, because it attracts fee-paying customers.

Continuing with the analysis of the effects of regulation, under $\delta = 0$ or $\delta = 0.02$, an expected consequence of the regulation is that it re-allocates consumers towards riskier portfolios. Due to the sorting, the safest portfolio attracts 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 spurs a shift towards riskier portfolio choices, as the AFPs try to minimize the probability of incurring regulatory penalties. Finally, regulation is associated with the modest increase in the probability that a worker chooses the formal sector of employment.

Table 15: Some 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

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

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” calculation. Specifically, we create a simulated sample of workers entering the pension market in the same year. We set the age at which individuals enter the job market to be equal to the median age for a corresponding education level and maintain the proportions of different educational levels as in the data. We consider both the case of the fixed sector of employment and the case with endogenous sector of employment for comparison purposes.

In the fixed employment sector case, we also replicate the distribution of individuals (conditional on education) across formal/informal sectors from 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 risk free rate at the level observed in the data and simulate balance growth for these individuals for 40 years. 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

²⁶The allocation of individuals across sectors in the fixed sector analysis corresponds to the allocation observed in the data which reflects the market equilibrium under additional regulatory restrictions ($\beta_j \leq 0.25$).

(consistent with Chilean life expectancy tables).²⁷ Individuals who draw an annuity below \$1000 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.

Table 15 reports the results. The reported numbers correspond to the fixed levels of income (fixed at the quantiles of income distribution). The variation in final balances and in disposable income arises for multiple reasons: (i) individuals' 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 the pension balance.

Specifically, the average balance almost doubles for all income quantiles under the full model. Recall that the participation margin is not greatly affected, i.e. participation in the formal sector does not substantially increase under the regulation. However, in the presence of regulation individuals are able to place their balance in riskier portfolios, which earn higher return on average, even when they choose to work in the informal sector. In contrast, in the world without the regulation the individuals who decide to work in 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, because they tend to spend a larger portion of their working life in the informal sector.

The regulation significantly reduces the probability of government support. Specifically, in the absence of regulation the individuals in the lowest two income quantiles require support with very high probability (52% and 24% correspondingly). Under 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 are paying higher fees relative the case of no regulation. Our results in this case indicate that consumers gain from regulation in terms of average accumulated balance and thus in terms of post-retirement consumption. We use the utility measure as a way to capture the net effects of these two factors 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 fixed employment sector. However, the magnitudes of the effects are smaller. The ability of individuals to choose sector amplifies the impact of the regulation on this market.

To summarize, the regulation induces individuals to invest their wealth into riskier portfolios. This increases volatility in the individuals' accumulated balances. However, it also drives up the

²⁷We 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.

average accumulated balance, which in the end reduces the probability of the government support and increases average expected utilities of consumers.

9 Conclusions

This paper 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 incentivizes the industry towards choosing riskier investments relative to the case without the regulation if the minimal return is tied to the average firm performance. However, the relationship in the population between the consumers' pension accumulations, income and risk preferences may either mitigate or enhance these incentives. 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 impact of the regulation 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 working age population is quite risk averse.

Our results show that the regulation results in a set of riskier portfolios offered in the market along with higher fees charged by industry for pension management services. The pension balance accumulated by workers by the age of retirement is characterized by higher variability but also a higher mean. The increase in mean is sufficiently large to substantially reduce the proportion of individuals relying on government support after retirement. The outcomes may depend on the restrictiveness of the regulatory policy, which means that policy parameters should be carefully calibrated for a specific market.

The regulation impacts the market primarily through two channels: (i) it protects consumers from the downside risk and thus makes them more willing to invest into risky portfolios, (ii) it imposes additional costs on industry. We find that the first component contributes significantly towards facilitating balance accumulation. First, it ensures that individuals are willing to place their balance with an AFP offering risky portfolios which, in turn, incentivizes the industry to offer such portfolios. Second, it mitigates the regulatory cost born 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 paper 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.

References

- AMEMIYA, T. (1985): *Advanced Econometrics*. Harvard University Press.
- BAEZA, S., F. MARGOZZINI, AND L. L. ARROYO (1995): *Quince A nos Despu'es: Una Mirada Al Sistema Privado De Pensiones*. Centro de Estudios Públicos.
- BERRY, S., AND P. HAILE (2011): "Nonparametric Identification of Multinomial Choice Demand Models with Heterogeneous Consumers," *Cowles Foundation Discussion Papers*, 1718.
- BERRY, S., J. LEVINSOHN, AND A. PAKES (1995): "Automobile Prices in Market Equilibrium," *Econometrica*, 63, 841–890.
- (2004): "Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Car Market," *Journal of Political Economy*, 112(1), 68–105.
- BOLLESLEV, T., R. ENGEL, AND J. WOODRIDGE (1988): "A Capital Asset Pricing Model with Time-Varying Covariances," *Journal of Political Economy*, 96(1), 116–131.
- CAPLIN, A., AND B. NALEBUFF (1991): "Aggregation and Imperfect Competition: on the Existence of Equilibrium," *Econometrica*, pp. 25–59.
- CHEYRE, H. (1988): *Prevision en Chile ayer y hoy*. Centro de Estudios Publicos.
- COGAN, J. F., AND O. S. MITCHELL (2003): "Perspectives from the President's Commission on Social Security Reform," *The Journal of Economic Perspectives*, 17(2), 149–172.
- COHEN, A., AND L. EINAV (2007): "Estimating Risk Preferences from Deductible Choice," *American Economic Review*, 97(3), 745–788.
- DRAGANSKA, M., M. MAZZEO, AND K. SEIM (2009): "Beyond Plain Vanilla: Modelling Joint Product Assortment and Pricing," *Quantitative Marketing and Economics*, 7(2).
- EIZENBERG, A. (2014): "Upstream Innovation and Product Variety in the United States Home PC Market," *Review of Economic Studies*, 81(3), 85–122.

- FAN, Y. (2013): “Ownership Consolidation and Product Characteristics: A Study of the US Daily Newspaper Market,” *American Economic Review*, 103(5), 1598–1628.
- HANDEL, B. (2013): “Adverse Selection and Inertia in Health Insurance Markets: When Nudging Hurts,” *American Economics Review*, 103(7), 2643–2686.
- HASTINGS, J., A. HORTACSU, AND C. SYVERSON (2015): “Sales Force and competition in Privatized Social Security: The Case of Mexico,” Discussion paper, NBER Working Paper N0 w18881.
- IGLESIAS, P. A., AND R. R. ACUÑA (1991): “Chile: Experiencia con un régimen de Capitalización 1981-1991, Sistema de Pensiones en América Latina,” Discussion paper, CEPAL/PNUD,.
- JOUBERT, C. (2015): “Pension Design with a Large Informal Labor Market: Evidence from Chile,” *International Economic Review*, 56(2), 673–694.
- LUCO, F. (2013): “Distinguishing Sources of Inertia in Defined Contribution Pension System,” Discussion paper, Northwestern University.
- LUSARDI, A., AND O. MITCHELL (2007): “Financial Literacy and Retirement Preparedness: Evidence and Implications for Financial Education,” *Business Economics*, 42(1), 35–41.
- MCFADDEN, D. (1989): “A Method of Simulated Moments for Estimation of Discrete Response Models Without Numerical Integration,” *Econometrica*, 57(5), 995–1026.
- MESA, A., D. BRAVO, J. R. BEHRMAN, O. S. MITCHELL, AND P. E. TODD (2006): “The Chilean Pension Reform Turns 25: Lessons from the Social Protection Survey,” Discussion paper, University of Pennsylvania.
- NEWHEY, W., AND D. MCFADDEN (2016): *Handbook of Econometrics*. Elsevier.

Appendix

A. Estimating the Distributions of Returns

We use data on AFPs returns to estimate $E[R_{j,t}]$ and $Var[R_{j,t}]$. In particular, we use a diagonal VEC model as described in Bolleslev, Engel, and Woodridge (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 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,

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

To obtain $E[\tilde{R}_{j,t}]$ and $Var[\tilde{R}_{j,t}]$ 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,

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

where the elements of variance-covariance matrix of $\epsilon_{j,t}$ and $\epsilon_{0,t}$ follows VEC (1,1) process.²⁸ More specifically,²⁹

$$\begin{aligned}\sigma_{\epsilon_j;t}^2 &= \gamma_{j;0} + \gamma_{j;1}\epsilon_{j,t-1}^2 + \gamma_{j;2}\sigma_{\epsilon_j;t-1}^2 \\ \sigma_{\epsilon_0;t}^2 &= \gamma_{0;0} + \gamma_{0;1}\epsilon_{0,t-1}^2 + \gamma_{0;2}\sigma_{\epsilon_0;t-1}^2 \\ \sigma_{\epsilon_j,\epsilon_0;t} &= \gamma_{j,0;0} + \gamma_{j,0;1}\epsilon_{j,t-1}\epsilon_{0,t-1} + \gamma_{j,0;2}\sigma_{\epsilon_j,\epsilon_0;t-1}.\end{aligned}$$

We then use the estimated coefficients of this process to compute the estimates for $E[\tilde{R}_{j,t}]$ and $Var[\tilde{R}_{j,t}]$ 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 a the same bivariate technique as above.

$$\begin{aligned}\Delta R_{j,t} &= b_j + \epsilon_{j,t} \\ \Delta R_{m,t} &= b_m + \epsilon_{m,t}\end{aligned}$$

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

$$\begin{aligned}\sigma_{\epsilon_j;t}^2 &= \alpha_{j;0} + \alpha_{j;1}\epsilon_{j,t-1}^2 + \alpha_{j;2}\sigma_{\epsilon_j;t-1}^2 \\ \sigma_{\epsilon_m;t}^2 &= \alpha_{m;0} + \alpha_{m;1}\epsilon_{m,t-1}^2 + \alpha_{m;2}\sigma_{\epsilon_m;t-1}^2 \\ \sigma_{\epsilon_j,\epsilon_m;t} &= \alpha_{j,m;0} + \alpha_{j,m;1}\epsilon_{j,t-1}\epsilon_{m,t-1} + \alpha_{j,m;2}\sigma_{\epsilon_j,\epsilon_m;t-1}.\end{aligned}$$

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

²⁸Here $\Delta \bar{R}_t = \bar{R}_t - r_{0,t}$.

²⁹Alternatively, we could have estimated full system of joint evolution of all funds returns and then used inferred covariance structure to derive $E[\tilde{R}_{j,t}]$ and $Var[\tilde{R}_{j,t}]$. 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.

portfolio choice decision in our model.

B. Moment Conditions

This section reports formal expressions for the moment conditions used in the estimation.

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

where $A_{i,t}$ is an indicator variable which is equal to one if individual i is affiliated with pension system (has a non-zero pension balance) at time t and is equal to zero 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 $A_{i,t} = 1$.

C. 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 individual's 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 AFP's marketing strategy, the use of the sales force and overall customer service. We allow the coefficients associated with various portfolio characteristics to depend on individual's demographics.

The estimated parameters are summarized in Table 16. The estimated coefficients should be

Table 16: Discrete Choice Regression for the Exogenous Employment Sector Model

	Quadratic Wealth		Residual Income	
	Parameter	Std. Error	Parameter	Std. Error
Constant	-3.143***	0.021	-4.857***	0.765
30 ≤ Age < 45, Education < 8	-1.555***	0.002	0.323	0.43
45 ≤ Age, Education < 8	0.272***	0.02	3.223***	1.34
Age < 30, 8 ≤ Education < 12	-0.842***	0.02	-0.552***	0.21
30 ≤ Age < 45, 8 ≤ Education < 12	-1.123***	0.01	-0.450***	0.07
45 ≤ Age, 8 ≤ Education < 12	-0.859***	0.001	1.468***	0.03
Age < 30, 12 ≤ Education	1.089***	0.004	1.420	1.02
30 ≤ Age < 45, 12 ≤ Education	0.164***	0.01	-1.099***	0.23
45 ≤ Age, 12 ≤ 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 ≤ Education < 12	0.662***	0.23	1.987	2.01
5 ≤ Experience < 10	-1.720***	0.43		
10 ≤ Experience	0.260***	0.03		
\$3000 ≤ Income < \$8000	-2.330***	0.13	-0.249	1.54
\$8000 ≤ 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				

The 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.

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 important role in individual's choices and that the coefficients of corresponding to portfolio characteristics depend on individual's demographics in non-trivial 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 individual's 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 which 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 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.

D. 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 paper the set of assets AFPs were allowed to use for investment was very limited. This effectively imposed an upper bound on riskiness of portfolios which could be offered in the market (effectively, β s were restricted to be below 0.25). Table 17 summarizes 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 non-negligible when β s are allowed to be quite high.

Table 17: Restriction on the Range of β Values: Full Model

Firms	$\beta \leq 0.25$		$\beta \leq 0.5$		$\beta \leq 0.75$	
	Average Beta	Average Price	Average Beta	Average Price	Average Beta	Average 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

E. The Role of the Informal Sector

Here we explore the role of informal sector in determining impact of the minimal return regulation. In this analysis, we recompute an 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 18.

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 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 is lower.

Table 18: Impact of Regulation: Eliminating the Informal Sector

Firms		With		Without	
		Informal Sector		Beta	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	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	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

This table investigates the role of 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 reflects 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.