Choice of Product under Government Regulation: The Case of Chile Pension System

Elena Krasnokutskaya
Department of Economics, University of Pennsylvania

Petra Todd
Department of Economics, University of Pennsylvania

Ludwig Ressner
Department of Economics, University of Munich

Preliminary and incomplete draft. Please do not cite.

March 15, 2008

Abstract

Chile has one of the oldest individual-account pension systems. When designing the pension system Chilean government sought to restrict the downside of pension investment. In particular, the companies involved with the management of pension funds, AFPs, were required to guarantee non-negative real returns. This requirement resulted in AFPs offering very homogenized set of products with limited risk and earning opportunities.

We study a model of balance accumulation where consumer chooses an AFP to manage his investments. The amount of monthly contribution is regulated and restricted to 10% of labor market earnings. The supply side is modeled as an oligopolistic environment in which AFPs sequentially choose product location (mean and variance of the return), and fee they charge for service while taking into account consumers' preferences for risk. We assess the cost of non-negative return requirement in terms of forgone earnings and compare it to the benefit of limited government spending on minimum pension support. We also analyze alternative regulations the government could use towards the same goal.

1 Introduction

Chilean pension system is organized in the form of the individually-funded investment accounts. The government guarantees some minimal support to needy participants. Therefore, from the beginning it sought to limit the downside of the market investment. To this end the companies undertaking management of pension funds were required to deliver non-negative real returns. Hence, the downside risk of market investment was essentially shifted towards money managing companies, AFPs. Our goal is to study consequences of this regulation on the choice of products offered by AFPs as well as on the eventual pension earnings of the system participants. Arguably, other regulations can be used to limit the downside of pension investments, e.g. the choice of investment instruments can be explicitly restricted. In this paper we compare alternative regulatory strategies to the one chosen by Chilean government. Our comparison is based on two criteria: (1) average life-time earnings of individuals; (2) government obligations towards system participants who are not able to accumulate sufficient funds.

We describe the process of balance accumulation which gives rise to the consumer's AFP choice over his life-cycle. When aggregated over individual consumers this process describes demand for an AFP product as a function of product characteristics and fund's fee at a given point in time. The supply side of the market is modelled as an oligopolistic environment in which AFPs sequentially choose location (mean return and risk) and fees while taking into account the distribution of consumers' preferences and consumer types as defined by consumer characteristics. We take this model to data and estimate the parameters of the distribution of consumers' tastes and companies' cost function. We use estimated parameters to conduct counterfactual experiments.

The game of location choice with pricing has generated many theoretical studies. The modelling origins of this game lie with the Hotteling's model of linear city. It has been shown that for some locations' configurations in this game the equilibrium of the pricing game may not exist. Later, some more encouraging results were obtained. Specifically, Caplin and Nalebuff (1991) show that the equilibrium of pricing game does exist for any location configuration in the large class of models which satisfy some broad restrictions on the interplay of product locations and consumer tastes as well as the distribution of consumer tastes. We believe that our environment can be summarized by a model for which these restrictions are satisfied. However, Caplin and Nalebuff also show that the equilibrium is not unique, in general. We take this fact into account in our choice of estimation strategy as well as when performing counterfactual analysis.

2 Industry Description

Chile's personal accounts pension system was launched in 1981 as a replacement of a number of bankrupt pay-as-you-go defined benefit system. The new system of Administradoras de Fondos de Pensiones (AFPs) is a mandatory contribution scheme wherein wage workers are required to pay 10% of their monthly earnings to one of the privately managed and licensed pension funds. Workers are permitted to hold their money in only one AFP at a time, and they must move all their pension accruals to a new AFP if they wish to switch money managers. This restriction was intended to help participants keep track of their money and avoid the growth of many small and potentially orphan accounts, a phenomenon observed in some other Latin nations. While the exact rules governing the switch between money managers changed several time over the years, starting 1984 the switch does not entail any monetary costs on the part of the system participant.

Pension funds charged fees for their services. To begin with the fee was a three part non-linear tariff which consisted of the fixed fee, the fee proportion to participant's contribution, and the fee proportional to participant's balance. Some companies also charged a fee for the funds withdrawal. Starting 1984 the government did not allow AFPs to charge a fee on the balance or a fee on withdrawal. Currently most AFPs charge two-part tariff which consists of the fixed fee and the fee proportional to participant's contribution.

From the start, the government exerted strong control over the investment choices: initially workers' money could only be held in government bonds, and then over time, the investment options were expanded. However, even though restrictions on investment instruments were relaxed the government required that AFP should deliver non-negative real return. The AFP were essentially responsible to cover with their own capital for the unexpectedly low realizations of returns. During the period after 1987 when risky investment was allowed a number of AFPs run into financial difficulties because of these restrictions and had to exit the market. In each case the exit was organized as a merger with one of the existing AFP so that the clients of an exiting AFP were transferred to its merging partner.

From the inception until 2000 each AFP was offering essentially a single investment product. Starting 2000 they were allowed to offer four instruments which differed according to the riskiness of the investment. Each of them had a targeted age group. Under this system investor's money are automatically re-allocated into age-appropriate fund unless he/she gives explicit instructions to the contrary.

3 Data Description

We use data from 2002, 2004 and 2006 rounds of household surveys conducted by the Microdata Center of the Department of Economics of the Universidad de Chile. The data contain information on to 17,246 individuals of age 15 or older. The data include information on household characteristics, education, training and work history, assets, pension plan participation, savings, as well as more limited information on health, disability status and utilization of medical services. Of particular relevance to this project are the retrospective data on labor force participation which goes back to 1981. There are also extensive questions that are aimed at assessing financial literacy. Lastly, there are some questions designed to elicit individual's attitudes towards risk.

The sampling frame of the 2002 HLSS survey consists of individuals enrolled in the social security system for at least one month during the 1981-2001 time period. The sample included individuals who in 2002 were working, unemployed, out of the labor force, receiving pensions, or deceased (in this case the information was collected from surviving relatives). The sample was drawn from a sampling frame of approximately 8.1 million current and former affiliates of the social security system that was compiled from official databases (obtained from the Secretary of Labor and Social Security). This sample covers around 75% of the population aged 15 and older in 2001. The sampling frame in 2004 was augmented to include a subsample of individuals not affiliated with the social security system, so that the sample is representative of the entire Chilean population over the age of 15.

We complement survey data with the (a) the administrative data that we have obtained from the pension fund regulatory agency, (b) data on the performance of various pension funds (their returns, costs and profits), and (c) data on the fees/commissions of pension funds that were in operation at different points in time.

4 Model

This section describes our model of consumer choice and oligopolistic competition of pension funds.

4.1 Consumer Choice of AFP

Since in Chilean system consumers may freely move between AFPs we model consumer problem as a choice of a fund in a given time period. A consumer i in a period t is characterized by (x_{it}, b_{it}), where x_{it} is the size of his pension contribution in period t which is equal to 10% of his income in this period, and b_{it} is the pension balance of consumer i at time t. We further assume that the consumer $i's$ utility function in a given period of time is quadratic in consumption and also additively depends on other non-pecuniary costs of obtaining products and services. Quadratic utility function implies that consumer is risk averse. More specifically, his coefficient of risk aversion is given by α_{it}.[1] Other costs which are relevant for our study, ε_{ijt}, are non-pecuniary costs (utility) which consumer i associates with using company j at time t.

In a given period t, a consumer can choose between n_t pension management companies. A portfolio of company j is characterized by return r_{jt} which is distributed according to normal distribution with mean μ_{jt} and variance σ^2_{jt}. Additionally, company j charges consumer - specific fee $p_{ijt} = p_{j0t} + p_{j1t}x_{it}$.[2] Therefore, the part of expected utility of a consumer i which can be affected by his choice at time t is given by[3]

$$u_{ijt}(x_{it}, b_{it}, \alpha_{it}, \varepsilon_{it}) = E_t[U_{ijt}] = (1 + \mu_{jt})(b_{it} + x_{it}) - p_{ijt} + \alpha_{it}\sigma^2_{jt}(b_{it} + x_{it})^2 + \varepsilon_{ijt} \quad (1)$$

if consumer i allocates its pension money with company j during period t. Consumer chooses the company which offers the highest contemporaneous utility function.

Consumers decisions determine companies market shares within consumer subsets defined by consumer income, current balance, etc.

$$\begin{aligned} A_{jt}(x_{it}, b_{it}) &= \{(\alpha_{it}, \varepsilon_{it}) : \ u_{ijt} \geq u_{ikt} \text{ for } k \neq j |\ x_{it}, b_{it}\}, \\ s_{jt}(x_{it}, b_{it}, j_{it}) &= \int\limits_{A_{jt}(x_{it}, b_{it}, j_{it})} \frac{e^{(1+\mu_{jt})(b_{it}+x_{it}) - p_{ijt} + \alpha_{it}\sigma^2_{jt}(b_{it}+x_{it})^2}}{\sum\limits_{k \neq j} e^{(1+\mu_{kt})(b_{it}+x_{it}) - p_{ikt} + \alpha_{it}\sigma^2_{kt}(b_{it}+x_{it})^2}} dF_a(\alpha_{it}) dF_b(b_{it}). \end{aligned}$$

In a similar manner we can define $s_{jt}(x_{it})$, $s_{jt}(b_{it})$ and s_{jt}.

Notice, that so far we have assumed that consumer is perfectly informed about $(\mu_{jt}, \sigma^2_{jt})$. In reality, consumers have to form an opinion about pension manager's portfolio. We assume that consumer forms beliefs about $(\mu_{jt}, \sigma^2_{jt})$ on the basis of the past realizations

[1] The coefficient of risk aversion may potentially depend on gender, age and marital status. That is why we allow it to depend on t. Later we model it as a parametric function of consumer characteristics.

[2] We characterize the product offered by pension management companies in the most general terms here. Later we we would assume that the products offered may only change if there is an entry/exit in the industry or if one of the funds changes the person in charge of the portfolio management.

[3] Consumer only cares about the final accumulation of his pension funds. It can be shown, however, that given the quadratic structure of utility function the relevant portion of consumer's value from accumulated funds is given by formular in (1).

of AFP's return and also on the basis of the other information available about the company. We denote this other information by ξ_j and model it as a company-specific random effect. We allow this fixed effect to change when the portfolio manager of the company changers. This random effect is likely to be correlated with price if it provides any information on the reputation of the company or company's portfolio manager. We allow this variable to reflect how good the company is in a sense how close this firm can get to delivering efficient portfolio's average return given the risk point. We also assume that consumers use the same technology to form expectations about AFP's portfolio characteristics and that this technology can be summarized by a GARCH model. Therefore, consumers' period t expected utility is given by

$$u_{ijt}(x_{it}, b_{it}, j_{it}, \alpha_{it}, \varepsilon_{it}, \gamma_i) = E_t[U_{ijt}] = (1+\widehat{\mu}_{jt}+\xi_j)(b_{it}+x_{it}) - p_{ijt} + \alpha_{it}\widehat{\sigma}^2_{jt}(b_{it}+x_{it})^2 + \varepsilon_{ijt}$$

where $(\widehat{\mu}_{jt}, \widehat{\sigma}^2_{jt})$ are GARCH forecasts properly weighted to account for the contribution of ξ_j to consumers prediction.

4.2 AFP's choice of price and location

We assume that all AFPs have access to the same technology and therefore the same cost function. This function, however, depends on unobserved type of the company, ω, which is reflected in the data. Also, in equilibrium companies' cost per customer may differ due to the differences in the choice of the location. The technology which AFPs use can be summarized by the following cost function:

$$C(m, B, \mu, \sigma^2|\omega) = c_0 + (c_1+\omega_1)m + (c_2+\omega_2)B + (c_3+\omega_3)\sigma^2 + (c_4+\omega_4)(\mu - \phi(\sigma^2))^2,$$

where m denotes the number of consumers served by a company, B denotes the total balance serviced by the company, $\phi(\sigma^2)$ denotes the efficient portfolio's mean return which corresponds to σ^2 risk point. Here we assume that $\mu - \phi(\sigma^2)$ reflects company's quality which is also denoted by ξ.

Additionally, the regulatory restriction that non-negative return should be delivered imposes additional cost on the management company given by

$$\int^0 rBdF_r(r)$$

where $F_r(r)$ is the distribution function of companies return.

Therefore, profit of the firm j if it chooses location (μ_j, σ_j^2) and fees $p_j = (p_{0j}, p_{1j})$

is given by

$$\Pi_j(\mu_j, \sigma_j^2, \mu_{-j}, \sigma_{-j}^2, p_j, p_{-j}|\omega_j) = M(p_{0j}s_j + p_{1j}\int xs_j(x)dF_X(x)) - C(Ms_j, M\int bs_j(b)dF_B(b), \mu_j, \sigma_j^2|\omega_j).$$

The profit under regulation is

$$\Pi_j^R(\mu_j, \sigma_j^2, \mu_{-j}, \sigma_{-j}^2, p_j, p_{-j}|\omega_j) = \Pi_j(\mu_j, \sigma_j^2, \mu_{-j}, \sigma_{-j}^2, p_j, p_{-j}|\omega_j) - \int^0 Mr\int bs_j(b)dF_B(b)dF_{rj}(r).$$

At a given point in time AFP first choose "locations" for their products, i.e. (μ, σ^2) or (ξ, σ^2), and then given locations they choose their fees, (p_0, p_1). Given the sequence of the choices, the fees depend on on the locations chosen by funds. Therefore, firms when choosing locations have to take into account the effect of their choices on the future pricing game.

Caplin, Nalebuff (1991) establish that under certain regularity conditions ((a) the individual utility function is linear in consumer tastes, (2) the distribution of consumer tastes satisfies generalized conditions for concavity) the equilibrium of the pricing game exists for every possible configuration of companies' locations. Given the existence of pricing equilibrium the location equilibrium also exists. However, they show that the equilibrium of the pricing and location games, in general, is not unique. We take non-uniqueness into account when we choose estimation strategy and perform our counterfactual experiments.

The estimation strategy crucially depends on the smoothness of the profit function. We are still working to establish this property for our model. If the profit function is smooth then the first order conditions of the pricing and location game can be derived and used to form equality moment restrictions similar to Berry, Levinsohn, Pakes (1995, 2004). If the profit function is not smooth then we have to rely only on the optimality of choices in our estimation. Therefore, in this case, we would use the moment inequality technique developed by Pakes, Porter, Ho and Ishii (2006).

Below we proceed under the assumption of smoothness which seem to be satisfied in our setting.

We first describe the necessary first order conditions for the pricing game.

$$
\begin{aligned}
0 &= \frac{\partial \Pi_j^R}{\partial p_{0j}} = s_j + p_{0j}\frac{\partial s_j}{\partial p_{0j}} + p_{1j}\int x\frac{\partial s_j(x)}{\partial p_{0j}}dF_X(x) - (c_1+\omega_{1j})\frac{\partial s_j}{\partial p_{0j}} - \qquad (2)\\
&\quad -(c_2+\omega_{2j})\int b\frac{\partial s_j(b)}{\partial p_{0j}}dF_B(b) - \int^0 r\int b\frac{\partial s_j(b)}{\partial p_{0j}}dF_B(b)dF_{rj}(r)\\
0 &= \frac{\partial \Pi_j^R}{\partial p_{1j}} = p_{0j}\frac{\partial s_j}{\partial p_{1j}} + \int xs_j(x)dF_X(x)) + p_{1j}\int x\frac{\partial s_j(x)}{\partial p_{1j}}dF_X(x) - (c_1+\omega_{1j})\frac{\partial s_j}{\partial p_{1j}} - \\
&\quad -(c_2+\omega_{2j})\int b\frac{\partial s_j(b)}{\partial p_{1j}}dF_B(b) - -\int^0 r\int b\frac{\partial s_j(b)}{\partial p_{1j}}dF_B(b)dF_{rj}(r)
\end{aligned}
$$

The system of equations (2) can be solved to express $(\omega_{1j}, \omega_{2j})$ as a function of the data and demand side parameters.

Similarly, we can derive the necessary first order conditions of the location game.

$$
\begin{aligned}
0 &= \frac{\partial \Pi_j^R}{\partial \sigma_j^2} = \frac{\partial p_{0j}}{\partial \sigma_j^2}s_j + p_{0j}\frac{\partial s_j}{\partial \sigma_j^2} + \frac{\partial p_{1j}}{\partial \sigma_j^2}\int xs_j(x)dF_X(x)) + p_{1j}\int x\frac{\partial s_j(x)}{\partial \sigma_j^2}dF_X(x) - \qquad (3)\\
&\quad -(c_1+\omega_{1j})\frac{\partial s_j}{\partial \sigma_j^2} - (c_2+\omega_{2j})\int b\frac{\partial s_j(b)}{\partial \sigma_j^2}dF_B(b) - (c_3+\omega_{3j}) + 2(c_4+\omega_{4j})(\mu_j - \phi(\sigma_j^2))\phi'(\sigma_j^2) - \\
&\quad -\int^0 r\int b\frac{\partial s_j(b)}{\partial \sigma_j^2}dF_B(b)dF_{rj}(r) - \int^0 r\int bs_j(b)dF_B(b)\frac{\partial f_{rj}(r)}{\partial \sigma_j^2}dr\\
0 &= \frac{\partial \Pi_j^R}{\partial \mu_j} = \frac{\partial p_{0j}}{\partial \mu_j}s_j + p_{0j}\frac{\partial s_j}{\partial \mu_j} + \frac{\partial p_{1j}}{\partial \mu_j}\int xs_j(x)dF_X(x)) + p_{1j}\int x\frac{\partial s_j(x)}{\partial \mu_j}dF_X(x) - \\
&\quad -(c_1+\omega_{1j})\frac{\partial s_j}{\partial \mu_j} - (c_2+\omega_{2j})\int b\frac{\partial s_j(b)}{\partial \mu_j}dF_B(b) - 2(c_4+\omega_{4j})(\mu_j - \phi(\sigma_j^2)) - \\
&\quad -\int^0 r\int b\frac{\partial s_j(b)}{\partial \mu_j}dF_B(b)dF_{rj}(r) - \int^0 r\int bs_j(b)dF_B(b)\frac{\partial f_{rj}(r)}{\partial \mu_j}dr
\end{aligned}
$$

The system of equations (3) also can be solved for $(\omega_{3j}, \omega_{4j})$. Expressions for $\{\frac{\partial p_{0j}}{\partial \sigma_j^2}, \frac{\partial p_{1j}}{\partial \sigma_j^2}, \frac{\partial p_{0j}}{\partial \mu_j}, \frac{\partial p_{1j}}{\partial \mu_j}\}$ can be obtained by further differentiating (2) with respect to σ_j^2 or $\partial\mu_j$.

5 Estimation Strategy

We estimate this model using generalized method of moments. We follow the methodology developed in BLP(1995, 2004) and Petrin (2002). On the demand side we use individual moments relating the age, gender and education of individuals to their choice of AFP.

6 Descriptive Statistics

This section records some of the regularities present in the data we use. Table 1 documents realized returns of the money management companies present in the market in a given year. For every year it reports an average real return and standard deviation of the returns measured in means unit. The table reports both actual returns as well as GARCH forecast of the returns based on 1 year window. The table shows that the variation was relatively mild when the system just started and then became stronger after 1987 when the restrictions on the exact content of the investment portfolio were relaxed.

Table 1: AFPs' Returns: Evidence of Product Differentiation

	actual		forecast	
year	mean	std.dev/mean	mean	std.dev/mean
1981	2.6%	9.5%	2.7%	12.0%
1982	3.5%	4.7%	2.6%	10.7%
1983	3.5%	5.1%	3.5%	3.6%
1984	1.9%	3.1%	2.4%	3.1%
1985	3.1%	3.7%	2.9%	5.9%
1986	2.3%	3.7%	2.7%	6.1%
1987	2.2%	3.9%	2.2%	7.4%
1988	1.4%	4.3%	1.7%	2.4%
1989	2.2%	4.3%	1.8%	5.3%
1990	3.7%	16.7%	3.3%	22.2%
1991	3.7%	4.2%	3.9%	7.0%
1992	1.4%	12.7%	1.9%	39.5%
1993	2.1%	7.3%	1.3%	46.6%
1994	2.1%	13.1%	2.6%	27.2%
1995	0.4%	67.5%	1.0%	60.5%
1996	0.9%	12.0%	0.8%	25.1%
1997	0.9%	8.3%	1.0%	5.6%
1998	0.1%	219.5%	0.1%	204.4%
1999	1.5%	5.2%	1.6%	1.8%
2000	0.7%	2.9%	1.0%	4.1%
2001	0.8%	2.3%	0.8%	4.8%
2002	0.5%	10.1%	0.6%	6.1%
2003	1.0%	3.9%	0.8%	5.2%
2004	2.0%	134.5%	1.3%	83.6%

This period also corresponds to large market structure turmoil when many money manager's had to exit due to the shortness of capital caused by excessively risky investment. Table 2 records these changes in the market structure.

Table 2: Market Structure and Funds Turnover

	# of AFP	# bankrupt
1981	12	
1982	12	
1983	12	
1984	12	
1985	11	2
1986	12	
1987	12	
1988	13	
1989	14	
1990	14	
1991	15	
1992	20	
1993	22	2
1994	22	
1995	18	5
1996	13	3
1997	13	
1998	8	8
1999	8	
2000	8	
2001	7	1
2002	7	
2003	7	
2004	6	1

7 Bibliography

Caplin A. and B. Nalebuff (1991), "Aggregation and Imperfect Competition: On the Existence of Equilibrium," *Econometrica*, Vol.59 (1), pp. 25-59.

Caplin A. and B. Nalebuff(1986), "Multi-Dimensional product Differentiation and Price Competition," *Oxford Economic Papers*, New Series, Vol. 38, pp. 129-145.

Berry S., Levinsohn J. and A. Pakes (1995), "Automobile Prices in Market Equilibrium," *Econometrica*, Vol 63 (4), pp.841-90.

Berry S., Levinsohn J. and A. Pakes (2004), "Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Vehicle Market," *Journal of Political Economy*, 112(1), pp. 68-104.

Pakes A., Porter J., Ho K. and J. Ishii (2006), "Moment Inequalities and Their Application," Working Paper

Petrin A. (2002), "Quantifying the Benefits of New products: The Case of Minivan," *Journal of Political Economy*, 110(4), pp. 705-729.