Reforms to an Individual Account Pension System and their Effects on Work and Contribution Decisions: The Case of Chile

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Working Paper
University of Pennsylvania

(PRELIMINARY VERSION)

September 2008

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[1]The author is grateful for research support from the National Institutes of Health - National Institute on Aging (grant number P30 AG12836); the Boettner Center for Pensions and Retirement Security at the University of Pennsylvania; and the National Institutes of Health - National Institute of Child Health and Development Population Research Infrastructure Program (R24 HD-044964). The research reported herein was also performed pursuant to a grant from the U.S. Social Security Administration (SSA) through the Michigan Retirement Center (Grant 10-P-98362-5), funded as part of the Retirement Research Consortium. The opinions and conclusions expressed are solely those of the author and do not represent the opinions or policy of the Social Security Administration, any agency of the Federal government, or the Michigan Retirement Center. Helpful comments and guidance were provided by Jere Behrman, Olivia S. Mitchell, Petra Todd, and Kenneth Wolpin, and data assistance from Javiera Vasquez is much appreciated. Opinions and errors are solely those of the author and not of the institutions with whom the author is affiliated.

Abstract

This study evaluates the effect of Chile's pension system rules and regulations on individuals' contribution and working decisions. In 1980 Chile was the first country to switch from a pay-as-you-go system to a privatized system based on individual investment accounts; then it has since been a model for pension reforms in many other Latin American countries. The Chilean system has also been considered by U.S. policy makers as a possible prototype for reform. This paper develops and estimates a dynamic behavioral model of individual decision-making about formal or informal sector employment and about pension contributions, accounting for regulations that govern the timing and level of pension benefits. Model parameters are obtained by the method of simulated maximum likelihood applied to longitudinal data from a new household survey, the Social Protection Survey (2002 to 2004), and administrative data from the pension regulatory agency. The estimated model is used to simulate the impact on employment and contribution patterns of changing the system rules. Reducing the number of quarters required to obtain the Minimum Pension and increasing the size of that pension increases work in the formal sector and contributions in the informal sector.

1 Introduction

The main goal of this study is to evaluate the effect of Chile's pension system rules on individuals' pension contributions and working decisions. The case of Chile is interesting because it was the first country to switch from a pay-as-you-go system to a privatized system based on individual investment accounts. Since the reform in 1980, Chile's pension system has been a model for pension reforms in many other Latin American countries such as Mexico, Argentina, Peru, Uruguay, etc. Moreover, this retirement system has also been considered by U.S. policy makers as a model for a possible reform. However, lately, the success of the Chilean pension system is being questioned because more than half of the Chilean workforce is not currently contributing. This is observed especially among the self-employed, for whom contribution is voluntary. Therefore, improving the private pension system is one of the main priorities of the government in Chile.

In Chile, as in most of the Latin American countries, the labor market is divided into two sectors: covered and uncovered. In general, the covered sector is where individuals sign a contract that provides them with employment benefits (health care, housing plans, etc.) and obligations (payment of taxes and fees, for instance).

The most fundamental characteristics of the pension system are that each member of the new system has an individual account to which pension contributions are paid. These accounts are managed by a Pension Fund Administrator (AFP) that charges commissions for its services. Member's pensions are financed with the resources accumulated in their individual accounts. When the funds in the account are not enough to finance the minimum pension set by the government, the state guarantees the payment of the minimum pension to members that fulfill the requirement of 20 years of contribution.

In March 2006, President Michelle Bachelet set up an independent commission of experts to study and propose improvements to the pension system. In December 2006, the government passed some reform proposals to Congress along the commission's recommendations. One of the recommendations aims to extend the state safety net. The commission proposed eliminating the requirement of 20 years of contributions to obtain the minimum pension and introducing a universal basic pension for the poorest. Another recommendation aimed to increase coverage by giving the self-employed the same rights and responsibilities as those workers employed in the formal sector. This means that contributions would gradually become obligatory.

Because individuals may adjust their decisions as the system rules change, it is necessary to develop a model that is able to explain how individuals make their labor market participation and contribution decisions. Accordingly we develop and estimate a dynamic behavioral model of individual decisions about labor participation and pension contributions in Chile. The model also takes into account the fact that individuals working in different labor sectors face different contribution rules. Among these rules is that membership of the pension system is voluntary for the self-employed and uncovered sector employees.

Most researchers who have developed dynamic models to analyze retirement decisions have used data from the United States (see Rust and Phelan (1997) and French (2003)). However this would not necessarily be a good representation of how individuals would behave under a privatized retirement accounts system in a developing country. The few empirical studies on the Chilean Pension System have been limited to the use of aggregate and macro data (see Corsetti and Schmidt-Hebbel (1995)). This paper's contribution is to analyze pension contribution patterns and employment decisions using micro data to evaluate alternative policy experiments. The estimated model is used to simulate the impact on employment and contribution patterns of modifications to the system rules, for example, of a change of the number of years of contributions required to get a minimum pension or a change in the commissions that are charged by the AFPs.

The remainder of this paper is organized as follows: Section 2 reviews the related literature. Section 3 describes the Chilean Pension System. Section 4 describes the data set and presents the descriptive statistics of the sample used. Section 5 develops the dynamic behavioral model, explains the model solution and the estimation method. The estimation results and model goodness of fit are presented in Section 6. The policy experiment results are presented in Section 7. Finally, Section 8 concludes.

2 Literature Review

This work builds on previous studies that develop and estimate dynamic behavioral models for the purpose of studying how social security and pension rules affect labor supply and retirement behavior such as Gustman and Steinmeier (1986), Rust and Phelan (1997), French (2002), and Van der Klaauw and Wolpin (2005). These studies use data from individuals whose retirement benefits are defined benefit not defined contribution. In a defined benefit plan, the retirement benefits depend on age of retirement, an average of the past earnings and years of service. In a defined contribution scheme, such as that in Chile, the retirement benefits depend on contribution accumulations.

An early paper by Gustman and Steinmeier (1986) develops and estimates a life-cycle model that they use to study how social security and pension benefits affect working and retirement behavior. Individuals may be working full-time, be partially retired or fully retired. The model includes the fact that individuals in partial retirement obtain a lower wage rate than those working full time. Once the model is estimated, it is used to simulate retirement behavior. The simulations of the percentages of individuals who are working full-time, partially retired, and fully retired are very similar to those observed in the data, including the peaks in retirement percentages at age 62 and 65. These peaks are the result of the effect that social security and pension benefits have on wages and therefore on retirement behavior. Their paper was the first empirical study to treat each year as a separate period for obtaining optimal labor supply paths over the entire life cycle. In this paper, I also obtain these paths in order to examine how changes in retirement benefits affect labor decisions of young individuals.

Rust and Phelan (1997) study how social security and Medicare affect retirement behavior when some individuals do face borrowing constraints and do not have access to annuities and health insurance. They develop and estimate a dynamic programming model about individual decisions on labor supply and application for social security benefits that incorporates constraints imposed by incomplete markets and allows for uncertainty in future earnings. They find that the peak in retirement at 62 is explained by the borrowing constraints and that the peak at 65 is explained by the incomplete markets on annuities and health insurance and the facts that, for those older than 65, the social security benefit is unfair and Medicare is available only when already applied for social security benefits. In my model I also introduce uncertainty in future earnings and individuals are not allowed to save.

Most recent empirical analysis of how social security regulations affects retirement behavior incorporate savings behavior and heterogeneity, for instance, French (2002) and Van der Klaauw and Wolpin (2005). As opposed to the earlier papers mentioned before, these authors use the estimated model to conduct various policy experiments to evaluate not only the effects on labor supply and retirement behavior of older workers but also on that of workers younger than 62 years old. Changes on the size of social security benefits and on the legal age of retirement are some of the policy experiments they conduct. French (2002) finds that the effects of those changes on working decisions of younger individuals are smaller than those of old workers. Van der Klaauw and Wolpin (2005), who model the decisions of married and single individuals, find that, in general, the behavior of singles is more affected by those changes than that of married individuals. Although in my model I do not incorporate savings, I include heterogeneity. Also, as in the above two papers, I am very interested in evaluating the behavior of young individuals.

The main difference between the models described above and the model I develop here is that I model not only the labor supply decision, but also the contribution decision. The model is estimated using micro data from Chile. Most empirical studies of the Chilean pension system analyze aggregate and macro data. For instance Corsetti and Schmidt-Hebbel (1995) use an overlapping generations model with endogenous growth and formal-informal production sectors to show how the privatization of the pension system explains the increasing private savings and rising growth. The authors suggest that switching from a pay-as-you-go system to a fully funded system creates incentives to move employment to the more efficient formal sector.

There are a few papers that use micro data, mostly for descriptive purposes. Areanas de Mesa et. al. (2004) examine coverage of the Chilean pension system. They use the 2002 round of the *Historia Laboral y Seguridad Social (HLLS)* survey to estimate the density of contributions, which is calculated by adding the number of months of contributions since January 1980 and dividing it by the total number of months since January, 1980. That paper concludes that the average density 52% of months, which implies substantially lower replacement rates for representative individuals upon retirement than would a hypothetical contribution density of 80% as assumed in previous studies that forecast old-age pensions. In a subsequent paper, Arenas de Mesa et. al. (2006) use the same data linking information on contributions to the administrative records provided by the pension fund regulatory agency, which are the same administrative data used in this paper. They show that, over their lifetimes, men contribute more than women and self-reported payments indicate higher contribution levels than those observed in the contribution records. Also, they note that people usually do not contribute during periods of unemployment or self-employment. They also provide evidence that most workers know very little about the rules and regulations of the pension system.

Following the findings in Arenas de Mesa et al (2004, 2006) I study the Individual Account Chilean Pension System in order to design the best policies aimed at increasing contributions. Since contributions are low for self-employed, I evaluate the effect of changing the rules of the system on employment in the covered sector and uncovered sector.

3 The Chilean Pension System

The new Chilean Pension System known as the "AFP system" is based on individual capitalization. Each member of the system has an individual account where contributions are deposited. The accounts are managed by a Pension Fund Administrator (AFP). The AFPs are competitive firms whose purpose is to invest the pension funds in the capital market to provide to their affiliates their corresponding retirement benefits. Each AFP must offer five funds with different levels of risk, and therefore, different returns. Members of the system may change from one AFP to another whenever they want.[2]

For those members of the AFP system who are working it is mandatory to pay the following monthly contributions calculated as a percentage of the their taxable wage and other taxable income with an upper limit of 60 UF [3]: 1) 10% for the pension fund, 2) 7% for health services, 3) around 0.8% to finance the disability and survivorship insurance, and 4) around 1.6% for the AFP expenses and profits. Besides the last two which together are called the percentage commission, there is a fixed commission charged every month. The commissions are set by each Administrator.

Pensions are financed with the resources accumulated in the individual account. If a member of the AFP system does not save enough to obtain a pension equivalent to the minimum pension, the State finances the remainder provided the individual has accumulated 20 years of contribution by his retirement age. The legal age of retirement is 65 for men and 60 for women. Early retirement is allowed, provided that the retiree can obtain a pension equal or greater than half his average earnings in the last 10 years and equal or greater than 1.1 times the minimum pension guaranteed by the State.[4]

[2] There are currently six AFPs operating in Chile.

[3] The value of the UF as of December 2004 was $17,317 pesos (US$31)

[4] At retirement, a member can choose from three pension payout options: 1) programmed withdrawals, the member keeps his savings in his individual account and withdraws annual amounts (in monthly payments). The AFP manages the account and recal-

Membership of the AFP system is mandatory for those individuals in the covered sector employed for the first time after January 1983 and voluntary for the self-employed. Individuals that started working before January 1983 and belonged to the old pay-as-you-go system have the right, but not the obligation, to switch systems. Workers who switch to the individual capitalization system obtain their Recognition Bond, an instrument issued by the State that represents the contributions paid to the pay-as-you-go system. The bond becomes payable when the legal age of retirement is reached and it is deposited in the worker's individual account. The pensions and contributions of those that stayed in the old system are managed by the Institute of Social Security Normalization (INP) which was created in 1980.

4 The Data

The Social Protection Survey (EPS) is a longitudinal data set that contains information at the individual level on a representative sample of the working-age population in Chile. The survey covers around 17,000 respondents: 14,000 affiliated either with the pay-as-you-go system or the AFP system at any time since 1981, and 3,000 not affiliated to any pension system. The respondents were either working, unemployed, out of the labor force, or officially retired. The survey contains information on affiliation status, employment history since 1980, pension contributions, retirement plan participation, savings, education, health, family background, family income, assets, and capital. The first round of the survey was administered in 2002, and the second one in 2004. The 2006 follow-up has been already administered and an additional follow-up round is planned for 2008. Half of the respondents are men. The most relevant information collected in the EPS survey for this study is the retrospective data on employment, non-employment, and unemployment spells, back to 1980.

culates the annual amount every year; 2) life annuity, the member purchases a life annuity from a life insurance company where his savings are transferred. The Company promises to make monthly payments until the death of the member; 3) temporary income with deferred life annuity, the member keeps part of his savings in his individual account and purchases a life annuity with the other part. He withdraws annual amounts until he starts to receive the life annuity.

The EPS information can be linked to administrative records on mandatory and voluntary monthly contributions, monthly wages, changes between AFPs and delayed payments. There are also data on the value of the Recognition Bond for those who switched systems and information on the type of pension plan that retirees receive. For the purposes of this study, the most important administrative information is the histories of monthly contributions and wages for those that contribute since January 1981. The 2002 and 2004 Social Protection Surveys linked to administrative records provide the essential data base for studying the effect of the rules of the pension system on employment and contribution decisions.

Because many women do not work in the paid labor market more than half of the time, this study focuses on men. Moreover, the parameters of the model will be estimated using only the information on men between 18 and 39 years old in 2004 for the following reasons: 1) it is assumed that men can start contributing at 18, the age at which they should finish high school; 2) membership of the AFP system is mandatory for those entering the workforce for the first time after January 1983, then, it could be that men older than 39 years old in 2004 contributed to the old pay-as-you-go system; and 3) there is no information on contributions paid to the old pension system.

4.1 Descriptive Statistics

The sample used in the estimation of the model consists of 2,517 men between 18 and 39 years old in 2004 with an average age of 30.4 who, by 2004, already finished their studies.[5] Regarding the region of residence, 37.8% of them live in the metropolitan area. The distribution of the individuals by education is the following: 12.4% of them didn't complete the basic education (8 years of education), 32.6% have between 8 and 11 years of education, and 42.2% completed high school (12 years of education). The other 12.8% studied at least one year of college. In average, they have 10.7 years of education. Regarding marital and health status in 2004, 66.6% are already married and 9.3% have been diagnosed with a chronic disease, such as diabetes, hypertension, etc. Table 1 shows the socio-demographic characteristics of the sample.

[5]The education decision is not included in the model. Individuals enter the sample once they finished studying

Table 1: **Socio-demographic Characteristics**

	Percentage	
Residence in metropolitan area in 2004	37.8%	
Bad health in 2004	9.3%	
Married in 2004	66.6%	
	Mean	**Std. Dev.**
Age in 2004	30.4	5.6
Years of education in 2004	10.7	3.0

As shown in Table 2, in average, individuals have worked 72.6% of their time since they finished studying. From that percentage, 26.6% of the time they worked in a covered sector job and the other 46.0% they worked in the uncovered sector. The mean of annual earnings in the covered sector (2.2 million pesos) is higher than that in the uncovered sector (1.5 million pesos). The density of contributions is defined as the percentage of quarters of contribution of the total number of quarters elapsed since an individual finishes his studies. The mean of the density of contributions at the beginning of the year is only 30.3%. From that 30.3%, 26.5% corresponds to contributions paid while working in the covered sector and the other 3.8% comes from contributions while in the uncovered sector. Notice that while individuals work in average 46.0% of the time in an uncovered job, they only contribute voluntarily 3.8% of the time.

Table 2: **Labor and Contribution Statistics ***

Labor sector participation	**Mean**	**Std. Dev.**
Working	72.6%	32.3%
Covered sector	26.6%	29.1%
Uncovered sector	46.0%	35.0%
Not working	27.4%	32.3%
Annual earnings in thousands of pesos**		
Covered sector	2,225	1,723
Uncovered sector	1,534	1,243
Contribution to the pension		
Density of contributions	30.3%	29.4%
Covered sector	26.6%	29.1%
Uncovered sector	3.8%	10.5%

* counting since they finished studying and until 2004

** 1,000 pesos = US$1.785, 2004 pesos

Tables 3 to 5 present average earnings, the average of accumulated quarters of work and contributions, the average percentage of time working, and the average density of contributions in both labor sectors by age groups. As shown in Table 3, after-tax earnings in the covered sector are between 40% and 50% greater than earnings in the uncovered sector for every group of age.

Table 3: **Earnings in the Covered and Uncovered Sectors by Group of Age ***

	Thousands of Pesos*			
	Covered		**Uncovered**	
Age Group	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
18-20	1,223	687	874	699
21-25	1,727	1,122	1,230	907
26-30	2,542	1,912	1,694	1,283
31-35	2,965	2,052	1,915	1,445
36-39	3,077	1,979	2,140	1,507

* counting since individuals finished studying and until 2004

** 1,000 pesos US$1.785, 2004 pesos

Table 4 shows that, although earnings are higher in the covered sector, the proportion of time working in the uncovered sector is greater than that in the covered sector for all groups of age. However, the difference between these proportions decreases with age, with the youngest working 31.8% more time in the uncovered sector and the oldest working only 14.8% more in that sector. Notice that the group of individuals between 36 and 39 years old have accumulated more than 65 quarters of work in both sectors. Had they contributed every quarter, they needed only 15 quarters more of contributions to be eligible for the minimum pension. Nevertheless, this group of age has accumulated only 31.3 quarters of contribution in average. The density of contributions is very low for every group of age in the uncovered sector where it is voluntary to contribute (see Table 5). It increases with age from 1.6% to only 5.5%.

Table 4: **Accumulated Quarters of Work and Percentage of Time Working in the Covered and Uncovered Sectors by Group of Age***

	Means			
Age Group	**Covered**		**Uncovered**	
18-20	0.5	8.5%	2.4	40.3%
21-25	4.2	21.3%	8.7	45.3%
26-30	12.2	33.5%	17.6	47.2%
31-35	20.9	38.2%	27.7	48.7%
36-39	27.3	37.5%	38.6	52.2%

*Counting since individuals finished studying

Table 5: **Accumulated Quarters of Contribution and Density of Contribution in the Covered and Uncovered Sectors by Group of Age***

	Means			
Age Group	**Covered**		**Uncovered**	
18-20	0.5	8.5%	0.1	1.6%
21-25	4.2	21.3%	0.6	3.3%
26-30	12.2	33.5%	1.7	4.4%
31-35	20.9	38.2%	2.9	5.1%
36-39	27.3	37.5%	4.0	5.5%

*Counting since individuals finished studying

The dynamic model estimated incorporates the probabilities of getting married and being diagnosed with a chronic disease that depend on age and years of education. Table 6 presents the reduced form logit estimation of the probability of getting married with age, age squared, years of education, and years of education squared as independent variables. The estimated coefficients are significant at 5%. The probability of marriage increases with age and years of education, although the positive relationship with age is stronger than that with years of education. The relationship with the squared terms is negative. Table 7 presents the reduced form logit estimation of the probability of being diagnosed with a chronic disease with age, years of education and years of education squared as independent variables. Age has a positive and significant effect on the probability of being in bad health. Years of education has a negative effect on this probability, although it is not significant.

Table 6: **Marriage Probability, Logit Estimates**

Variable	Parameter	Std. Error
Constant*	-15.186	0.944
Age*	0.960	0.075
Age squared*	-0.018	0.0015
Years of education*	0.139	0.041
Years of education squared*	-0.007	0.002
Observations	17,493	

* significant at 5%

Table 7: **Bad Health Probability, Logit Estimates**

Variable	Parameter	Std. Error
Constant*	-6.377	1.365
Age	0.004	0.137
Years of education	-0.145	0.090
Years of education squared**	0.008	0.004
Observations	30,775	

* significant at 5%

** significant at 10%

Wage offers in both the covered sector and the uncovered sector are also incorporated to the dynamic model. They depend on years of education, region of residence, and years of work experience. Table 8 (9) presents the reduced form OLS estimation of income in the covered (uncovered) sector using the logarithm of annual after-tax income as dependent variable. Years of education, and living in the metropolitan area have a positive and significant effect on income in both sectors. In each sector, work experience of the same sector has a higher effect on earnings than that experience in the other labor sector. In the covered sector, years of work experience in that sector have a positive effect on earnings while years of work experience in the uncovered sector have a negative effect. In the uncovered sector, the effect of years of work experience in that sector on earnings is twice as that of the years of experience of the covered sector.

Table 8: **Log Earnings from Covered Sector Jobs, OLS Estimates**

Variable	**Parameter**	**Std. Error**
Constant*	13.137	0.024
Years of education*	0.082	0.002
Region*	0.080	0.011
Tenure in covered sector*	0.034	0.0015
Tenure in covered sector squared*	-0.0003	0.00002
Tenure in uncovered sector*	-0.010	0.001
Tenure in uncovered sector squared*	0.0003	0.00002
Observations	13,711	

* significant at 5%

Table 9: **Log Earnings from Uncovered Sector Jobs, OLS Estimates**

Variable	**Parameter**	**Std. Error**
Constant*	12.516	0.066
Years of education*	0.085	0.005
Region*	0.155	0.033
Tenure in covered sector*	0.011	0.003
Tenure in covered sector squared	0.0001	0.0001
Tenure in uncovered sector*	0.019	0.003
Tenure in uncovered sector squared*	-0.0001	0.00004
Observations	4,740	

* significant at 5%

5 The Model

The model represents an individual's decision problem regarding labor participation and contribution to the pension. The model starts at the age the individual finishes his studies a_o and ends at age $\bar{A} = 85$. The individual makes decisions until retirement, at age A. At the beginning of each period $a \leq A$, that is, when the individual turns a years old, he receives wage offers from both labor sectors, the covered sector and the uncovered sector, and decides how many quarters to work, how many quarters not to work, or retire. We define the covered sector as the one where workers have signed employment contracts and pension contribution is compulsory, and the uncovered sector where they do not have a signed contract or are self-employed and it is optional to contribute to the pension. If the individual chooses to work, he also decides whether to work in the covered or uncovered sector. In the covered sector he has to contribute the same number of quarters he works. In the uncovered sector, the contribution decision is also assumed to be made by quarter: he has to decide how many quarters to contribute from the quarters he works in this sector. Finally, it is assumed that an individual does not contribute when not working.

Initial conditions of the model are: a) years of education, $E\epsilon\{0, 1, ..., 18\}$, b) region of residence, $G\epsilon\{0, 1\}$, which takes the value of 1 when the individual lives in the metropolitan area, c) previous health status, $H\epsilon\{0, 1\}$, which is 0 when good and 1 when bad, and d) previous marital status, $M\epsilon\{0, 1\}$, which is 0 when single and 1 when married. The possible employment choices at the beginning of each period at age a are the combinations of quarters of work in a covered job, $s_a^c\epsilon\{0, 1, 2, 3, 4\}$, quarters of work in an uncovered job, $s_a^u\epsilon\{0, 1, 2, 3, 4\}$, or retirement, $r_a\epsilon\{0, 1\}$. At retirement the model ends, so retirement, $r_a = 1$, is an absorbing state. As mentioned before, in the covered sector, it is mandatory to contribute to the pension; in this case the number of quarters of contribution equals the number of quarters of work in a covered sector job, $q_a^c = s_a^c$. The maximum number of possible contribution periods in the uncovered sector is the number of quarters of work in an uncovered sector job, $q_a^u \leqq s_a^u$.

The individual's utility function, at each age a , is given by:

$$U_a = U(C_a, l_a, s_a^u; M_a, H_a, \varepsilon_a^C, \varepsilon_a^l, \mu) \tag{1}$$

where C_a represents the individual's consumption at age a. The individual obtains non-pecuniary utility from quarters not working and for quarters working in the uncovered sector, $l_a \epsilon \{0, 1, 2, 3, 4\}$ and $s_a^u \epsilon \{0, 1, 2, 3, 4\}$, respectively. The utility also depends on marital status, $M_a \epsilon \{0, 1\}$, and health status, $H_a \epsilon \{0, 1\}$. The terms $\varepsilon_a^C, \varepsilon_a^l$ are age-varying shocks to the marginal utilities of consumption and leisure. The term μ is a vector of unobserved individual-specific factors that affect his preferences for consumption and time working.

Consumption at age $a < A$ is equal to earnings minus contributions in case the individual works, or an unemployment benefit otherwise. At ages $a \geqq A$ it equals the pension:

$$C_a = \begin{cases} s_a^c \frac{w_a^c}{4} [1 - (\tau + \phi)] + \frac{w_a^u}{4} [s_a^u - q_a^u(\tau + \phi)] + C_M I(l_a = 4), & \forall a < A; \\ P_a, & \forall a \geq A, \end{cases} \tag{2}$$

where w_a^c is annual earnings paid to the covered worker, w_a^u is annual earnings paid to the uncovered worker, and b is the unemployment benefit the worker receives when he does not work that year.[6] The contribution rate is 10% of taxable earnings, $\tau = 0.1$. The average fees and commissions that AFPs charge per year are represented by ϕ.

In any period a, an individual may have either good health, $H_a = 0$, or bad health, $H_a = 1$. The individual has good health until diagnosed with a chronic disease. He observes his health status at the beginning of the period. The probability of being diagnosed with a chronic disease that year depends on age, years of education, and previous health status:

$$\pi_a^H = \pi^H(a, E; H_{a-1} = 0, \mu), \tag{3}$$

where μ is a vector of unobserved individual-specific factors that affect the probability of having a chronic disease. For the health status only chronic diseases are taken into account, so poor health is an absorbing state.

Regarding marital status, the individual can be married, $M_a = 1$, or single, $M_a = 0$. It is assumed that once an individual gets married he stays

[6] Incorporating savings other than the pension contributions greatly increases the complexity of the estimation problem. Moreover, few people report other types of savings in the data.

married. The probability of getting married at the beginning of the period depends on age, years of education, and previous marital status:

$$\pi_a^M = \pi^M(a, E; M_{a-1} = 0, \mu), \tag{4}$$

where μ is a vector of unobserved individual-specific factors that affect the probability of getting married.

Wage offers are sector-specific, w^j, where $j = c$ is covered and $j = u$ is uncovered. The wage offer for an individual at age a is:

$$w_a^j = \rho^j K_a^j(E, G, T_a^j, T_a^{-j}, \varepsilon_a^j; \mu), \tag{5}$$

where ρ^j is a sector-specific skill rental price, and K_a^j is the individual's stock of human capital at age a that varies with the job market sector. The individual accumulates capital through years of work experience. The cumulative years worked in the sector j up to age a is represented by T_a^j(tenure). ε_a^j is an age-varying shock that differs by sector and μ is a vector of unobserved individual-specific factors that affect wage offers. Denote by $W_a = [w_a^c, w_a^u]$ the vector that includes the wage offers received by an individual at the beginning of period a.

Pensions are financed with the funds accumulated in the individual accounts where pension contributions are deposited,

$$P_a = \frac{B_a}{factor(a, M_a)}, \tag{6}$$

where B_a is the account balance at the end of period a, and $factor(a, M_a)$ is an annuity factor that depends on age and marital status. The account balance at the end of the period a is $B_a = (B_{a-1} + \Gamma_a)(1 + R)$, where Γ_a is the amount of contributions during period a, and R represents the average annual rate of return of the pension fund which varies every year. The expected annual rate of return is $E[R] = \kappa$, then

$$R = \kappa + \varepsilon^R, \tag{7}$$

where ε^R is an annual-varying shock.

When the funds in the account are insufficient to finance the minimum pension set by the government, $P_M = US\$110$, the state guarantees the payment of the minimum pension to members that fulfill the requirement of 20 years of contribution (80 quarters). Denote by Q_a the number of quarters of contributions at the end of period a. The legal retirement age for men is 65 years old, but retirees have the option to take early retirement provided that the pension is higher than half the average earnings in the last 10 years, $\overline{W}_a$, and higher than 1.1 times the minimum pension.

Individuals who are not members of any pension system have the right to get a basic pension, called PASIS [7], that is financed by the government. To be eligible to get the PASIS the individual has to be at least 65 years old and to have an income lower than the minimum pension. The size of the PASIS is half of the minimum pension.

The state variables at age a are the initial conditions of the model plus age, year, previous marital status, previous health status, years of work experience, tenure, quarters of contribution, balance in the individual account, and the vector of shocks ϵ_a. Denote the state space at age a by Ω_a,

$$\Omega_a = \left\{a, E, G, M_{a-1}, H_{a-1}, T_a^c, T_a^u, Q_a, B_a, \overline{W}_a, \epsilon_a\right\}. \tag{8}$$

The age-varying shocks to consumption, leisure, the wage offer in the covered sector, the wage offer in the uncovered sector, and the rate of return are assumed to be *iid* with mean zero and jointly normally distributed, $f(\epsilon(a))$, and jointly serially uncorrelated.[8] Additionally, the vector of unobserved individual-specific factors, μ has a distribution function $z(\mu)$ and is assumed to be independently distributed from the vector of stochastic shocks.

The functional forms for the utility, the wage offers, and the probabilities of being in bad health and of getting married are presented in Appendix A.

[7] PASIS stands for *Pension Asistencial*

[8] There are also implicit shocks to the probabilities of marriage and bad health, which are assumed to be independently distributed from the explicit shocks considered.

5.1 Model Solution

Each period $a \leq A$, the individual has to choose one of the mutually exclusive available options $k \in K_a$, which are the combinations of labor and contribution decisions or retirement. The individual's optimization problem can be represented in value function form:

$$V\left(\Omega_a, a\right) = \max_{k \in K_a} E\left(\sum_{\tau=a}^{\bar{A}} \delta^{\tau-a}(1 - D(\tau))^{\tau-a} U^k(\tau)|\Omega_a\right), \tag{9}$$

where δ is the discount factor and D is the probability of dying next period. This problem can be stated in a dynamic programming form using the Bellman equation representation:

$$V(\Omega_a, a) = \max_{k \in K_a} V^k(\Omega_a, a), \tag{10}$$

where the right-hand side represents the maximization over alternative-specific value functions. These value functions are given by:

$$V^k(\Omega_a, a) = \begin{cases} U^k(a, \Omega_a) + \delta E\left(V(\Omega_{a+1}, a+1)|k, \Omega_a\right), & \forall a < A; \\ U^k(A, \Omega_A) + E\left(\sum_{\tau=A+1}^{\bar{A}} \delta^{\tau-a}(1 - D(\tau))^{\tau-a} U(\tau)|\Omega_A\right), & a = A. \end{cases} \tag{11}$$

The model is solved by backwards recursion, starting from the last period the individual makes decisions, A, to the initial period a_0. It is assumed that by 70 years old everyone retires. The terminal value is the discounted value of the remaining lifetime utility which depends on the pension and therefore on the state space at age of retirement.[9] At period $A-1$ the individual chooses the option that maximizes his period utility plus the terminal value given the state space Ω_{A-1}. Then at period $A-2$, he calculates the alternative value functions using the distribution of the shocks at period $A-1$, for every option and every point in the state space, that is, the expected value next period $A-1$ given the decision $k \in K_{A-2}$ and every state point in Ω_{A-2}. This is called the Emax function by Keane and Wolpin (1994, 1997).

The model does not have a closed-form solution, only a numerical one. It is not possible to calculate the expected value for every point in the state space

[9] It is assumed that individuals discount their utility until they are 85 years old. This assumption has no effect on the results but provides important computational time savings.

given its size both due to the number of variables it contains and because some of the state variables are continuous. The value of the Emax function is approximated using a method proposed in Keane and Wolpin (1994, 1997). The values computed at a subset of points of the state space are used to approximate the Emax function by a polynomial in the state variables. To calculate the expected value it is necessary to do a multivariate integration of dimension 5, that is, to integrate over the shocks. Because the Emax function calculation implies a multivariate integration, Monte Carlo integration has to be performed.[10]

5.2 Model Estimation

The parameters of the model are estimated using the Simulated Maximum Likelihood method. The likelihood for a sample of I individuals is the product of the I probabilities of the outcomes being observed each period up to an age, given the initial conditions and the unobserved heterogeneity of each individual. The observed outcomes include the following: a) the choice k that is a combination of labor and contribution decisions, b) the health status H that can be bad or good, c) the marital status M that can be single or married, d) the wage offers $\{w^c, w^u\}$ received form each sector, and e) the annual rate of return R. The vector of outcomes at period a is represented by $O_a = \{k_a, H_a, M_a, w_a^c, w_a^u, R_a\}$. The vector of initial conditions is the state space at period a_0 denoted by Ω_{a_0}. Assume that the individual-specific unobserved characteristics identifies 2 types of individuals in the population, μ_1 and μ_2. Then, heterogeneity is represented by the vector of types $\mu = \{\mu^1, \mu^2\}$.

The likelihood for the sample of I individuals observed from their initial period a_0^i to period $\hat{a}^i$ is

$$\prod_{i=1}^{I} P\left(O_{\hat{a}^i}, O_{\hat{a}^i-1}, ..., O_{a_0^i} | \Omega_{a_0^i}, \mu\right). \tag{12}$$

Since the type is known by the individual but unobserved by the econometrician, it is integrated out. Also, because the initial conditions are exogenous

[10]The model is solved using 2,600 state space points and 100 draws for the shocks.

conditional on type, the sample likelihood becomes:

$$\prod_{i=1}^{I}\sum_{t=1}^{2}\left\{P\left(O_{\hat{a}^i},O_{\hat{a}^i-1},...,O_{a_0^i}|\Omega_{a_0^i},\mu^t\right)\times P\left(\mu^t|\Omega_{a_0^i}\right)\right\}, \tag{13}$$

where $P\left(\mu^t|\Omega_{a_0^i}\right)$ is the probability of individual i of being of type t. These type probabilities are functions of the initial conditions and are also estimated.

A difficulty that has to be considered in calculating the likelihood is that some of the wages are missing in the data. This problem is solved by integrating out over all possible wages.

Due to the shocks' serial independence assumption, the probability of observing the outcomes up to some age given the initial conditions and the type t for an individual i can be written as:

$$P\left(O_{\hat{a}^i}|\Omega_{\hat{a}^i},\mu^t\right)P\left(O_{\hat{a}^i-1}|\Omega_{\hat{a}^i-1},\mu^t\right)...P\left(O_{a_0^i}|\Omega_{a_0^i},\mu^t\right). \tag{14}$$

The following example shows how how the conditional probabilities are computed. Consider some available option k_a for the $i-$th individual at age a. Assume that the individual ends the current period in good health and single. The option k_a consists of the individual working in a covered sector job for 2 quarters, working in an uncovered sector job for 1 quarter and not contributing, and taking a quarter of leisure. Then, the observed output includes both wages, the annual rate of return, and the marriage and health status. The conditional probability of observing the described outcome is:

$$\begin{aligned}&P\left(k_a=1,w_a^c,w_a^u,R_a,H_a=0,M_a=0|\Omega_a,\mu^t\right)=\\&P\left(w_a^c,w_a^u,R_a,H_a=0,M_a=0|k_a=1,\Omega_a,\mu^t\right)\times\\&\qquad\qquad\qquad\qquad P\left(k_a=1|\Omega_a,\mu^t\right),\end{aligned}$$

where the first term in the second row of the equation is the joint density of both sectors' wages, the rate of return, the marital status, and the health status, conditional on choosing option k_a, the state space at period a, and the individual's type. The second term is the probability of choosing option k_a conditional on the state space at age a and the individual's type. Then, the likelihood contribution at age a for individual i can be rewritten as follows:

$$P\left(k_a = 1, w_a^c, w_a^u, R_a, H_a = 0, M_a = 0 | \Omega_a, \mu^t\right) =$$
$$\int_\epsilon f\left(w_a^c, w_a^u, R_a, H_a = 0, M_a = 0 | k_a = 1, \Omega_a, \mu^t\right) \times$$
$$P\left(k_a = 1 | \Omega_a, \mu^t\right) d\epsilon,$$

where the integral above is taken over the vector of shocks, ϵ. The first term on the right-hand side is obtained from the distributional assumptions made for the shocks. The second term, can be computed using a smoothed frequency simulator such as the following: 1) for each one of V draws of the shocks' vector, compute

$$\frac{\exp\left(\frac{V^{k^*}(a) - \max_k(V^k(a))}{\tau}\right)}{\sum_j \exp\left(\frac{V^i(a) - \max_k(V^k(a))}{\tau}\right)}, \tag{15}$$

where τ is a smoothing parameter chosen such that it provides enough smoothing given the magnitudes of the value functions computed;[11] this kernel represents the probability of choosing option k^*, conditional on the state space and the individual's type; 2) integrate over the V draws of the vector of shocks.

The maximization of the likelihood function iterates between the solution of the model and the computation of the likelihood function. Because the available options and choices in the model are discrete, we require the use of a maximization algorithm that does not make use of first order conditions such as a simplex method. The identification of the parameters in the model is obtained from the combination of exclusion restrictions and the functional forms assumed.

[11] In the estimation procedure, the smoothing parameter τ is set equal to 10,000. 100 draws are used to perform the numerical integration.

6 Estimation Results and Model Fit

6.1 Parameter Estimates

The functional forms for the utility, the wage offers, and the probabilities of being in bad health and of getting married are presented in Appendix A. The estimates and standard errors of the 51 estimated parameters are shown in Appendix B.

6.2 Model Goodness of Fit and Base-Line Model Statistics

This section presents the model's goodness of fit to the data. It should be reminded that the data used in the estimation procedure includes data for men at ages 18-39 only. In this section some simulations of the decisions for individuals at later ages are also shown as a way of presenting the baseline model used in the policy experiments in Section 7.

Using the estimated parameters it is possible to observe that the model fits the data quite well in several dimensions. Tables 10 to 14 compare the model and the data regarding several statistics of interest. Table 10 presents the comparison of the average number of quarters of work per sector by groups of age. The model predicts quarters of work very well, although the predictions are slightly higher than those observed in the data for the covered sector and slightly lower than those observed for the uncovered sector. For age groups starting at 40 years old, only simulated data are available.

Table 11 shows how the model fits the data on accepted annual wages by sector. As can be observed, the model predicts average annual earnings slightly higher in the uncovered sector than those observed in the data. For two of the three groups of age, the predictions are slightly higher than those observed and lower in the other group.

The model fits the patterns of accumulated quarters of contribution in the uncovered sector fairly well. However, the simulated accumulations for old ages are constant in that sector. In the case of the covered sector, the

Table 10: **Accumulated Quarters of Work in the Covered and Uncovered Sectors**

Age Group	Data/Simulated Covered (mean)	Data/Simulated Uncovered (mean)
18-25	3.1/3.9	6.8/6.5
26-32	13.7/14.7	19.2/18.2
33-39	24.4/27.9	33.3/31.0
40-44	– /39.3	– /42.1
45-49	– /48.6	– /51.1
50-54	– /57.3	– /59.9
55-59	– /65.4	– /68.5
60-64	– /72.7	– /76.8
65-69	– /79.0	– /84.0

model predicts slightly higher accumulations than those observed in the data.

Table 13 shows the model's fit of the proportion of married men. The model predicts very well this proportion for the first two groups of age. The difference in the third group of age is small.

The model predicts a slightly higher proportion of men in bad health for the third group of age than that observed in the data, although the difference is small. In the other groups the predicted probability is the same as in the data (see Table 14).

Table 11: **Accepted Annual Wages in the Covered and Uncovered Sectors**

	Data/Simulated	
Age Group	**Covered (mean)**	**Uncovered (mean)**
18-25	1,640,718/1,648,139	1,124,914/1,340,707
26-32	2,675,647/2,378,733	1,724,703/1,917,354
33-39	3,039,368/3,230,492	1,993,377/2,251,030
40-44	– /3,775,020	– /2,529,600
45-49	– /3,992,639	– /2,728,268
50-54	– /4,056,046	– /2,883,663
55-59	– /3,981,479	– /3,010,349
60-64	– /3,843,688	– /3,101,069
65-69	– /4,305,409	– /2,663,775

Table 12: **Accumulated Quarters of Contribution in the Covered and Uncovered Sectors**

	Data/Simulated	
Age Group	**Covered (mean)**	**Uncovered (mean)**
18-25	3.1/3.9	0.4/1.0
26-32	13.7/14.7	1.8/2.3
33-39	24.4/27.9	3.4/2.9
40-44	– /39.3	– /3.1
45-49	– /48.6	– /3.1
50-54	– /57.3	– /3.1
55-59	– /65.4	– /3.1
60-64	– /72.7	– /3.1
65-69	– /79.0	– /3.1

Table 13: **Proportion of Married Men**

	Data/Simulated
Age Group	**Married (mean)**
18-25	0.28/0.28
26-32	0.70/0.70
33-39	0.85/0.83
40-44	–/0.84
45-49	–/0.84
50-54	–/0.84
55-59	–/0.84
60-64	–/0.84
65-69	–/0.84

Table 14: **Proportion of Men in Bad Health**

	Data/Simulated
Age Group	**In bad health (mean)**
18-25	0.02/0.02
26-32	0.05/0.05
33-39	0.08/0.09
40-44	–/0.17
45-49	–/0.26
50-54	–/0.40
55-59	–/0.58
60-64	–/0.76
65-69	–/0.90

7 Counterfactual Policy Experiments

7.1 Minimum Pension

The Minimum Pension Program is a welfare program sponsored by the government. It is provided to those members of the AFP system who are at least 65 years old (60 for women) and do not save enough in their individual accounts to obtain the current minimum pension set by the government. The State guarantees to finance the difference between the minimum pension and the pension obtained with the savings accumulated in the individual account provided 20 years of contributions. In January 2004, the minimum pension annual benefit was approximately $860,000 pesos.

This program was created in 1980 when the pay-as-you-go pension system in Chile was replaced by an individual capitalization system. Nowadays, after 25 years of operation, this system is facing some challenges, for instance, a low density of contributions. In a recent study, Arenas de Mesa et al (2006) found that people mostly do not contribute during periods of unemployment and self-employment. It is more likely that poor people face more periods of unemployment and then they will not be able to obtain a minimum pension if they do not fulfill the requirement of 20 years of contributions.

In order to provide the poor with a minimum pension in their old-age, the Chilean government proposed eliminating the requirement of 20 years of contributions for the poor. At the beginning of 2008 the Congress approved the proposed reform to the pension system regarding the minimum pension. Starting July 2008 the fixed minimum pension benefit was switched for a graduated minimum pension benefit called the *Aporte Previsional Solidario de Vejez (APS)*. It is a complement to the pension obtained with the resources accumulated in the individual account that the State guarantees to finance. The size of the APS depends on the size of the contributory pension that each member can get, the larger the contributory pension the larger the APS. This complement will be provided to those members of the AFP system who fulfill only two requirements: to be at least 65 years old (60 for women) and to have a contributory pension lower than the *Pension Máxima con Aporte Solidario*, which is a maximum pension set by the government.

It is of policy interest to asses the impact of changing the rules regarding the Minimum Pension benefit. The estimated model developed in this study is used to evaluate the impact on employment and contribution patterns of changes in the Minimum Pension rules similar to those already approved by the Congress at the beginning of this year. Individual decisions on labor participation and contribution to the pension are simulated under alternative scenarios.

7.1.1 Years of contributions required to get the Minimum Pension

I study the effect of changes in the quarters of contributions required to be eligible to obtain the Minimum pension. Table 15 compares the simulated accumulated quarters of work in both sectors for three different numbers of years required to be eligible to obtain the minimum pension: 80 (baseline), 60 and 40. There is a higher effect of these changes on work decisions of young people than on those of old people. For instance, on the one hand, the number of accumulated quarters of covered work for those at ages 18-25 increases from 3.9 to 4.1 when the requirement goes down to 60 quarters and from 3.9 to 4.3 when the requirement is 40 quarters. On the other hand, the accumulated quarters of work in the covered sector for those ages 60-64 increases only from 72.7 to 73.7 and from 72.7 to 75.2 respectively. Therefore, decreasing the number of quarters of contributions required to get the minimum pension from 80 to 60, that is, by 25%, increases work of the youngest group of individuals in the covered sector by 5% and when that requirement is lowered from 80 to 40 quarters, that is 50% lower, their work increases 10%.

According to the simulations, the number of quarters of work in the uncovered sector does not decrease as much as it increases in the covered sector, which implies that it is not the case that people switch from the uncovered sector to the covered one. Part of the effect is explained by the fact that those individuals that stay at home in the baseline choose to work instead in the covered sector when the requirement of quarters of contributions decreases.

Table 15: **Accumulated Quarters of Work in the Covered and Uncovered Sectors**

Required Quarters of Contributions	**80**		**60**		**40**	
	Baseline					
Age Group	**Cov**	**Uncov**	**Cov**	**Uncov**	**Cov**	**Uncov**
18-25	3.9	6.5	4.1	6.5	4.3	6.5
26-32	14.7	18.2	15.2	18.0	15.8	17.8
33-39	27.9	31.0	28.7	30.6	29.6	30.1
40-44	39.3	42.1	40.2	41.5	41.4	40.8
45-49	48.6	51.1	49.6	50.4	50.9	49.6
50-54	57.3	59.9	58.4	59.2	59.8	58.3
55-59	65.4	68.5	66.4	67.8	67.9	66.9
60-64	72.7	76.8	73.7	76.2	75.2	75.3
65-69	79.0	84.0	79.6	82.9	80.4	81.6

Table 16 shows the effect of changing the number of quarters required to get the minimum pension on contributions. Because it is mandatory to contribute while working in the covered sector, the effect on contributions in the covered sector is the same as the one described above for work in that sector. The effect on contributions in the uncovered sector for young people is interesting because even when work in that sector decreases, the quarters of contributions are a lot higher. When the requirement changes from 80 to 60 quarters, there is an increase of more than 30% and when it changes to 40 quarters, accumulated contributions increase by more than 70%. Although the number of quarters of contributions in the uncovered sector is small, a change in the number of quarters required to get the minimum pension affects the contribution decision importantly.

Table 16: **Accumulated Quarters of Contributions in the Covered and Uncovered Sectors**

Required Quarters of Contributions	80		60		40	
	Baseline					
Age Group	Cov	Uncov	Cov	Uncov	Cov	Uncov
18-25	3.9	1.0	4.1	1.3	4.3	1.7
26-32	14.7	2.3	15.2	3.1	15.8	4.0
33-39	27.9	2.9	28.7	4.1	29.6	5.4
40-44	39.3	3.1	40.2	4.4	41.4	6.0
45-49	48.6	3.1	49.6	4.5	50.9	6.1
50-54	57.3	3.1	58.4	4.5	59.8	6.1
55-59	65.4	3.1	66.4	4.5	67.9	6.1
60-64	72.7	3.1	73.7	4.5	75.2	6.1
65-69	79.0	3.1	79.6	4.5	80.4	6.1

7.1.2 Size of the Minimum Pension

In order to measure the impact of changing the size of the Minimum Pension on employment and contribution decisions, first I increase it by 25% from $\$800,000$ pesos to $\$1,000,000$ pesos and then by 50% to $1,200,000$ pesos. In these policy experiments it is still required to have 80 quarters of contributions to be eligible to get the minimum pension.

The results about the effect on accumulated quarters of work are presented in Table 17. Work in the covered sector increases when the size of the minimum pension is higher, specially for young men. By ages 33-39 an individual has accumulated 2.8 more quarters of work in the covered sector when the minimum pension increases 25% and 7.9 more quarters when the minimum pension is 50% higher. Work in the uncovered sector decreases although the effect is not as high.

Table 17: **Accumulated Quarters of Work in the Covered and Uncovered Sectors**

Size of the Minimum Pension in pesos	**$800,000**		**$1,000,000**		**$1,200,000**	
	Baseline					
Age Group	**Cov**	**Uncov**	**Cov**	**Uncov**	**Cov**	**Uncov**
18-25	3.9	6.5	4.7	6.5	6.3	6.5
26-32	14.7	18.2	16.6	17.5	20.1	16.7
33-39	27.9	31.0	30.7	29.7	35.8	27.6
40-44	39.3	42.1	42.6	40.3	48.8	37.4
45-49	48.6	51.1	52.1	49.1	58.8	45.9
50-54	57.3	59.9	60.9	57.9	67.7	54.6
55-59	65.4	68.5	68.8	66.6	75.6	63.4
60-64	72.7	76.8	76.1	75.0	82.6	71.9
65-69	79.0	84.0	81.9	81.8	87.9	78.2

The accumulated quarters of contributions in the uncovered sector increase steadily for young individuals as observed in Table 18. At ages 33-39 a worker accumulates 4.6 more quarters of contributions when the size of the minimum pension increases 25% and when it increases 50% an individual accumulates 13.7 more quarters of contributions. In the last case, the accumulation of contributions is almost 5 times higher than in the baseline.

Table 18: **Accumulated Quarters of Contributions in the Covered and Uncovered Sectors**

Size of the Minimum Pension in pesos	**$800,000**		**$1,000,000**		**$1,200,000**	
	Baseline					
Age Group	**Cov**	**Uncov**	**Cov**	**Uncov**	**Cov**	**Uncov**
18-25	3.9	1.0	4.7	2.3	6.3	4.4
26-32	14.7	2.3	16.6	5.5	20.1	11.1
33-39	27.9	2.9	30.7	7.5	35.8	16.6
40-44	39.3	3.1	42.6	8.3	48.8	19.8
45-49	48.6	3.1	52.1	8.6	58.8	21.9
50-54	57.3	3.1	60.9	8.6	67.7	21.9
55-59	65.4	3.1	68.8	8.6	75.6	21.9
60-64	72.7	3.1	76.1	8.6	82.6	21.9
65-69	79.0	3.1	81.9	8.6	87.9	22.0

7.2 Commissions

In addition to the 10% of the taxable income that members pay as monthly contributions, they have to pay for health insurance and commissions. The level of the commissions is set by each AFP. Currently the approximated average percentage commission is 2.5% of taxable income. From that 2.5%, 0.85 percentage points are used to finance the disability and survivorship insurance, and the other 1.65 percentage points cover the AFPs' administrative costs and profits. pesos.

In the 1980s, the level of the percentage commission was around 3.5%, and it decreased until it reached around 2.5% in 2004. People in Chile still complain about the high commissions charged by the AFPs. For this reason, when the president Michelle Bachelet appointed a commission of experts to study the possible reforms to the pension system, some of the points to discuss were to lower the administrative fees and to boost competitiveness among AFPs.

According to the reforms to the pension system that the Congress approved at the beginning of 2008, the new members of the system will be automatically affiliated to the AFP that charges the lowest fees. These will increase the economic competitiveness among AFPs and will lower the percentage commission.

In order to asses the impact of changing commissions on employment and contributions, I will use the estimated model to study the effect of lowering the commission from 2.5% to 2.0% and then to 1.5%. As can be observed in Table 19 the effect on work decisions of changes in commissions is very small. There is a positive effect on work in the covered sector but even by decreasing fees by 1% the increase in accumulated quarters of covered work is lower than 1 quarter. On the contrary, the effect in the uncovered sector is negative but of the same magnitude as that in the covered sector.

Table 19: **Accumulated Quarters of Work in the Covered and Uncovered Sectors**

Percentage Commission	**2.5% Baseline**		**2.0%**		**1.5%**	
Age Group	**Cov**	**Uncov**	**Cov**	**Uncov**	**Cov**	**Uncov**
18-25	3.9	6.5	4.0	6.5	4.0	6.5
26-32	14.7	18.2	14.7	18.1	14.8	18.1
33-39	27.9	31.0	28.1	30.9	28.2	30.7
40-44	39.3	42.1	39.6	41.8	39.8	41.6
45-49	48.6	51.1	48.9	50.8	49.2	50.5
50-54	57.3	59.9	57.7	59.6	58.0	59.2
55-59	65.4	68.5	65.7	68.1	66.1	67.8
60-64	72.7	76.8	73.1	76.4	73.5	76.0
65-69	79.0	84.0	79.4	83.6	79.8	83.2

As Table 20 shows when lowering the percentage commission there is a very small positive effect on accumulated contributions. Although small, that effect on contributions in the uncovered sector is higher for young individuals when the commission is decreased from 2.5% to 1.5%.

Table 20: **Accumulated Quarters of Contributions in the Covered and Uncovered Sectors**

Percentage Commission	2.5% Baseline		2.0%		1.5%	
Age Group	Cov	Uncov	Cov	Uncov	Cov	Uncov
18-25	3.9	1.0	4.0	1.1	4.0	1.7
26-32	14.7	2.3	14.7	2.5	14.8	2.6
33-39	27.9	2.9	28.1	3.1	28.2	3.4
40-44	39.3	3.1	39.6	3.3	39.8	3.6
45-49	48.6	3.1	48.9	3.4	49.2	3.7
50-54	57.3	3.1	57.7	3.4	58.0	3.7
55-59	65.4	3.1	65.7	3.4	66.1	3.7
60-64	72.7	3.1	73.1	3.4	73.5	3.7
65-69	79.0	3.1	79.4	3.4	79.8	3.7

8 Conclusions

Since most pension systems around the world are having financial problems, studying them is one of the main priorities of the governments in every country. The Chilean Pension System has received much attention from researchers and policy makers because Chile was the first country that switched from a pay-as-you-go pension system to a private one based on individual capitalization. In the new system contributions are deposited in individual accounts that are managed by the Pension Funds Managers (AFPs). The success of the AFP system is being questioned because more than half of the workforce is not currently contributing, especially the self-employed, for whom contribution is voluntary, and the young workers, who stay at home or work in the uncovered sector. Therefore, at the beginning of this year, in order to increase coverage and extend the state safety net, the AFP system was reformed.

In order to understand how the reforms to the Individual Account Pension System affect contributions, I develop a dynamic behavioral model of individual employment and contribution decisions. Although the low contribution problem for these kind of pension systems has been studied before, this is the first structural model that takes into account that individuals working in different labor market sectors face different contribution rules. In the covered sector it is mandatory to contribute to the pension while in the uncovered sector it is voluntary. Then, using the estimated structural model it is possible to measure how individuals change their work and contribution decisions as the characteristics of the system change. Because the rules regarding the state minimum benefits are also included in the model, I asses the impact of changing those rules on employment and contribution.

I conduct two kinds of policy experiments regarding the Minimum Pension: 1) lower the number of quarters of contributions required to obtain the minimum pension guaranteed by the State and 2) increase the size of the minimum pension. These changes are similar to those reforms already approved by the Chilean Congress in January 2008. The effect of these changes in the rules is more pronounced on the decisions of young individuals, especially for those younger than 40 years old.

For those young individuals, when the required number of quarters of contributions is decreased by 25%, the accumulated number of quarters of work in the covered sector increases between 3 and 5% and the accumulated quarters of contributions increase between 30 and 40%. Moreover, when that required number is decreased by 50%, covered work increases between 6 and 10% and accumulated contributions paid while in the uncovered sector increase between 70 and 85%. The effect on contributions while in the covered sector is exactly the same as that on covered work because it is mandatory to contribute there.

With respect to the second kind of experiments and for the same group of young individuals, when the size of the minimum pension is increased by 25%, the accumulated quarters of work in the covered sector increase between 10 and 20% and accumulated quarters of contributions in the uncovered sector increase more than 100%. The impact of increasing the size of the minimum pension by 50% is even higher. Accumulated quarters of work in the covered sector increase between 30 and 60% and accumulated quarters of contribution in the uncovered sector increase by around 4 times.

Two of the main goals of reforming the Chilean Individual Account Pension System were to increase contribution in the informal sector and to encourage labor market participation of young people. According to the results of the policy experiments, both reducing the quarters of contributions required to get the minimum pension and increasing the size of that pension have a positive effect both on work in the covered sector and on contributions in the uncovered sector.

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10 Appendix A: Functional Forms

Utility Function

$$U_a = \frac{C_a^{\sum_{h=1}^{2} I(type=h)\theta_1^h}}{\sum_{h=1}^{2} I(type=h)\theta_1^h} \left[1 + exp\left(\theta_2 l_a + \theta_3 M_a + \theta_4 H_a + \theta_5 \varepsilon_a^C\right)\right] + \theta_6 l_a + \theta_7 l_a M_a + \theta_8 l_a H_a + \theta_{10} s_a^u + \theta_9 \varepsilon_a^l \tag{16}$$

Wage Function in Covered Sector

$$ln(w_a^c) = \sum_{h=1}^{2} I(type=h)\gamma_1^h + \gamma_2 a + \gamma_3 a^2 + \gamma_4 E + \gamma_5 E^2 + \gamma_6 G + \gamma_7 T_a^c + \gamma_8 (T_a^c)^2 + \gamma_9 X_a + \gamma_{10} X_a^2 + \gamma_{11} \varepsilon_a^c \tag{17}$$

Wage Function in Uncovered Sector

$$ln(w_a^u) = \sum_{h=1}^{2} I(type=h)\xi_1^h + \xi_2 a + \xi_3 a^2 + \xi_4 E + \xi_5 E^2 + \xi_6 G + \xi_7 T_a^u + \xi_8 (T_a^u)^2 + \xi_9 X_a + \xi_{10} X_a^2 + \xi_{11} \varepsilon_a^u \tag{18}$$

Probability of Getting Married ($M_a = 1$)

$$\pi_a^M = \sum_{h=1}^{2} I(type=h)\alpha_1^h + \alpha_2 a + \alpha_3 a^2 + \alpha_4 E + \alpha_5 E^2 \tag{19}$$

Probability of Being in Bad Health ($H_a = 1$)

$$\pi_a^H = \sum_{h=1}^{2} I(type=h)\beta_1^h + \beta_2 a + \beta_3 a^2 + \beta_4 E + \beta_5 E^2 \tag{20}$$

11 Appendix B: Estimates

Table 21: **Estimates: Part 1**

Utility function	**Mean**	**Std. Error**
CRRA parameter type 1	0.5	.
CRRA parameter type 2	0.5	.
Consumption*leisure	0.2	.
Consumption*bad health	-0.08	.
Shock to consumption	0.1	.
Leisure	70.0	.
Leisure for young	70.0	.
Leisure*single	574.1	.
Leisure*bad health	400.0	.
Shock to leisure	0.1	.
Non-pecuniary term for work in the uncovered sector	0.3	.
Wage Offer in the Covered Sector	**Mean**	**Std. Error**
Constant type 1	12.8	.
Constant type 2	12.3	.
Years of education	0.08	.
Region of residence	0.07	.
Years of work exp. in the covered sector	0.033	.
Years of work exp. in the covered sector squared	-0.00023	.
Years of work exp. in the uncovered sector	0.0028	.
Years of work exp. in the uncovered sector squared	-0.000025	.
Wage Offer in the Uncovered Sector	**Mean**	**Std. Error**
Constant type 1	11.7	.
Constant type 2	11.8	.
Years of education	0.08	.
Region of residence	0.1	.
Years of work exp. in the covered sector	0.0001	.
Years of work exp. in the covered sector squared	-0.00001	.
Years of work exp. in the uncovered sector	0.024	.
Years of work exp. in the uncovered sector squared	-0.00014	.
	27.4%	.

Table 22: **Estimates: Part 2**

Probability of getting married	**Mean**	**Std. Error**
Constant type 1	-15.2	.
Constant type 2	-15.3	.
Age	0.9	.
Age squared	-0.018	.
Years of education	0.1	.
Years of education squared	-0.007	.
Probability of being in bad health	**Mean**	**Std. Error**
Constant type 1	-8.3	.
Constant type 2	-8.2	.
Age	0.1	.
Age squared	0.000001	.
Years of education	-0.9	.
Years of education squared	0.006	.
Probability of being type 1	**Mean**	**Std. Error**
Constant	-1.95	.
Age when finished studying	0.02	.
Years of education	0.11	.
Region	0.18	.
Married	0.01	.
Bad health	0.01	.
Returns	**Mean**	**Std. Error**
Mean	0.11	.
Variance-Covariance matrix for the shocks	**Mean**	**Std. Error**
Variance preference for consumption	1.1	.
Variance preference for leisure	1.1	.
Variance covered sector wage offer	0.7	.
Variance uncovered sector wage offer	1.5	.
Variance returns	0.005	.