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Dynamic Labor Supply and Saving incentives Under a Privatized Pension System: Evidence from Chile

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Abstract
Chile became in 1981 the first country to opt for a pension program based on privately-managed individual pension accounts. 27 years later, after recognizing that a large fraction of the workforce was effectively not covered by the individual capitalization scheme, Chile implemented an important reform that increased the coverage and generosity of state-financed minimum pension benefits, thereby expanding the role of the State in the pension system. The purpose of this dissertation is to understand how the design of a privatized pension system with mandatory pension contributions and a state-financed safety net affects a household's economic decisions, in order to investigate the causes of the low coverage rate of the pension system, and to predict the effects of the 2008 reform. Linked administrative and self-reported data on employment histories, earnings and savings are used to estimate a dynamic behavioral model in which a couple faces a labor market composed of a covered sector, that is subject to mandatory pension contributions, and an uncovered sector of self-employed and informal jobs. In addition to the pension savings, which are illiquid until retirement, the couple can save privately in a risk-free asset. The estimated model is used to determine the extent to which the pension contributions reduce the pension system's coverage rate and crowd out private savings. Then, the expanded safety net implemented by the 2008 reform is introduced into the model to evaluate ex-ante its potential effects in terms of coverage, saving decisions and the fiscal cost of the reform.

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ABSTRACT

DYNAMIC LABOR SUPPLY AND SAVING INCENTIVES UNDER A PRIVATIZED PENSION SYSTEM: EVIDENCE FROM CHILE

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Chile became in 1981 the first country to opt for a pension program based on privately-managed individual pension accounts. 27 years later, after recognizing that a large fraction of the workforce was effectively not covered by the individual capitalization scheme, Chile implemented an important reform that increased the coverage and generosity of state-financed minimum pension benefits, thereby expanding the role of the State in the pension system. The purpose of this dissertation is to understand how the design of a privatized pension system with mandatory pension contributions and a state-financed safety net affects a household's economic decisions, in order to investigate the causes of the low coverage rate of the pension system, and to predict the effects of the 2008 reform. Linked administrative and self-reported data on employment histories, earnings and savings are used to estimate a dynamic behavioral model in which a couple faces a labor market composed of a covered sector, that is subject to mandatory pension contributions, and an uncovered sector of self-employed and informal jobs. In addition to the pension savings, which are illiquid until retirement, the couple can save privately in a risk-free asset. The estimated model is used to determine the extent to which the pension contributions reduce the pension system's coverage rate and crowd out private savings. Then, the expanded safety net implemented by the 2008 reform is introduced into the model to evaluate ex-ante its potential effects in terms of coverage, saving decisions and the fiscal cost of the reform.

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Chapter 1

Introduction

Increasing life-expectancy and decreasing fertility are causing the world's population to age rapidly. The number of working age people (ages 15-64), per person 65 or older is projected to fall from 9 to 4.1 worldwide by 2050.[1] As a result, many traditional pay-as-you-go pension systems, in which current workers finance current old-age pensions, are in danger of becoming insolvent. For example, the 2009 update on the Congressional Budget Office's long-term projections for Social Security, predicts that "34 years from now, the Social Security Administration (SSA) will not have the legal authority to pay full benefits."[2] These dismal projections have fostered a policy debate that pits incremental reform of existing pension systems, through a reduction of payments or an increase in payroll taxes, against a more radical change of paradigm.

Over the last three decades, many countries in Latin America and Eastern Europe, opted to completely overhaul their pension systems by transitioning to privately-managed individual accounts systems.[3] Chile was one of the earliest countries to make this transition in 1981, and its pension system strongly influenced the

[1] World population aging 1950-2050 - United Nations - 1999

[2] [24]

[3] For example (year of the reform): Peru (1993), Argentina (1994), Mexico (1997), Hungary(1998), Poland (1999), Bulgaria (2000).

design of many other countries' systems. However, 27 years later, after recognizing that a large fraction of its workforce was effectively not covered by the pension system, Chile shifted gears by implementing in 2008 a dramatic expansion of the role of the State as a retirement benefit provider.

In this paper, I develop and estimate a behavioral dynamic discrete choice model using Chilean data to empirically assess how the design of a privatized pension system affects labor market participation, savings accumulation, coverage of the pension program and the government's budget. My model describes the decision process of a couple faced with uncertain earnings and asset returns under the pre-2008 pension system rules. The couple, modeled as a unitary household, decides in every period until they retire whether each spouse will work in a covered job, subject to tax-deferred mandatory pension contributions, an uncovered job or not at all. The household can also save privately to insure against income fluctuations or to supplement the pension savings accumulated in the covered sector. I use the estimated model to simulate changes in the system's rules.

In particular, I evaluate ex-ante the impact of the major expansion of the system's safety net passed in 2008, that provides a good illustration of the tradeoffs faced by policy makers. Proponents of privatization hoped that a system based on individual accounts would create smaller labor distortions and improve participation in the pension system ([5]). However, in Chile the coverage rate of the defined contribution plan has remained low: the fraction of the labor force that contributes to their individual pension account at a given point in time was 62% in 2004 ([2]). In the years preceding the 2008 reform, micro-data on labor histories were used to establish that a large number of workers go in and out of pension-covered work and fail to make regular contributions ([1], [3]). Concern over old age poverty among these low-contribution workers was the major impetus behind the reform. However, as pointed in [21], a generous safety net can create additional disincentives for pension contributions. First, by reducing the marginal value of consumption in retirement and second, by imposing an effective marginal tax (EMT) on pension contributions if these reduce the benefit received by the worker.[4] For example, before the 2008 reform, Chile's safety net was composed of a means-tested welfare pension (*pension asistencial*, PASIS) and a minimum pension guarantee (MPG) for individuals with 20 or more years of contributions to their individual pension accounts (see 1.1). These both took the form of top-ups, so that workers eligible to either benefit faced an effective marginal tax of 100%, as additional contributions to their account would not increase the level of their pension.[5] The 2008 reform implements a unified safety net which guarantees a minimum pension level regardless of the number of years of contribution. For each peso of self-financed pension, the benefit is reduced by 0.3 pesos, lowering the implicit marginal tax rate on pension contributions to about 37%. However, this gradual reduction can also significantly increase the fiscal burden to the government.

In addition to analyzing ex-ante the impact of the 2008 reform, I perform a second policy experiment that assesses the disincentives to participate in the pension program created by mandatory pension contributions. In Chile, salaried workers are required to contribute 10% of their wages to their pension account.[6] The very low level of additional voluntary pension contributions above the required level of 10% suggests that this lower bound on the saving rate is binding for most workers.[7] A higher mandatory contribution rate could increase household savings and reduce the fiscal cost of the safety net, unless it discourages participation in pension covered jobs too much. Conversely, a lower contribution rate could improve pension coverage, but would potentially increase government liabilities.

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[4]The effect of the marginal tax created by minimum pensions on retirement decisions is analyzed in the context of Spain by [18] and [23].

[5]In a top-up design, if the level of the pension afforded by the worker's contributions is below the minimum pension, the benefit paid by the government is equal to the difference between the two.

[6]In addition, 2.6% of administrative fees and disability insurance premium as well as 7% of contributions to a health insurance scheme are deducted from the payroll.

[7]Fewer than two percent of pension system members had positive balances in their voluntary contributions account in 2005.

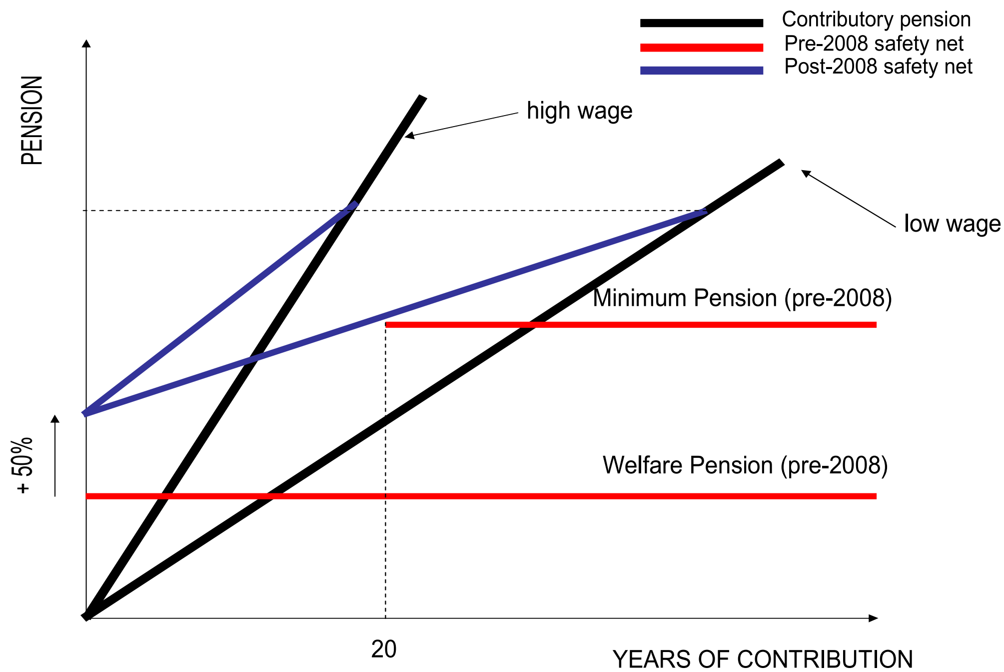

Figure 1.1: The 2008 reform of the Chilean pension safety net

In the model, incentives to work in the covered sector are dynamically affected by labor decisions made in previous periods as spouses endogenously accumulate sector-specific human capital. The level of accumulated private and pension savings also influences labor sector choice by changing the marginal value of additional illiquid pension contributions. In the model, spouses may work in different sectors to qualify for a minimum pension while at the same time avoiding oversaving. Having one spouse work in the informal sector can alleviate the reduction of disposable income resulting from mandatory pension contributions. Another key element of the model that is needed to accurately capture the impact of pension rules on coverage is the degree of segmentation between the two labor sectors. My model accounts for the possibility that the uncovered sector is a residual labor market. Although workers can always work in the uncovered sector, I allow the probability of receiving a covered job offer to be less than one and to depend on individual characteristics, including the number of years already worked in the covered sector.[8]

I estimate the parameters of the earnings offer function, of preferences and of the probability of receiving a covered job offer using the Method of Simulated Moments ([20]). I use a unique dataset collected for the purpose of analyzing social protection in Chile, and the pension system in particular. The data is composed of a longitudinal survey ("Encuesta de Proteccion Social" or EPS) linked with administrative data from the pension system's regulatory agency.[9] The survey data include retrospective employment histories, as well as self-reported household labor earnings and household assets collected in 2002, 2004 and 2006. The administrative data contain the longitudinal history of pension savings of the respondents since the 1980 pension reform.

I use my estimated model to perform two policy experiments that evaluate the impact of pension rules on household savings, participation in the pension system and fiscal liabilities to the government. First, I perform an ex-ante evaluation of Chile's 2008 pension reform. My results suggest a very low projected fiscal cost for the pre-2008 system, with only about 1.5% of males and 5% of females in the sample qualifying for the guaranteed minimum pension benefits. The low level of the minimum pension, the stringent 20 years of contribution eligibility requirement and the high historical rates of return on Chilean pension funds explain this result. In contrast, the more generous safety net from the 2008 reform will benefit more than 20% of the sample, be six times as costly to the government and generate a small reduction in coverage and female labor force participation.

The second experiment changes the mandatory contribution rate from 10% to values ranging from 5% to 20%. I find that the government can significantly increase total household savings by increasing the required contribution rate. Faced with

[8] Uncovered or informal labor markets have been viewed as either residual (i.e. providing low-paying jobs to workers without access to the formal market) as in [9] or [15] or competitive, as in [19].

[9] *Superintendencia de Administradoras de Fondos de Pensiones* (SAFP).

a contribution rate of 15% instead of 10%, households partially offset the higher mandatory pension contributions by reducing their private savings, but still end up saving 14% more overall. However, it also lowers pension system coverage by 5 percentage points as people leave the covered sector for the uncovered sector.

1.1 Related Literature

The model incorporates three key mechanisms shown in the literature to be influenced by pension system rules. The first is the choice of portfolio between a taxable, liquid asset and tax-deferred, illiquid pension savings. How that tradeoff evolves over the lifecycle as a function of the relative strength of the precautionary and retirement saving motive has been studied in the context of Individual Retirement Accounts (IRAs) ([10], [8], [7]). More recently, [6] and [11], look at the optimal lifecycle portfolio choice between taxable and tax-deferred accounts, and evaluate the welfare cost from contributing at a suboptimal rate. A related paper is [17] who show that the substitution between pension and private wealth can account for the low savings accumulation observed in a fraction of American households. These papers take household income as an exogenous process, whereas in my model income is endogenous due to the labor force participation choices.[10] The second mechanism is the joint labor supply decision made by the spouses. [26] highlight the importance of allowing for income risk pooling within the household to accurately study the incentives created by social pension programs.[11] The third mechanism is each spouse's choice to work in either the covered or the uncovered sector. Agents can choose not to participate in the pension program altogether by working informally or as a self-employed worker. [25] uses a two-period general equilibrium model to analyze theoretically the crowding effects of the safety net on pension contributions

[10] to keep the model tractable and in light of the extremely low level of voluntary contribution in the data, I do not allow households to make additional contribution over the 10% mandated by law.

[11] Other recent examples include [13], [14], [4].

under different designs, but does not perform a quantitative analysis. [22] specify and estimate a dynamic stochastic model, in which agents can save privately and exert effort to increase their probability of working in the formal sector, to estimate the potential effect of a large set of social insurance policies in the context of Brasil. They estimate preference parameters using age-profiles of the fraction of individuals in the covered, uncovered, unemployed and retired states, but do not use data on wages, assets, sector-specific experience or longitudinal transitions. [27] also studies the effect of Chile's pension rules on the contributions decisions, but looks at male individuals without allowing for private savings or a joint household labor supply decision.

Chapter 2

Overview of the Chilean Pension System

2.1 The crisis of the old Pay-as-you-go system

Before 1981, Chile had a heterogeneous Social Security system composed of up to 32 different institutions called "Cajas de Prevision", that covered different professions and categories of the population. Each specified different contribution and benefit rules. Originally designed as partially-funded, the system evolved into a pay-as-you-go program, with a chronic deficit financed by the State that represented 40% of payments in 1980. Despite repeated attempts at reforms dating back to the fifties, the financial imbalances of the pension system deteriorated. The system was caught in a vicious circle by which deficits would lead to higher contributions (over 50% of a worker's monthly remuneration in 1974[1]), higher contributions would result in increased payment evasion (the ratio of active contributors over people in work fell from 83 in 1973 to 71 in 1980), which accentuated the decline in the Contributors-to-Pensioners ratio (3.5 in 1973, 2.2 in 1980) and the system's budget deficit.

[1]Note that this number refers to a global contribution rate which financed pensions but also health benefits and industrial accidents, among other things.

2.2 The Chilean Pension System

On November 4th 1980, Chile created a new Pension System, known as "AFP"[2] system. The previous system was reorganized into a unified institution named Institute of Social Security Normalization (INP) which to this day manages the old system's pensioners and workers who decided to remain affiliated to the old system. In order to encourage transfers, workers who opted for the new system received an increase in net income of 12.6% (which corresponds to the new contribution rate plus commissions or fees) and the benefits accrued under the old system were recognized by issuing a "recognition bond" payable upon retirement.

The main component of the new AFP Pension system is a savings program based on defined-contribution individual accounts. The program is mandatory for salaried workers and voluntary for the self-employed. Affiliated workers must pay 10% of their monthly wages in a tax-deferred pension account which is locked until retirement. The contributions are capped at 60 UFs[3]. In addition to the 10% pension contribution, workers must pay a contribution of 7% for health services, 0.8% for a disability and survivorship insurance, and 2.6% to the pension fund manager as a commision or fee.

The worker can choose from a number of pension fund administrators (the "AFP"s) who manage the savings deposited on the account and invest them on the financial markets. The number of AFPs has changed over the years, reaching 32 in 1997 but was down to 5 in 2008. Initially, AFPs were required to invest all of the funds in government bonds, but they have gradually been allowed to offer a broader array of investment choices, including foreign assets and stocks. In addition, since 2002, each AFP must offer 5 portfolio options, called multifunds, to their affiliates. The funds are labeled A to E with an increasing weight on fixed-income assets. By default, older workers are assigned to a more conservative portfolio (D or E).

[2]AFP: Administradoras de Fondos de Pensiones, or Pension Funds Administrators

[3]UFs or Unidades de Fomento are indexed on inflation. The value of the UF as of December 2004 was $17,317 pesos (US$31)

Workers can access their pension savings at 65 years old for men and 60 years old for women. They have three withdrawal options: Programmed Withdrawals (Retiro Programado), purchase an annuity from an insurance company (Renta Vitalicia), or a mix of phased withdrawals for a period of time and a deferred lifetime annuity. The law allows for early retirement, provided that the worker can obtain a pension equal to or greater than 110% of the minimum pension guaranteed by the State[4]. Before 2008, the state provided retirement income transfers through two mechanisms. A welfare or assistance pension (*pension asistencial* or PASIS), equal to about 1/3 of the minimum wage[5] was provided to individuals above 65 years of age, irrespective of their contribution history, provided that their earnings and their household's per capita earnings per capita were both below that level. The second transfer was a minimum pension guarantee (MPG) equal to about twice the PASIS: individuals with more than 20 years of contribution would receive the MPG if their accumulated contributions could not finance a higher pension. Both these benefits took the form of a top-up: the benefit was equal to the difference between the guaranteed level and the pension financed by the worker's account.

2.3 The 2008 Reform of the Safety Net

The analysis of histories of pension contributions at the micro level revealed that about half of the working population was contributing to the system too little to finance a minimum pension or to qualify for the State MPG. This led to an overhaul of the system of minimum pensions paid by the State. The reform also tackled other problems such as insufficient price competition in the AFP industry or gender equity, but I focus in this work on the reform of the eligibility and level of the safety-net. The 2008 reform replaced the PASIS and MPG with a "New Solidarity

[4]The pension must also be equal to or greater than 50% of the average taxable income for the last 10 working years

[5]In 2007, the PASIS was 44.186 per month for workers between 65 and 70, 47.103 between 70 and 75, and 51.503 between 75 and 80 (82, 87 and 95 dollars per month respectively).

Pillar" comprised of a unique means-tested welfare pension which guarantees to all individuals in the 60% less affluent fraction of the population a pension of 75000 pesos per month.[6] This represents an increase of nearly 50% with respect to the PASIS. The main innovation is that instead of constituting a floor pension, the benefits are gradually reduced, at a rate of 30%, for workers with some accumulated pension contributions. That is, a worker who can finance a pension of 100000 pesos per month with the funds accumulated in her individual account will receive a benefit equal to 75000 -(100000*0.3)=45000. Her total pension will then be 145000 pesos per month. Before the reform, eligible workers effectively faced an implicit marginal tax rate of 100%: additional contributions would not increase the level of her pension at retirement. The means-tested welfare pension also created disincentives for participation as workers anticipating to benefit from it would not gain from saving into the system. The new system ensures that an additional contribution always increase the level of the retirement pension, and it maintains a constant implicit marginal tax rate of about 37% on additional contributions.

[6]The current level is 60000 pesos but will be increased gradually until 2012

Chapter 3

The Model

3.1 Description of the Model

The model represents the decision problem of a married or unmarried couple. I use the husband/wife terminology in both cases for simplicity. The optimization problem starts when the couple is formed ($t = t_0$). Initial conditions are comprised of work experiences and schooling levels of both spouses and the household's assets. A period corresponds to a calendar year and is indexed by the husband's age. Spouses are assumed to remain together until they both die at $t = t_D$.

3.1.1 Decisions

To keep the model tractable, I assume that both spouses claim their pension benefits and stop working at $t = t_R$. At each working age $t \in \{t_0, ...t_R - 1\}$, households make two decisions: the household consumption decision c_t and a joint labor force participation decision $d_t = (d_t^H, d_t^W)$, where H, W refers to Husband and Wife. Three employment options are available to spouse $j \in \{H, W\}$: to work in the covered sector ($d_t^j = 1$), to work in the uncovered sector ($d_t^j = 2$), or to stay home ($d_t^j = 3$). After retirement, both spouses stay at home ($d_t = (3, 3)$) and only make a consumption decision.

3.1.2 Preferences

Couples form a unitary household with a single common period utility function. They care about total household consumption through a CRRA utility function. They also care about whether each spouse works or not through non-pecuniary benefits derived from leisure denoted by δ^H and δ^W. Finally, they pay a cost when switching between covered and uncovered sectors (ϕ_s^H, ϕ_s^W), and when returning to work after a period at home (ϕ_a^H,ϕ_a^W). The period utility function is given by:

$$
\begin{aligned}
&\forall t \in \{t_0, t_D\}, \\
&\quad u(c_t, d_t) \;=\; \frac{c_t^{1-\sigma}}{1-\sigma} \\
&\qquad + \; (\delta^H + \epsilon_t^H) \cdot I_{\{d_t^H = 3\}} \\
&\qquad + \; (\delta^W + \epsilon_t^W) \cdot I_{\{d_t^W = 3\}} \\
&\qquad + \; \phi_s^H \cdot (I_{\{d_t^H = 1, d_{t-1}^H = 2\}} + I_{\{d_t^H = 2, d_{t-1}^H = 1\}}) + \phi_a^H \cdot I_{\{d_t^H \neq 3, d_{t-1}^H = 3\}} \\
&\qquad + \; \phi_s^W \cdot (I_{\{d_t^W = 1, d_{t-1}^W = 2\}} + I_{\{d_t^W = 2, d_{t-1}^W = 1\}}) + \phi_a^W \cdot I_{\{d_t^W \neq 3, d_{t-1}^W = 3\}}
\end{aligned}
$$

where the shocks to the value of leisure are assumed to be distributed normally and to be uncorrelated over time:

$$(\epsilon_t^H, \epsilon_t^W) \sim iidN(0, \Sigma_p)$$

The model's state variables are the following: a_t denotes the household's non-retirement or private savings at age t; B_t^H and B_t^W are the balances on the retirement accounts of the two spouses at age t; $X_{U,t}^H$, $X_{U,t}^W$, $X_{C,t}^H$ and $X_{C,t}^W$ are the four stocks of sector-specific experience, with the subscripts U and C denoting the uncovered and covered labor sectors. They correspond to the number of years each spouse has worked in each sector up to period t. E^H and E^W are the schooling levels of the spouses. d_{t-1} is the pair of labor decisions in the previous period. c is the birth cohort of the husband.

Lifetime preferences are additively separable over time and can be expressed recursively as a function of the state variables:

$$\begin{aligned}
&\forall t \in \{t_0, t_D\}, \\
&\quad V_t(a_t, \{B_t^i\}_i, \{E^i\}_i, \{X_{j,t}^i\}_{i,j}, d_{t-1}; c) = \\
&\quad u(c_t, d_t) + \beta E V_{t+1}(a_{t+1}, \{B_{t+1}^i\}_i, \{E^i\}_i, \{X_{j,t+1}^i\}_{i,j}, d_{t-1}; c)
\end{aligned}$$

where $i \in \{H, W\}$ is the spouse-specific subscript, $j \in \{U, C\}$ is the sector-specific subscript and EV_{t+1} is the so-called Emax function that gives expected future utility as a function of current period state variables.

3.1.3 Household Income

Households face a two-sector labor market with a covered and an uncovered sector. Each spouse may receive a stochastic earnings offer from the covered sector that depends on her level of schooling, sector-specific experience stocks and the birth cohort of the husband. Each spouse also receives a stochastic earnings offer from the uncovered sector with probability 1. The probability Γ_t^i for spouse i to receive an earnings offer from the covered sector in period t is a logistic function of education, the number of years of covered experience, and having been employed in the covered sector in the previous period:

$$\begin{aligned}
&\forall i \in \{H, W\}, t \in \{t_0, t_R\}, \\
&\quad \Gamma_t^i = (1 + exp\{-(\gamma^i + \gamma_{cov}^i I_{\{d_{t-1}^i=1\}} + \gamma_E^i E^i + \gamma_{XP}^i X_C^i)\})^{-1}
\end{aligned}$$

The log-earnings offers (for spouse $i \in \{H, W\}$, in sector $j \in \{C, U\}$) are given by:

$$w_{j,t}^i = \alpha_j^i + \theta_c^j \cdot c + \theta_{E,j}^i \cdot E^i + \theta_{X,j}^i(E) \cdot (X_j^i + \tau_{XP}^j X_{-j}^i) + \epsilon_{j,t}^i$$

where α_j^i is a gender- and sector-specific constant, θ_c^i a sector-specific cohort effect, $\theta_{E,j}$ the returns to schooling, $\theta_{X,j}^i(E)$ are the returns to experience, and $\tau_{XP}^j \in [0,1]$ captures the transferability of cross-sector experience. $\epsilon_{j,t}^i$ is an iid sector-specific earnings offer shock that is uncorrelated accross time-periods and potentially correlated within a household:

$$(\epsilon_{j,t}^i)_{j=U,C}^{i=H,W} \sim N(0, \Sigma_o)$$

The total household disposable labor income y_t is the sum of accepted earnings offers, net of contributions:

$$y_t = \sum_{i \in \{H,W\}} ((1-\tau) \cdot w_{C,t}^i \cdot I_{\{d_t^i=1\}} + w_{U,t}^i \cdot I_{\{d_t^i=2\}})$$

where τ is the pension contribution rate.

Covered labor earnings net of pension contributions and private savings returns are subject to a progressive income tax. Taxes due at period t are denoted $T(a_t, w_{C,t}^H, w_{C,t}^W, d_t)$, and depend on the household's stock of private savings, received covered sector offers and decisions to accept them. Net borrowing and borrowing against pension savings is not allowed. Private savings earn the risk-free rate r. The balances on each spouse's pension account accrue interests stochastically and are augmented by the current period's contribution. Returns on the pension accounts are modeled as an iid process: $r_B \sim iidN(\bar{r_B}, \sigma_B^2)$.[1].

[1] Allowing for serial correlation in the returns would require adding past returns as additional continuous state variables which would significantly complicate the numerical solution of the problem

3.1.4 The Working Household's Problem

The optimization problem faced by the household at working ages can be written recursively:

$$
\begin{aligned}
&V_t(a_t, \{B_t^i\}_i, \{E^i\}_i, \{X_{j,t}^i\}_{i,j}, d_{t-1}; c) = \\
&\quad \max_{c_t, d_t} \{u(c_t, d_t) + \beta E V_{t+1}(a_{t+1}, \{B_{t+1}^i\}_i, \{E^i\}_i, \{X_{j,t+1}^i\}_{i,j}, d_{t-1}; c)\}
\end{aligned}
$$

s.t.

$$
\begin{aligned}
a_{t+1} &= y_t + a_t \cdot (1+r) - c_t - T(a_t, w_{C,t}^H, w_{C,t}^W, d_t) \\
a_{t+1} &\geq 0 \\
B_{t+1}^i &= B_t^i \cdot (1 + r_B) + \tau \cdot w_{C,t}^i \cdot d_{C,t}^i, \;\; i \in \{H, W\}
\end{aligned}
$$

3.1.5 Retirement

At retirement, spouses stop working:

$$d_t = (3,3) \; for \; t > t_R$$

They receive as a lump sum the welfare or minmum pension benefits if they meet the eligibility criteria, and then withdraw all pension savings and pool them with their private savings:

$$a_{t_R} = a_{t_R} + B_{t_R}^H + B_{t_R}^W + \; Benefits$$

There is no uncertainty remaining at this point, and households run down their total accumulated private and pension savings by optimally saving and consuming until they die. Letting a_t denote the total amount of savings at t, pensions included, the problem of the retired household becomes:

$$\begin{aligned}\forall t \in \{t_R, ...t_D\}\ V_t(a_t) &= \max_{a_{t+1}}\{u(c_t,(3,3)) + \beta \cdot EV_{t+1}(a_{t+1})\} \\ where \quad c_t &= a_{t+1} - a_t \cdot (1+r) \\ a_t &\geq 0 \\ and \quad V_{t_D+1}(a_{t_D+1}) &= 0\end{aligned}$$

3.2 Solution Method

The problem of the retired household can be solved analytically. The details are presented in appendix A. For working periods, the model does not have an analytic solution. Instead it is numerically solved by backwards recursion.

The details of the solution procedure are the following. At age $t_R - 1$, a household decides on consumption and labor sectors to maximize the weighted sum of current and future period utilities, denoted by $V_{t_R-1}(\overline{S_{t_R-1}}, \{\epsilon^i_{j,t_R-1}\})$, where the state space, S_{t_R-1} , is divided into a deterministic component containing the elements that are not random at the beginning of period $t_R - 1$, $\overline{S_{t_R-1}}$, and a shock component containing the vector of random earnings shocks drawn at $t_R - 1$, $\{\epsilon^i_{j,t_R-1}\}$.

For any given value of the deterministic and shock components of the state space, optimal consumption is obtained by comparing utility on a grid of possible consumption levels, for each of the nine possible choices of husbands' and wives' labor sectors. The labor decision and associated optimal consumption that maximizes total utility is chosen for that value of the state space. At any deterministic state point, the expected value of V_{t_R-1} is obtained by Monte Carlo integration, that is, by taking draws from the shock vector distribution and averaging to obtain $EV_{t_R-1}(\overline{S_{t_R-1}})$. This expectation is calculated at a subset of the deterministic state points and the function is approximated for all other state points by a polynomial regression following an approximation method developed by Keane and Wolpin (1994, 1997). I denote this function as $Emax(t_R - 1)$.

This procedure is repeated at age $t_R - 2$. Using the recursive formulation of the value function, substituting the $Emax(t_R - 1)$ function for the future component, the optimal decision is computed. Monte Carlo integration over the shock vector at $t_R - 2$ provides $EV_{t_R-2}(\overline{S_{t_R-2}})$ for a given deterministic state point. A polynomial regression over a subset of the state points again provides an approximation to the function, denoted by $Emax(t_R - 2)$. Repeating the procedure back to the initial age provides the $Emax$ polynomial approximation at each age. The set of $Emax(t)$ functions fully describe the solution to the optimization problem.

Chapter 4

Data and Estimation

4.1 Description of the Dataset and Variables of Interest

The model is estimated using individual and household earnings, labor sector choice and asset data from the *Encuesta de Proteccion Social* longitudinal survey (EPS) together with the linked administrative records of pension balances and contributions to retirement accounts, obtained from the *Superintendencia de Administradoras de Fondos de Pension* (SAFP) (the Chilean supervising agency for pension fund administrators). EPS is a new household survey, conducted in 2002 by the Microdata Center (Centro de Microdatos) of the Department of Economics of the Universidad de Chile. It was initially called HLLS and later renamed Encuesta de Proteccion Social (EPS). The questionnaire was designed specifically to study Chile's social protection public programs.[1] In 2004 and 2006, two follow-up surveys were administered. The 2009 follow-up survey was administered in the course of 2009 and was not exploited in this study.

[1] Historia Laboral y Seguridad Social

The 2006 survey contains information on a representative sample of 16443 individuals of age 15 or older. For the 14337 of them that are affiliated to the AFP pension system, the administrative records of all the transactions on their pension accounts are linked to the EPS survey.

The variables used in the estimation are: age, schooling level, schooling level of the spouse, number of years the respondent worked in the covered sector, number of years the respondent worked in the uncovered sector, labor sector choice, labor sector choice of the spouse, annual accepted earnings, individual pension wealth and private household wealth.

The schooling level variables were constructed as a discrete indicator taking values 4 (individuals with less than 8 years of schooling), 8 (individuals with 8 to 11 years of schooling), 12 (individuals with 12 to 15 years of schooling), and 16 (individuals with 16 years of schooling or more). The four categories are labeled No High School, High School drop-out, High School graduate and College graduate for simplicity thereafter.

Respondents were asked to report their spells of employment since their first job or since 1980, whichever happened last. Employment spells in salary jobs with a contract were coded as covered, while self-employed spells and salary jobs without a contract were classified as uncovered.[2] From employment spells, a monthly indicator of employment status was constructed. This monthly indicator was aggregated to an annual indicator in the following way. A respondent with no working months during the year is Home($d_t^3 = 1$). A respondent with a majority of months in covered jobs is Covered ($d_t^2 = 1$), and a respondent with a majority of uncovered jobs is Uncovered ($d_t^2 = 1$). The annual indicator was then summed from the year in which the respondent turned 16 to the each year to obtain the number of years in each labor choice. Regarding the spouse's labor sector choice, it was constructed in the

[2]For self-employed workers, contributions to the system are optional rather than mandatory. About one out of six self-employed worker is actually covered ([1]). This paper assesses the effect of the constraint imposed by mandatory savings on coverage, so that self-employed workers, who are not subject to that constraint are classified as uncovered.

same way for the years the survey was administered (2002-2004-2006). Monthly labor earnings were reported for each employment spell starting in 2002. They were summed over each year to obtain annual accepted earning.

Household wealth was reported in the 2004 and 2006 surveys and is composed of main housing, real estate, cars, savings, equipment, businesses and debts. The pension wealth of the EPS respondent was obtained from the pension account administrative records in the following way. Every time a pension contribution is made (i.e. every month worked in a covered job), the transaction records the balance on the account at the time of the contribution. For month in which the respondent didn't work in a covered job (i.e. was at home or working in an uncovered job), the balance is computed using the last available balance, the returns obtained by the corresponding pension fund, and the commissions or fees charged by the pension fund manager. All variables except for pension balances are available for both spouses in years 2004 and 2006. Pension balances are available for the survey's interviewee from 1980 to 2005, but not for his or her spouse. Labor decisions of the survey's interviewee are reported from 1980 to 2006 and his or her earnings from 2002 to 2006.

The sample used in the analysis is restricted as follows. First, I keep 8193 married and cohabitating couples that have been together at least from 2002 to 2006. Of those, I exclude 822 who kept their affiliation to the old pension system, which is not modeled in this paper. Couples formed after the husband turned 25 were also dropped to avoid having households with significant asset accumulation and work experience prior to marriage, since initial conditions are kept fixed in the policy experiments. This leaves 4154 couples. The final sample consists of the 2097 households that were formed after 1980, and were subject only to the post-1980 privatized pension system.

The data includes individuals that were born between 1965 and 1981. The older cohorts are observed from the age of 25 to the age of 51, while the younger cohorts are observed only one or two years (see table B.16).

Table B.15 presents summary statistics for the sample. Median private savings at age 35 in the sample are about 4.8 million pesos, or about 8000 dollars. This corresponds roughly to twice the median earnings in the covered sector. In comparison, median pension savings at the same age are about 2.3 million pesos for males and 0.3 million pesos for females. The relative importance of pension savings increases over the lifecycle. The fact that the median female pension savings is much lower and is decreasing with age is due to low female labor force participation, particularly for older cohorts.

The median male worker earns 2.4 million pesos annually when working in the covered sector, versus 1.7 million pesos in the uncovered sector. This difference is in part due to the different levels of schooling in the two sectors. The sample is divided into 4 schooling levels: less than High School, some High School, High School graduates and College graduates. Lower schooling levels are over-represented in the uncovered sector: the fraction of males with no High School education is 24% among uncovered workers versus 15% in the total sample. Table B.15 also reports the joint sector choices made by households in the sample: about 37% households have two working members, 59% have one, and 4% have none. 24% of couples have two spouses in the same sector: 18% in the covered sector, and 8% in the uncovered sector. A sizeable fraction of the sample, 13% is comprised of couples that are split between the two sectors, about 1/3 of all two-income households.

Looking at the fraction of working years spent in the covered sector, it is possible to distinguish three types of workers. 20% of males and 25% of females work less than 25% of the time in the covered sector. That is, they almost only work in uncovered jobs. Similarly, 60% of males and 58% of females work almost exclusively in covered jobs. Finally, a large fraction of the sample (20% of males and 17% of females) switches in and out of covered jobs.

4.2 Estimation of the Model's Parameters

I estimate the model using a Method of Simulated Moments (MSM).[3] I use the approximated age-dependent value functions, conditional on the state variables, to simulate moments of the wealth, sector-specific earning and labor choice distributions. The moments are generated for any given set of parameters by simulating the behavior of 5 "clones" of the $2,097$ couples in the estimation sample. The estimation procedure then minimizes the distance between the simulated moments and corresponding data moments. The weights are the inverses of the estimated variances of the moments.

4.2.1 Data Moments Used in the Estimation

The groups of data moments used for the estimation are listed below with the number of moments in parentheses:

- Joint Labor Sector Choice:

  1. The proportion of households choosing each of the nine joint occupations by age group (9x6 moments).
  2. The proportion of households choosing each of the nine joint occupations by schooling level of the husband (9x4 moments).
  3. The proportion of households choosing each of the nine joint occupations by schooling level of the wife (9x4 moments).
  4. The proportion of two-income households by age group (6 moments).
  5. The proportion of two-income households by schooling level of the husband (4 moments).

[3]This method more easily accommodates missing state variables than does simulated maximum likelihood, which would require integrating over possible values of missing state variables.

6. The proportion of two-income households by schooling level of the wife (4 moments).
7. The proportion of one-income households by age group (6 moments).
8. The proportion of one-income households by schooling level of the husband (4 moments).
9. The proportion of one-income households by schooling level of the wife (4 moments).
10. The proportion of husbands choosing each of the three alternatives by schooling level(3x4 moments).
11. The proportion of husbands choosing each of the three alternatives by age group (3x6 moments).
12. The proportion of wives choosing each of the three alternatives by schooling level(3x4 moments).
13. The proportion of wives choosing each of the three alternatives by age group (3x6 moments).
14. The proportion of husbands choosing each of the three alternatives by 5-year tranches of covered experience (3x6 moments).
15. The proportion of husbands choosing each of the three alternatives by 5-year tranches of uncovered experience (3x6 moments).
16. The proportion of wives choosing each of the three alternatives by 5-year tranches of covered experience (3x6 moments).
17. The proportion of wives choosing each of the three alternatives by 5-year tranches uncovered experience (3x6 moments).
18. The proportion of husbands choosing each of the three alternatives by agegroup and birth cohort ((6+6+5+4+3)x3 moments).[4]

[4]Cohorts 1 and 2 are observed over 6 age groups, cohort 3 over 5 age groups etc.

19. The proportion of wives choosing each of the three alternatives by age-group and birth cohort ((6+6+5+4+3)x3 moments).[5]

- Wealth:

1. The mean private savings level by age and schooling level of the husband (4x6 moments).
2. The mean private savings level by age and schooling level of the wife (4x6 moments).
3. The variance of private savings by age (6 moments).
4. The variance of private savings by schooling level of the husband (4 moments).
5. The variance of private savings by schooling level of the wife (4 moments).
6. The mean pension savings level by sex, age and schooling level (2x4x6 moments).
7. The variance of pension savings by sex and age (2x6 moments).
8. The variance of pension savings by sex and schooling level (2x4 moments).
9. Fraction with no private savings by age group (5 moments).
10. Fraction with private savings between 0 and 6 million pesos by age group (5 moments).
11. Fraction with private savings over 6 million pesos by age group (5 moments).
12. The mean private savings level by age and current sector of the husband (2x6 moments).
13. The mean private savings level by age and current sector of the wife (2x6 moments).

[5] The labor force participation decisions of cohorts 1 and 2 are observed over 6 age groups, cohort 3 over 5 age groups etc.

14. The mean pension savings level by agegroup and birth cohort (6+5+4+3+2 moments).

- Earnings:

  1. The mean annual log-earnings by sex, age and sector (2x6x2 moments).
  2. The variance of the annual log-earnings by sex, age and sector (2x6x2 moments).
  3. The mean annual log-earnings by sex, age and schooling level (2x4x2 moments).
  4. The variance of the annual log-earnings by sex, age and schooling level (2x4x2 moments).
  5. The mean annual log-earnings by sex, sector and experience (2x2x6 moments).
  6. The mean first-difference in annual log-earnings by current and 1-year lagged sector and by sex(2x2x2 moments).
  7. The mean first difference in annual log-earnings by age, current sector and by sex (6x2x2 moments).

- Career Transitions:

  1. 2-period joint transitions of number of working spouses in the household (9 moments).
  2. 1-period transitions between the three employment status by age group and sex (3x3x6x2 moments).
  3. mean years in each sector by age group and sex (3x6x2 moments).
  4. Fraction of years in covered sector under age 35 by sex (5x2 moments).
  5. Fraction of years in covered sector over age 35 by sex (5x2 moments).

6. Fraction of years at home under age 35 by sex (5x2 moments).

7. Fraction of years at home over age 35 by sex (5x2 moments).

The total number of moments is $M = 953$, the number of parameter to be estimated is $K = 59$.

4.2.2 Standard Errors

Let's denote x_i^m the contribution of observation i to moment m, $i \in 1..N, m \in 1...M$. Denote S^m the set, and N^m the number, of observations that contribute to moment m. Finally, the theoretical model predicts a value for each moment, denoted $\mu^m(\theta)$, where $\theta = [\theta_1, ... \theta_K]$ is the vector of estimated parameters.

The Method of Simulated Moments estimator is defined as:

$$\hat{\theta}_N = \arg\max_{\theta\in\Theta} \left[\frac{1}{N^m} \sum_{i\in S^m} (x_i^m - \mu^m(\theta)) \right]'_{m=1...M} W^{-1} \left[\frac{1}{N^m} \sum_{i\in S^m} (x_i^m - \mu^m(\theta)) \right]_{m=1...M}.$$

The inverse of the weighting matrix W is an M by M diagonal matrix with the m^{th} diagonal elements equal to the sample variance of x_i^m.

Given the moments chosen above, not all observations contribute to all moments. In order to derive the asymptotic properties of the estimator it is convenient to note that:

$$\hat{\theta}_N = \arg\max_{\theta\in\Theta} \left[\frac{1}{N} \sum_{i\in S} (x_i^m - \mu^m(\theta)) \cdot D_i^m \cdot \frac{1}{N^m} \right]' W^{-1} \left[\frac{1}{N} \sum_{i\in S} (x_i^m - \mu^m(\theta)) \cdot D_i^m \cdot \frac{1}{N^m} \right]$$

where D_i^m is a dummy that is equal to one if observation i contributes to moment m, and S is the union of all S^ms.

Taking first order conditions with respect to θ yields:

$$\left[\frac{1}{N}\frac{\delta\mu^m}{\delta\theta}|_{\hat{\theta}_N}\right]' W^{-1}\left[\frac{1}{N}\sum_{i\in S}(x_i^m-\mu^m(\theta))\cdot D_i^m\cdot\frac{1}{N^m}\right]=0 \tag{4.1}$$

A Taylor expansion of μ^m around the true parameter vector θ_0 yields:

$$\mu^m(\hat{\theta}_N)=\mu^m(\theta_0)+\frac{\delta\mu^m}{\delta\theta}|_{\theta*}\cdot(\hat{\theta}_N-\theta_0) \tag{4.2}$$

for some $\theta*$ between $\hat{\theta}_N$ and θ_0. Combining (4.1) and (4.2), we obtain after rearranging:

$$\sqrt{N}(\hat{\theta}_N-\theta_0)=$$
$$\left[\left[\frac{\delta\mu^m}{\delta\theta}|_{\hat{\theta}_N}\right]' W^{-1}\left[\frac{\delta\mu^m}{\delta\theta}|_{\hat{\theta}*}\right]\right]^{-1}\left[\frac{\delta\mu^m}{\delta\theta}|_{\hat{\theta}_N}\right]' W^{-1}\left[\frac{1}{\sqrt{N}}\sum_{i\in S}(x_i^m-\mu^m(\theta_0))\cdot D_i^m\cdot\frac{N}{N^m}\right].$$

A central limit theorem can be applied after redefining

$$\tilde{x}_i^m\equiv x_i^m\cdot D_i^m\cdot\left(\frac{N}{N^m}\right)$$

and

$$\tilde{\mu}_i^m(\theta_0)\equiv\mu_i^m(\theta_0)\cdot D_i^m\cdot\left(\frac{N}{N^m}\right).$$

The estimator's asymptotic variance-covariance matrix is given by:

$$Asy.Var(\hat{\theta}_N)=\left(D_0'W^{-1}D_0\right)^{-1}D_0'W^{-1}W_0^{-1}W^{-1}D_0\left(D_0'W^{-1}D_0\right)^{-1\prime},$$

where $D_0=E\left[\frac{\delta\mu^m}{\delta\theta}|_{\theta_0}\right]$, $W_0=E\left(\left[\tilde{x}_i^m-\tilde{\mu}_i^m(\theta_0)\right]'\left[\tilde{x}_j^m-\tilde{\mu}_j^m(\theta_0)\right]\right)$.

In computing the standard errors, D_0 is approximated by the numerical derivatives of the model's moments at the estimated vector of parameters, W_0 is approximated by the sample variance-covariance of $\left[\tilde{x}_j^m-\tilde{\mu}_j^m(\theta_0)\right]$, and the standard errors are corrected for the variance resulting from replacing the true model-implied moments by simulated moments. The standard errors are reported below the parameter estimates in tables B.1, B.2, B.3 and B.4.

4.3 Estimation Results

4.3.1 Parameter Estimates

Tables B.1, B.2, B.3 and B.4 report parameter estimates with the standard errors in parentheses. The discount rate is estimated at 0.067 (for a discount factor of 0.937). This is slightly higher than what is usually found in models estimated or calibrated on American data (usually under 0.05). However, this is to be compared to the higher interest rates experienced by Chile over the estimation period. In fact, the ratio $\frac{1+r}{1+\rho}$, which drives asset accumulation, is close to what is found elsewhere in the literature at 1.0127 (compared to 1.0106 in [12], for example). The elasticity of intertemporal substitution is estimated at 1.559, which is within the (wide) range of estimates found in the literature. For example [26] find estimates of 1.59 and 1.68, and [12] obtain 1.397.

Some parameters from the earnings offer function are worth highlighting. First, experience transferability is estimated to be high, at 0.97. This would imply that sector-specific human capital accumulation is not an important factor in keeping workers away from the covered sector. It must be noted that the standard errors on this parameter are relatively high at 0.111. On the other hand, the probability of receiving a covered offer is significantly below one, but only for the lowest schooling level. Male workers with no High School and one year of experience in the covered sector have almost 5% of chances of not receiving a covered offer every period (see figure C.2). The importance of this is magnified by the fact that workers anticipate that if they accept a covered offer they might have to switch sectors and pay the corresponding non-pecuniary costs sometime in the future. This probability is lower as covered experience is accumulated, but only to an extent. No High School male workers with 15 years of covered experience still face about 3% chances of not receiving a covered offer (see figure C.3). The probability of receiving a covered offer increases with the schooling level, and is, for example, 0.99 for High School dropouts with 15 years of experience. In other words, only low schooling workers find themselves sometimes exogenously excluded from the covered sector. Also, the returns to education are estimated to be higher in the uncovered sector than in the covered sector (3.4% higher for men and 1.8% higher for women). This implies that the earnings gap between sectors is higher for low schooling levels. Overall, these estimates suggest that the segmented or residual model of the uncovered sector is relevant for workers with low levels of schooling, possibly because minimum wage regulations induce an excess supply of labor in the covered sector. For workers with some schooling, however, even High School dropouts, the estimates are consistent with an uncovered sector that offers real "career" opportunities, with human capital accumulation that is portable to jobs in the covered sector.

4.3.2 Model Fit

We next examine evidence on how the model fits the data within sample. Tables B.5 and B.6 provide evidence on the within-sample fit of the model in the savings accumulation dimension. Tables B.7, B.8, B.9, B.10, B.11 and B.12 show aspects of the labor sector choices. Tables B.13 and B.14 summarize earnings.

First, the model is able to generate the overall dispersion of the private savings, pension savings and earnings in the sample, as seen in tables B.5 and B.6. In addition, the education and age patterns of mean savings and earnings are well captured overall. Two aspects of the fit could be improved. First, the model tends to underpredict pension savings accumulation at older ages for college graduates. Looking at earnings, the mean for that schooling level are also lower in the model simulations than in the data. In fact, college graduate earnings exhibits a fat right tail of high earners that the model is not well equipped to capture. The fact that these high earnings are persistent over time explains that this right tail in the earnings distribution also translates into a fat right tail in the pension savings distribution, which is responsible for the underestimation of college graduate pension savings. The pension savings accumulated by these high earning individuals will tend to pull the mean up at older ages.[6] The second aspect is the low mean earnings of younger males and of females in the uncovered sector. This comes from workers who are only partially employed during the year, a situation that is common in the informal sector at younger ages. Since I make the simplifying assumption not to model the intensive margin of the labor supply decision, the model is not well equipped to capture that fact.

Second, the joint labor force participation of couples in the nine possible pairs of employment choices (table B.7) is also well captured. So are the individual choices of husbands and wives, summarized by age (table B.8) and schooling level (table B.9). For example, the model reproduces the high percentage of women with no High School education who stay home (14.8% versus 13.4% in the data) and the much lower percentage for college graduates (27.4% versus 25.0% in the data).

Third, it is important that the model captures how workers switch or stay in the same sector over their careers as seen in table B.10. The model reproduces the bimodal distribution of time spent in the covered sector at different ages and for the two genders. For example, 18.8% of men under 35 have worked than 25% of the time in covered jobs (18.8% in the data), while 58.7% have worked more than 75% of the time in covered jobs (58.5% in the data). Tables B.11 and B.12 show the individual transition matrices for 45-50 year-old men and women and for their younger counterparts (25-30). In particular, the persistence in sector choices is adequately captured for both genders and age groups.

[6] A possible remedy would be to introduce unobserved heterogeneity in the earnings offer, effectively allowing for persistently high earnings and pension savings accumulation for a fraction of the sample.

Chapter 5

Policy Experiments

Having estimated the structural parameters governing preferences, earnings offers and labor market segmentation, I use the model to perform policy experiments that assess the effect of the rules of the pension system on asset accumulation, pension system coverage, labor force participation, and the fiscal cost of the pension system's safety net. In particular, I solve the model under the alternative rules, and simulate the decisions of the sampled households from the first decision period (start of marriage/cohabitation) rather than imposing the new rules form a given year on, in order to evaluate the long-term effects of the alternative rules.[1]

Given that they are primitives of the model, the estimated preference parameters can be taken as invariant to policy changes. The prices in the labor and capital markets, however, might be subject to equilibrium adjustments when pension rules are changed. Equilibrium effects could operate through three channels. First, asset returns might adjust to an increase or a reduction in household savings, thus attenuating the behavioral response to the policy change. It seems reasonable to assume, however, that Chile is a small open economy and that asset returns are invariant to the policy experiment. Second, the adjustment in the relative wages of the covered

[1]Note that the experiments are not tax-neutral: the additional cost to the government are not translated into higher taxes. Results for same policy changes modeled as an unanticipated and tax-neutral event will be the object of future work.

and uncovered sector can be expected to reduce the extent to which workers switch sectors in response to changes in the rules of the system. Similarly, if new rules cause workers to reduce their labor force participation, wages might go up in equilibrium and limit the magnitude of the response. The wage equilibrium effects are outside the scope of my paper, so the estimates of the employment responses to the policy experiments presented here should be taken as upper bounds on the equilibrium response.

In reporting the effects of the policy experiment, I use 2004 as the baseline year since the EPS sample was chosen to be representative of the Chilean population in that year. As previously noted, there are several sample selection criteria and the results here apply only to the sample analyzed.

5.1 Alternative Contribution Rules

I first study changes in the mandatory pension contribution rate, which is currently set at 10%. The goal of the experiment is to understand the strength of the incentives for workers to switch to the uncovered sector in order to avoid paying pension contributions. In other words, the idea is to determine to what extent low pension coverage might be related to the level of illiquid pension contribution. In addition, from a public finance point of view, it is interesting to see whether higher pension contributions result in higher total savings and how the cost of the pension system is affected.

5.1.1 Findings

Table B.17 summarizes the outcomes of interest under counterfactual contribution rates ranging from 5% to 20%. Realized pension returns after 2009 are assumed to be 5.98%, which corresponds to the weighted average return on Chile's pension funds from 2002 to 2009[2]. Statistics like mean savings and the fraction of husbands and wives in each occupation are reported for the year 2004. I also project the decisions of the households in the sample until retirement to obtain age profiles of mean private and pension savings (pooling together all birth cohorts in the sample), eligibility for minimum pension benefits and government liabilities.

The exercise essentially measures the elasticity of pension coverage to the level of pension contributions implied by the model. Changes in the mandatory contribution rate can affect pension coverage and labor force participation by reducing the value of covered earnings offers. The predicted coverage rate in 2004 shows that households significantly adjust their labor force participation in response to a change in mandatory savings. Increasing the contribution rate from 10 to 15 percent decreases the coverage rate by 1.1 percentage points or 5.9% for husbands and 16.5% for wives. In addition, female labor force participation decreases by 3.2%. However, the coverage rate by itself provides an incomplete picture of participation in the pension system. It does not capture whether the same workers participate continuously over their lifetime while others never do or whether most workers switch in and out of covered jobs to some extent. To see this, I consider the density of contributions, which is the number of years in which contributions where made over the number of working-age years.[3] Table B.18 shows the distribution of contribution densities at age 64 under a contribution rate of 10% and 15%. As expected, contribution densities are lower when the contribution rate is higher. However, different parts of the distribution are affected by changes in the contribution rate for men and women. Women who reduce their participation in the covered sector are those with otherwise low contribution densities. The fraction of women with more than 75% of contributions remains virtually unchanged. In other words, a higher contribution rate discourages sporadic participation in the covered sector. In contrast, the whole contribution density distribution for male shifts to the left, exhibiting more workers with only uncovered

[2]The effect of different returns assumptions are explored in the second policy experiment.
[3]I define working ages as ranging between 16 and 64.

experience and fewer with only covered experience.

In addition to impacting coverage, the contribution rate could be a tool to increase aggregate savings by effectively imposing a lower bound on a household's overall saving rate. However, the magnitude of that effect depends on the extent to which households can make countervailing adjustments to their private savings. The effect of the contribution rate on asset accumulation is captured by several statistics. First, I report the average private, pension and total savings for the sample in 2004 in the different scenarios. The results show that total savings respond strongly to an increase in the contribution rate: increasing the contribution rate from 10 to 15 percent increases average total savings by 13.4%, from 10.8 to 12.2 million pesos. This effect can be decomposed into an increase in pension savings (+1.7 million pesos for males and +0.3 million pesos for females) partially offset by a decrease in private savings (-0.6 million pesos).

The contribution rate also affects the cost of the state-provided safety net. First, if high contributions reduce participation in the covered sector, fewer workers will reach the number of years of contributions requirement to obtain the minimum pension. Second, conditional on being eligible, workers subject to a higher contribution rate requirement are less likely to have a pension below the guaranteed minimum. To assess the impact of the contribution rate on government liabilities, I determine for each individual in the sample whether they qualify for either the minimum pension or the welfare pension and compute the present value of predicted benefits payments. I discount the payments by the risk free rate and average over the total number of individuals in the sample. I project that less than 2% of males and 5% of females will qualify for the minimum pension. This results from the level of the minimum pension level (about 3/4 of the minimum wage), the number of years of contributions required to qualify and the returns achieved by the system. Conditional on reaching the 20 years of contribution, few workers will accumulate less than the minimum pension level. As a consequence, the projected liability of workers in the sample remains limited at 655000 pesos per capita. That is, if the government wanted to pay off in 2004 all future benefits to workers in the sample, it would have to pay the equivalent of 6 months worth of the minimum wage to each of them. Multiplied by the total Chilean population this sum would represent 11% of GDP.[4]

5.2 Ex-ante Evaluation of the 2008 Reform of the Safety Net

The second policy experiment studies the effect of the 2008 reform of the safety net that was described in the introduction. The objectives of the reform were to protect workers with few pension contributions against old age poverty while increasing coverage by improving incentives to participate in the system. The model considers two channels by which retirement transfers can affect pension coverage. First, benefits can reduce labor force participation through an income effect. Second, the safety net might create a implicit marginal tax rate on additional pension contributions if they render the worker ineligible or reduce his claims to benefits.

I consider the question of whether the new system will improve or reduce pension coverage, and compare the predicted liabilities it will generate with that generated by the pre-2008 system's. My approach simulates the sample's lifetime decisions under the two pension system designs and compare outcomes. This exercise requires making an assumption on the realized rate of return achieved by pension funds. In the simulations, I use the historical realized rate of return from 1981 to 2009, and also consider three alternative scenarios. In the first scenario, post-2009 returns are fixed at 9.94%, which is the mean return on the years spanned by my data (1981-2006). In the second scenario I use the mean return from 2002 to 2009, which includes large negative returns corresponding to the 2008 financial crisis (The Chilean pension

[4]See [16] for a discussion of implicit pension debt calculations

funds lost about 20% of their value in 2008), for an average of 5.98%.[5] Finally I consider a low return scenario, in which pension accounts accrue 2.99%, or half the returns in the second scenario.

5.2.1 Findings

The results of the simulations are presented in table B.19. I list the same outcomes as in the alternative contribution rate policy experiment, namely the fraction of husbands and wives in each sector in 2004, the fraction with contribution densities below 75% at retirement, mean private and pension savings in 2004 and by age until retirement, the fraction of the sample that is eligible for retirement transfers and the present value of those transfers, per capita, in 2004.

If we look at the coverage rates in the sample in 2004, the reform has almost no effect on males and a small negative effect on females (-1.9%). However, the sample only contains the relatively young cohorts that started working under the new system, after 1980. As a result, the 2004 coverage rate does not capture the effects of the reform at older ages. In tables B.20 and B.21, I reproduce the projected sector choices by age groups. Although decisions at younger ages remain largely unaffected, the reform has a significant effect as retirement nears. For example the fraction of 60-64 year-old males who work in the covered sector decreases by 4.8% while females show a similar effect that starts earlier in the lifecycle and increases progressively with age.

The effect on uncovered sector participation differs in sign for males and females. Under the reformed system, females are less likely to work in either sector, which is consistent with an income effect on the demand for the home sector. However, males increase their participation in the uncovered sector as a result of the reform, which

[5] Before 2000, each pension fund managed a unique portfolio. I use the average of all the funds' returns weighted by their value at the end of each year. In 2000 and 2002, pension funds were required to managed additional portfolios with different risk-return profiles. By default most accounts were attributed to the medium risk portfolio or "fondo C", whose returns I use in calculating returns post 2000.

cannot be explained by an income effect. A closer look at the change in marginal tax rates provides a explanation. Although workers who would have qualified for either the welfare or the minimum pension in the old system see their implicit marginal tax rate decrease, and their incentives to work in covered jobs increase, the reverse is true of workers who become eligible under the 2008 reform. Those would see their marginal tax rate increase instead of decrease. Table B.19 shows that the fraction eligible for any kind of retirement income transfer increases by 16.6 and 13.7 percentage points for husbands and wives respectively under the reform. This implies that the fraction of workers for whom the marginal tax rate increased is higher than that of workers for whom it decreased, which explains the shift towards the uncovered sector.

The expansion of the number of beneficiaries also implies an increase in the fiscal cost of the safety net. Table B.19 reports predicted eligibility and fiscal liabilities for the old welfare pension, the old guaranteed minimum pension and the new welfare pension. Under the baseline scenario, with returns on pension accounts of 5.98%, the present value of liabilities in the old system is estimated at $655,300$ pesos per capita, versus $4,311,260$ for the new system, which is 6.5 times higher. Multiplied by the Chilean population, these numbers correspond to 10.8% and 71.7% of the country's GDP in 2004. This large difference is due to the fact that only 1.5% of husbands and 4.4% of wives would have qualified for the guaranteed minimum pension, and another 3.6% of households would have received the lower welfare pension, according the model's projections. By contrast, 21.7% of households are projected to receive benefits under the old system, and benefits will be on average higher than in the old system.

Predictions under alternative levels of realized returns show that the cost of the old safety net is very sensitive to pension returns and increases substantially when pension returns are low. Assuming returns of 2.99%, the percent eligible for the old minimum pension goes up to 10.8% for males and 7.4%, and the cost of the old safety net is multiplied by 2.5, at $1,611,320$ pesos per capita (eq. to 26.6% of GDP). In comparison, the fiscal cost of the new system is also sensitive to returns, but the cost only increases by 50%.

Chapter 6

Conclusion

The existence of a large uncovered labor market, in which it is difficult to mandate participation to pension schemes, poses formidable challenges for designing pension systems in developing countries. In many of them, the fraction of workers who contribute to the existing pension scheme is low. In this context, choosing how much workers should contribute could affect participation, pension savings accumulation and ultimately the cost for the State to provide a safety-net in the form of retirement income subsidies. Conversely, generous eligibility requirements and benefits for such a safety-net could also crowd-out individual pension and private savings, further increasing the fiscal cost of the system. This study explores these mechanisms by specifying and estimating a dynamic model of employment and savings decisions for a sample of Chilean couples under a privatized pension system. The model explicitly incorporates the main features of the pioneering Chilean pension system and allows households to adjust to pension regulation through a private saving decision and by varying the labor force participation decision of each spouse. In addition, the model accounts for the existence of a large uncovered labor market, in which household members can work without being subject to pension contributions.

In particular, this study attempts to determine to what extent pension rules themselves can be held responsible for the problem of low participation to the pension system. Specifically, are workers avoiding pension contributions? Do social pensions crowd-out contributions? Or are workers being rationed out of covered jobs due to labor market segmentation? In addition, it tries to assess what the effects of actual or potential policies that aim to increase income in retirement will be. This include increasing the contribution rate, and expand social pensions in the way Chile did it in 2008.

I find that Chilean data used in estimation are broadly consistent with a competitive, as opposed to a segmented, uncovered labor market sector. Labor market segmentation accounts for 13% of uncovered work overall (up to 22% for workers with no High School education).

I also predict that participation in jobs covered by the pension system are sensitive to the rules of the pension system. A higher contribution rate reduces participation in jobs that are covered by the pension system at a rate of 1 percentage point of coverage per additional percentage point of contribution. Private and pension savings are found to be only partial substitutes. Higher contributions would be partially offset by a reduction in private savings: the decrease in private savings equals roughly 25% of the increase pension savings. This implies that increasing contributions from 10% to 15% would increase total savings by 14%.

The model is used to ex-ante evaluate the 2008 expansion of Chile's safety net. I find that the reform operates a large redistribution towards workers with low pension saving accumulation and will result in a large increase in fiscal liabilities linked to welfare pensions (about 6 times the cost of the previous safety net). In addition, reduced labor force participation at older ages should be expected (husbands -5%, wives -23%) despite a design that tries encourage participation.

Future research would be needed to externally validate the model using the next, post-reform round of the survey. In addition, it would be interesting to conduct revenue-neutral policy experiments, that take into account the impact of the income tax increases required to finance the new safety net. The effects of a number of other possible policies could be investigated: alternative taper rates, matching of contributions by the State, and age-dependent contribution rates.

Appendix A

Solution of the retired household's problem

The solution of the problem is derived from the period budget constraints, the terminal condition $a_{t_D+1} = 0$ and the set of Euler Equations:

$$\forall t \in \{t_R, ...t_D - 1\} \quad u'(c_t) = \beta \cdot (1 + r) \cdot u'(c_{t+1})$$

Given the CRRA preferences, the Euler equations become:

$$\forall t \in \{t_R, ...t_D - 1\} \quad c_{t+1} = \beta \cdot (1 + r)^{\frac{1}{\sigma}} \cdot c_t$$

Let us iterate this relationship to obtain consumption at each period c_t as a function of consumption at retirement c_{t_R}:

$$\forall t \in \{t_R, ...t_D - 1\} \quad c_t = c_{t_R} \cdot (\beta(1 + r))^{\frac{t-t_R}{\sigma}}$$

A vertical summation of the period budget constraints, premultiplied by $(\frac{1}{1+r})^{t-t_R}$, yields:

$$a_{t_R} = \sum_{t=t_R}^{t_D} (\frac{1}{1+r})^{t-t_R} c_t$$

The solution is characterized by consumption at each period as a function of assets at retirement:

$$c_{t_R} = a_{t_R} \cdot \frac{1}{\sum_{t=t_R}^{t_D} (\frac{p_t}{p_{t_R}} \cdot (\beta(1+r)^{1-\sigma})^{t-t_R})^{\frac{1}{\sigma}}}$$

$$\forall t \in \{t_R, ...t_D - 1\} \quad c_t = c_{t_R} \cdot (\beta(1+r))^{\frac{t-t_R}{\sigma}}$$

Appendix B

Tables

Table B.1: Parameter Estimates: Preferences

Name	Symbol	Value
Discount factor	ρ	0.067
		(0.00155)
Intertemporal Elasticity of Substitution	σ	1.559
		(0.03661)
Value of leisure (Female - type 1)	δ^W	0.085
		(0.00329)
Value of leisure (Female - type 2)	δ^W	0.044
		(0.00219)
Value of leisure (Female - type 3)	δ^W	0.180
		(0.01715)
Value of leisure (Male - type 1)	δ^H	0.095
		(0.00657)
Value of leisure (Male - type 2)	δ^H	0.009
		(0.00219)
Value of leisure (Male - type 3)	δ^H	0.008
		(0.01890)
Cost of switching sectors (Male)	ϕ_s^H	0.074
		(0.00438)
Cost of switching sectors (Female)	ϕ_s^W	0.262
		(0.01694)
Cost of returning to work (Male)	ϕ_a^H	0.258
		(0.02044)
Cost of returning to work (Female)	ϕ_a^W	0.724
		(0.05000)
Standard Deviation of Leisure shocks (Male)	σ_P^H	0.001
		(0.00007)
Standard Deviation of Leisure shocks (Female)	σ_P^W	0.001
		(0.00006)

Standard errors are in parentheses.

Table B.2: Parameter Estimates: Earnings Offers

Name	Symbol	Male	Female
Covered sector constant	α^i_C	-0.565	-1.364
		(0.02500)	*(0.02592)*
Uncovered sector constant	α^i_U	-1.060	-1.789
		(0.01180)	*(0.01373)*
Cohort effect	θ^c	0.050*	0.050*
		(0.00490)	*(0.00490)*
Returns to education (Covered sector)	$\theta^i_{E,C}$	0.085	0.067
		(0.00910)	*(0.01522)*
Returns to education (Uncovered sector)	$\theta^i_{E,U}$	0.119	0.085
		(0.00890)	*(0.01411)*
Returns to covered experience	$\theta^i_{X,C}$	0.020	0.045
		(0.00098)	*(0.00190)*
Returns to uncovered experience	$\theta^i_{X,U}$	0.023	0.039
		(0.00110)	*(0.00190)*
Experience-schooling interaction	$\theta^i_{X,E}$	0.003	0.005
		(0.00030)	*(0.00035)*
Experience-schooling interaction (College graduates)	$\theta^i_{X,E}$	0.018	0.005
		(0.00110)	*(0.00094)*
Experience transferability	τ^j_{XP}	0.971*	0.971*
		(0.11114)	*(0.11114)*
Sd of shocks to earnings offers (Covered)	σ^i_C	0.219	0.208
		(0.01296)	*(0.03129)*
Sd of shocks to earning offers (Uncovered)	σ^i_U	0.265	0.134
		(0.02324)	*(0.02221)*

Standard errors are in parentheses.
* Cohort effects and experience transferability were constrained to be equal across gender and sectors to reduce the number of parameters to be estimated.

Table B.3: Parameter Estimates: Probability of Receiving a Covered Offer

Name	Symbol	Male	Female
Constant	γ^i	1.999	2.167
		(0.33419)	*(0.54840)*
Schooling level	γ^i_E	0.999	0.881
		(0.17035)	*(0.25461)*
Covered Job at t-1	γ^i_{Cov}	0.098	0.995
		(0.0457)	*(0.41108)*
Covered experience	γ^i_{XP}	0.029	0.072
		(0.00876)	*(0.02756)*

Standard errors are in parentheses.

Table B.4: Parameter Estimates: Types Logit Parameters

Name	Symbol	Type 1	Type 2	Type 3
Constant	$\lambda(\psi)$	-1.310*	1.899	0.019
			(0.20512)	*(0.06689)*
Schooling level (Husband)	$\lambda_E^H(\psi)$	0.701*	-0.207	-1.203
			(0.06608)	*(0.38683)*
Schooling level (Wife)	$\lambda_E^W(\psi)$	0.001*	-0.339	-1.201
			(0.07867)	*(0.28379)*
Cohort	$\lambda_E^C(\psi)$	0.002*	-0.298	1.042
			(0.05728)	*(0.10012)*

Standard errors are in parentheses.
* Since the type probabilities must sum to one, the coefficients of only two out of three Types can be identified so Type 1's coefficients were held fixed through estimation.

Table B.5: Model Fit: Private Savings

	Data	Model
mean	6.46	7.35
sd	8.41	7.80
p10	-.06	.09
p50	4.12	5.45
p90	16.25	16.54
By Age		
20	3.64	4.03
25	4.03	5.80
30	5.46	6.94
35	6.80	7.80
40	8.09	8.39
45	9.47	8.22
By Education of the Husband		
No HS	4.75	4.98
HS dropout	5.51	6.75
HS grad	7.04	7.84
College grad	11.86	11.81

Table B.6: Model Fit: Pension savings

	Husband		Wife	
	Data	Model	Data	Model
mean	1.21	1.22	.29	.28
sd	2.22	1.72	.90	.87
p10	0	0	0	0
p50	.39	.58	0	0
p90	3.20	3.35	0.75	0.78
By Age				
20	.18	.29	.07	.10
25	.61	.70	.17	.19
30	1.50	1.58	.34	.35
35	2.91	2.73	.64	.57
40	4.91	3.80	1.15	.85
By Education of the Husband				
No HS	.50	.57	.07	.23
HS dropout	.91	1.03	.16	.26
HS grad	1.59	1.48	.42	.32
College grad	2.75	2.29	.56	.38

Table B.7: Model Fit: Household Labor Force Participation

	Data	Model
Husband's/Wife's sector		
Covered/Covered	18.0%	20.0%
Covered/Uncovered	7.5%	8.6%
Covered/Home	40.2%	41.7%
Uncovered/Covered	6.3%	8.6%
Uncovered/Uncovered	4.9%	3.6%
Uncovered/Home	16.7%	14.5%
Home/Covered	1.4%	2.0%
Home/Uncovered	0.9%	0.3%
Home/Home	4.1%	0.5%

Table B.8: Model fit: Labor sector choice by age

	Husbands		Wives	
	Data	Model	Data	Model
Covered Sector				
20	66.0%	63.9%	30.8%	23.9%
25	71.8%	69.0%	28.5%	27.6%
30	68.3%	70.2%	26.1%	27.0%
35	65.1%	69.5%	25.4%	24.8%
40	60.7%	69.7%	24.4%	23.9%
45	61.4%	67.8%	20.5%	22.7%
Uncovered Sector				
20	26.2%	31.4%	10.4%	8.7%
25	25.2%	28.0%	9.9%	10.4%
30	28.4%	26.2%	11.2%	12.4%
35	30.7%	27.2%	15.0%	13.3%
40	33.8%	26.4%	18.0%	10.1%
45	31.5%	27.1%	19.9%	10.6%
Home				
20	7.8%	4.7%	58.8%	67.3%
25	3.1%	3.0%	61.6%	62.1%
30	3.3%	3.6%	62.8%	60.6%
35	4.3%	3.3%	59.6%	61.9%
40	5.5%	3.9%	57.6%	66.1%
45	7.1%	5.2%	59.6%	66.7%

Table B.9: Model fit: Labor sector choice by schooling level

	Husbands		Wives	
	Data	Model	Data	Model
Covered Sector				
No H.S.	51.4%	63.7%	13.4%	14.8%
H.S. dropout	63.4%	66.8%	19.3%	18.5%
H.S. grad	75.2%	71.2%	34.3%	31.6%
Col. Grad	77.6%	76.4%	61.5%	64.9%
Uncovered Sector				
No H.S.	42.0%	27.6%	10.7%	8.5%
H.S. dropout	32.8%	29.5%	14.4%	11.3%
H.S. grad	21.0%	26.8%	11.7%	12.3%
Col. Grad	14.8%	23.1%	13.5%	7.8%
Home				
No H.S.	6.6%	8.7%	75.9%	76.7%
H.S. dropout	3.8%	3.7%	66.3%	70.2%
H.S. grad	3.8%	2.0%	54.0%	56.1%
Col. Grad	7.6%	0.5%	25.0%	27.4%

Table B.10: Model fit: Distribution of years worked in covered jobs/total years worked

	Data	Model
Husbands under age 35		
0-25%	18.8%	18.8%
25-50%	8.1%	6.2%
50-75%	14.3%	16.6%
75-99%	23.0%	29.7%
100%	35.7%	28.8%
Husbands over age 35		
0-25%	12.7%	15.9%
25-50%	7.3%	6.8%
50-75%	13.4%	15.4%
75-99%	17.5%	20.9%
100%	49.1%	41.0%
Wives under age 35		
0-25%	24.1%	32.1%
25-50%	8.8%	7.9%
50-75%	9.2%	12.8%
75-99%	10.1%	10.5%
100%	47.8%	36.7%
Wives over age 35		
0-25%	15.2%	22.5%
25-50%	6.8%	5.4%
50-75%	10.9%	8.6%
75-99%	11.0%	8.0%
100%	56.1%	55.5%

Table B.11: Model fit: Transitions between labor sector choices (age 45-50)

		Husbands		Wives	
		Data	Model	Data	Model
From Covered...	... to Covered	93.5%	94.2%	83.7%	90.8%
	...to Uncovered	5.4%	4.9%	9.3%	0.8%
	...to Inactive	1.1%	0.9%	7.0%	8.5%
From Inactive...	... to Covered	27.3%	18.2%	3.9%	0.8%
	...to Uncovered	13.6%	16.7%	8.7%	3.2%
	...to Inactive	59.1%	65.2%	87.4%	95.9%
From Uncovered...	...to Covered	12.9%	11.5%	5.6%	2.2%
	...to Uncovered	83.0%	81.7%	78.7%	78.8%
	...to Inactive	4.1%	6.8%	15.7%	19.0%

Table B.12: Model fit: Transitions between labor sector choices (age 25-30)

		Husbands		Wives	
		Data	Model	Data	Model
From Covered...	...to Covered	95.5%	91.5%	84.2%	94.5%
	...to Uncovered	3.7%	7.4%	2.5%	0.7%
	...to Inactive	0.8%	1.1%	13.3%	4.8%
From Inactive...	...to Covered	31.5%	31.8%	4.2%	3.2%
	...to Uncovered	6.6%	23.1%	2.4%	3.7%
	...to Inactive	61.9%	45.0%	93.4%	93.1%
From Uncovered...	...to Covered	9.6%	21.2%	5.6%	3.0%
	...to Uncovered	89.8%	76.4%	79.2%	78.9%
	...to Inactive	0.5%	2.4%	15.2%	18.1%

Table B.13: Model Fit: Earnings (Husbands)

	Covered Sector		**Uncovered Sector**	
	Data	Model	Data	Model
Distribution				
mean	2.92	2.97	2.41	2.63
sd	2.13	1.99	2.13	2.00
p10	1.38	1.20	0.72	0.81
p50	2.4	2.50	1.80	2.14
p90	5.35	5.26	4.71	5.04
By Age				
20	2.08	2.41	1.57	2.44
25	2.59	2.65	1.91	2.57
30	2.96	2.82	2.54	2.59
35	2.91	3.05	2.54	2.66
40	3.21	3.31	2.39	2.67
45	3.64	3.49	3.18	2.82
By Schooling level				
No HS	1.77	1.57	1.42	1.11
HS dropout	2.18	2.32	2.13	2.00
HS grad	3.29	3.35	3.09	3.34
College grad	6.44	5.96	5.50	5.35

Table B.14: Model Fit: Earnings (Wives)

	Covered Sector		**Uncovered Sector**	
	Data	Model	Data	Model
Distribution				
mean	1.78	1.68	1.13	0.86
sd	1.21	1.35	1.03	0.62
p10	0.41	0.54	0.15	0.31
p50	1.56	1.33	0.84	0.70
p90	3.60	3.23	2.40	1.58
By Age				
20	1.40	1.06	0.77	0.72
25	1.94	1.30	1.14	0.77
30	2.01	1.57	0.96	0.80
35	1.66	1.77	1.07	0.84
40	1.62	2.09	1.21	0.98
45	1.97	2.4	1.66	1.01
By Schooling level				
No HS	0.93	0.87	0.72	0.44
HS dropout	1.23	1.18	0.96	0.73
HS grad	1.92	1.77	1.32	0.95
College grad	2.89	2.82	2.31	1.77

Table B.15: Summary statistics

	Husband	Wife	Household
Private assets (million pesos)			
median at 25	-	-	1.5
median at 35	-	-	4.8
median at 45	-	-	8
Pension savings (million pesos)			
median at 25	0.3	0.1	-
median at 35	2.3	0.3	-
median at 45	4.5	0.0	-
Median annual earnings (thousand pesos)			
Covered sector jobs	2409	1547	-
Uncovered sector jobs	1680	720	-
Schooling level (sample)			
No High school	15%	15%	-
High school dropouts	36%	36%	-
High school graduates	43%	45%	-
College graduates	6%	4%	-
Schooling level (Uncovered sector workers)			
No High school	24%	14%	-
High school dropouts	42%	40%	-
High school graduates	31%	42%	-
College graduates	2%	5%	-
Joint labor sector choice			
Husband's/Wife's sector			
Covered/Covered	-	-	18%
Covered/Uncovered	-	-	8%
Covered/Home	-	-	40%
Uncovered/Covered	-	-	6%
Uncovered/Uncovered	-	-	5%
Uncovered/Home	-	-	17%
Home/Covered	-	-	1%
Home/Uncovered	-	-	1%
Home/Home	-	-	4%
Years worked in covered jobs			
>75% of total number of years	60%	58%	-
<25% of total number of years	20%	25%	-

Table B.16: Person-period observations by age group and birth cohort

	Age of the Husband						
Birth cohort	25	30	35	40	45	50	**Total**
1955	2,775	2,776	2,780	2,780	2,460	321	13,892
1965	3,282	3,280	3,280	2,888	411	0	13,141
1970	2,840	2,840	2,499	355	0	0	8,534
1975	2,402	2,160	307	0	0	0	4,869
1980	1,621	250	0	0	0	0	1,871
Total	12,920	11,306	8,866	6,023	2,871	321	42,307

Table B.17: Changing the contribution rate

Policy Parameters							
Contribution rate	**5%**	**7.5%**	**10%**	**12.5%**	**15%**	**17.5%**	**20%**
Welfare Pension							
Level (monthly pesos)	48000	48000	48000	48000	48000	48000	48000
Taper rate (%)	100	100	100	100	100	100	100
Minimum Pension							
Level (monthly pesos)	105000	105000	105000	105000	105000	105000	105000
Eligibility (yrs)	20	20	20	20	20	20	20
Pension returns projection (%)	5.98	5.98	5.98	5.98	5.98	5.98	5.98
Outcomes							
Husbands' coverage							
% covered	0.744	0.723	0.699	0.677	0.660	0.634	0.611
% uncovered	0.234	0.252	0.272	0.293	0.310	0.334	0.356
% inactive	0.022	0.024	0.028	0.029	0.030	0.0.31	0.032
% density under 75%	42.910	43.880	45.580	46.610	48.110	49.450	50.910
Wives' coverage							
% covered	0.334	0.327	0.303	0.276	0.260	0.246	0.237
% uncovered	0.101	0.111	0.125	0.136	0.150	0.151	0.157
% inactive	0.563	0.561	0.571	0.587	0.590	0.601	0.605
% lifetime density under 75%	85.740	85.760	86.440	86.480	86.570	86.780	86.380
Welfare Pension							
% eligible husbands	4.010	3.960	3.620	3.620	4.100	4.100	4.480
% eligible wives	6.720	4.770	3.580	3.580	4.100	4.150	4.480
Projected liabilities*	903300	711650	439200	569450	655750	646250	709035
Minimum Pension							
% eligible husbands	35.190	7.300	1.530	0.240	0.190	0.100	0.100
% eligible wives	21.220	9.540	4.430	1.570	0.860	0.520	0.380
Projected liabilities*	3905347	936585	216100	117100	80100	45450	36300
Mean Private savings							
2004 Cross-section	8.307	7.290	7.040	6.637	6.390	6.166	5.920
Age profile							
25	4.837	4.600	4.526	4.442	4.370	4.297	4.240
35	9.828	8.600	8.370	7.860	7.490	7.178	6.820
45	19.824	17.750	17.430	16.610	16.210	15.780	15.120
55	38.670	35.470	33.770	31.900	30.720	29.250	27.890
65	74.849	47.250	42.230	38.370	35.410	32.930	31.130
Mean Male Pension savings							
2004 Cross-section	1.124	2.089	3.029	3.940	4.780	5.588	6.310
Age profile							
25	0.191	0.587	0.804	1.014	1.220	1.409	1.589
35	0.986	2.350	3.400	4.407	5.340	6.249	7.069
45	2.674	6.010	8.758	11.400	13.860	16.240	18.400
55	5.708	12.890	18.868	24.000	30.020	35.160	39.860
65	9.173	20.790	30.520	40.020	48.790	57.190	64.870
Mean Female Pension savings							
2004 Cross-section	0.316	0.522	0.713	0.886	1.060	1.212	1.370
Age profile							
25	0.000	0.186	0.230	0.278	0.320	0.365	0.400
35	0.027	0.626	0.861	1.070	1.280	1.470	1.665
45	0.135	1.640	2.290	2.873	3.450	3.980	4.516
55	0.353	3.688	5.152	6.457	7.780	8.970	10.232
65	0.592	6.050	8.440	10.610	12.820	14.830	17.010
Mean Total savings							
2004 Cross-section	9.748	9.901	10.782	11.463	12.230	12.966	13.600
Age profile							
25	3.384	5.373	5.560	5.734	5.900	6.071	6.229
35	8.676	11.576	12.631	13.337	14.100	14.897	15.554
45	15.909	25.400	28.478	30.883	33.530	36.000	38.036
55	35.571	52.048	57.790	62.357	68.500	73.380	77.982
65	62.696	74.090	81.190	89.000	97.030	104.950	113.010

*Present value in 2004 of payments made to workers in the sample until their death, per capita

Table B.18: Effect of an increase in the contribution rate on the distribution of contribution densities

Contribution rate	**10%**	**15%**	Δ
Husbands' contribution densities			
0-25%	20.1%	25.0%	*4.9%*
25-50%	11.0%	11.7%	*0.8%*
50-75%	14.6%	11.4%	*-3.2%*
75-100%	54.3%	51.9%	*-2.5%*
Total	100.0%	100.0%	
Wives' contribution densities			
0-25%	66.5%	73.8%	*7.3%*
25-50%	12.6%	7.0%	*-5.6%*
50-75%	7.7%	5.7%	*-2.0%*
75-100%	13.2%	13.4%	*0.3%*
Total	100.0%	100.0%	

Table B.19: Effects of the 2008 Reform of the Minimum and Welfare Pension

Policy Parameters						
Contribution rate	10%	10%	10%	10%	10%	10%
Welfare Pension						
Level (monthly pesos)	**48000**	**75000**	**48000**	**75000**	**48000**	**75000**
Taper rate (%)	**100**	**30**	**100**	**30**	**100**	**30**
Minimum Pension						
Level (monthly pesos)	105000	-	105000	-	105000	-
Eligibility (yrs)	20	-	20	-	20	-
Pension returns projection (%)	**5.98**	**5.98**	**2.94**	**2.94**	**9.94**	**9.94**
Outcomes						
Husbands' coverage						
% covered in 2004	69.9	70.1	69.9	70.1	63.4	70.1
% uncovered in 2004	27.2	26.7	27.2	26.7	33.4	26.7
% home in 2004	2.8	3.2	2.8	3.2	3.1	3.2
% density under 75% at age 64	45.6	46.7	43.6	44.9	49.5	54.3
Wives' coverage						
% covered in 2004	30.3	28.4	30.3	28.5	24.6	28.5
% uncovered in 2004	12.5	12.3	12.5	12.3	15.1	12.3
% home in 2004	57.1	59.2	57.2	59.3	60.1	59.3
% density under 75%	86.4	87.8	84.8	86.5	86.8	90.7
Welfare Pension						
% eligible husbands	3.6	21.7	3.9	33.1	4.1	12.9
% eligible wives	3.6	21.7	5.0	33.1	4.1	12.9
Projected liabilities*	439200	4311260	734950	6432700	614625	2283800
Minimum Pension						
% eligible husbands	1.5	-	10.8	-	0.1	-
% eligible wives	4.4	-	7.4	-	0.5	-
Projected liabilities*	216100	-	876370	-	45462	-
Mean Private savings						
Sample mean in 2004	7.0	7.7	7.0	7.0	6.2	7.7
Age profile						
25	4.5	4.7	4.5	4.7	4.3	4.7
35	8.4	9.3	8.3	9.2	7.2	9.3
45	17.4	19.1	17.0	18.9	15.7	19.5
55	33.8	34.6	34.6	35.3	29.2	32.8
65	42.2	40.0	47.7	44.9	32.9	29.3
Mean Male Pension savings						
Sample mean in 2004	3.0	3.0	3.0	3.0	5.6	3.0
Age profile						
25	0.8	0.8	0.8	0.8	1.4	0.8
35	3.4	3.4	3.2	3.2	6.2	3.7
45	8.8	8.8	7.1	7.1	16.2	11.9
55	18.9	18.9	12.5	12.5	29.3	34.1
65	30.5	30.6	17.7	17.6	57.2	66.9
Mean Female Pension savings						
Sample mean in 2004	0.7	0.7	0.7	0.7	1.2	0.7
Age profile						
25	0.2	0.2	0.2	0.2	0.4	0.2
35	0.9	0.8	0.8	0.8	1.5	0.9
45	2.3	2.2	1.8	1.8	4.0	3.0
55	5.2	4.9	3.5	3.3	9.0	8.8
65	8.4	8.0	5.1	4.7	14.8	17.3
Mean Total savings						
Sample mean in 2004	10.8	11.4	10.8	10.7	12.9	11.4
Age profile						
25	5.6	5.7	5.6	5.7	6.1	5.7
35	12.6	13.5	12.3	13.2	14.8	13.9
45	28.5	30.1	26.0	27.8	35.9	34.4
55	57.8	58.4	50.5	51.1	67.4	75.6
65	81.2	78.5	70.5	67.2	104.9	113.5

*Present value in 2004 of payments made to workers in the sample until their death, per capita

Table B.20: Effect of the 2008 reform on the coverage of Husbands, by age

	% Covered			
Age	**Baseline**	**Reform**	Δ	$\%\Delta$
20	65.4	65.5	*0.2*	0.3%
30	71.5	70.8	*-0.7*	-1.0%
40	69.6	68.9	*-0.8*	-1.1%
50	67.9	66.7	*-1.2*	-1.8%
60	51.7	46.9	*-4.8*	-9.3%

Table B.21: Effect of the 2008 reform on the coverage of Wives, by age

	% Covered			
Age	**Baseline**	**Reform**	Δ	$\%\Delta$
20	26.7	26.4	*-0.3*	-1.1%
30	29.0	28.1	*-0.9*	-3.1%
40	29.8	27.5	*-2.2*	-7.4%
50	23.5	20.3	*-3.2*	-13.6%
60	11.3	8.1	*-3.2*	-28.3%

Appendix C

Figures

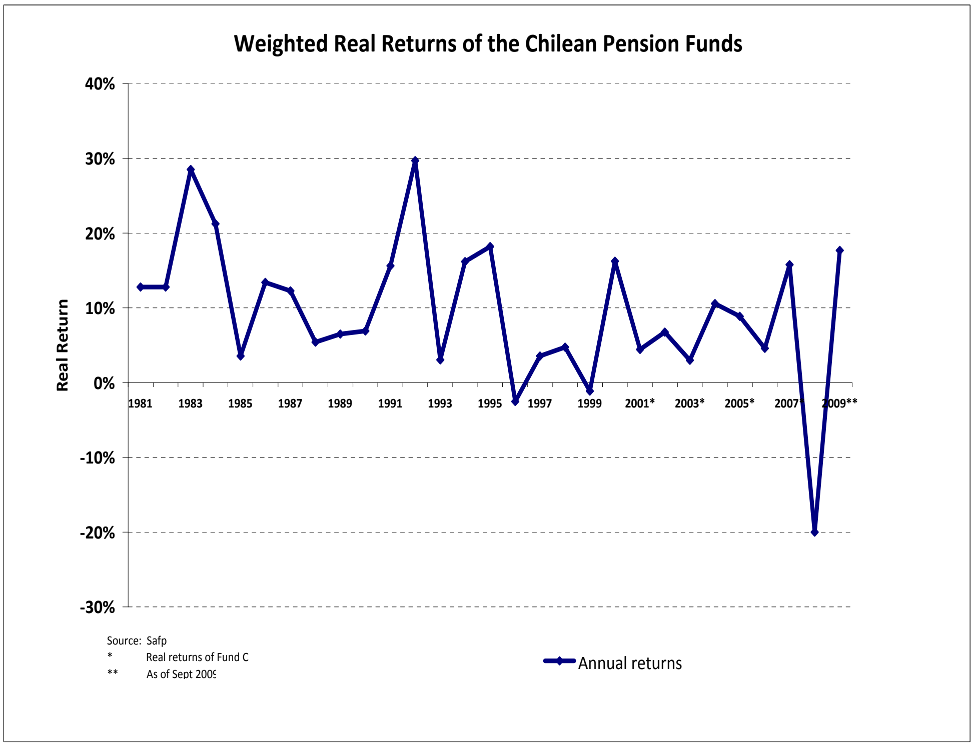

Figure C.1: Rentability of the Chilean Pension Funds 1981-2009

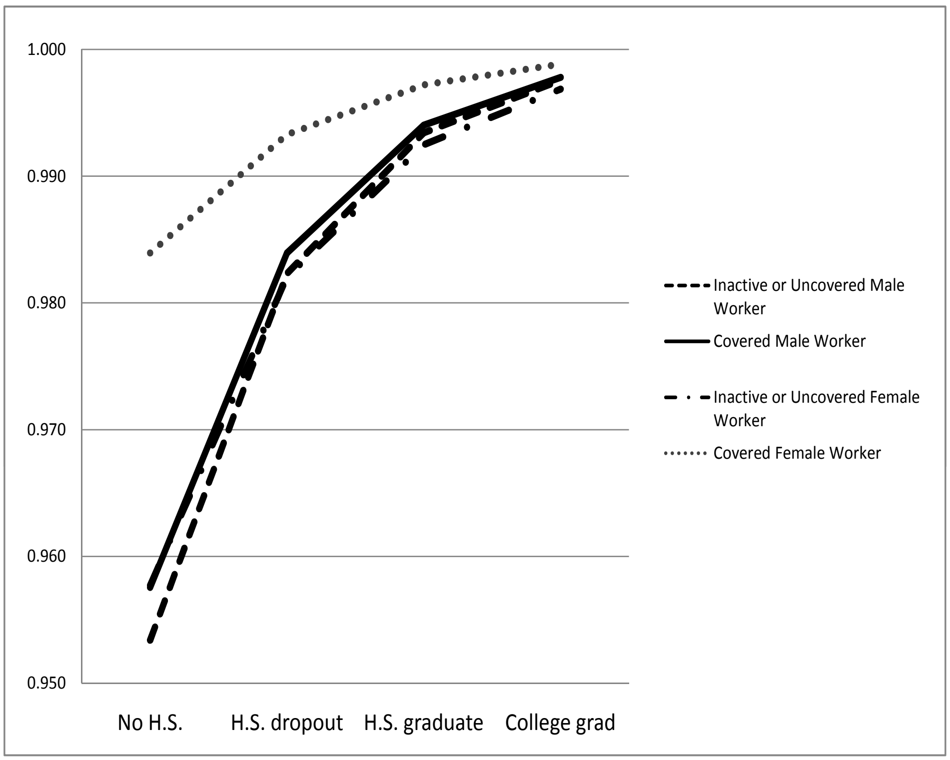

Figure C.2: Probability of receiving a covered earnings offer (workers with 1 years of covered experience)

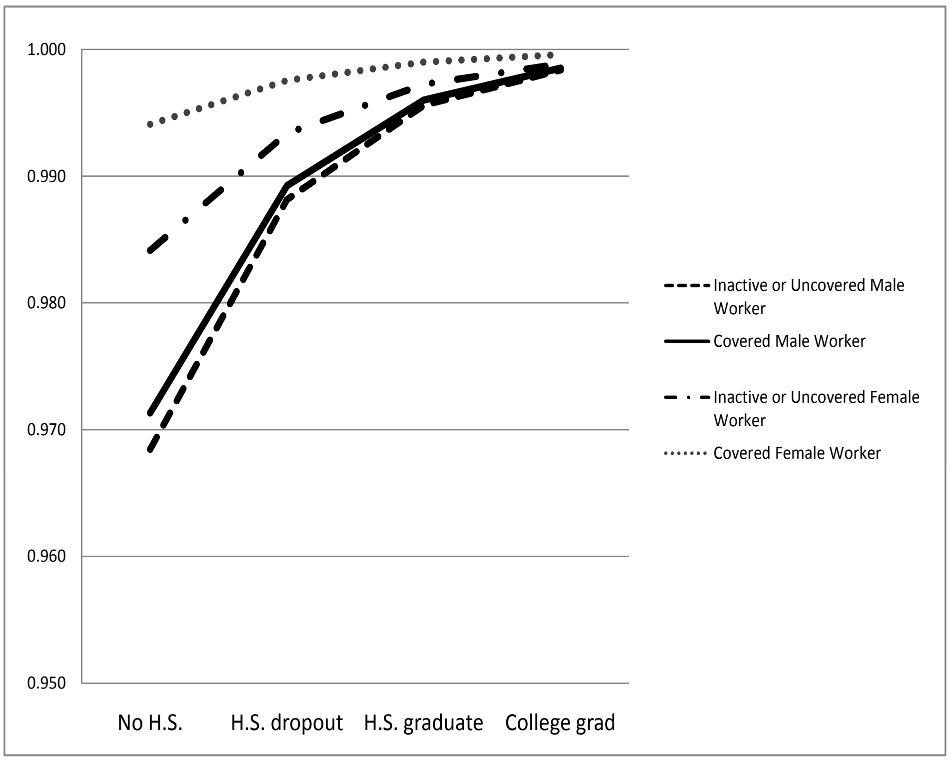

Figure C.3: Probability of receiving a covered earnings offer (workers with 15 years of covered experience)

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