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Rodrigo Cerda

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Rodrigo Cerda

The University of Chicago

And

Pontificia Universidad Catolica de Chile

Correspondence address: 5125 South Kenwood Avenue, Apt. 407, Chicago, IL, 60615

Telephone number: 773-6671107

E-mail: r-cerda@uchicago.edu

Does social security affect retirement and labor supply? Using the Chilean experience as an experiment

Rodrigo Cerda[1]

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Abstract

The paper explores the effects of the social security system over retirement and labor supply decision of individuals aged 55 to 65 in Chile. We use the 1998 CASEN survey elaborated by the Chilean government. Due to regulations established by the current social security law, two social security systems coexist on 1998: the "Pay-as-you-go" and the individual account system. This property of the dataset, allows us to disentangle the effects of those two systems over retirement and labor supply. The results show that social security may significantly affect retirement and labor supply decisions. The effects are mainly twofold. First, larger benefits may induce earlier retirement and lower labor supply and second, larger variance of benefits may induce later retirement and larger labor supply, due to a precautionary motive. This last effect seems to be important when analyzing the path of the Chilean retirement rates on the nineties.

[1] University of Chicago and Pontificia Universidad Catolica de Chile. Correspondence address: 5125 S. Kenwood Avenue, # 407, Chicago, IL, 60615. E-mail: r-cerda@uchicago.edu

1. Introduction

One of the trends that seem to characterize the behavior of the labor market on industrialized countries during the second half of the twentieth century is the earlier retirement of individuals over time. In fact when considering males aged 60 to 64 on the US, the labor force participation ranged near 80% on 1960 and it decreases steadily to almost 50% on 1995. Even when this change on labor force participation may seem large, larger changes had been observed on European countries. Belgium and France had a 70% of labor force participation on 1960 for the group of male aged 60-64. However, their participation rates for the same group was only 20% on 1995[2].

An explanation for the decreasing trend on labor force participation is attributed to existence of a "Pay-as-you-go"(PAYG) social security system. Social security systems by themselves have been a topic of large research due to their increasing financial problems. Those financial problems have been largely attributed to changes on the age pyramid. However, those financial problems are exacerbated if social security induces earlier retirement. In fact if PAYG social security systems provide incentives to leave the labor force early, we face an endogenous financial problem as the number of individuals paying social security taxes becomes lower while the number of individuals receiving benefits becomes larger. Moreover, it may exist also an intensive margin effect if holding retirement date constant; worker's labor supply is affected by social security benefits. This last effect may also exacerbate the financial problem of the PAYG system.

An alternative to the PAYG system is the individual account social security system. The effects over retirement and labor supply of switching to this type of social security system is an important policy issue, as an increasing number of countries facing the financial problems of the

[2] See Gruber and Wise (1997).

PAYG system are switching from the former to the later system. However, no clear empirical answer to these effects over retirement and labor supply has been given.

This paper analyzes the effects of the PAYG and individual account social security system over retirement and labor supply by using the Chilean experience. The particularity of using Chile as a reference country is that Chile was one of the first countries to move from a PAYG social security system to an individual account social security system on 1981. The Chilean data shows as a characteristic, that contrarily to the experience of industrialized countries, retirement among individual aged 60 to 64 have been decreasing during the nineties. In fact, retirement rate among individual aged 60 to 64 was 24.4% on 1990 while it was 18.8% on 1998 for the same group. Graph 1 shows the evolution of retirement rates for different age groups, during the nineties. All the groups show this decreasing trend on retirement.

[Insert Graph 1]

It should be noticed that Chile, since the eighties, presents resemblances with the industrialized countries, as demographic changes -due to lower mortality rates and lower fertility rates- and sustained increases on per capita income. Hence, one of the possible factors that may influence this different pattern on retirement may be linked to the exogenous change on the social security system rather to other characteristics of the economy. In fact, a flavor of this possible effect may be obtained by comparing current retirement rates between individuals affiliated to the PAYG and individuals affiliated to the individual account social security system. As it will be explained below, some set of individuals in Chile is currently enrolled on the PAYG system while some other set is enrolled on the individual account system due to regulations established by the 1981 social security reform law. Table 1 shows retirement rate by age group and social security systems on 1998. Retirement rate for any age group is always smaller on the individual account system. As individuals become older, the difference on retirement rates becomes larger reaching an 18% of difference on the group of individuals aged 60 to 65 years old. This paper will explore carefully the effects of different social security system over retirement and labor supply.

[Insert Table 1]

We use the 1998 CASEN survey on individuals elaborated by the Chilean government. The dataset presents an interesting characteristic for the study. It contains individuals affiliated to the new individual account social security system while at the same time it also contains another set of individuals affiliated to the old PAYG social security system. In fact, the 1981 social security law allowed individuals already affiliated to the PAYG system to choose between switching to the new individual account system or remaining on the old PAYG system. Also, given the information on the dataset we construct estimates for the social security wealth on the PAYG system and the individual account system, plus estimates of the variance of the social security wealth on the individual account system. This last variable is included on the study because the social security wealth on the individual account system depends on volatile returns obtained from the capital stock market. This volatility of the rate of return allows us to investigate the effect over retirement and labor supply of a precautionary motive.

There is however an identification problem on the estimation. The characteristic of the dataset above specified implies that individuals may self-select between the two different systems. When unobservable characteristics of the individuals have some influence on the process of self-selection, the estimation obtained may be biased if the covariance between the social security variables and unobservable characteristics that influence retirement decision (or labor supply decision) are different from zero. This will be the case when the unobservable characteristics influencing labor supply and retirement decisions and the unobservable characteristics influencing the self-selection process between social security systems are similar.

We use the regulations of the 1981 social security law that reformed the system, to provide exogenous variation on our estimates. The 1981 law, as indicated above, allows individuals affiliated on 1981 to the old system to choose between the systems. However there exists a large set of individuals that did not have the choice between systems. Three groups can be identified. First, individuals already retired on 1981 stayed on the old PAYG system as they were already obtaining pension benefits. Second, individuals entering the labor market, after the law changed, were required to affiliate to the new individual account system. Finally, individuals working on the army forces were required to stay on the old PAYG system.

The study will focus on the labor supply and retirement decisions for individuals aged 55 to 65 years, as those individuals are the ones that face retirement decisions. It will use the affiliation to the army forces and some other set of individual affected by the 1981 reform law, as a source of exogenous variation. We find strong evidence that affiliation to army force (plus the other instrumental variables used) must be uncorrelated with all others observable variables that may influence retirement and labor supply decisions, including demographic and income shocks. Most importantly, the covariance between the instrumental variable and the labor supply seems to be equal to zero.

Using the instrumental variable approach, the analysis indicates that an increase of 1% on the individual account social security benefits increases the probability of retirement on the range 0.2-0.6% while the effect of the same variable on the PAYG system ranges between 0.6 and 1.7%. This same variable shows effects over labor supply among individuals currently working. In fact, a 1%-increase on the level of benefits produce a decrease of 0.11% on hours supplied to the labor market. However, a second component that affects the retirement and labor supply decision on the individual account system is the variance of the benefits. In fact, an increase of 1% on the variance of the portfolio in the individual account system depresses retirement on a range of 0.4% to 1%. This last effect argues for a precautionary motive as a determinant of retirement date.

The paper is developed in the following way. Section 2 provides a lifecycle model with social security system. The model focuses on the case of random return of social security investments, resembling the privatized Chilean system. Section 3 discusses the Chilean historical background while Section 4 discusses the data and the empirical strategy. Section 5 discusses the results and Section 6 concludes.

2. A simple lifecycle model with social security

This section will provide a lifecycle model with social security system where retirement date is a chosen variable. Two cases will be considered. First, social security benefits will depend on returns from a risky investment and second, social security benefits will have no uncertainty. Those two cases are considered since there have been two different social security systems in Chile since 1925. First since 1925 to 1981, a PAYG obligatory system existed. In this system, the benefits depended on exogenous rules while since 1981 to the present, there exists an individual account social security system. The contributions, on this last system, are invested on a portfolio of assets with a random return. Hence, the case with random return will be associated with the individual account system while the case with no uncertainty will be associated with the PAYG system.

Consider first the case with random returns. The basic description of the economy is the following. The economy has three basics characteristics. First, the economy has a representative individual that lives between age t=0 and t=T. She faces a working and a retirement period. A social security system is imposed to assure income flows during her retirement. Some specialized firms that may be private or public institutions manage those contributions. Second, the economy has two assets on the capital market, a risk-free asset with return r and a risky asset with return z. The return of this asset is normally distributed with mean μ and variance σ^2, where $\mu > r$. The individual only can borrow or lend at the rate r on the capital market and the institution managing the social security contributions can only use the risky asset[3]. Third, there is an insurance market where the representative individual can fully insure herself.

The individual works during the first R period of her life and retires for the next T-R periods. To maximize her lifetime welfare function, she chooses consumption, hours of labor supplied to the labor market and her retirement date. Hours supplied to the labor market are restricted by a time limit. In fact, the individual has one unit of time as time endowment. Also she faces a social security system that works as follows. It taxes the individual's labor income at period t at rate τ_t and invests those taxes on the risky asset. When the individual retires, the uncertainty on the asset return is resolved. The return of the social security system becomes a retirement fund that is invested at the risk-free interest rate on the capital market. Periodically, between R and T, an amount Φ is debited from the retirement fund and paid to the individual. The amount Φ will be an increasing function of the realized return z, $\Phi = \Phi(z)$, $\Phi_z>0$. At the end of period T, the fund reaches a zero value. Hence, the individual uses all her retirement account.

The current utility level is separable over time and it will be defined by additive constant relative risk aversion functions on consumption and hours worked. The specification will be assumed to be $u(c,h)=\frac{c(t,z^t)^{1+\phi}}{1+\phi}-m\frac{h(t,z^t)^{1+\theta}}{1+\theta}$, where $c(t,z^t)$ and $h(t,z^t)$ are current consumption and hours worked. Notice that $\phi>0,\theta<0$ due to the concavity of the function and m is a just parameter of the utility function measuring disutility of work. Also the notation (t,z^t) indicates that the decision variables are time dependent and state dependent on the realization of z. I use the notation z^t to make clear the fact that two different sets for the financial return apply. First, when $t<R$, the return is not yet realized and the framework does not have uncertainty, therefore the set of realization for z could be represented by a degenerated function while for $t\geq R$, the set that applies is the one that supports the realizations for the random variable z. Finally, it is assumed that the individual discounts the future at the rate ρ. Given that after retirement the individual does not provide labor supply, the welfare function of the representative individual is

$$E[\int_0^R (\frac{c(t,z^t)^{1+\phi}}{1+\phi}-m\frac{h(t,z^t)^{1+\theta}}{1+\theta})e^{-\rho t}dt+\int_R^T (\frac{c(t,z^t)^{1+\phi}}{1+\phi})e^{-\rho t}dt].$$

[3] We can allow that the financial institutions managing the social security fund invest on a portfolio composed by the risky asset and the risk free asset. However, assuming risk neutrality on this firm, the fact that $\mu>r$ implies that the firm invests on the risky asset only.

The earnings profile, the individual faces, is the following. Between age t=0 and age t=R, the individual works and she obtains some labor income determined by the after-tax wage rate $w_t(1-\tau_t)$ and the time she supplies to the labor market. She also obtains returns from any investment made on the capital market at the risk-free rate of return. Between age t=R and t=T, the individuals receives $\Phi(z)$ as social security benefit plus the assets returns. Let $A(t, z^t)$ be the level of asset hold by the individual at period t and let the initial level of assets A_0 be equal to zero for simplicity. The change on the level of assets at the end of each period is determined as the part of total income not consumed. The problem of the individual is to choose her consumption, labor supply and retirement date given the evolution of assets and the feasibility constraint that the retirement date must be smaller than T. Hence the problem faced by the individual is:

$$\max_{\{c,h\}_{t=0,..,T},R} E[\int_0^R (\frac{c(t,z^t)^{1+\phi}}{1+\phi} - m\frac{h(t,z^t)^{1+\theta}}{1+\theta})e^{-\rho t}dt + \int_R^T (\frac{c(t,z^t)^{1+\phi}}{1+\phi})e^{-\rho t}dt]$$

$$s.t.$$

$$\dot{A}(t,z^t) = rA(t,z^t) + w_t(1-\tau_t)(1-h(t,z^t)) - c(t,z^t), \forall t \leq R \tag{1}$$

$$\dot{A}(t,z^t) = rA(t,z^t) + \Phi(z) - c(t,z^t), \forall t > R$$

$$R \leq T$$

On this economy, we have the possibility of full insurance. Hence, the set of equations relating to the evolution of assets over time can be written on the following single budget constraint:

$$\int_0^T E(c(t,z^t))e^{-rt}dt = \int_o^R w_t(1-\tau_t)E(h(t,z^t))e^{-rt}dt + \int_R^T E(\Phi(z))e^{-rt}dt \tag{2}$$

Let λ be the Lagrange multiplier of budget constraint. The problem will be characterized next. Notice that when the discount factor equal the free-risk interest rate - ρ=r -, the first order conditions are:

$$c(t,z^t) = \lambda^{1/\phi}, \forall t \tag{3}$$

$$h(t,z^t) = [\frac{\lambda w_t (1-\tau_t)}{m}]^{1/\theta}, \forall t \tag{4}$$

$$w_R(1-\tau_R)E(h(R,z^R)) = w_R(1-\tau_R)h(R,z^R) \geq E(\Phi(z)) \tag{5}$$

Equation (3) and (4) follows from the first order condition of consumption and labor supply respectively. Notice that the right hand side of each of those equations does not depend on the random return. In fact, the right hand side of equation (3) is a constant, while the right hand side of equation (4) is time dependant if after tax wage varies over time. But even in that case, conditional on some moment of time, labor supply is constant and hence it does not depend on the random return. Those properties basically follow from the fact that there is full insurance available. Equation (5) determines the retirement date. This equation indicates that when the expected value of social security benefits, if the individual retires, equals the alternative labor income, the individual is willing to retire. Notice that the first equality follows from equation (4), as the random return does not matter under full insurance. When the inequality slacks, the individual does not retire and she works until t=T. The result for retirement is not surprising. In fact, the individual has a concave utility function on consumption and she would like to smooth consumption over time. Hence, large changes on income due to retirement are not desired, as they would produce large fluctuations on consumption.

An interesting property with respect to retirement date relates to the properties of the distribution function of the random asset. As the distribution function is normally distributed, we can write the expected value of benefits as $E(\Phi(z)) = \Psi(\mu, \sigma^2)$, where $\psi_\mu > 0$ and $\psi_\sigma < 0$. In fact, the normal distribution function is completely characterized by its mean and variance and the expected value must be an increasing function of the mean while a decreasing function of the variance[4]. Hence, the optimality condition that determines the retirement date can be written as:

$$w_R(1-\tau_R)h(R, z^R) \geq \Psi(\mu, \sigma^2) \tag{5'}$$

Suppose the condition holds with equality, indicating an interior solution for R. An increase on μ must be related with smaller labor supply and possible with earlier retirement. In fact, the right hand side increases and the left hand side must adjust through the level of labor supply, as taxes and wages are exogenous to the individual problem. In the same way, an increase on the variance of the return must be associated with later retirement date by the same argument. The intuition for this result follows from the normality of leisure and the shape of the utility functions. When the mean of expected social security benefits increases, holding the variance constant, the individual is able to afford more leisure while when the variance increases, holding the mean constant, the individual prefers to accumulate more assets as a precautionary motive for the retirement years.

The property of labor supply above stated deals with retirement, namely the extensive margin decision. We will discuss now the effect over the intensive margin labor supply decision, namely the number of hours supplied to the market. To characterize labor supply, it will be useful to solve for the shadow price of wealth, λ.

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[4] See Varian (1992).

Using equations (3) and (4) plus the budget constraint –equation (2)- we get that λ=λ(w*,Φ*), where $w^{*}=\dfrac{\int_{0}^{R}(w_{t}(1-\tau_{t}))^{1+1/\theta}e^{-rt}dt}{m^{1/\theta}\int_{0}^{T}e^{-rt}dt}$, $\Phi^{*}=\dfrac{\int_{R}^{T}E[\Phi(z)]e^{-rt}dt}{\int_{0}^{T}e^{-rt}dt}$ and $\lambda_{w^*},\lambda_{\Phi^*}<0$. This expression is quite intuitive. In fact, w* and Φ* are just non-linear weighted average of labor income flows and expected social security benefits. Hence, marginal utility of wealth - λ - is a decreasing function of those weighted average types of wealth. Basically, larger wealth is related with smaller marginal utility of wealth, as in any lifecycle model.

Given this information, plus equation (4) and (5'), labor supply now can be easily determined. In fact labor supply will be given by:

$$\ln(h(t,z^{t}))=-\frac{1}{\theta}\ln(m)+\frac{1}{\theta}\ln(\lambda(w^{*},\mu,\sigma^{2}))+\frac{1}{\theta}\ln(w_{t}(1-\tau_{t})) \qquad (6)$$

As above, notice that the right hand side does not depends on the realized state of the risky asset; hence the labor supply does not depend on it. This equation resembles the usual specification used on the literature (MaCurdy, 1981). In fact, an increase on current after tax wage rate holding constant the shadow price, increase labor supply, as this is a pure substitution effect while an increase on the shadow price, holding constant the after tax wage rate, is a pure income effect and hence it decreases labor supply. The main difference with the literature is that equation (6) also shows that the properties of the distribution of the risky asset matters. In fact, a larger mean of the return on the risky asset is associated with lower labor supply while larger variance of the return is associated with larger labor supply, on the intensive margin. The intuition is basically the same argument than in the case of retirement.

In summary, as it can be seen on equation (5') and (6), a social security system that invests its funds on a risky asset may have important effects over retirement and labor supply. In fact, the properties of the distribution of the risky assets are quite important when considering retirement and labor supply problems. Larger mean of the risky asset are associated with income effects that produce earlier retirement and lower labor supplied to the labor market. However, larger variances of the risky assets are associated with later retirement and larger labor supplied to the labor market due to the precautionary motive.

Finally, it is easy to extend the model to a case where social security funds are not invested on risky assets. In that case, equations (5) and (6) become:

$$w_R(1-\tau_R)h(R) \geq \Phi_R \tag{5''}$$

$$\ln(h_t) = -\frac{1}{\theta}\ln(m) + \frac{1}{\theta}\ln(\lambda(w^*, \Phi^*)) + \frac{1}{\theta}\ln(w_t(1-\tau_t)) \tag{6'}$$

Where $\Phi^* = \frac{\int_R^T \Phi_t e^{-rt} dt}{\int_0^T e^{-rt} dt}$ and Φ_R is the social security benefit at R. Clearly in this case only the increase on mean benefits matters, as there is no variance. The effect has the same sign, meaning that an increase on social security benefits is associated with earlier retirement and lower labor supply due to income effects. This last case is similar to a PAYG social security system with no uncertainty, as contributions are not related to later benefits.

Finally, it should be noticed that this section emphasizes the second moment of the distribution of assets as a determinant of retirement and labor supply. In fact, this property holds due to the fact that we are using a normal distribution that is completely characterized by its two first moment conditions for simplicity. Usually, larger moment of the distributions may also affect the decisions as they also characterize the distribution of the return.

3 The Chilean social security system.

Chile implemented a PAYG social security system on 1925. The system became not sustainable and it was replaced on 1981 by an individual account system. The new system became obligatory to individuals entering the labor force after the law changed. However, individuals currently working on 1981 had the choice between remaining on the old PAYG system or switching to the new individual account system. As a result a large fraction of those individuals did not switch to the new system –almost 25%-, when the law was implemented. Also the 1981 law allows some set of individuals to remain not affiliated to any social security system. Individuals that have not entered the labor force and self-employed individuals compose this set. In fact, social security tax depends on labor income that is not easily verifiable on the case of self-employed individuals. To avoid this problem, the law allows self-employed individuals to affiliate and pay taxes only if they wish. Employers directly reduce social security taxes from their employee labor income. Hence, labor income is easily verifiable from firms' information.

Individuals affiliated to the PAYG social security system may be affiliated to four main institutions. The four institutions are: the social security administration (SSA), the private worker pension administration (PRWPA), the public worker pension administration (PUWPA) and the army forces pension administration (AAFFPA[5]). Some others institutions existed, but their size was smaller than those cited above. The social security administration manages the pension funds of unskilled workers of the non public sector. Individuals that remained affiliated to the SSAA currently pays 19.1% of their labor income as social security tax. The PRWPA includes skilled workers of the non public sector and taxes their affiliates at a 20.15%. The PUWPA includes the majority of public sector workers and it taxes their affiliates at 19.03%. Finally the AAFFPA includes as contributors all individuals working on the army force. They are taxed at 20%. Those taxes were quite large compared with the tax rate faced by an individual affiliated to the new individual account system. In fact those individuals in the private system, pay only a 10% of their labor income as social security tax. This tax differential and the subsequent increase on the disposable income for those individuals switching to the new system may have been very influential on the overall switching from the old to the new system.

It should be noticed that the hazard rate of switching to the new system on 1981 was age dependent. The rationality for this age dependency on the switching decision may be explained by the way pension benefits were determined in both systems. Pensions on the PAYG system were mainly determined by wage income during the last 5 years of work. Hence workers had a strong incentive to obtain higher wages during the last part of their working life. In the new system, as the individual has a private account that accumulates interests over time, they have incentives to work and accumulate pension funds over all the working life. In that scenario older individuals that did not work hard enough during their working life before 1981 did not have incentives to switch as the pension they would receive on their retirement age would be lower than the one they would obtain on the PAYG system. On the other hand a fairly young individual at the moment the law was passed, was not negatively influenced, as she did not have already played her working life strategy. In fact, only 8% of affiliated workers aged 63 at the moment of the reform switch to the new system while almost 100% of the affiliated workers aged 28 or younger switch to the new system. Graph 2 shows the fraction of affiliated that switch to the new system when the law was implemented as a function of their age.

[Insert Graph 2]

There were also larger incentives to stay on the old system for some identifiable groups. As it was indicated above, on the PAYG system the pension are determined as fraction of the wage income obtained during the last years before retirement –usually the last 5 years -. Also

[5] There also existed a pension administration for the police department.

there are debits on the wage income if the worker is a women or a hard laborer. In fact if the worker is widow, she obtains an increase of 2 years of wage income if she is affiliated to the social security administration or the private worker pension administration. If she switches to the new system, she looses the subsidy over its income base used for the calculation of pensions. Maternity has a similar impact, as an increase on 1 years of wage income is added to the calculation base per child if she stays on the same institution, but looses the benefit if switching to the new system. Hard laborers have 10 years of debits in their accounts if they were affiliated the social security administration and they work at the mining sector and 5 years of debits if they were affiliated to the social security administration and they did not work on the mining sector. Also workers on night shifts got 5 years of subsidy if they were affiliated to the private worker pension administration. Those workers also lost their subsidy if they switch to the new pension system.

Some others incentive to stay on the old system are linked to the level of compensation obtained from the institution they were affiliated. In fact, when we compare the level of pension on the 4 main institutions on the PAYG system, we find that on 1980 the average pension receiver of the SSA obtained a 46% of the average Chilean pension, while individuals affiliated to the PRWPA obtained 77% of the average and individuals affiliated to the PUWPA received 148% of the average. In the case of the army forces pension administration, the benefit was 350% of the average Chilean pension[6]. There could exist some self selection in those data in the sense that workers affiliated to the social security administration are unskilled workers while the one affiliated to the private worker pension administration are skilled and hence the difference on pension may be explained, at least in part, by differences on past contributions. However there is also some exogeneity on those benefits. Public workers are not very different to private workers and also army forces do not have larger wage incomes than the rest of the economy in general.

[6] See Arellano (1984)

Hence this difference on the level of pension may have had an impact on the decision of switching to the new pension system.

On the private system, private corporations denominated as "AFP" manage the contributions of individuals on the private social security system. Those corporations invest the contributions and pay the benefits when the individual retires. Individuals on the other hand, pay commissions for the administration of the fund. Individuals may choose the AFP they affiliate and they can switch among AFPs as they wish. However, individual cannot distribute their contribution among AFPs. The market is regulated by the "SAFP", a government institution which only activity is the regulation of the private fund market.

One of the characteristics of the private system has been the large and highly variable rate of return of the AFPs' investment. Since the implementation of the system on mid-1981 until the end of 2000, the average rate of return is 11.1% with a standard deviation equal to 9.49%. Graph 3 shows the evolution of the return on the period 1981-2000. The standard deviation of the rate of return among different AFPs is quite small, ranging from 0.2 % on 1996 to 3.1% on 1981, when the system was first implemented[7]. Hence the average rate of return and its evolution represents quite well the evolution of any individual account in the private system.

[Insert graph 3]

Finally, it should be noticed that there were individuals that contributed for some given periods of time to the PAYG system and when the law was implemented they switched to the new system. The way the government handled the contributions already paid to the old system in those cases, was to pay a 4% annual real return on contributions to the PAYG system. Hence, the return obtain from those individuals over their lifetime contribution to social security systems was composed by a random component given by the return on contribution paid after they switch to the new system and 4% annual real return on the contribution they paid to the PAYG system.

4. The data and the empirical strategy

4.1 The empirical strategy

The paper focus on the set of individuals aged 55 to 65 years old on 1998. The empirical strategy followed in the paper to estimate the retirement and the labor supply equation will be the following. We work with the set of individuals that already entered the labor force and hence are affiliated to any social security system. First, the probability of retirement is estimated using a switching regression models. We use a switching regression model because individuals may choose between two different statuses, affiliation to the individual account social security system and the affiliation to a PAYG system. As shown on section 3, the choice of social security system may affect differently retirement, as the AFP system has a larger variance on its return.

Second, we estimate the labor supply function among working individual by correcting the self-selection decision of being out or in the labor force, as in Heckman (1974). Those procedures are explained next.

4.1.1 The retirement decision

The estimation of the retirement decision function focuses on the intuition underlined on equations (5') and (5''). Since the PAYG social security system presents less risk than the individual account social security system, we are going to link the equation (5'') with the PAYG social security system while equation (5') with the individual account system. The basic difference is that retirement will depend on the variance of the social security return in the case of the individual account system while it will not on the PAYG system. The estimation will be a switching regression model as a specific individual could be affiliated to the PAYG or the individual account system.

The general specification of the econometric model will be the following:

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[7] See Barrientos (1998).

$$I_1^* = 1(PAYG) = 1(Z_1\gamma_1 > \varepsilon_1) \quad (7)$$

$$DR^{PG} = \beta_o^{PG} SSW + X\alpha + u, \ldots if \ldots I_1^* = 1 \quad (8)$$

$$DR^{PS} = \beta_o^{PS} SSW + \beta_1^{PS} Var(SSW) + X\alpha + u, \ldots if \ldots I_1^* = 0 \quad (9)$$

Where 1(•) is an indicator function equal to one if the enclosed statement is true and zero otherwise. Equation (7) describes the individual's decision between social security systems. Hence, Z_1 are variables determining the affiliation to the PAYG social security social security system. The error term ε_1 is an unobservable component that affects the decision process. The variable DR is an indicator function equal to one if the individual declares himself as retired on the survey and zero otherwise. Equation (8) and (9) describe the retirement behavior of individuals on the PAYG and the individual account system respectively. The variable SSW and Var(SSW) are the level and variance of the return obtained by the individual portfolio on the individual account system. The superscript PG and PS indicate PAYG and individual account system respectively. Equation (8) and (9) present similar specifications, but equation (9) is the one that indicates the behavior under the individual account system since it includes also the variance of the portfolio. The matrix X contains all others observable variables that may influence retirement, including demographic variables. In fact, the variables included may be quite important, as wages are not observed for retired individuals. Equation (5) –on section 2- or any of its alternative specifications indicates that current wage may be an important determinant of the retirement decision. Given that wages are not observed for everyone, additional variables as education, age and age squared are included to specify the behavior of wage rates. Finally, notice that theory implies that $\beta_0^{PG}, \beta_0^{PS} \geq 0$, $\beta_1^{PS} \leq 0$ and u is a well-behaved error term.

It must be noticed that the main econometric problem faced while estimating the model is the one of self-selection between social security systems. To correct this potential bias, we will use an instrumental variable approach, as it will be explained below.

The specification indicated by the equations (7)-(9) can be combined in the following way:

$$DR = DR^{PS}(1 - I_1^*) + DR^{PG}(I_1^*) \qquad (10)$$

Or

$$DR = X\alpha + \beta_o^{PS}(SSW) + (\beta_0^{PG} - \beta_0^{PS})(I_1^* SSW) + (\beta_1^{PS})[(1 - I_1^*)Var(SSW)] + u \qquad (11)$$

Where (I_1^*SSW) is a variable that includes the level of social security benefits if the individual is affiliated to the PAYG system and zero otherwise and [(1-I_1^*)Var(SSW)] is a variable that includes the variance of the level of benefits if the individual is affiliated to the individual account system and zero otherwise. As above DR and SSW represent the indicator function for retirement and the level of present value of benefits on any social security system respectively. Notice that the effect of an increase on individual account social security wealth over retirement, holding constant the variance, is given by the coefficient on SSW, while the effect of an increase on the PAYG social security wealth is given by the sum of coefficients of SSW and I_1^*SSW. The effect of an increase on the variance of social security benefits on the individual account system is given by the coefficient of (1-I_1^*)Var(SSW).

It can be clearly seen now, that a bias on the estimation can be produced if we estimate equation (11) directly by least squares. In fact, notice that to obtain consistent estimates we require that the covariance between the right hand side variables and the error term is zero and moreover that cov(SSW,u)=cov(I_1^*SSW,u)=cov((1-I_1^*)Var(SSW),u)=0. However, those conditions may possibly not hold, as the individuals may be self-selecting between social security systems based on unobservable variables to the econometrician.

To avoid the problem of inconsistency we are going to use some variables as exogenous instruments. Three variables will be used as instrumental variables. This number of exogenous instrumental variables is enough to identify the parameters, as the number of variables presenting the self-selection problem is also three – SSW, I_1^*SSW and (1-I_1^*)Var(SSW). The first variable will be the set of individuals affiliated to the army forces. The instrument will be a dummy variable equal to one if the individual works on the army forces and zero otherwise. In fact, this set of individuals was required to remain affiliated to the PAYG system by the 1981 law and hence could not choose between systems. The second instrument will be a second indicator function equal to one if the person is not a self-employed worker and zero otherwise. This instrument follow from the fact that self-employed worker are allowed by the 1981 law to remain not affiliated to any social security system if they wish, hence the instrument is equal to one for all the individual that must be affiliated to a social security system. This instrument provides a way of measuring affiliation and allows us to instrument for the self-employed individual's decision. Finally, the third instrumental will be an indicator function equal to one if the individual is aged 43 years or less on 1981 and zero otherwise. As indicate above, the overall switching to the new system was age dependant and older individuals were less likely to switch to the new system. Notice that an individual aged 43 years old on 1981 is aged 61 years old on 1998, the years the survey is realized. Hence, the threshold represents the median age of the individuals on our sample –55 to 65 years old.

The three instrumental variables are correlated with SSW, I_1^*SSW and (1-I_1^*)Var(SSW), as they determine system selection. Also the instruments are exogenous since it is basically the 1981 law and its regulation that determines that army forces workers should remain on the old system and gives incentives for switching mainly to younger individuals as explained on section 3. Hence, those instruments should be uncorrelated with the error term of equation (11), as those individuals cannot react to the social security system as a response to unobservable variables. Some evidence of this fact is shown below.

4.1.2 The labor supply decision

The second step on the labor supply estimation deals with the amount of hours supplied to the labor market among the individuals that decided to work. First, a probit model on the labor force participation decision is run. The probit resembles equation (11), however the set of individuals out of the labor force includes retired individuals, students, sick individuals, parents taking care of their children, etc. Hence, this group obviously has a larger size than the set of retired individuals. Using the probit estimates, we form a control function as in Heckman (1974). But notice, that the additional problem is again that this procedure must be followed for PAYG affiliates and individual account system affiliates. Hence, there is a switching regression model and we need some instrumental variables, as the selection between systems is endogenous.

To clarify the procedure, the main econometric system will be now stated:

$$I_1^* = 1(PAYG) = 1(Z_1\gamma_1 > \varepsilon_1) \tag{7}$$

$$\ln(h^{PG}) = \alpha_o^{PG} SSW + \widetilde{X}\widetilde{\alpha} + \psi(\hat{c_i}) + e, \ldots if \ldots I_1^* = 1 \tag{12}$$

$$\ln(h^{PS}) = \alpha_o^{PS} SSW + \alpha_1^{PS} Var(SSW) + \widetilde{X}\widetilde{\alpha} + \psi(\hat{c_i}) + e, \ldots if \ldots I_1^* = 0 \tag{13}$$

Where h indicates labor supply and $\psi(\hat{c_i})$ is the fitted control function obtained from the estimation of the first step, namely the probit estimation. Equation (12) and (13) are the empirical counterpart of equation (6) and (6') -on section 2- after controlling by the selection decision of being on the labor force. The matrix X contains a measure of lifetime income labor wage –this is a way of measuring w* on section 2. Also, it may contain variables related to the characteristics of the individual and her work, plus after tax labor income. The inclusion of variables related to individual and job characteristics follows from the fact that preferences include a parameter, m, related to disutility of work. This parameter indicates that disutility of work may depend on individual and current job characteristics. Equation (7) is the same selection equation between social security systems. As above, this set of equations can be combined in the following single equation:

$$\ln(h) = \alpha_o^{PS} SSW + (\alpha_o^{PG} - \alpha_o^{PS})[I_1^* SSW] + \alpha_1^{PS}[(1 - I_1^*)Var(SSW)] + \tilde{X}\tilde{\alpha} + \psi(\hat{c_i}) + e \quad (14)$$

Equation (14) will be estimated. Analogous to equation (11), notice that the effect of an increase on individual account social security wealth over labor supply, holding constant the variance, is given by the coefficient on SSW, while the effect of an increase on the PAYG social security wealth is given by the sum of coefficients of SSW and I_1^*SSW. The effect of an increase on the variance of social security benefits on the individual account system is given by the coefficient of (1-I_1^*)Var(SSW). The equation must be estimated using instrumental variables by the same argument stated above. The same set of instruments will be used.

4.2 the data

This paper uses the 1998 CASEN[8] survey realized by the Chilean government during November and December of 1998. The survey is based on a random sample of 48107 households[9] with a probabilistic error of 0.45%. There are 188360 individuals on the sample. The survey has information on schooling, health, housing, income and employment plus demographic characteristics. I will describe next how we compute the main variables of the system, namely information about hours supplied to the labor market (if any), value of social security benefits and the variance of the benefits on the individual account system.

The employment section of the dataset provides information about the current labor status of the individuals. The first question asks if the individual worked during the precedent week to

[8] This survey describes the socioeconomic characteristics of the Chilean population.

the survey. In the case the individual's answer is no, subsequent questions ask if she was absent temporarily of the job and if she had worked anytime during her lifetime. Also, if the individual was not working and she was not looking for a job, the survey asks about the reason of not searching for a job. Possible answers are being sick, taking care of children, student, not currently interested and retired, among others. This question allows us to define an indicator function equal to one if the individual answers to be retired and zero otherwise. Also, hours supplied to the labor market for working individuals are directed measure by question 11 of the employment section. This question asks about the number of hours worked the week before the survey was realized.

We construct a variable containing the present value of the social security benefits (SSW) by using two pieces of information. First, we use the question 21 of the CASEN employment section. The question is: Are you affiliated to any pension system? The possible answers are: (1) Social Security Administration, (2) Public Worker Pension Administration, (3) Private Worker Pension Administration, (4) AFP[10] (private system), (5) Army Forces Pension System, (6) Other and (7) Not affiliated. This piece of information indicates that among individuals aged 35 and older –individuals 18 and older on 1981 when the law changed who were allowed to choose between systems- 41% is not affiliated at all to any social security system, while 22% is affiliated to the "pay-as-you-go" system and 37% to the individual account system. Those non-affiliated individuals are out of the labor force or self-employed workers. The second piece of information is data on retirement income for individuals affiliated to the PAYG system and labor income for affiliates to the individual account system.

In fact, to estimate the present value of benefits on the PAYG system, we use the data on retirement income on the PAYG system. A reduced form equation for pensions were estimated as function of age, age squared, schooling and demographic variables. Next, this equation was used to simulate the path of pensions on the PAYG system, for all the individuals affiliated to the

[9] 33714 urban and 14393 rural households
[10] Individual account system

PAYG social security system –information that we know from the answer on question 21. Varying age, from 60 to 80 in the case of women and 65 to 80 in the case of men, the lifecycle retirement income profile for each individual was obtained[11]. Using a 5% discount rate, the present value of benefits on the PAYG system was obtained. It was measured at age 20.

To compute the level of the benefits on the individual account system, a different approach was followed. We have information on labor income and we use this information for individuals affiliated to the private system. We compute a Mincer-type equation for labor income as a function of age, age squared and schooling (plus demographic variables). Using this equation and varying age from 20 to 65 in the case of men and 20 to 60 in the case of women, the estimated lifecycle wages for each individual affiliated to the private system was obtained. Given the social security tax rate, the year contribution was obtained and using a 5% discount per year we compute the present value of tax contribution. Given the present value of taxes, the expected present value of benefits can be computed by using the average rental rate of return of the system. This follows from the definition of the individual account system, where future benefits are directly linked to benefits and the rental rate of return obtained on the investment of the funds – 11.1% as indicated above. For individuals that contributed to the PAYG system in part of their lives and switch to the individual account system later, instead of using the rental rate of the funds, we use as rental rate of return for the contributions a weighting average between rate of return of the funds and the 4% return paid by the government for contributions realized on the PAYG system. The weights are the defined as the fraction of time spent on each of the systems, e.g. if the individual was 10 years of her life on the PAYG system, we define the weight for the rental rate paid by the government as 10/(65-20), where 65 is set as a priori retirement date and 20 is set as a priori age of entering to the labor force.

[11] Women should retire at 60 years and men at 65 years old by law. However, they could anticipate retirement if they have accomplish they have a large amount of contributions on their retirement funds. See the 1981 law. Also, life expectancy was around 80 years old on 1998.

Also, using the lifecycle path for labor income simulated above with the Mincer equations, we compute a present value lifetime labor wealth at age equal to 20, by using a 5% discount rate. This is a measure that approximates w*, on section 2. The way of computing the variance of the benefits on the individual account system is next. We calculate a standard deviation for the portfolio of the individual as follows. We know the average standard deviation of the investment on the individual account system and we also know that if an individual contribute part of her life to the PAYG system and then switch the individual account system, the contributions to the old system will pay a 4% return with complete certainty. Hence, as above the standard deviation of the individual portfolio is set as a weighted average between the average standard deviation of the individual account system and the zero-standard deviation of the PAYG system. Then we use the present value of the contribution and the individual portfolio standard deviation to calculate the variance of the benefits on the individual account system.

5. The results

5.1 The instrumental variables

In this section, the results are going to be discuss, however first some evidence on the appropriateness of the instrumental variables used will be given.

It should be noticed that if individuals do not select between social security systems, we would not require the instrumental variable estimators. In that case, individuals would be randomly allocated between systems. But we have some evidence indicating that self-selection exists. Table 2 tests for mean equality of different characteristics (demographic, labor income, subsidies, geographic location) between different groups. The first two columns are the group of individuals affiliated to the PAYG system and the set of individuals affiliated to the individual account system. The third column tests the equality between both, for the different characteristics on the table. The means reported on the columns corresponding to the PAYG system and the private systems are statistically different for different variable considered, as shown on the third column. Hence, we may conclude that people on the two systems have different characteristics and hence self-selection between systems is highly probable.

[Insert table 2]

In fact, we run a probit and a linear probability model between a dummy variable indicating PAYG affiliation and a set of observable variables. We use the set of individuals 35 years and older on 1998. In fact, those individuals were 18 years and older on 1981, when the law was reformed, and they could self-select among social security programs. Both probability models are highly significant as it can be seen on table 3. This result indicates that people that have the possibility of self-selection do self-select among observable variables and hence it is highly probable that they do select based on unobservable characteristics also.

[Insert Table 3]

To solve our econometric problem, we require that the instrumental variables are uncorrelated with the error term, e.g. cov(z,u)=0 where z is our set of instrumental variables and u is the error term of equation (11) or equation (14). In fact, we should expect this result to hold, as for instance, the individuals on the army forces -that determine one of our instrumental variables- were not allowed to choose between social security systems. It is not possible to determine the correlation between the unobservable variables and the instrumental variable; but even in that case, some useful tests may exist.

In fact, notice that a stronger condition will be zero covariance between the instrumental variables and the independent variable itself, namely hours supplied to the labor market or retirement. The independent variable contains the observable and the unobservable components and hence if there is no correlation between the independent variable and the instrumental variables, we have a good indicator that, in general, cov(z,u)=0 holds. A second type of condition that may indicate that cov(z,u)=0 holds, is to check if the covariance between the instrumental variable and observable differences between households such as demographic variables, location and income is zero. If this last covariance is not largely significant, we can be confident that demographic, location or income shocks are not correlated with the instrumental variables and hence we have another good indicator that cov(z,u)=0 holds.

Table 2 shows those tests for individuals aged 55 to 65 years old, the main group in this study. Notice that columns (4)-(6) show the means and test its equality between individuals affiliated and not affiliated to the army forces while column (7) to (9) test for mean equality for individual aged less than 44 years old on 1981 and individual aged more than 44 years old on 1981. Finally, columns (10) to (12) do the same analysis with self-employed and non self-employed individuals. The row related to hours supplied to the labor market shows that in fact hours supplied are statistically different between individuals affiliated to the PAYG and individual account system and however, hours supplied to the labor market are not statistically different for any of the different groups involved on the three instrument used. Hence, cov(z,y)=0 cannot be rejected.

In the same way, the other rows of the table show if the instruments are correlated with some observable shocks. Table 2 tests for mean equality among demographic variables, location variables and income variables (including subsidies). It is interesting to notice that variables such as location, income, and subsidies present in general statistically equal means when the instrumental variables are used and statistically different means when we compare private system versus PAYG system. Hence, demographic characteristics, labor income shocks, subsidies shocks and geographic shocks are uncorrelated with our instrumental variables.

Those two pieces of information give us a good indication that the instrumental variables here used are uncorrelated with the unobservable shocks.

5.2 The effects of the social security system over retirement and labor supply

Retirement decisions are estimated by using equation (11). Initially we obtained fitted values for the variables SSW, I_1^*SSW and (1-I_1^*)Var(SSW) using our instrumental variables and later, estimates of the parameters of equation (11) are obtained by using those fitted values. As retirement is a zero-one decision variable, we run a linear probability model and a probit model. To characterize the sensitivity of the results, we first introduce new variables on our matrix X and later we estimate the same equation for different groups of individuals. The groups are defined by income and later by age.

On the baseline specification, the matrix X includes schooling, and demographic variables such as dummy variable for females, dummy variable for married individuals, dummy variable for widow individuals, a dummy variable for broken households and the size of the household. Also, it includes location variables –indicating region and county of residency of the individual- and government subsidies. The first three columns of table 4 shows the results of the baseline case for a direct least square regression on equation (11) –hence without using our instruments- and the results of the linear probability and the probit model. The results shows that the signs obtained on the least square case are different that the ones implied by theory on section 2. This is an indicator that self-selection between systems may be producing bias in our estimators. However, when the instruments are used, we obtain the right signs. In fact, an increase of 1% on the level of social security wealth on the individual account system produces an increase of 0.2% of the retirement probability on the linear probability model and a 0.6% on the probit model. The effect of the level of benefits on the PAYG is larger than in the individual account system as shown by both models. In fact a 1% increase of social security wealth on the PAYG system should have a positive effect over retirement probability, ranging from 0.6% on the linear probability model to a 1.8% on the probit model. The effect of a 1% increase on the variance of the benefits on the individual account system, are associated with a 0.36% decrease on the probability of retirement in the linear probability model and with almost a 1% decrease on the probability of retirement in the probit model. Columns (4) to (6) and (7) to (9) of the table present the results when the matrix X additionally includes variables relating to health status and age. The results in both cases are not significant modify.

[Insert table 4]

Tables 5.1 and 5.2 present the results conditioning on income groups and age groups. The results indicate that individuals in the 60% lowest percentile of income or individuals younger than 61 years old do not have significant differences on their retirement behavior with respect to the others individuals aged between 55 and 65 years.

[Insert Table 5.1 to 5.2]

In summary, estimating directly equation (11) seems to bias the estimators while the instrumental variable approach is very consistent, as changing the specification of the model and the groups used on the estimating sample does not significantly modify our point estimates. The results show that increases of social security wealth on the PAYG and the individual account system induce earlier retirement while larger variances of the benefits on the individual account system should induce later retirement.

The effects of social security system over labor supply of individual that decided to enter the labor market are shown on table 6.1 and 6.2. Table 6.1 presents a probit estimate for the individual's decision of entering the labor force while table 6.2 presents the results over labor supply. Column 1 of table 6.2 shows the results for the baseline case. This case includes as independent variable the same variables included on the retirement decision plus the lifetime labor income, w*, the control function, the natural log of labor income and job characteristics[12]. The second column shows the estimations among individuals on the lowest 60^{th} percentile of the income distribution while the third column shows the estimation for the richest 40^{th} percentile. Finally, columns 4 and 5 of the table show the estimations individuals between 55 and 61 years old and individuals between 61 and 65 years old.

[Insert table 6.1 and 6.2]

The estimates, on column 1, show that larger lifetime labor income would depress current labor supply –this is an income effect holding constant current wages-. Also, larger social security wealth should depress labor supply on both systems and larger variance of benefits on the individual account system should increase labor supply. Those results are in line with theory, however, the coefficient of I_1^*SSW and $(1-I_1^*)Var(SSW)$ are not significant. Since the coefficient of SSW is significant while the one of I_1^*SSW is not, we may conclude that the effect of an increase of the social security wealth is the same on both systems. The point estimate shows that an increase of 1% on the social security wealth should be associated with a 0.1% decrease on hours of labor supplied to the market. The control function is significant indicating that self-selection on the decision of entering the labor force arises and labor income has a positive and significant effect over hours supplied to the labor market, as expected.

However, estimates obtained for individuals on the lowest 60th percentile of the income distribution seem to indicate that those individuals are not affected by social security and their point estimate elasticity with respect to current labor income -a substitution effect- is larger that for richest individuals. This later group of individuals seems to react to changes on level of social security benefits. A 1% increase in social security wealth produces a 0.2% decrease on hours supplied to the labor market. The point estimates for the variance seems to be more significant, but nevertheless we cannot reject the null hypothesis that the coefficient is zero at 5%. Their elasticity with respect to labor income is smaller and they clearly self-select among to enter or not to the labor force. Finally, notice that younger individuals seems not to be affected by social security, but as they becomes older than 60 years and they approach 65 years old, the age required by law to retire in the case of men, social security wealth seems to become an important determinant of labor supply decisions.

Hence, social security seems mainly to affect retirement decisions. Labor supply decisions (hours supply to the market assuming the individual has decided to work) are influenced by social security only as individuals are nearer to 65 years old -the retirement age determined by law.

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[12] Basically, we include dummy variable for permanent, temporary and part time jobs.

Those results seem to explain the decreasing retirement rate during the nineties in Chile. In fact, the fraction of individual affiliated to the PAYG system decreases steadily through time, as any individual currently entering to the labor force must be obligatorily affiliated to the individual account system. With the exemption of the army forces, on the long run all individuals should be affiliated on the individual accounts system. However, this last system presents a larger variance on their benefits and individuals react through expanding their working life and hence retiring later. Hence, as the fraction of individuals affiliated to the individual account system continues to increase, aggregate retirement rates should continue to decrease.

6. Summary and policy implications

The paper deals with the effect of the social security system over labor supply and retirement decisions in the case of Chile. This case allows us to investigate the effects of the PAYG and the individual account system. A stylized theoretical model provided in the paper indicates that larger social security wealth should depress labor supply and induce earlier retirement while larger variance of those benefits should increase labor supply and induce later retirement. The paper, under different specification forms and for different group of individuals aged between 55 and 65 years old, shows that those predictions are, in general, empirically corroborated. Hence, the fact that over time the fraction of individuals on the individual account system increases and the fact that those individuals face larger variances on their social security benefits, may explain why retirement rate had decreased in Chile during the nineties.

Some policy implications for industrialized countries can be inferred from the Chilean experience. As the paper shows that social security may affect retirement and labor supply decisions on the group of individuals aged 55 to 65, countries with larger PAYG social security system should have larger retirement rate on the group of individuals aged 55 to 65 years old. Also, due to a sustainability problem, countries with large PAYG social security system have recently reformed -or they are currently studying the reform- their social security system. A usual, a discussed alternative is the privatization of the system, as in Chile -the case here analyzed. Alternative reforms may not involve privatization but individual account system managed by the public sector. The paper shows that whatever is the alternative of reforms chosen, if the reform involve large variance of social security benefits, retirement rates may be modify substantially. In that case, the increase in retirement rates observed in industrialized countries may be reversed due to individual's willingness to accumulate larger wealth before retirement in case of a lower return on their social security investment funds.

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Data Appendix

The data used is the 1998 CASEN survey from Chile. This survey aims to describe the socioeconomic characteristics of the Chilean population. It can be obtained from the Chile government.

Table 1
Retirement rate by age group and social security system, 1998

Group	Retirement rate Individual account System %	Retirement rate PAYG system %
45-50 yrs	0.6	7.1
50-55 yrs	2.6	10.9
55-60 yrs	5.8	21.2
60-65 yrs	17.5	35.4

Table 1.2
Summary Statistics

Variable	Number of Observations	Mean	Standard Deviation	Min	Max
1(Retired)	7313	0.2056	0.4042	0	1
Hours worked	4059	53.70	77.72	0	96
1(married)	7313	0.7168	0.4505	0	1
1(widow)	7313	0.1204	0.3255	0	1
Household size**	7313	1.216	0.549	0	2.70
Social security benefits*	7313	11.90	1.25	0	14.12
Individual account benefits**	3253	12.44	0.66	10.75	14.12
Variance of benefits**	3282	18.51	2.21	0	22.36
1(Gov. subsidy)	7313	0.197	0.398	0	1
1(female)	7313	0.376	0.484	0	1
Schooling years	7254	8.16	4.23	0	19
1(Broken marriage)	7313	0.067	0.251	0	1
1(Permanent work)	7313	0.434	0.495	0	1
1(temporary work)	7313	0.088	0.284	0	1
1(self-employed worker)	7313	0.158	0.365	0	1
1(army force worker)	7313	0.001	0.03	0	1
1(employee)	7313	0.333	0.471	0	1
1(family member working on family business)	7313	0.004	0.066	0	1
Age on 1981	7313	43.47	2.96	39	48
Labor income wealth (w*),**	7254	15.70	1.23	12.89	18.59

Note: 1( ) is an indicator function equals to one if the enclosed statement is true and zero otherwise. Also "Gov. Subsidy" indicates government subsidy to buy a house and ** indicates that the variables are in natural log

Table 2
Social Security systems and Instrumental variable estimators by characteristics, Age group 55-65 years old

	PAYG	AFP	T TEST	ARMY FORCES	NOT ARMY FORCES	T TEST	AGE <=44 on 1981	AGE >44 on 1981	T TEST	NON Self-Employed	Self-Employed	T TEST
Number of Children	1.13	1.29	-5.46	1.22	1.25	0.08*	1.43	1.15	13.2	1.20	1.22	-0.4*
Size of household	3.8	3.97	-3.37	3.66	3.96	0.42*	4.13	3.86	7.7	3.73	3.91	-2.75
Married	0.66	0.77	-10.2	0.88	0.71	-1.1*	0.75	0.68	8.1	0.77	0.70	4.78
Widow	0.14	0.08	8.8	0.00	0.12	1.1*	0.08	015	-12.2	0.07	0.12	-5.03
Female	0.44	0.27	15.2	0.11	0.52	2.4*	0.51	0.53	-1.8*	0.19	0.41	-13.8
Location	0.28	0.34	-5.7	0.44	0.27	-1.1*	0.27	0.27	0.09*	0.25	0.32	-4.29
Education	8.7	7.7	-10.3	12.0	7.4	-3.2	7.89	7.26	8.9	8.04	8.17	-1.0*
Hours worked	**46.6**	**48.2**	**-2.9**	**44.4**	**46.8**	**0.4***	**46.96**	**46.93**	**0.05***	**47.2**	**47.8**	**-0.9***
Labor income	189269	279249	-6.67	332864	223667	-0.6*	244754	211424	2.5*	293889	222606	4.71
Subsidy 1	1162	1382	-3.65	444	1092	0.82*	1197	1036	4.03	713	1368	-8.08
Subsidy 2	418	380	0.93*	0	542	0.8*	579	503	2.2*	465	389	1.4*
Subsidy 3	307	293	0.47*	222	305	0.19*	278	314	-1.7*	263	309	-1.1*
Subsidy 4	2830	1782	4.92	3333	3778	0.11*	2774	4427	-8.8	2244	2248	-0.5*

Note: * indicates not significant at 1%. Location is a dummy variable equal to one if the individual lives on Santiago (The main city in Chile). Subsidy 1 is a subsidy mainly related to minimum pensions for elderly. Subsidy 2 is governmental subsidy per child attending school. Subsidy 3 is an unemployment subsidy. Subsidy 4 is a subsidy for low-income families to pay water supply services.

Table 3
Probability estimations of being affiliated to the PAYG system

	Linear Probability Dependent variable 1(PAYG)	Probit Dependent variable 1(PAYG)
1og of labor income	-0.007 (-2.40)	-0.079 (-3.81)
1(Gov. housing subsidy)	-0.005 (-1.35)	-0.039 (-1.31)
Age	-0.016 (-15.8)	-0.015 (-2.21)
Age squared	0.0002 (22.7)	0.0006 (9.09)
Years of Schooling	-0.004 (-6.17)	-0.023 (-5.71)
1(fem)	-0.003 (-0.92)	-0.03 (-1.08)
1(married)	-0.012 (-2.89)	-0.12 (-3.18)
1(widow)	0.054 (2.93)	0.13 (1.73)
1(broken household)	-0.02 (-2.34)	-0.15 (-2.55)
Log of household size	-0.003 (-0.77)	0.03 (1.09)
1(Permanent work)	0.22 (14.8)	1.52 (9.22)
1(temporal work)	0.23 (14.6)	1.60 (9.58)
1(part time work)	0.24 (12.2)	1.59 (9.11)
1(sick)	0.009 (1.94)	0.02 (0.83)
1(attending hospital last 3 months)	0.01 (3.27)	0.09 (3.06)
Pseudo R^2	0.3272	0.3513
Prob >chi2 or F	0.0000	0.0000
Number of Observations	49886	49886

Note:1(•) is an indicator function, one if true and zero otherwise. The estimation is among individuals 35 years and older. T-ratios are in parenthesis. Job characteristics are omitted from the table. Probit coefficients are marginal effects.

Table 4
Retirement decisions, Individuals aged 55 to 65 years old

	LS Linear Probability	IV Linear Probability	IV Probit	LS Linear Probability	IV Linear Probability	IV Probit	LS Linear Probability	IV Linear Probability	IV Probit
Ln(Ssw)	0.004 (0.12)	0.19* (24.9)	0.57* (163.7)	0.004 (0.12)	0.19* (24.92)	0.57* (166.59)	-0.006 (-0.18)	0.21* (25.06)	0.54* (11.06)
Ln(I_1*Ssw)	-0.26* (-13.1)	0.38* (12.1)	1.23* (292.1)	-0.26* (-13.07)	0.37* (12.1)	1.23* (294.5)	-0.24* (-12.16)	0.42* (14.56)	1.18* (10.83)
Ln(Var[(1-I_1*)Ssw])	-0.02 (-1.82)	-0.6* (-12.3)	-0.97* (-430)	-0.002 (1.82)	-0.35* (12.29)	-0.96* (-433.5)	-0.0014 (-0.86)	-0.34* (-12.9)	-0.91* (-10.8)
1(gov. Subsidy)	-0.05* (-3.8)	-0.04* (-2.79)	-0.01* (-2.6)	-0.057* (-3.84)	-0.043* (-2.89)	-0.01* (-2.70)	-0.045 (-3.09)	-0.04 (-2.83)	-0.01* (-2.72)
1(female)	-0.05* (-3.6)	-0.02 (-1.35)	-0.006 (-1.55)	-0.05* (-3.55)	-0.02 (-1.52)	-0.007 (-1.71)	-0.046 (-2.98)	-0.02 (-1.49)	-0.006 (-1.57)
Schooling	0.02 (0.62)	-0.0002 (-0.18)	-0.000 (-0.28)	0.002 (0.62)	-0.000 (-0.04)	-0.000 (-0.12)	0.0048 (1.12)	0.0004 (0.26)	0.000 (0.12)
Other Demographics	YES	YES	YES	YES	YES	YES	YES	YES	YES
Location Var	YES	YES	YES	YES	YES	YES	YES	YES	YES
Health Var.	NO	NO	NO	YES	YES	YES	YES	YES	YES
Age	-	-	-	-	-	-	YES	YES	YES
R^2	0.1582	0.1432	0.1622	0.1585	0.1438	0.1637	0.1860	0.1537	0.1756
Number of Observations	8035	8032	8032	8035	8032	8032	8035	8032	8032

* indicates significant at 1%. T-tests are in parenthesis. Probit coefficients are marginal effects.
Note: 1( ) is an indicator function equals to one if the enclosed statement is true and zero otherwise. Also "Gov. Subsidy" indicates government subsidy to buy a house.

Table 5.1

Retirement decisions, Individuals aged 55 to 65 years old, by income groups

	LS Linear Probability Lowest 60th percentile	IV Linear Probability Lowest 60th percentile	IV Probit Lowest 60th percentile	LS Linear Probability 60th-100th percentile	IV Linear Probability 60th-100th percentile	IV Probit Lowest 60th-100th Percentile
Ln(Ssw)	-0.39 (-0.86)	0.19* (17.51)	0.99* (9.07)	0.027 (0.52)	0.22* (17.11)	0.23* (8.18)
Ln(I_1*Ssw)	-0.17* (-8.36)	0.41* (10.45)	2.08* (8.59)	-0.30* (-9.30)	0.43* (9.63)	0.51* (8.03)
Ln(Var[(1-I_1*)Ssw])	-0.003 (-1.56)	-0.32* (-9.19)	-1.60* (-8.55)	-0.0005 (-0.19)	-0.36* (-8.66)	-0.39* (-8.09)
1(gov. Subsidy)	-0.024 (-1.32)	-0.022 (-1.17)	-0.01 (-0.97)	-0.061* (-2.65)	-0.06* (-2.64)	-0.006* (-2.61)
1(female)	-0.068 (-3.56)	-0.038 (-1.99)	-0.022 (-2.20)	-0.03 (-1.38)	-0.015 (-0.71)	-0.001 (-0.76)
Schooling	0.005 (0.94)	-0.001 (-0.51)	-0.0007 (-0.53)	0.003 (0.47)	-0.0008 (-0.3)	-0.0001 (-0.40)
Other Demographics	YES	YES	YES	YES	YES	YES
Location Var	YES	YES	YES	YES	YES	YES
Health Var.	YES	YES	YES	YES	YES	YES
Age	YES	YES	YES	YES	YES	YES
R^2	0.1766	0.1405	0.1567	0.2123	0.177	0.2055
Number of Observations	4623	4623	4623	3412	3409	3409

* indicates significant at 1%. T-tests are in parenthesis. Probit coefficients are marginal effects.

Note: 1( ) is an indicator function equals to one if the enclosed statement is true and zero otherwise. Also “Gov. Subsidy” indicates government subsidy to buy a house.

Table 5.2

Retirement decisions, Individuals aged 55 to 61 years old and individuals aged 61 to 65 years old

	LS Linear Probability 55-61 years	IV Linear Probability 55-61 years	IV Probit 55-61 years	LS Linear Probability 60-65 years	IV Linear Probability 60-65 years	IV Probit 60-65 years
Ln(Ssw)	0.007 (0.19)	0.21* (11.69)	0.65* (2.58)	-0.025 (-0.52)	0.21* (15.98)	0.72* (6.54)
Ln(I_1*Ssw)	-0.21* (-9.28)	0.41* (7.30)	1.39** (2.5)	-0.36* (-12.18)	0.21* (3.76)	0.26 (0.18)
Ln(Var[(1-I_1*)Ssw])	-0.0007 (-0.38)	-0.32* (-5.99)	-1.07** (-2.5)	0.0004 (0.20)	-0.16* (-3.45)	-0.15 (-0.13)
1(gov. Subsidy)	-0.045* (-2.84)	-0.040 (-2.52)	-0.014** (-2.4)	-0.05 (-2.12)	-0.046 (-1.87)	-0.029 (-1.90)
1(female)	-0.068* (-3.86)	-0.046* (-2.67)	-0.017 (-2.7)	-0.029 (-1.23)	0.004 (0.17)	0.002 (0.16)
Schooling	0.0007 (0.15)	-0.001 (-0.93)	-0.0006 (-0.98)	0.008 (1.44)	0.002 (1.23)	0.002 (1.21)
Other Demographics	YES	YES	YES	YES	YES	YES
Location Var	YES	YES	YES	YES	YES	YES
Health Var.	YES	YES	YES	YES	YES	YES
Age	YES	YES	YES	YES	YES	YES
R^2	0.1579	0.1039	0.1450	0.1646	0.1242	0.1353
Number of Observations	5102	5101	5101	4323	4320	4320

* indicates significant at 1% and ** indicates significant at 2%. T-tests are in parenthesis. Probit coefficients are marginal effects.

Note: 1( ) is an indicator function equals to one if the enclosed statement is true and zero otherwise. Also “Gov. Subsidy” indicates government subsidy to buy a house.

Table 6.1
Decision to enter the labor force, Individuals aged 55 to 65 years old

	IV Probit 1(Not currently employed)
Ln(Ssw)	9.74* (16.37)
$Ln(I_1*Ssw)$	20.72* (15.84)
$Ln(Var[(1-I_1*)Ssw])$	-16.00* (-15.78)
1(gov. Subsidy)	-0.13 (-2.09)
1(female)	0.90* (15.96)
Schooling	-0.024* (-3.80)
Other Demographics	YES
Location Var	YES
Health Var.	YES
Age	YES
R^2	0.2657
Number of Observations	8032

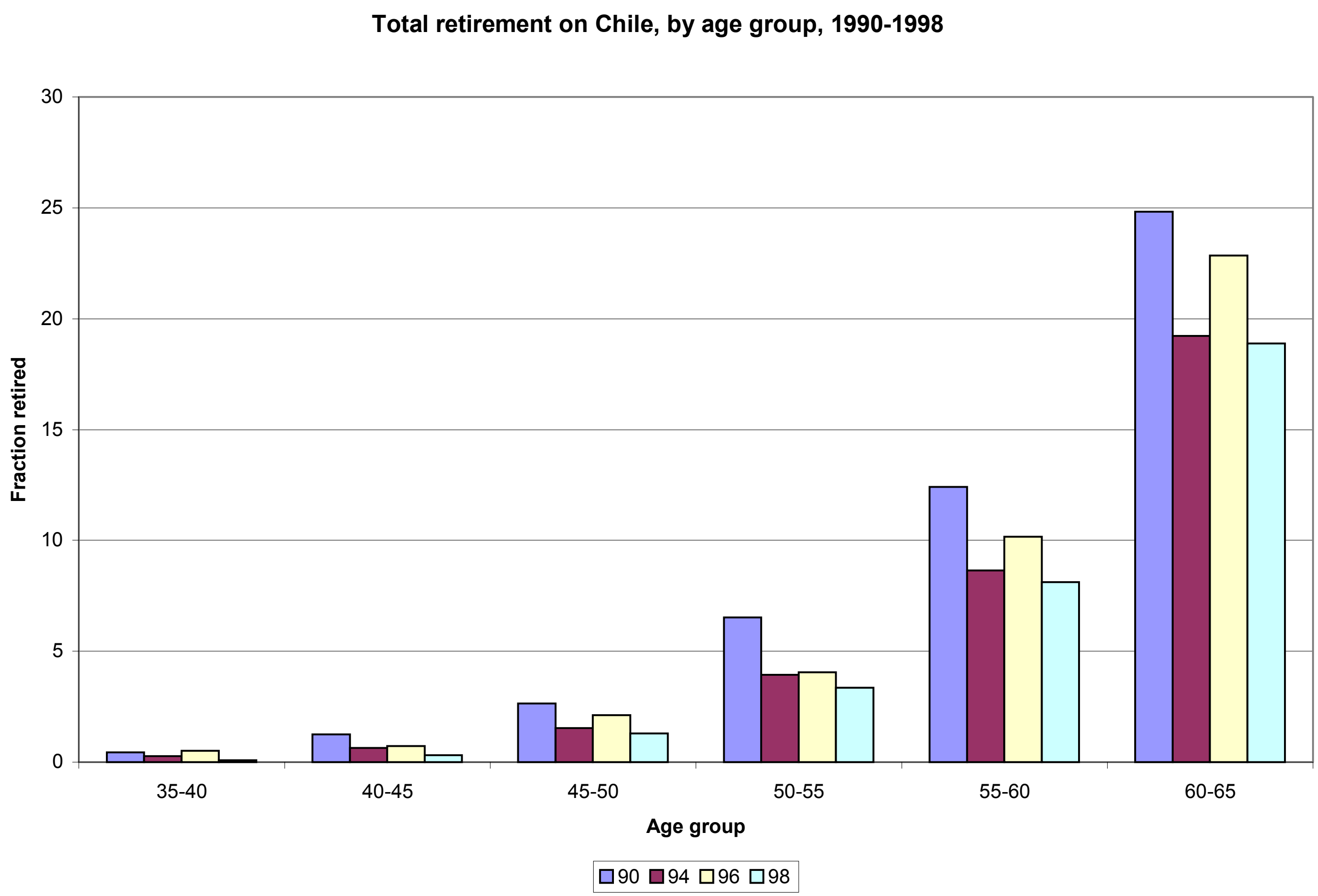
* indicates significant at 1%. T-tests are in parenthesis. Coefficients do not show marginal effects.
Note: 1( ) is an indicator function equals to one if the enclosed statement is true and zero otherwise. Also “Gov. Subsidy” indicates government subsidy to buy a house.

Table 6.2
Labor supply, Individuals aged 55 to 65 years old

	IV Ln(hours worked)	IV Ln(hours worked) Lowest 60th percentile	IV Ln(hours worked) 60th –100th percentile	IV Ln(hours worked) 55-61 years	IV Ln(hours worked) 60-65 years
Ln(Ssw)	-0.11** (-1.97)	0.11 (0.94)	-0.18* (-2.86)	-0.038 (-0.43)	-0.20** (-2.08)
$Ln(I_1$*Ssw)	-0.19 (-1.45)	0.02 (0.08)	-0.26 (-1.75)	-0.064 (-0.29)	-0.089 (-0.57)
$Ln(Var[(1-I_1$*)Ssw])	0.17 (1.57)	0.018 (0.09)	0.21 (1.71)	0.093 (0.51)	0.072 (0.57)
Ln(w*)	-0.014 (-1.53)	-0.008 (-0.64)	-0.013 (-1.02)	-0.01 (-1.02)	-0.029** (-1.93)
Ln(labor income)	0.072* (5.32)	0.20* (3.92)	0.05* (2.93)	0.063* (4.66)	0.08* (3.42)
Control function	-1.09* (-3.07)	-0.41 (-0.67)	-1.13* (-2.72)	-0.71** (-2.03)	-1.55** (-2.36)
Demographics	YES	YES	YES	YES	YES
Location Var	YES	YES	YES	YES	YES
Health Var.	YES	YES	YES	YES	YES
Age	YES	YES	YES	YES	YES
Job Var	YES	YES	YES	YES	YES
R^2	0.0940	0.1402	0.1141	0.0876	0.1225
Number of Observations	4447	2259	2188	3174	2010

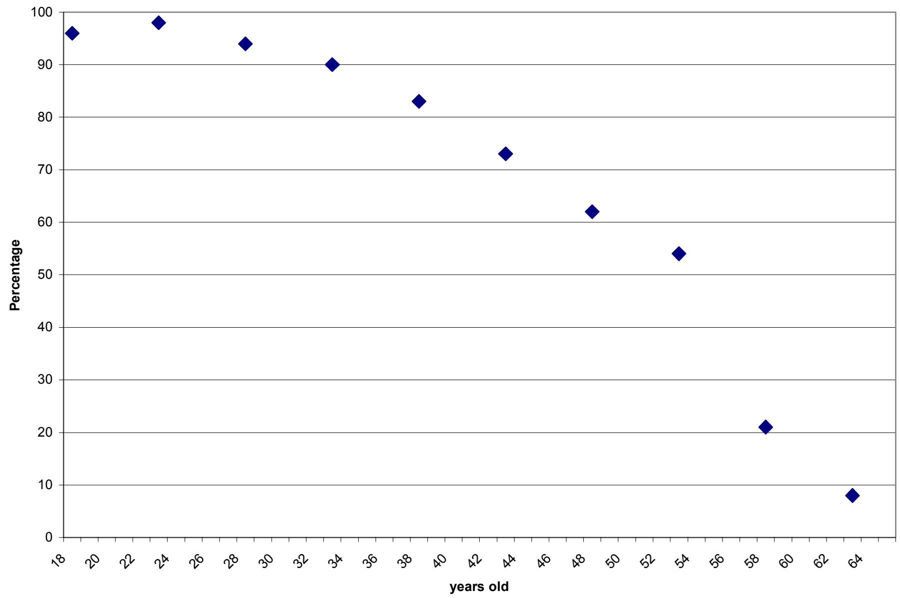
* indicates significant at 1% while ** indicates significant at 5%. T-tests are in parenthesis.
Note: 1( ) is an indicator function equals to one if the enclosed statement is true and zero otherwise. Also “Gov. Subsidy” indicates government subsidy to buy a house.

Graph 1


Total retirement on Chile, by age group, 1990-1998
Fraction retired
30
25
20
15
10
5
0
35-40
40-45
45-50
50-55
55-60
60-65
Age group
90
94
96
98

Graph 2

Fraction of people switching to the individual account system on 1981, by age



Graph 3

AFP return, 1981-2000