Effects of Pension System Reform on Individuals' Decisions

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I, Ximena Quintanilla confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

In 1981 Chile was the first country in the world to privitise its pension system moving from a pay-as-you-go scheme (PAYG) to a Defined Contributions (DC) scheme. Individuals in the labour market at the time of the reform were given the choice to either stay in the PAYG system or to opt-out to the DC scheme. New entrants must join the DC system.

Exploiting the wide differences in pension formulas across schemes, I firstly find that the reform significantly increased expected pension wealth for most of those who opted-out. I then investigate the extent to which households substitute this increase by decreasing accumulation of other wealth. As the decision to either stay or to opt-out was not random, I gain identification through an instrumental variable approach. I find a pension offset of around 30%. Among the possible reasons for the incomplete offset are imperfect information, the desire to compensate for new risks faced and habit formation.

Lastly, through a non-linear random effects dynamic model that allows for state dependence and unobserved heterogeneity, I estimate the effect of pension system design on individuals' formal/informal labour market decisions. Results indicate that individuals in the DC scheme are 23% more likely to be formal than those in the PAYG scheme at any one period. Further, simulations show that the boost in formality caused by the reform lasts throughout the life cycle. State dependence is even more important indicating that labour market past decisions do affect future ones. The unobserved heterogeneity is also high and significant but it is only a fifth of the state dependence. The results on state dependence and initial condition suggest that there is scope for public policy to affect formality decisions.

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1 Introduction

This thesis analyses the effects that a large pension reform had on individuals' decisions. Focusing in the case of Chile, which completely privatised its pension system in the early eighties, three particular decisions are considered - whether individuals maximised pension value when choosing their pension scheme, the extent of private wealth crowd out and participation in the formal labour market.

There is widespread concern about the consequences of ageing populations both on the provision of adequate income for older individuals and on the sustainability of existing pension plans. The World Bank, with its publication "Averting the Old Age Crisis" in 1994, initiated a rich debate on how to best design pension schemes. According to Ogawa and Takayama (2006) there is consensus on several points such as that the PAYG system is not a pure insurance scheme but rather involves huge intergenerational transfers that could bring them into conflict and thus give rise to a political problem. The authors mention that there is also agreement in that "the basic design of the pension program should be incentive-compatible". Contributions should be closely linked to benefits, leaving minimum thresholds to be provided by a different tier with separate funding.

Chile reformed its pension system precisely along the lines of the preceding paragraph, by moving from a traditional defined benefits Pay As You Go scheme (PAYG) to a fully funded Defined Contributions (DC) plan with individual accounts. While several countries are evaluating reforms to face the ageing and insolvency challenges, many others have already undertaken reforms, following the Chilean design to different degrees. This thesis aims to add to the discussion with empirical evidence of the effects of this particular reform on individuals' behaviour.

Individuals in the labour market at the time of the reform were given the

choice to either stay in the PAYG system or to opt-out to the DC scheme. Thus, the PAYG scheme was kept for all those who decided to stay, meaning that more than two decades after the reform, the old plan operates alongside the new one. This is the source of variation exploited in the chapters of this thesis to analyse the effect of the pension reform at a micro level.

Chapter two begins by providing a detailed comparison of the two schemes, pointing out the main differences from the individuals' point of view: contribution rates, requirements for eligibility, pension formulas and the risks that individuals face in either system.

Using detailed pension formulas, the net present value of expected pension wealth for each individual in both systems is computed. From this, it is possible to conclude that the DC scheme brought about a higher net present value of expected pension wealth for the vast majority of individuals, mainly due to non-linearities in the PAYG system. This finding confirms that different designs do give rise to variation in incentives and thus behavioral responses should be expected.

Chapter two then explores whether individuals maximised the net present value of expected pension wealth when choosing between the PAYG and the DC system. Results indicate that, overall, only over half of those with choice did. In particular, individuals vulnerable to frequent and/or long unemployment spells or prone to work in the informal sector stayed in the PAYG system, in spite of being less likely to benefit from the redistribution in this arrangement. Among the reasons behind the lack of maximisation of this group may be low interest rate expectations, a misunderstanding and/or distrust of the new PFA system. This finding becomes timely as there are initiatives and schemes already in place that allow individuals to choose between a number of alternatives in different aspects of pension savings such as fund type, savings rates and asset allocation. These important decisions may affect retirement and yet require sophisticated knowledge about assets returns, life cycle consumption planning

and projections. Indeed, the evidence shows that individuals heavily rely on default settings of their saving plans, thus policy makers must ensure the default options are appropriately designed (Creighton and Piggott (2006)).

Chapter three uses the increase in net present value of expected pension wealth across pension systems found in chapter two to look at the extent to which it crowded-out non-pension wealth. The empirical specification is motivated by a simple version of the life cycle model that predicts there should be a perfect offset between pensions and other wealth. Economists have been looking at the issue since the mid 1970's. For example, Feldstein (1974), Gale (1998), Attanasio and Brugiavini (2003) and Attanasio and Rohwedder (2003) all find evidence of crowding out, though not of 100%. Coronado (1998) is the only study that focuses on Chile using individual-level micro data and concludes that increased pension savings crowds-in private savings. This counter-intuitive result is likely to be driven by unobserved heterogeneity, for instance in the taste for savings, that affects decisions. Chapter three overcomes this issue with novel instrumental variables. The IVs used are based on the degree of choice individuals had when choosing pension system. Thus, the IVs exploit the fact that the pension reform of the early 1980's exogenously changed pension wealth for some groups and did not for others. Results indicate that individuals indeed reduced private wealth in response to the reform, although the pension offset was not complete. This result, which is in line with the evidence found for other countries, could be due to several reasons such as uncertainty about future earnings and rates of returns, lack of understanding/trust of the reformed pension system and habit formation. Though beyond the scope of this thesis, we attempt to provide some evidence on the latter explanation.

While chapters two and three take the individuals' labour market histories as given after their pension system choice, chapter four looks at how the labour market histories were affected, given their pension choice. In other words, chapter four analyses the effect of pension systems' design on participation in the

formal labour market. Roughly speaking, the strong link between pension savings during the entire working life and benefits upon retirement of the funded DC system with individual accounts is expected to reduce the perceived tax component of contributions to pensions and thus to promote higher participation in the formal labour market vis-à-vis the highly non-linear final salary formula in the defined benefits scheme. A random effects dynamic probit model for the current formality decision is estimated; this specification allows me to distinguish the impact of the pension system from the effect of past formality decisions (structural persistence) and of unobserved heterogeneity (spurious persistence). A control function is used to take care of pension system endogeneity where, as in chapter three, the exclusion restriction is based on the actual, as opposed to nominal, choices individuals had. To separate out how formality decisions are determined by either source of persistence is essential for policy design. While there may be scope for public policy to affect behaviour if past decisions are found to have a strong influence, individuals are less likely to respond if the persistence is spurious.

In spite of being rather rich in inputs, the random effects dynamic model used is, under certain assumptions, fairly easy to estimate. Average partial effects are also easily computed. They confirm that, relative to the PAYG arrangement, the DC scheme indeed boosted participation in the formal labour market in any one period t. This result helps to take a step towards understanding how to bring about inclusion to developing countries' labour markets. While structural persistence is found to have a strong role on current decisions, the effect of unobserved heterogeneity is considerably milder.

The evidence found on structural persistence, added to the discrete nature of the dependent variable, imply that a change in pension system should have a discontinuous and lasting effect on formality throughout the life cycle. The simulations carried out to take into account the dynamics of the model show that this is indeed the case -the effect of the pension system reform persists over

time and is even higher at the end of the working life. An interesting result is that the boost in formality due to the reform is higher for those who would not have been formal under the PAYG scheme.

Apart from observing exogenous variation in pension system, it is necessary to have appropriate micro data to identify causal effects of mandatory savings on individuals' decisions. This thesis uses a comprehensive survey as the main data source. The survey is one of the first longitudinal data type efforts in Chile and is used for different parts of this research.

As future research plans, I aim to estimate a structural model that will allow me to identify the effect of mandatory pension savings jointly on private savings and on labour market participation. The research will benefit from distinguishing different and competing mechanisms such as individuals' preferences for each system and the variation that pension systems bring about to the budget constraint (contribution rates, eligibility and pension formulas). A structural model will allow me to predict with more precision the quantitative importance of these factors at play.

2 Individual Choice of Pension System. Did Chileans Maximise Pensions when Choosing between PAYG and DC?

Abstract

In 1981 Chile was the first country in the world to privitise its pension system moving from a traditional unfunded pay-as-you-go scheme (PAYG), where benefits are defined ex-ante by a final salary formula, to a Defined Contributions (DC) scheme where each individual's benefit depends entirely on his own pension savings. Individuals in the labour market at the time of the reform were given the choice to either stay in the old PAYG system or to opt-out to the DC scheme, whereas new entrants must join the DC system. Exploiting the wide differences in pension formulas across schemes, in this chapter we analyse for whom it was optimal (in terms of higher net present value of expected pension wealth, EPW) to opt-out and for whom to stay in the PAYG system. Using self-reported employment and contribution histories, we compute the net present value of EPW each individual in our sample will get in the pension scheme he is currently enrolled in and the pension he would have got had he made the opposite staying/opting-out out decision. We find that overall 87% of individuals would have got a higher pension in the DC system than what they would have got in the PAYG scheme. This share varies significantly by cohort but not so much by education or sex. When looking at who actually maximised the net present value of EPW when choosing pension arrangement the results show that 57% did. Responses vary across current pension system: while 90% of men and 80% of women currently in the DC scheme maximised the net present value of EPW, less than 15% of individuals currently in the PAYG did.

2.1 Introduction

In 1981 Chile was the first country in the world to privitise its pension system moving from a traditional unfunded pay-as-you-go system (PAYG), where benefits are defined ex-ante by a final salary formula, to a defined contributions (DC) scheme where each individual's benefit depends entirely on his own pension savings.

Even though the reform completely closed the PAYG system to new entrants (thus they must enter the DC scheme), it allowed individuals already in the labour market (and enrolled in the pension system at the time) to choose between either staying or opting-out to the DC plan. Thus, nearly three decades after the reform took place, Chile has two opposite systems operating in parallel: together with the new DC scheme, the old system is still functioning for those who chose to stay as the PAYG scheme is still receiving contributions from its working member as well as is paying benefits to its pensioners.

The decision to stay in or to opt out was likely determined by the individual's understanding of the benefits structure and requirements under the two options, his beliefs about expected financial markets returns, mortality risk, financial and political risk, the value of choice and the value of inheritability (Brown and Weisbenner (2007)). We cannot pin down the effect of each of these variables on the choice of pension system. Instead, defining an optimal decision as the one that maximises the expected net present value of EPW, we focus first on for whom it was optimal to stay in the PAYG scheme and for whom it was optimal to emigrate to the DC, and second on whether individuals in our sample actually maximised pension wealth, given the labour market trajectory that was subsequently observed. We will refer to this as the optimal choice hereafter.

There are two main contributions of this chapter. The first contribution of the chapter is that, to our knowledge, it is the first attempt to compare benefits between the two systems at a micro-level using fine detail on pension

formulas and individuals' characteristics[1]. A comprehensive micro-panel data set is used to empirically compute how much individuals will actually get as a benefit from their current pension system and how much they would have got had they chosen the other scheme.

We find that 87% of individuals that had the staying/opting-out option would be better off in the new system than they would have been in the old arrangement. This share varies significantly by cohort mainly due to the length of the time exposed to the high returns in the PFAs. The proportion of individuals better off in the DC plan also varies by education among women, but not so much by education among men. These results are explained by the non-linearities of the PAYG scheme and the interaction between these non-linearities and the attachment to the formal labour market. Individuals with interrupted careers or that alternate between formal and informal employment (mostly women and low skill workers) are not eligible to claim benefits whatsoever in the PAYG scheme while they certainly get a pension (although perhaps rather low) in the DC plan. Moreover, non-linearities at the top mean that skilled and highly attached to the formal labour market individuals see their pensions capped in the PAYG plan while, provided that the rate of return is positive, the accrual rate is always positive in the new system.

The second contribution relates to providing evidence on how individuals react when faced with choice. This is particularly relevant in the international context since, in an attempt to address increasing pensions liabilities (due to ageing population and shorter working lives), many countries have reformed or are in the process of reforming their pension systems. Some of these reforms (as in Chile) allow individuals to select their pension plan while some others have default systems where individuals who do not actively make a choice are

[1] Baeza and Burger (1995) compute replacement rate for a subsample of pensioners members of one specific Pension Fund Administrator (Santa Maria) that claimed the benefit between January and September 1994. Based on their results, Edwards (1998) claims that "To December 1994, average old age pensions under the capitalization system were 42% higher than those under the PAYG regime".

assigned to a previously defined plan.

We find that 57% took the choice that maximised pension benefits. This figure is significantly higher for those who opted-out than for those who stayed. The latter result is due to a combination of the design of the PAYG system and to individuals' characteristics - individuals vulnerable to frequent and/or long unemployment spells or prone to work in the informal sector stayed in the PAYG system, in spite of being less likely to benefit from the redistribution in this arrangement. The choice of pension system they made may have been driven by low interest rate expectations, a lack of understanding and/or a lack of trust in the new DC system, which made some workers reluctant to opt-out. The finding that only over half took the optimal decision should be taken into account when designing policies that allow individuals to choose between different alternatives regarding their pension savings.

It must be noted that the empirical approach we follow in this chapter does not identify causal relations between pension system design and EPW. We simply analyse the sources of variation and compute the net present value of EPW under the two schemes. However, this chapter is the input for chapter three where we do identify the effect of the increase in pension wealth due to the reform on private savings decisions. To compare pension wealth in the two systems is the first stage to then study the causal effect on individuals' responses. Further, in chapter four we investigate the effect of the pension system incentives on participation in the formal labour market.

The rest of the chapter is organised as follows: in the next section we describe both pension schemes, focusing on the differences on incentives and risks each poses on individuals. Then, subsection 2.2.1 uses hypothetical types of individuals to analyse how the different designs affect pension benefits. Section 2.3 describes the data sources used and the subsample considered for the empirical analysis. Then, section 2.4 describes how pensions for each individual

are computed in either system and, in order to do so, how earnings and contributions patterns for unobserved periods are projected from the observed data. Subsection 2.4.4 intends to acknowledge the measurement error derived from our computations. Section 2.5 presents the results of the empirical analysis and section 2.6 concludes.

2.2 The PFA system vis-à-vis the PAYG system

From the early twenties up to the seventies, Chile had a somewhat traditional PAYG pension system. Workers were members of a pension provider and would get retirement benefits from a (mainly) final salary formula. Pension providers were roughly organised by occupational sector. There were two providers for the armed forces and three main pension providers for civilians: one for blue-collar workers, one for white-collar employees and one for civil servants. However, there were also many providers for smaller groups with high political power that enjoyed more generous benefits than the general rule. Furthermore, disproportionate schemes were created for particular groups even within the main pension providers. As a result, at the end of the seventies there were more than 30 pension providers and 150 different pension arrangements, making the pension system complex, segregated and unequal (Arenas de Mesa (2000), Berstein, Larraín, and Pino (2005b))

Even though between the late 50's and early 70's democratic governments attempted to reform the pension system (aiming to extend its coverage, to unify the rules of the multiple arrangements and to tackle the financial crisis already in place, none of them made substantial improvement (Arenas de Mesa (2000), Berstein et al. (2005b)). Eventually, in 1980 the military government radically reformed the pension system, introducing a privately managed, fully funded individual accounts scheme. As mentioned in Edwards (1998), "the decision to undertake the reform responded to four considerations: (a) the explosive fiscal consequences of the old regime, (b) the high degree of inequality of the old

system, (c) its implied efficiency distortions, and (d) an ideological desire to reduce drastically the role of the public sector in economic affairs".

The new system replaced the civil component of the PAYG plan, while the police and armed forces plans remained unchanged. Individuals who were a member of a pension provider before 31 December 1982 could either stay or opt-out into the new system, where the opting-out decision was irrevocable. On the other hand, those who started to work (or more accurately had not made prior contributions to the old pension system) on 1 January 1983 and thereafter were required to join the new system affiliating to a Pension Fund Administrator, PFA, private firms in charge of the management of retirement savings in the Chilean DC scheme. From now on we will refer to the DC as the PFA scheme.

The reform completely changed the rules of the Chilean pension system and since the PAYG scheme is still in operation for workers who chose to stay, Chile sets up an interesting case to examine how the pension system design affects individuals decisions. Thus, we turn now to explicitly mention the main differences from the individual's point of view between the two arrangements. First of all, the contribution rate to the PAYG scheme is 19.1% of labour earnings in the main PAYG provider[2], while in the PFA is 12.5%, of which 10% goes directly to the individual's account and the rest is used to pay administration fees and the disability and survival insurance.

Second, upon retirement, the way eligibility and pension benefits are calculated differs substantially across schemes. Benefits are determined ex-ante in the PAYG system through a formula that yields a pension proportional to the final salary, i.e. it is a *defined benefits* scheme. On the other hand, benefits are not defined a priori in the PFA system but, as mentioned above, are the result of individual savings and the return on those savings. The parameter that is

[2]It is, respectively, 20.15% and 19.03% in the second and third main providers (in terms of number of members).

defined in this kind of arrangements is the contribution rate (10% in the Chilean case) and thus they are commonly known as *defined contribution* schemes.

To be eligible for a benefit in the PAYG system the individual needs at least 800 weeks of contributions and a density of contributions[3] of no less than 50%. Once these two requirements have been met, the pension benefit starts with a minimum of a 56% of average earnings in the last 60 months (thus it is a final salary scheme). The benefit increases 1% for every 50 weeks on top of the first 800 with a cap at 70% of the average earnings of the last 60 months, which leads to a maximum of 30 years of positive accrual. Note the strict requirement of 800 weeks of contributions to be eligible for the benefit, i.e. individuals with less than (roughly) 16 years of contributions will not get a pension from the PAYG system whatsoever. The exact formula that summarises these features is[4]:

$$P_{PAYG}= \begin{cases} \frac{\sum_{t=1}^{60} E_t}{60} * Min\{0.7, (0.5 * first\ 500\ weeks \\ \qquad + 0.01 * every\ 50\ weeks)\} & if\ 800\ weeks \\ & of\ contributions \\ & and\ dens >= 0.5 \\ 0 & otherwise \end{cases} \tag{1}$$

Where E_t represents labour earnings in each period t of the last 60 months.

In contrast, at retirement age R, the PFA system does not impose requirement of any sort to be eligible for a pension. The benefit depends entirely on the pension savings the individual has accumulated during her working life, which in turn depends on the contributions made to the PFA each period (netted out

[3] Density of contributions is defined as the rate of the number of periods contributed to the potential number of periods contributed during the working life.

[4] This is the pension formula for men in the main provider of the old PAYG scheme, the Social Security Service (SSS). Other providers had different formulas but in the interest of space and to ease comparison with pensions in the PFA system, we show only this formula in the text. However, we do apply the right formula for each individual in the empirical analysis.

of the fixed administration fee), and the market returns on those savings. Due to the compound interest effect, contributions in early periods are relatively more important than later contributions. The Individual Pension Fund, IPF, at R then is:

$$IPF_{PFA} = \sum_{t=1}^{(R-1)} (0.1 * E_t - fixed\ fee_t) * \prod_{v=t}^{(R-1)-1} (1 + r_v) \tag{2}$$

where t represents the first month the individual contributed (contributes) to the PFA. τ takes the value of zero for all those who were never members of the PAYG scheme and takes the value of the opting-out date for those who were.

If the individual was previously enrolled in the PAYG system, then he is likely to be entitled to a Recognition Bond, RB, which is the instrument devised to credit past contributions to the new system [5]. Pension wealth at R will then be comprised by both the RB and the IPF. Thus, pensions in the PFA scheme is an always increasing function of the interest rate, labour earnings and periods contributed (participation). In other words, as long as the rate of return is positive, the accrual rate is always positive[6].

Summarising, pensions in the PAYG system are highly non-linear in the number and timing of contributions. In contrast, pensions in the PFA scheme do not have kinks of any sort. Figure 1 shows these features[7]. The non-linearities of the PAYG pension formula result in different degrees and types of redistribution. On the one hand, the 800 weeks requirement to be eligible for a benefit is a form of regressive redistribution against those with low attachment to the formal labour market. On the other, the cap of benefits at 70% of the average

[5] See Appendix 2.2 for requirements and formulas of the Recognition Bond.

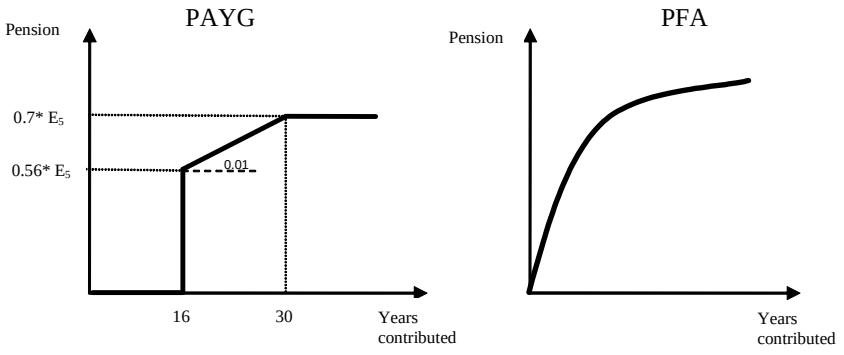
[6] See Appendix 2.3 for the series of annual real rate of return from 1981 to 2009. It can be seen that the rate of return has been negative only in 3 years -1995, 1998 and 2008 - where the latter was the most dramatric due to the credit crunch.

[7] Figure 1 is for illustrative purposes only. The two graphs are not to scale. In the PFA graph we have omitted the Minimum Pension Guarantee, which is the floor level of pension the Government guarantees for those who meet the requirements. As it has strict access conditions, only a small share of individuals get it. We have also abstracted from the RB in the PFA system.

earnings of the last five years and the 30 years of maximum accrual is a form of progressive redistribution against those with high earnings and stable jobs. Thus, the redistribution is in favour of low and middle income individuals with relative high attachment to the formal labour market.

From the description of benefits requirements and formulas, it is easy to see that individuals face very different incentives to contribute depending on the pension system they are enrolled in. On the one hand, in the PAYG system the incentives are (i) not to contribute if not likely to meet the 16 years requirement; (ii) to contribute just the time needed to be eligible to receive a pension if the individual had an interrupted employment history; (iii) to contribute no more than 30 years and (iv) to contribute for the highest possible salary in the years prior to retirement[8]. On the other hand, the close link between contributions and benefits in the PFA schemes aligns individuals' incentives and financially-sustainable pension systems, thus leaving less scope for opportunistic behaviour. The incentives are even stronger in early periods of the working lives when contributions matter most.

Figure 1



What kinds of risks and to what extent individuals face those risks is the third substantial difference between the Chilean versions of the PAYG and PFA

[8] This would probably require some worker-employer collusion.

plans[9]. Firstly, while in the former once the eligibility requirements are satisfied, the risk of interrupted careers and periods of low earnings is pooled among contributors and/or taxpayers, in the PFA plan these risks are faced by the individual. However, while in the PAYG system only the last 60 months of labour earnings matter for the computation of pensions, all labour earnings matter in the PFA, thus there is more earning smoothing in the latter. Secondly, even though the Chilean PAYG system was not provided by employers, recall that pension providers were organised around occupational sectors, thus vesting periods posed a high job (occupation) tenure risk on workers. This risk is not present whatsoever in the PFA system since funds are fully portable. Third, there are two main benefit alternatives individuals can choose from upon retirement in the PFA scheme, programmed withdrawals and annuities. Programmed withdrawals are decreasing in life expectancy, thus the longevity risk is faced by the individual. The non-mandatory annuitisation feature may lead to adverse selection problem which would result in an inefficient allocation: low risk individuals would result uninsured. In other words, individuals with a low probability of living longer than average will not be willing to buy an annuity, thus having to bear themselves the longevity risk of the programmed withdrawals. On the contrary, pensions in the PAYG system are independent of life expectancy with the result that tax payers and/or future cohorts bear the burden of longer lives. Fourth, while only members of the PFA plan are subject to investment risk, only members of the PAYG scheme are subject to the replacement rate risk (pensioners to workers ratio is too high). Finally, nowadays inflation risk is not an issue because benefits are price-indexed in both arrangements.

We now turn to the common features of the two schemes. To contribute is

[9] Yet another three differences across systems are: the PAYG does not allow for early retirement whatsoever while the PFA plan allows members to retire early if they satisfy certain pension amount conditions; after retirement PAYG pensioners cannot continue working while PFA pensioners can do without their pension-earnings being taxed away; and anuuitization is not mandatory in the PFA scheme while it is in the PAYG plan. Though clearly relevant in the pension design, these differences are not relevant for the specific objective of this paper.

mandatory for employees and voluntary for the self-employed, regardless of the pension system they are members of. Individuals contribute on labour earnings greater than the minimum wage and up to an upper earnings limit. Both values are the same under the PAYG and PFA systems. In both pension plans the contribution is paid out of the worker's salary but the employer is the one responsible for depositing the contribution in the relevant institution. In both systems the legal retirement age, R, is 65 for men and 60 for women. Finally benefits from both arrangements are indexed to prices.

From the preceding discussion, there is variation in expected benefits arising not only from individual traits (time under the new system, pattern of contributions and labour earnings profile) but also from pension formulas in the two schemes. We exploit this variation to see for whom it was optimal to opt-out and for whom to stay in the PAYG scheme. We focus the analysis on expected future pension payments as the measure to compare which scheme would have been the best one for each individual. That is to say, we consider only this dimension, leaving aside other considerations such as differences in risk aversion or time preferences.

We want to stress that in this chapter we only compare the net present value of EPW in either system, but we do not identify a causal relationship between pension system and EPW. Chapter three uses the computation of this chapter as an input to identify the displacement effect between pension and other wealth.

2.2.1 Sources of Variation and Hypothetical Types of Individuals

In order to get a better understanding of the sources of variation (eligibility, pension formulas and individual traits), we compute pensions in both systems for different *hypothetical types* of individuals, which differ in three aspects: lifetime earnings, density of contributions and age at the time of the reform. For lifetime earnings we assume three cases: average earnings, minimum wage and upper limit earnings.

The second dimension in which our types of individuals vary is the *density of contributions*, which is defined as the rate of the number of periods contributed to the potential number of periods contributed during the working life. It is not straight forward to assume a value for the density of contributions since it is endogenous to the labour market performance and to the pension scheme design. Furthermore, there is empirical evidence suggesting substantial heterogeneity in contribution density among individuals. Indeed, the distribution of the contribution density is bimodal, with large fractions of the population in both edges of the interval [0%,100%][10]. Then, by using the mean contribution density we will not necessarily have a representative member of the pension system. Instead, we use the median density of contributions, 48%, computed from the PFAs administrative data (i.e. the median individual contributes 5.8 months within a year). We are aware that the lack of normality makes the median as "not representative" as the mean. However, we still need to choose a value to compute and compare pensions, thus we have chosen the median since is a bit lower than the mean (i.e. more conservative in the predictions) and it is not affected by extreme values. As the second scenario for the contribution density we assume 70%, value that has been widely used in the literature[11].

Finally, we take individuals of different ages in 1981: 20[12], 30, 40, 50, 60 and 64. Consequently, all possible combinations of the dimensions in which our hypothetical individuals vary gives a total of 36 hypothetical types.

The remaining assumptions we make to calculate pensions for individual types are: male who starts working at the age of 20, his contributions density is uniform across lifetime, retires at 65, claims an annuity and has no dependants For unobserved periods of earnings we assume a yearly real growth rate of 2% up to the age of 50 and no real growth after that age.

[10] See for example Berstein, Larraín, and Pino (2005a) for evidence from administrative data and Arenas de Mesa, Behrman, and Bravo (2004) for evidence from survey data.

[11] See for example Margozzini (1988).

[12] Actually, from our assumptions, a 20 years-old was not entitled to choose between systems. We still include this type of individual to compare his wellbeing under the two arrangements.

As in the empirical section below and since Individual Pension Funds are very sensitive to the rate of return, we compute pension savings under two scenarios, one with the actual series of the pension funds rate of return (from 1981 to 2004) and the other with the expected yield at the time of the reform[13]. Since the observed average rate of return is 9.24%[14] and the predicted by the designers of the reform was 4%, these two scenarios indeed produce very different results.

Individuals who meet certain requirements, are entitled to the Minimum Pension Guarantee. While the requirements in the PAYG plan is simply to be eligible for a pension (according to formula 1) in the PFA it is to have made at least 240 contributions. As a result, under the observed rate of return, we top up pensions to the MP for those earning the MW, in all ages and with low density of contributions; and for those aged 60 and 64 with high contribution density. Under the expected return scenario of 4%, we topped up benefits for the same types of individuals as before plus those aged 20 and 50 in the latter group.

We do the comparison in terms of the ratio between the pension in each system. Figure 2 graphically shows this ratio.

Note that due to our assumptions and by construction, the RR in the PAYG system varies only with the contribution density. Note also that the RR is capped at 70% for most representative individuals with high attachment to the labour market , i.e. those with contribution density of 70% (for both results see equation 1). On the contrary, the RR of the PFA plan shows much more variation with the time the individual has been in the system (thus with age in 1981), the contribution density and lifetime earnings.

It can be seen from the two top panels (using the observed (high) returns),

[13] In these two scenarios we also assume, respectively, observed and expected fixed administrative fee charged by the PFAs. This variable has a much milder effect on pension savings than the rate of return.

[14] Up to December 2009 for Fund Type C, which out of the 5 Fund Types available nowadays is the only one that has existed since 1981. See Appendix 2.3 for the complete series of the rate of return.

that out of the 36 types of individuals analysed, 31 get a higher or equal RR in the PFAs than in the PAYG scheme. Of the remaining 5 types that are worse-off with the reform, all have a low attachment to the labour market (due to unemployment, informality or inactivity). Further, 4 of them also have average lifetime earnings, an thus since they satisfy the requirements to be eligible for a benefit, they would probably benefit from the redistribution feature of the PAYG plan (panel (a)). All types of individuals with high contribution density (70%) are better off in the new system (panel (b)). Note the role of the means tested Minimum Pension plays among the low-skilled (those earning the MW): the subsidy brings pension income up and gives the same RR regardless of the pension system.

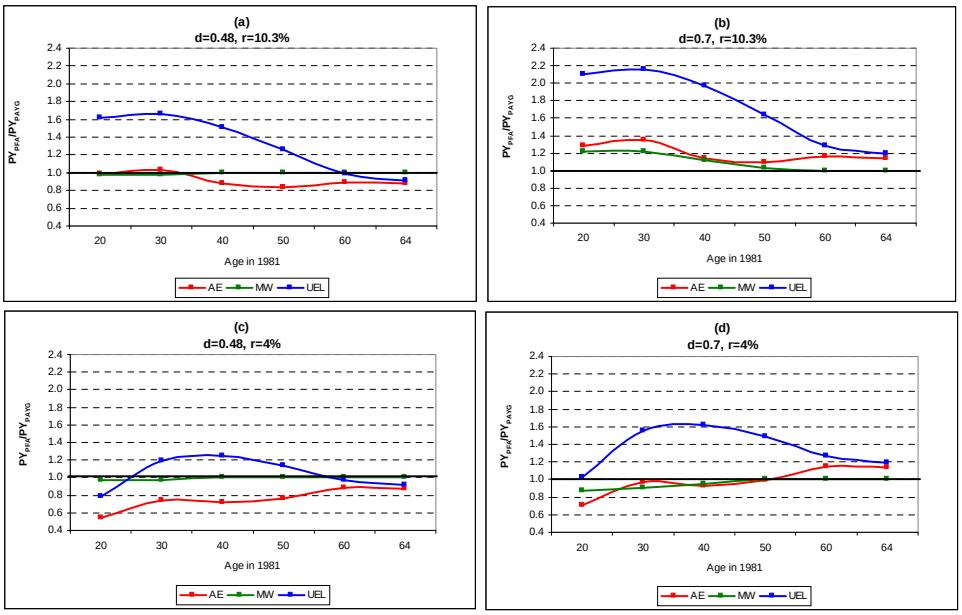
Therefore, if either the expectations in 1981 on future returns from the capital markets were very high or the evaluation is done now (*ex-post*), we conclude that (i) individuals with high attachment to the formal labour market (regardless of their earnings) and (ii) high skilled individuals (regardless of their attachment to the labour market) should have opted-out to the PFA plan. On the other hand, individuals with low attachment to the labour market and with average earnings will benefit from the redistribution in the PAYG system (provided that they are eligible for benefits in the first place).

Now, if at the time of the reform individuals were not very optimistic about future rates of return, decisions about membership were not on the side of the new system (panels (c) and (d) in figure 2). In panel (c), where the expected rate of return is 4% and individuals do not contribute in a regular basis, only those aged between 30 and 50 and in the top of the contributory-earnings distribution would benefit from the new pension system. Note however, that this effect is mostly driven by the generous RB as the youngest type is not entitled to it and the rate of return in the PFA system is not high enough, thus yielding him a lower RR than in the PAYG plan. Note again the effect of the Minimum Pension Guarantee, equalising RR across systems and thus making the low-

skilled indifferent between the two arrangements.

Finally, looking at panel (d), amongst individuals with high attachment to the labour market and with either AE or MW, only those older in 1981 would benefit from the reform, again thanks to the RB. However, younger individuals, that are exposed to low rates of return for longer periods, would be better off by staying in the PAYG system and taking advantage of the redistribution that takes place within it.

Figure 2: $\frac{PY^{PFA}}{PY^{PAYG}}$ for types of individuals and rate of return scenarios



Regardless of the rate of return we use, our results show that among the types of individuals in the analysis, older workers earning either the average wage or the upper earnings limit with high contribution density should opt-out to an PFA. This finding is driven by both the cap of 70% in the PAYG benefit and the generosity of the RB.

Recall, however, than under the assumptions made in this section all types of individual we have defined meet the 800 weeks requirement. If this were not the

case, they would not be entitled to a pension whatsoever in the PAYG scheme while they would certainly have a benefit (although perhaps rather low) in the PFA scheme. Indeed, we shall see from the empirical results in section 2.5 that not even 60% of individuals are eligible to claim a benefit in the PAYG system (see table 4).

Using different types of individuals, we conclude that whilst most high skill workers should have opted-out to an PFA, those earning average earnings and with low attachment to the labour market would have got higher pensions in the PAYG scheme. Also, the Chilean first tier (through the Minimum Pension) should top up benefits of most low-skilled types of workers, leaving them indifferent between the two systems in terms of pensions. On top of the effect of lifetime earnings, the expected rate of return on retirement savings in the PFA scheme plays a major role in determining pensions. The rate of return effect is increasing in the length of time spent in the new system. Last, but not least, we found that the generosity of the RB should have lead individuals with high contribution density and close to pension age at the time of the reform to opt-out instead of claiming a pension from the PAYG scheme, as they would have been in the flat accrual rate range in the latter. Moreover, the RB's relatively high interest rates should also have induced individuals in the middle of their life-cycle at the time of the reform to opt-out to an PFA.

We go a step further in the comparison by computing the internal rate of return, IRR, the different types of individuals would get in each system. This allows to take into account not only the differences in pension formulas as in the analysis before but also the contribution rates in each system, which are 19.1% and 12.5% in the PAYG and PFA system, respectively. Table 1 shows the results for types of individuals that are 20 years old in 1981 and that differ in their lifetime earnings and density of contributions. The first noticeable feature is that the IRR for the PAYG is always lower than for the PFA scheme. It can also be seen that, within lifetime earnings, while the IRR in the PAYG system

is always lower for the individual with higher density of contributions (indicating redistribution), it is constant in the PFA plan[15] (indicating the direct link between contributions and benefits). The non-linearities of the PAYG systems are further evidenced when comparing the lower IRR for those on the UEL with the IRR for those with lower earnings.

Table 1: Internal rate of return

Individual 20 years old in 1981

Internal Return Rate (%) (with observed r)						
Contribution Density	Average Earnings		Minimum Wage		Upper Limit Earnings	
	PAYG	PFA	PAYG	PFA	PAYG	PFA
48%	6,1%	8,5%	6,0%	8,3%	4,6%	8,5%
70%	5,1%	8,5%	5,0%	8,1%	3,6%	8,5%

2.3 Data and Sample

2.3.1 The data

We use two sources of information:

1. The Social Protection Survey, EPS[16], which is a nationwide representative sample of the population. The EPS is a longitudinal survey, with waves conducted in 2002, 2004 and 2006[17]. The survey comprises a wide range of socio-demographic characteristics, including current earnings, as well as retirement and life expectations, pensions entitlements, knowledge of the pension system, some information on savings, risk aversion, time preferences, etc.[18]

   The EPS2002 is also a *retrospective-panel* dataset in the sense that each interviewee was asked to report his/her contribution and employment history (and its features) from 1980 onwards. We use contribution histories

[15] Except in the case of the minimum wage where the types of individuals get a Minum Pension top up.

[16] EPS is the acronym of its name in Spanish

[17] The first wave is not nationally representative but instead it represents individuals who were enrolled in the pension system in 2002 (either the PAYG or the PFA scheme).

[18] The EPS2002 was conducted by the University of Chile on behalf of the Ministry of Labour. For further details visit www.proteccionsocial.cl

as an input to construct individual-specific contribution profiles for unobserved periods (before 1980 and future periods until retirement), and employment histories as an input to construct earnings profiles for each individual's working life. With these profiles in hand, we then compute the net present value of EPW.

However, as the employment histories in the EPS2002 do not have past earnings, we use the following survey to simulate earning profiles[19].

2. Employment and Unemployment Survey, EUS,1957-2002. The EUS is a cross-section survey that collects information on earnings of a (rotating) representative sample of the labour force in Greater Santiago. This is done yearly since 1957.

   We simulate earnings profiles for each EPS2002 respondent matching group-earnings profiles estimated from the consecutive waves of the EUS[20]. Further details in section 2.4.1.

Note that earnings and contribution profiles are needed to compute EPW, which in turn is needed for this chapter and chapter three. Therefore, this and the following chapters use both data sources just described. Chapter four, on the other hand, does not include EPW but only the pension system each individual is enrolled in, thus, only the EPS is needed.

2.3.2 Subsample used

As we analyse the extent to which pension system's design affects individuals decisions, our sample is comprised by those who were already in the labour

[19] The EPS has been linked, on an individual basis, to administrative records from the pension system. The link includes montly labour earnings and contribution histories. Unfortunately, the link is not yet accessible por for public use, so the approach we follow in this paper is the best we can do with the data available nowadays.

[20] We could have used instead the National Employment Survey to simulate earnings profiles. However, this survey is available only since 1986 so the time span is too short for the period we need to cover in this paper. On the other hand, the time span covered in the EUS is much longer (since 1957). Moreover, around two thirds of the working population is concentrated in the area covered by the EUS, hence the national vs. Great Santiago issue is not so serious. The EUS collects information on earnings of a (rotating) representative sample of the labour force in Great Santiago.

market, and more accurately, enrolled in the pension system at the time of the reform. Thus, we kept those who indeed had the choice to either stay in the PAYG system or to opt-out to the PFA scheme. We give more detail of further sample restrictions in each chapter.

2.4 Empirical Approach

The main objective of this chapter is to compute the net present value of EPW each individual in our sample will get in the pension scheme they currently are and compare that outcome (on an individual basis) with the net present value of EPW those same individuals would have got in the other system should they had made the opposite decision as they actually did.

Thus, we aim to compare the *actual* and the *would have been* net present value of EPW (NPV_EPW and npv_epw, respectively). For individuals currently in PFA:

$$NPV\_EPW_i^{PFA}(D_i = 1, X_i) \lessgtr npv\_epw_i^{PAYG}(D_i = 0, X_i)$$

And for those currently in PAYG

$$NPV\_EPW_i^{PAYG}(D_i = 0, X_i) \lessgtr npv\_epw_i^{PFA}(D_i = 1, X_i)$$

Where:

$$\mathrm{D}_i = \begin{cases} 1 \text{ if opted out to PFA} \\ 0 \text{ else} \end{cases}$$

$\mathrm{X}_i \equiv$ individual's characteristics

Since we do not observe the right hand side term in either of the preceding expressions, we assume that for individuals currently in PFA $npv\_epw_i^{PAYG}(D_i = 0, X_i) = npv\_epw_i^{PAYG}(D_i = 1, X_i)$ and for individuals currently in PAYG $npv\_epw_i^{PFA}(D_i = 1, X_i) = npv\_epw_i^{PFA}(D_i = 0, X_i)$. Thus we will compare:

For individuals currently in PFA

$$NPV\_EPW_i^{PFA}(D_i = 1, X_i) \lessgtr npv\_epw_i^{PAYG}(D_i = 1, X_i) \tag{5a}$$

For individuals currently in PAYG

$$NPV\_EPW_i^{PAYG}(D_i = 0, X_i) \lessgtr npv\_epw_i^{PFA}(D_i = 0, X_i) \tag{6a}$$

This is implicitly assuming that there are not pension contributions behavioral responses due to the pension system design, which is clearly a very strong assumption[21]. Thus, we do not claim to identify causality but merely correlations between pension system and pension wealth. As a robustness check, we compute the pension an individual who opted out to a PFA would have got in the PAYG scheme (right hand side of equation 6a) under two scenarios: (i) observed scenario, using their observed employment history to allocate them to a pension provider; and (ii) upper bound scenario, allocating them to their most frequent observed provider for their entire working life[22]. Under scenario (i) we implicitly assume that individuals would have had the same employment patterns and characteristics regardless of the pension system they are enrolled in, that is, we assume there are no behavioural responses. On the contrary, under scenario (ii) we assume that if the individual would have stayed in the PAYG system, he would have had less employment sector mobility so not to lose vesting periods to be eligible for benefits in the relevant provider (see section 2.2 for further details). Consequently, benefits computed under the latter scenario are an upper bound for the PAYG system.

In order to calculate an individual's pension wealth when reaching retirement age we need both individual earnings profiles and contribution patterns. We now

[21] Indeed, in the third chapter we look at impact the pension system's design has on individuals participation in the formal labour market and thus affects pensions entitlements.

[22] Then, the provider could vary from month to month within an individual in the first approach, while in the second one the individual is assigned to only one provider for his entire observed-employment history.

explain in turn the approaches followed to address these two issues.

2.4.1 Estimating Labour Earnings

As earning histories are not available in the EPS, we simulate them by matching EPS respondents to earnings profiles from consecutive waves of cross-section data, employing a method similar to that used by Blundell, Meghir, and Smith (2002) and Banks, Emmerson, and Tetlow (2005). The cross-section data we use is the Employment and Unemployment Survey, EUS, from 1957 to 2004. A quantile regression on log earnings is performed to find median gross earnings for a specific group in all years between 1957 and 2004[23]. Groups are defined by year of birth, gender and education level. We pooled together three birth years in one so as to have more observations in each group. Four education levels are used, no education, primary, secondary and degree. We allow full interactions between gender, education and cohorts.

With group-earning profiles on hand we match each EPS responded to the corresponding group. To do the matching, we use one extra piece of information: the earnings information available in the EPS2002 and in the EPS2004. With this, for each individual we compute the ratio of actual earnings in 2002 to group median earnings from the EUS in 2002 and the ratio of actual earnings in 2004 to group median earnings from the EUS in 2004. We then average the ratios for the 2 years. We see this as an "individual effect" and assume it does not vary over time, i.e. implicitly assuming that shocks affect individuals in the same group in the same way, so within group ordering does not change over time.

Hence, from group-earning profiles and the individual effect we get individual-specific earnings profiles.

Finally, to get earnings in years after 2004 and until R (when corresponding) we use the predicted values from a median regression of group-earnings on age,

[23] Median earnings were calculated across three consecutive years of data. For example, median group earnings for 1998 were found by taking the median earnings for people in that group in 1997, 1998 and 1999.

its square and the unemployment rate[24]

2.4.2 Estimating Probability of Contribution

From the employment history section of the EPS we know whether each respondent contributed or not and if so, to which pension system from 1980 (or his/hers first employment if later than that) to 2004. So we only need to project contribution patterns for unobserved periods (i.e. before 1980 and for future periods)

The first step in obtaining contribution profiles for unobserved periods is to estimate the probability of contribution for each individual. In doing so we use a probit model, in which for each observed period t in the EPS (from 1980 to 2004) the left-hand side variable takes the value of 1 if contributing or 0 if not; given an initial state in t-1 that can as well take the value of 1 if contributed or 0 if not. Thus, we get the transitions from one period to the next one assuming a 1st order Markov process.

$$\Pr(C_{it} = 1 | C_{it-1} = 0, X_i) = \boldsymbol{\phi}(C_{it-1} = 0, \delta_1 X_i) \tag{7}$$

$$\Pr(C_{it} = 1 | C_{it-1} = 1, X_i) = \boldsymbol{\phi}(C_{it-1} = 1, \delta_2 X_i) \tag{8}$$

The variables included in the X vector are age, age squared, level of education, cohorts dummies, the interactions between the last two variables and the unemployment rate. We also include monthly dummy variables to control for seasonality and a trend to control for a declining pattern observed in the data on the unconditional probability of contributing given an initial state, not least when the initial state is not contributing (see figure 7 in Appendix 2.5 depicting such trend). Separate regressions are run for men and women.

Based on the predicted values for the probability of contributing, the second step is to project the probability of contributing for each unobserved period. We

[24] The observed unemployment rate is used untill 2005. 7% is assumed from 2006 onwards.

follow the same approach to simulate contribution patterns for the two types of unobserved periods, before 1980 and after 2004. The former is relevant only for individuals that joined the labour force before 1980 while the latter matters for everyone who by 2004 had not yet reached retirement age.

Since we need to forecast a binary variable (to contribute or not to contribute), a random number is generated for each individual-period from a U[0,1] distribution. If the value of the random number is lower or equal than the predicted value, then a value of 1 is assigned to the variable in the unobserved period, i.e. the individual would contribute in that period. On the contrary, if the value of the random variable is higher than the prediction, then a value of 0 will be given to the individual-period observation, i.e. the individual would not contribute in that period. We do this recursively, so in each unobserved period we use the "updated" information on the contributing variable in the previous period and the relevant predicted value (either from equation 7 or from equation 8).

2.4.3 Computing expected pension wealth

Once we have projected earnings and contribution patterns as explained in sections 2.4.1 and 2.4.2, respectively, we have everything we need to compute each individual's pension under the PFA and the PAYG scheme.

As regards pension savings in the PFAs, we follow the same approach as for the hypothetical cases in subsection 2.2.1, adopting two scenarios for the rate of return: the actual series of the pension funds rate of return (which averaged 9.24% between 1981 and 2009) and the expected yield at the time of the reform (4%)[25]. The former scenario could be interpreted either as an ex-post (nowadays) evaluation of the staying/opting-out decision, with the observed realization of (high) returns; or as the expectations that an optimistic individual

[25] Jose Piñera, the father of the reform, states that the mandatory 10% rate of contributions was calculated on the assumption of a 4% average net yield during the whole working life, so that the typical worker would be able to fund a pension equal to 70% of his final salary (Piñera (2001)).

had about the financial market performance at the time of the reform. On the other hand, assuming a rate of return of 4% could be interpreted either as an ex-ante (in 1981) evaluation of the staying/opting-out decision, based on the information available at the time; or as conservative expectations about financial markets[26]. We assume a constant rate of return of 4% for all future periods. Further, pension savings in the PFAs include the Recognition Bond mentioned in section 2.2, which we compute according to formulas given in Appendix 2.2 using estimated contribution patterns and earnings profiles. Once we have pension savings we compute the corresponding expected annuity[27] using the same formula and program actually used in the Chilean system[28]. The formula takes into account variables such as sex and marital status of the claimant, age of the spouse[29], sex-based life expectancy tables[30], among others.

Regarding pensions in the PAYG we do take into account the different benefit formulas and eligibility rules the three main providers have. The EPS does not specify to which provider individuals are members. Nonetheless, affiliation is determined by employment-sector and this information is indeed included in the employment histories of the EPS. As mentioned in section 2.4, we adopt two alternative scenarios to allocate individuals to a provider in observed periods: (i) we allocate each *individual-period* to a provider according to the monthly employment details from EPS; and (ii) we allocate each *individual* to his most frequent (mode) provider according to the employment details survey data. Regarding unobserved periods (not in the EPS2004, either before 1980 or after

[26] Which scenario is the "right" one to project pensions savings is somewhat subjetive since some authors claim that at the time of the reform there were high expectations on the rates of return Edwards (1998)

[27] We chose to compute annuities (instead of programed withdrawals) so the comparision with pensions in the PAYG system is more appropiate.

[28] We are grateful to the Superintendency of Pensions for providing the program to compute pensions.

[29] We get information on these individual traits from the EPS

[30] In spite of the increasing life expectancy trends, the tables used in Chile to compute benefits were left unchanged since the beginning of system until 2005. In this year however, new legislation was passed, updating life expectancy tables to be used to compute benefits for new pensioners. Thus, while we use the old life expectancy table to compute pensions for individuals who reached pension age before 2005; we use the new tables to compute pensions for individuals who will reach pension age after 2005.

2004), individuals are assigned to the most frequent (mode) provider according to the employment details from the EPS data. Once we have allocated individuals to the relevant provider, we use fine details on the requirements to be eligible and on the benefit formulas in each provider to compute expected pensions in the PAYG scheme (more details on formulas in Appendix 2.1). We also take into account minimum and maximum values pensions can take[31].

As in subsection 2.2.1, we adjust expected pensions to the Minimum Pension Guarantee for those whose benefits are below the threshold and that satisfy the eligibility requirements (which are simply to be eligible for a pension (according to formula 1) in the case of tea PAYG system and to have made at least 240 contributions in the case of the PFA scheme).

As we need to compute the present value of EPW in either system, we discount the stream of the relevant expected annuity at a constant rate of 4% a year, considering the survivors' benefits if the individual has dependants[32] and their corresponding life expectancy[33]. Moreover, as contribution rates to the PAYG and PFA system are substantially different, we compute the *net present value* of EPW by deducting the present value of all contributions made up to retirement to the relevant scheme.

The remaining assumptions we make when computing expected pensions wealth are: we assume that everyone claims the benefit at the legal retirement age, we express all values in constant prices (of December 2002) and assume perfect foresight about inflation rates when computing future expected benefits. Finally, we assume that when forming their expectations about future pension benefits, people take their characteristics that affect pension benefits (such as current marital status) as given and fixed (Attanasio and Rohwedder (2003)).

[31] As defined by Law No. 15,386
[32] We get this information from the EPS
[33] We take average life expectancy from aggregate mortality statistics.

2.4.4 Measurement error

There are at least two reasons why computed EPW may be subjected to measurement error. In this subsection we intend to analyse the extent of these potential problems to gain a better understanding of the impact on our results.

Firstly, our measure of EPW is based on self reports of employment and contribution histories. The literature on measurement error on survey data, for example on the reporting of unemployment, indicates that the greater the length of the recall period, the greater the expected bias due to respondent retrieval and reporting error (see Bound, Brown, and Mathiowetz (2001) for a review of the literature and a comprehensive analysis of the topic)[34]. Applying this evidence to our case would suggests that individuals overestimate their contribution profiles, thus our measure of EPW would be biased upwards. The authors also point out that the length of time may not be the only or most relevant factor in the measurement error. In particular, in our framework, the quality of the reports could be positively correlated with the attachment to the labour market Therefore, both sources of measurement errors would affect the quality of the reports to a greater extent for those in the PAYG plan.

Ideally, it should be possible to compare on an individual basis the self-reports from the EPS with administrative pension savings records. This information exists but, unfortunately, is not publicly available yet. As an alternative validity check, for each period (month) in the EPS, we compute the ratio of the number of individuals contributing to the PFA system to the number of individuals contributing to either system (PFA or PAYG); and compared this (aggregated) ratio to the corresponding one from aggregate official figures[35]. Figure 6 in Appendix 2.5 shows that the difference between the two series is never greater than 3% in absolute value. Thus, the proportion of individuals

[34] However Bound et al. (2001) also emphasise that the empirical findings regarding the impact are not consistent.

[35] Reported by the Superintendency of Pensions and the Instituto de Normalizacion Previsional, INP. The latter is the govermental agency that manages the PAYG system.

who self-reported to have contributed to the pension system in any particular month does not significantly differ from the actual figures coming from aggregate statistics.

Secondly, when computing EPW we assume that everyone retires at pension age (and actually drops from the labour market). This assumption should be rather innocuous for those in the PAYG system as the main provider does not allow for early retirement whatsoever. However, those in the PFA scheme that satisfy the requirements could choose early retirement and thus we would overestimate their EPW.

In summary, when comparing the measurement error in the two systems we have that, on the one hand, both sources of error could mean a rather moderate over-estimation of EPW for those in the PFAs. On the other, the recall error could bring about a significant over-estimatimation in the PAYG system but computations for this scheme do not suffer measurement error due to early retirement. As long as the differences between computed and actual pension savings are similar across schemes, our conclusions on the optimum pension system choice should not be too biased.

2.5 Results

2.5.1 Pensions in either system (counterfactuals)

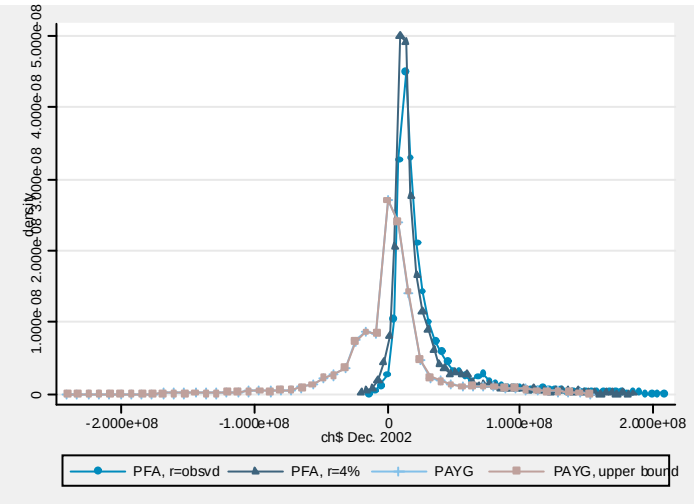
We now present the results from the empirical analysis just described. Firstly, Table 2 contains some summary statistics from the sample used for the comparison. Our sample has 4,237 individuals, of whom 40% are women. The overall average age at the time of the reform was 37 years and almost three in four individuals in the sample has primary education or less.

Table 2: Summary statistics

	All	Men	Women
Obs	4,237	2,562	1,675
Average age in 1981	36.9	36.8	37.2
No education	35.2%	35.8%	34.1%
Primary	39.6%	41.2%	37.0%
Secondary	14.2%	13.1%	16.0%
Degree	11.0%	9.9%	12.8%

Figure 3 depicts the densities for the computed net present value of EPW in each pension arrangement. Recall that we have computed benefits each individual in our sample would get under both systems, regardless of the scheme they are actually enrolled in. In order to ease the analysis when presenting the results, we have added-up all benefits an eligible individual gets from each different provider in the PAYG scheme.

Figure 3: Kernel densities for net present value of pension wealth at retirement age in the PFA and in the PAYG system



It can be seen that the two distributions of the net present value of pension wealth in the PAYG (for the actual (reported) employment histories and for the

upper bound) perfectly overlap and thus are indistinguishable from each other. This result suggests that if/when individuals change jobs, they probably stay in the same employment sector and thus in the same provider. Consequently, the net present value of EPW resulting from our hypothetical scenario in which individuals make their employment and mobility decisions trying not to loose vesting periods (upper bound) is very much the same as the net present value of EPW resulting when we use reported histories. Since the two scenarios produce rather similar outcomes, in what follows we will focus on the results using the actually observed employment histories and display the upper bound scenario results in appendix 2.6.

Figure 3 also shows the effects of the non-linearities in the PAYG formula. Vesting periods mean that a significant share of individuals would not get a benefit whatsoever in this scheme, but since they still made contributions, they get a negative net present value of pension wealth. On the other hand the distribution of the net present value of pension wealth in the PFA has only few observations with negative values and is to the right of the distribution of the PAYG scheme. Not surprisingly, the distribution with the actual realization of (high) interest rates is slightly to the right of that with r=4%. The former also has many more high values, showing the extent to which some individuals profited form periods with high returns.

Table 3 presents a more detailed comparison of the computed net present value of pension wealth for each individual in the two systems. We present the results for men and women separately and disagregated by education level and birth cohort. While the first comparison (columns 1 and 2 for men and women, respectively) uses the observed pensions fund rate of return to compute benefits in the PFA system, the second one (columns 3 and 4) uses a constant rate of 4%.

We find that when using the actual series of rate of returns, amongst members of the pension system at the time of the reform (thus those that in principle

could choose between the two plans) an overall 87% would have got (or are getting) a higher net present value of pension wealth from the PFA than what they would have got from the PAYG (weighted average of columns 1 and 2 of Table 3).

The share of individuals better off in the PFA scheme falls to 82% when assuming r=4% (weighted average of columns 3 and 4 of Table 3). The drop is no so dramatic as we are not comparing pension benefits but the *net present value of pension wealth,* thus netting out contributions and discounting all future payments (both benefits and contributions). Further, we include the RB for individuals who opted-out, which makes the pensions fund interest rate relatively less important in computing the annuity in the PFA. We come back to the rate of return issue in the next subsection.

The proportion of workers that would be better off in the PFA is a bit higher for men than for women. This result can be explained by Table 4. Even though the same share of men and women are eligible for benefits in the PAYG scheme (columns 1 and 2), columns 3 and 4 show that while three in four men would be in maximum accrual in the PAYG system, only one in two women would be. Thus, a higher proportion of men than women would benefit from the non-maximum accrual feature of the PFA arrangement drawing higher benefits than in the PAYG scheme.

An interesting result shown in Table 3 is that the proportion of women that would be better off in the PFA is decreasing in education. Again, this finds explanation in Table 4, column 2. There is a strong positive correlation between education and eligibility of women in the PAYG. Due to a low attachment to the (formal) labour market[36] and to vesting periods[37], around 1 in 2 women at the bottom of the education distribution would not be eligible for benefits

[36] See for example Contreras, Puentes, and Bravo (2005).

[37] Women members of the main provider in the PAYG system, the SSS, have less stringent requiremetns than men to be eligible for a benefit. The requirement is 520 weeks as opposed to 800 weeks for men (see equation 1 and Appendix A)

in the PAYG scheme, thus would get no pension whatsoever. This leads that 90% of women with no education would be better off in the PFA (see Table 3). As there is no minimum contribution time required to be eligible for an old age benefit in the privatised system, individuals with few contributions would draw a pension in any case (though probably rather low). On the other hand the positive correlation between education and eligibility of men is much milder than for women causing the proportion of males better off in the PFA to be fairly stable in education.

Along the same lines, the proportion of individuals with a degree that would get a higher pension in the PFA than in the PAYG is very different for men and women. While 85% of males would be better off in the PFA, the proportion reaches only 65% for females. This result is again due to the redistribution inherent in the PAYG system: even though the same proportion of men and women would be eligible for a benefit (around 3 in 4), 86% of men with a degree would be in maximum accrual making it more profitable for them to be in the PFA system. On the other hand, a highly educated woman possibly with an interrupted career (not least during child bearing age) but that is still entitled to a benefit would receive a rather high pension related to her final salary, thus benefiting from the redistributive nature of PAYG schemes.

Table 3 also shows that older cohorts, not least for men, would not have benefited as much from the PFA pension system as middle and younger cohorts would have (where, for example, cohort17/19 represents those individuals born between 1917 and 1919). As older cohorts would have been in the eve of their retirement, they would not have had time to benefit from the high interest rates in the early periods of the PFA. Further, even though we show in subsection 2.2.1 and appendix 2.2 that older workers with high ability and high attachment to the formal labour market would benefit from the generous RB as compared to the PAYG pension formula, the empirical analysis suggests that in reality older workers did not have these traits thus nearly half of them would have been

better off staying in the PAYG scheme. On the contrary, middle age workers (cohorts born between 1929 and 1959) would benefit from high interest rates, the compound interest and the generosity of the RB, thus making most of them better off in the PFA system.

Table 3: Comparison of net present value of EPW in PFA and PAYG

	% of whom $NPV\_PFA_{observed\ r} >= NPV\_PAYG$		% of whom $NPV\_PFA_{r=4\%} >= NPV\_PAYG$	
	Men	**Women**	**Men**	**Women**
All	88%	84%	85%	78%
No education	85%	90%	82%	83%
Primary	91%	88%	89%	82%
Secondary	89%	81%	87%	76%
Degree	85%	65%	77%	51%
cohort17/19	54%	-	54%	-
cohort20/22	54%	90%	48%	90%
cohort23/25	58%	73%	58%	73%
cohort26/28	86%	79%	83%	78%
cohort29/31	91%	96%	85%	96%
cohort32/34	80%	93%	74%	88%
cohort35/37	98%	96%	96%	84%
cohort38/40	97%	91%	94%	79%
cohort41/43	95%	96%	94%	89%
cohort44/46	95%	85%	94%	78%
cohort47/49	93%	79%	91%	62%
cohort50/52	91%	82%	89%	80%
cohort53/55	92%	86%	90%	84%
cohort56/58	97%	87%	96%	82%
cohort59/61	94%	49%	93%	34%
cohort62/64	34%	63%	25%	57%
cohort65/67	83%	40%	67%	40%

Table 4: Share of individuals that would be eligible for benefits and that would be in maximum accrual in PAYG system

	Share eligible for benefits		Share in maximum accrual	
	Men	Women	Men	Women
All	58.7%	58.9%	76.5%	52.2%
No education	58.2%	50.9%	66.4%	36.9%
Primary	54.9%	57.7%	80.9%	54.4%
Secondary	59.4%	63.4%	83.6%	61.9%
Degree	75.1%	78.1%	85.8%	74.9%

2.5.1.1 Rate of return What is the rate of return that would have made pensions in the PFA and PAYG schemes equivalent? To address this question, in this subsection we compute the rate of return in the PFA scheme that yields, on average, the same pension across systems. In doing so, we abstract from the different contribution rates across systems and future payments, thus we do the comparison in terms of the pension benefit itself (in other words we do not take into account the net present value of pension wealth). Further, we also leave out the recognition bond when computing pensions in the PFAs as is only a transitory component of the reform.

We find that an average annual real rate of return of 7% would have equalised average pension benefits across systems[38]. This is certainly lower than the average of 9.24% effectively observed rate of return of up to 2009, but higher than what is mostly assumed for the long term rate of return - between 4% and 6%.

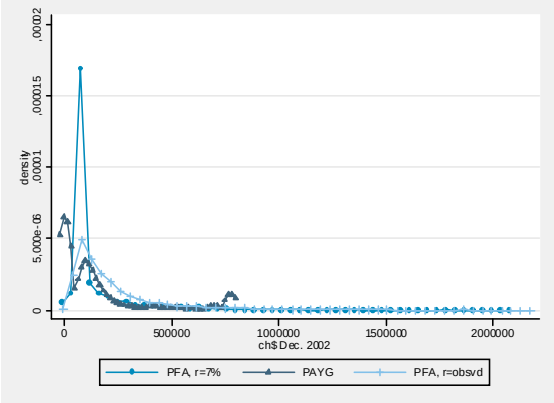
Although previously we found that with a rate of return of 4% the vast majority of individuals in our sample would be better off in the PFA system, recall that this result was obtained by comparing the *net present value of pension wealth* as opposed to comparing *annuities* as we do in this subsection. In other words, the rate of return is only one of the determinants of the difference in the net present value of pension wealth. As mentioned in section 2.2, other relevant factors are contribution rates and non-linearities in pension benefits. Regarding the latter, figure 4 plots the distributions of pensions in the PAYG scheme and in the PFAs when using the rate of return of 7% (the distribution of pensions in the PFAs when using the actually observed rate of return is also displayed as reference). Although the rate of return of 7% delivers equal average pensions across systems, the difference in the distributions is evident. Again, this is mainly due to strict vesting periods in the PAYG which gives rise to high clustering at zero benefits[39].

[38] This rate of return also equalises the median of pension benefits.

[39] There is also some clustering at the legal upper cap in pensions in the PAYG systems of

Figure 4: Kernel densities for pensions at retirement age in the PAYG and PFA system

Using r=7% for the PFA system

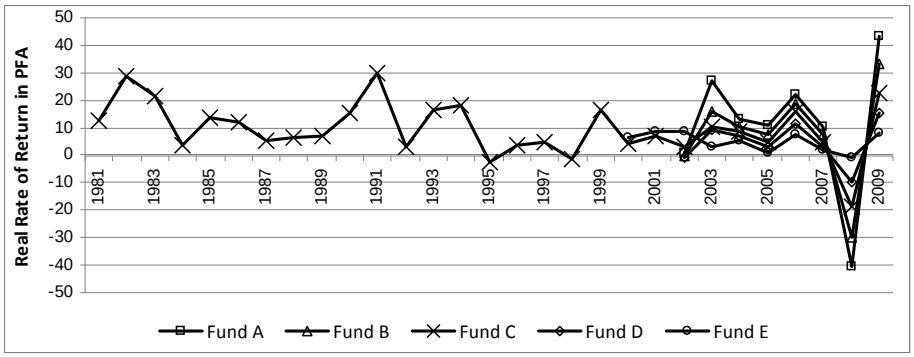


It is worth noting that the analysis in this subsection ignores the interest rate risk in the PFA scheme (as well as other risks such as the lack of portability in the PAYG system). Even though the average real rate of return of the system has been rather high since the DC system outset, individuals are subject to its volatility which is even more important when they are in the eve of retirement. Figure 5 and table 10 in appendix 2.3 display the trend in the real rate of return of the PFA system. Five series are shown, one for each Type of Fund that differ in the proportion of risky assets they are allowed to invest in. While Fund A is the riskiest, Fund E is the safest. Even though individuals close to retirement are not allowed in the riskiest funds, individuals that were to retire in 2008 potentially suffered a sharp decrease in their pension savings due to the financial crisis (although in this particular case all of the loss was recovered in 2009). It is natural to think that risk aversion would make individuals be interested not only with the level of pensions and incentives but also to be concerned with this type of risks when choosing between the PFA and the PAYG system.

ch$776,508 (as for Dec. 2002).

Figure 5: Real Rate of Return of PFA System

1981-2009



2.5.2 Pensions in the actual system

To gain insight into whether individuals made the right staying/opting-out decision, we split the sample by the pension scheme individuals are currently members of. Table 5 contains basic descriptives by pension system, showing that almost 2/3 of men but not even 1 in 2 women opted-out to the PFA scheme. Moreover, stayers were older and had lower levels of education.

Table 6 provides evidence on who *actually* made the optimal decision, meaning for our purposes, who chose the pension scheme that would deliver the highest net present value of EPW. When using the observed realization of the pensions fund interest rate, it turns out that 59.6% of the 66% males currently in the PFA and 5.5% of the 34% currently in the PAYG took the optimal choice. Thus, adding-up, a total of 65% men actually maximised their net present value of EPW when choosing pension scheme (see main diagonal on the top panel). This figure is much lower for women, only a total of 44% of females optimally chose pension scheme, of which 37.9% are currently in the PFA and 6% in the PAYG scheme[40].

[40] The figures when using r=4% are very similar as those with the actual realization of interest rates presented in the text. Results are available upon request.

Table 5: Summary statistics by pension system

		currently in PFA	currently in PAYG
Men	% of men in sample	66.0%	34.0%
	Average age in 1981	32.5	45.1
	No education	28.2%	50.7%
	Primary	43.3%	37.2%
	Secondary	16.2%	7.1%
	Degree	12.4%	5.0%
Women	% of women in sample	47.5%	52.5%
	Average age in 1981	31.0	42.7
	No education	19.5%	47.4%
	Primary	38.0%	36.1%
	Secondary	20.9%	11.6%
	Degree	21.6%	4.9%

The above figures leave us with 84% of men and 89% of women currently in PAYG [41] that are worse off with the decision they made, i.e. to maximise their net present value of EPW they should have opted-out instead. This result is due both to individuals' characteristics and to the pension formulas. As for the former, stayers were, on average, in the middle of their working lives and almost 1 in 2 have no education (column 2 in Table 5) and for the latter, as many as 42% of men and 53% of women do not /will not satisfy the requirements to be eligible for a benefit in the PAYG scheme (column 2 in Table 7). In other words, individuals vulnerable to frequent and/or long unemployment spells or prone to work in the informal sector stayed in the PAYG system, in spite of being less likely to benefit from the redistribution in this arrangement. The choice of pension system they made may have been driven by low interest rate expectations, a lack of understanding and/or a lack of trust in the new PFA system, which made some workers reluctant to opt-out.

[41] 28.5/34=83.7%for men, 46.5/52.5=88.5% for women.

Table 6: Share that would be "better off" in each system,

by current system (observed r)

Men			Would be better off in		All
			PFA	PAYG	
	Currently in	PFA	59.6%	6.4%	66.0%
		PAYG	28.5%	5.5%	34.0%
	All		88.1%	11.9%	
Women			Would be better off in		All
			PFA	PAYG	
	Currently in	PFA	37.9%	9.6%	47.5%
		PAYG	46.5%	6.0%	52.5%
	All		84.4%	15.6%	

Table 7: Share eligible for benefits and in maximum accrual in PAYG,

by current system

Men		Share eligible for benefits		Share in maximum accrual	
		currently in PFA	currently in PAYG	currently in PFA	currently in PAYG
	All	59.2%	57.7%	91.1%	48.3%
	No education	60.3%	55.9%	87.2%	44.1%
	Primary	53.7%	57.7%	92.8%	54.0%
	Secondary	58.6%	62.9%	92.7%	43.5%
	Degree	76.6%	68.2%	92.3%	54.5%
Women		Share eligible for benefits		Share in maximum accrual	
		currently in PFA	currently in PAYG	currently in PFA	currently in PAYG
	All	71.7%	47.4%	74.7%	31.9%
	No education	73.5%	42.4%	60.0%	28.3%
	Primary	67.9%	48.1%	74.8%	34.9%
	Secondary	68.7%	54.9%	78.3%	35.3%
	Degree	79.7%	72.1%	84.3%	37.2%

Regarding those currently in the PFA, Table 6 shows that 90% of men and 80% of women[42], averaging 86%, made the optimal decision. Again, from Table 7 we can see that even though most of those that opted- out would be eligible for benefits, a much higher share of men than women would have reached maximum accrual in the PAYG system, thus would have seen their benefits

[42] 59.6/66=90% for men, 37.9/47.5=80% for women.

capped. As there is no upper limit for pensions in the PFA, males would probably get a higher pension in the privatised system while women benefit from the redistribution in the PAYG.

Summarising, our results show that 65% of men and 44% of women (which averages to 57%) maximised the net present value of EPW when choosing pension arrangement. Thus, when faced with the choice of pension system, just over half of individuals made the optimal choice. Responses vary across current pension system: while 90% of men and 80% of women currently in the PFA maximised the net present value of EPW, less than 15% of individuals currently in the PAYG did. This later result is due both to the design of the systems (non-linearities in pension formulas, redistribution (or the lack of it)) and to individuals characteristics (age, attachment to the labour market, ability, understanding/trusting the reform).

We still find that 10% of men and 20% of women that chose to opt-out would have been better off staying in the PAYG system. Thus, in spite of the overall results that most individuals that had choice are better off in the PFA than they would be in the PAYG arrangement, there are still some individuals- amongst whom women are over represented- for whom the system operating nowadays may not provide enough old age protection. We take a closer look at this worst-off group in Table 8. When disaggregating the sample by education we find that, on the one hand, most worst off men and a fare share of women are low skill workers . Nonetheless, the proportion of individuals in younger generations with low educational levels is much lower nowadays (43% of those that in 2004 were between 25 and 30 years old had primary education or less, compared to 72% of those in our (older) sample). This means that as a natural consequence of development, population increases its schooling level and thus new generations are less likely to lose out in the PFA pension arrangement. On the other hand, there is a high share of women worst off in the PFA who have high levels of education (see bottom panel in Table 8). Again, these groups are

likely to meet the vesting period to be eligible in the PAYG scheme and thus benefit from its redistribution. In other words, they are worst off in the PFA system because now they rely only on their own savings to fund retirement with no redistribution towards them.

It is worth mentioning that family types are changing in the Chilean society in the sense that divorced and single women are more commonly observed nowadays. This brings about that less women will be able to rely on survivor pensions inherited from their husbands thus will have to fund retirement with their own pension savings. This effect comes over and above the effect of the non-redistribution of the PFA scheme aforementioned.

Table 8: Share in PFA that would be "better off" in the PAYG system (observed r)

Men	All	9.7%
	Education	
	none	2.8%
	primary	3.6%
	secondary	1.6%
	degree	1.8%
	Age in 1981	
	50+	0.9%
	30-49	3.5%
	15-29	5.3%
Women	All	20.1%
	Education	
	none	2.5%
	primary	5.8%
	secondary	4.9%
	degree	6.9%
	Age in 1981	
	50+	0.4%
	30-49	9.1%
	15-29	10.7%

We also find that, for both men and women, the losers of the privatisation were quite young at the time of the reform and thus they have spent most of

their working lives in the new scheme. This finding is of concern as the PFA is the system new generations of employees have to join, without having any alternatives to choose from.

2.6 Conclusions

The Chilean pension system went through a deep reform in the early eigthties, moving from a traditional PAYG defined benefits scheme to a privately managed DC plan. Individuals in the labour market at the time of the reform were given the choice to either stay in the old PAYG system or to opt-out to a PFA. Thus in spite of the deep change, the old system's rights were maintained for stayers.

In this chapter we first examine the main differences between the two pension plans in terms of eligibility rules,pension formulas, risks and degree of choice within each system. We then empirically analyse for whom it was optimal to stay and for whom to opt-out by comparing the net present value of EPW each individual will get under each of the two systems.

In order to compute the net present value of EPW we need both earnings profiles and contribution patterns for each individual in our sample. As we do not observe earning histories, we simulate them matching each individual in our sample to earning profiles estimated from consecutive waves of cross section data. On the contrary, we do observe individual contribution histories, so we only need to project contribution patterns for unobserved periods. We do so estimating a probit model for the probability of contributing to the pension system in period t, given an initial state (contributing or not contributing) in period t-1.

Once we have earnings and contribution profiles we compute the net present value of EPW using fine details on eligibility requirements and pension formulas in both systems. Our results show that overall 87% would be better off in the PFA than in the PAYG scheme.

Due to non-linearities in the PAYG system, in particular the cap in the benefits and maximum accrual which affects mostly men, the share of individuals better off in the PFA is higher for men than for women. As the latter are affected by these top end non-linearities to a lesser extent they benefit more from the redistribution feature inherent in the PAYG plan. Moreover, the non-linearities in pension formulas in the PAYG system mean that the proportion of women that benefited from the pension reform varies widely with schooling.

When looking at who actually made the optimal decision when choosing pension arrangement (in the sense of maximising the net present value of pension wealth), we find that 57% did. We also find high variation in this response to financial incentives by actual pension system: while 86% currently in the PFA maximised pensions, less than 15% currently in the PAYG did. This results are due both to the design of the systems and to individuals characteristics. Thus, when faced with choice regarding pension savings, half of the group with choice took the optimal choice. This result becomes relevant as allowing individuals to choose between different alternatives is becoming popular within reforms, not only in Chile but also in several other countries. The choice individuals face include fund type, savings rates and assets allocation; all important decisions that may affect retirement and yet require sophisticated knowledge about assets returns, life cycle consumption planning and projections. Indeed, the evidence shows that individuals heavily rely on default settings of their saving plans, thus policy makers must ensure the default options are appropriately designed (Creighton and Piggott (2006)).

We conclude that there is scope to improve the pension system to ensure that low skill workers from new generations and women get sufficient provision upon retirement. Regarding the former group, the system should both strengthen the first pillar to support the more vulnerable and should provide incentives to individuals to participate in the system from early ages. Along these lines the Chilean government has already taken some steps towards it through a new

pension reform that, amongst other things, introduced a Redistributive Pension System to which everybody older than 65 years old would be entitled to a pension, regardless of whether they contributed or not to the pension system during their working lives. The project also contemplates state subsidies to encourage young individuals to participate. Regarding women, they would with no doubt benefit from the proposed means-tested basic pension. Further, there will be a Children Contributions Voucher to compensate for time women spend out of the labour force while bringing up children. However, one of the main reasons why women get a lower pension than men in the PFA scheme is that their pension age is 5 years earlier while they live in average 5 years longer, thus having to finance an average of 10 extra years of retirement. The obvious measure would be to increase women's pension age, but this has been left out of the reform.

Appendix 2.1. Features and Benefits of the Chilean PAYG System

At the end of the seventies there were more than 30 pension providers, roughly organized according to employment sector. The reform in 1981 consolidated all these providers into one, managed by the Social Security Normalization Institute (INP for its name in Spanish). Members of a provider that stayed in the PAYG system, i.e. in the INP, kept the rights already acquired.

In spite of the large number of providers, there are 3 main ones, both in terms of the number of active contributors and number of pensioners. These larger providers are:

1. Social Security Service (Servicio de Seguro Social, SSS)[43]
2. Private Sector Employees provider (Caja de Previsión de Empleados Particulares, EMPART)[44].

[43] SSS members are workers whose job requires phisical rather than intellectual effort. Law No 10,383.

[44] EMPART members are workers whose job requires intellectual rather than physical effort.

3. National provider for Civil Servants and Journalists (Caja Nacional de Empleados Públicos y Periodistas, CANAEMPU)

The following table shows the monthly average number of contributors and pensioners in 2004, by provider:

Table 9: Monthly number of contributors and pensioners in the PAYG, by provider

	Contributors		Pensioners		
	No	%	No Normal Pension Age	No Early retirement	%
SSS	110,348	70.4%	243,598	n.a.	63.6%
EMPART	22,225	14.2%	37,040	22,583	15.6%
CANAEMPU	22,633	14.4%	12,933	28,575	10.8%
Others	1,598	1.0%	16,647	21,746	10.0%
Total	**156,804**	**100.0%**	**310,218**	**72,904**	**100.0%**

The 3 main Funds differ substantially in the requirements to entitle benefits:

1. **SSS**

Men	Women
• 65 years old • 800 or more weeks of contributions • Density of contributions no lower than 50%. This does not apply to those who have 1,400 or more weeks.	• 60 years old • 520 or more weeks of contributions

2. **EMPART**

Men	Women
• 65 years old • 10 or more years of contributions • Be a member of Empart at pension age or last contribution within 2 years before pension age	• 60 years old • 10 or more years of contributions • Be a member of Empart at pension age or last contribution within 2 years before pension age

Law No. 10,475.

3. **CANAEMPU**

Men	Women
• 65 years old • 10 or more years of contributions • At least 1 years of affiliation to Canaempu before pension age	• 60 years old • 10 or more years of contributions • At least 1 years of affiliation to Canaempu before pension age

The following table specifies the benefit formulas for the 3 main pension providers

SSS	AW of the last 60 months*(0.5 first 500 weeks+0.01every 50 weeks) • The pension cannot be higher than 70% of the AW • The pension cannot be lower than the minimum pension, Law 15,386, art. 26
EMPART	AW of the last 60 months*(No of years of contributions/35) • If the affiliate was unemployed in any of the 60 months, earnings can be used for up to 3 preceding years • Women can get one extra year of contributions for each child or two if she is widow • The max years of contribution is 35 • There is a maximum for the initial pension, Law 15,386, art. 25
CANAEMPU	AW of the last 36 months*(No of years of contributions/30) • If there are no earnings in one month, the formula uses the preceding one • The max years of contribution is 30 • There is a maximum for the initial pension, Law 15,386, art. 25

Appendix 2.2. The Recognition Bond

The recognition bond (RB) is defined as the capital needed for the individual opting out from the old PAYG scheme to receive a lifetime annuity equal to 80 percent of his taxable earnings prior to the reform, times the percentage of his working life contributing to the old system. The Government must pay this capital plus an annual real interest of 4% from the date of the transfer to the time the individual reaches retirement age.

There are several ways of computing the value of the Recognition Bond, depending on when the individual opted out the PAYG and whether he/she satisfies some conditions. However, there are 3 main types:

1. *For people who opted out in May 1981 and have at least 12 contributions between November 1975 and October 1980:*

$$\begin{aligned} RB &= 0.8 * \sum_{i=1}^{T} \frac{W_i}{T} * 12 * \frac{\text{No of years contributed}}{35} * A * B \quad (9) \\ Where &: \\ A &= 10.35 \text{ if man} \\ & \quad 11.36 \text{ if woman} \\ B &\equiv \text{factor increasing with age and that varies with sex} \end{aligned}$$

   T can be no greater than 12, that is to say, a maximum of 12 earnings are considered in the formula. Starting in June 1979, the formula goes backwards looking for earnings. If there is a month with no earnings the formula goes one month further back.

   The rate years of contributions/35 is included to proxy the density of contributions. It is capped at 1.

   The factor A is included to ensure that the RB will be enough to obtain a pension equal to 80% of the average earnings. Finally, the factor B is greater than 1 and increasing with age to account for the higher number of years contributed by older individuals.

2. *For people who opted out in May 1981, do not have 12 contributions between November 1975 and October 1980 but did contribute afterwards:*

   The RB is equal to 10% of the sum of the earnings from July 1979 and the date of opt out.

3. *For people who opted out after May 1981 and have 12 contributions between November 1975 and October 1980:*

   For earnings until June 1979 the RB is computed as in case 1. Thereafter, until the date the individual opted out, the RB is computed as in case 2. Hence the RB is a combination of the two former cases.

From comparing the RB and the pension in the PAYG system formulas (equation 9 vs. equation 1), one can see that older workers should have opted-out and get the RB instead of staying in the old system if either (i) the earnings in the last year before opting-out was higher than the average earnings of the last five years before retirement; (ii) the individual had more than 30 years of service; or (iii) the individual had less than 16 years of service (800 weeks). On the other hand, if it is the case that the individual has a low contribution density (and so less than 30 years of tenure), but still has the minimum requirement of 800 weeks to get a pension, he would be probably better off in the PAYG system as the pension formula ensures a minimum pension of 56% of the average earnings.

Appendix 2.3. Observed Rate of Return of Pension Funds

Table 10: Real Rate of Return by Fund Type

Year	Fund A	Fund B	Fund C	Fund D	Fund E
1981			12,80		
1982			28,51		
1983			21,25		
1984			3,56		
1985			13,42		
1986			12,29		
1987			5,41		
1988			6,49		
1989			6,92		
1990			15,62		
1991			29,68		
1992			3,04		
1993			16,21		
1994			18,18		
1995			-2,52		
1996			3,54		
1997			4,72		
1998			-1,14		
1999			16,26		
2000			4,44		6,32
2001			6,74		8,41
2002	0,68	-0,52	2,98	-1,03	8,90
2003	26,94	16,02	10,55	8,94	3,34
2004	12,86	10,26	8,86	6,80	5,44
2005	10,71	7,32	4,58	2,84	0,94
2006	22,25	18,82	15,77	11,46	7,43
2007	10,06	7,46	4,99	3,29	1,89
2008	-40,26	-30,08	-18,94	-9,86	-0,93
2009	43,49	33,41	22,53	15,34	8,34
Average (1)	8,90	7,03	9,24	4,99	5,12

Note: (1) From September 2002 to December 2009 for Funds A, B and D; from July 1981 to December 2009 for Fund C and from May 2000 to December 2009 for Fund E.

Appendix 2.4. Estimating Labour Earnings-Details

Two adjustments were made when estimating group-earning profiles as explained in section 2.4.1. First, as there are some groups that have no observations (individuals) for certain ages/years, we impute the predicted median earnings for the same group in the previous year, (where median earnings were accordingly updated with average earnings growth). Second, as those still in employment after the legal retirement age are not likely to be representative of the rest of their cohort, we replace their median earnings with the values predicted in the year before the legal retirement age.

As some EPS respondents were out of work by the time of the survey we firstly need to simulate earnings for them in that particular year (both for 2002 and 2004). We used a quantile regression (using the median) of earnings across individuals younger than pension age in employment in the relevant year. We include age, age square and education dummies as covariates and estimate separate equations for men and women.

As an alternative to matching actual earnings in 2002 and 2004 to group earnings, we computed the distance each individual in the EPS is to the nearest group-quartile in the EUS and then assume this distance is the same for every year. Even though this is a more flexible way to get earnings profiles (than just to do it through group-median regression from the EUS), there is a trade-off with precision due to the amount of data we have. Indeed, when comparing the resulting EPW of each method to aggregate administrative data and to self-reports we get that the group-mean approach yields better results.

It is worth mentioning that we aim to compute *gross* pensions and *gross* pension wealth. However, earnings reported in the surveys are *net* earnings, both from income-taxes and from payroll taxes (pensions, health and unemployment contributions). Thus, to be consistent in our measures, we recovered gross earnings using the actual tax schedules that have been used in the last 40 years.

Appendix 2.5. Figures

Figure 6: Share of individuals contributing in PFA

(Administrative Data - EPS self reported Data)

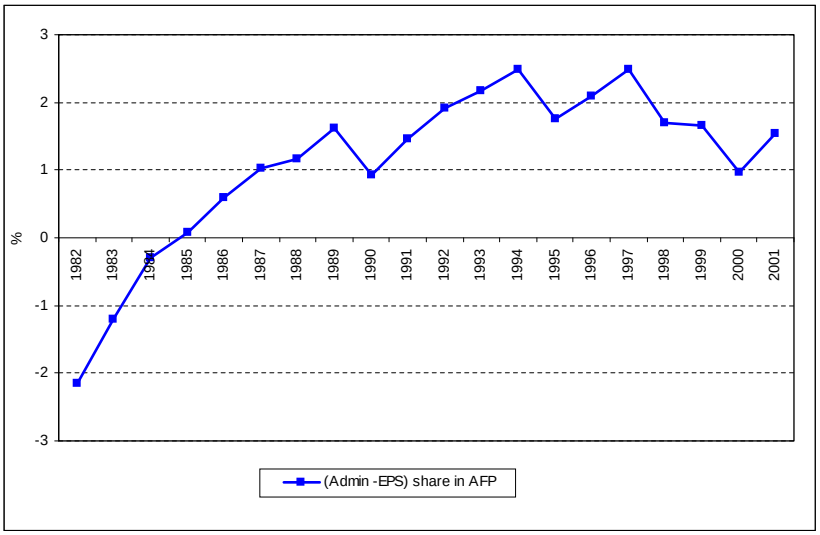
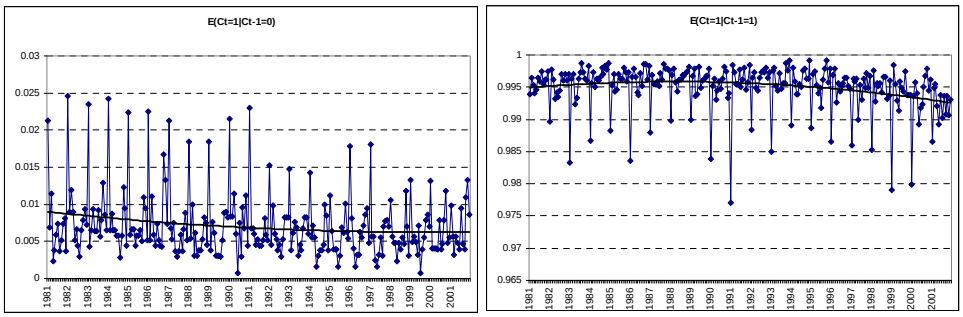


Figure 7: Unconditional probability of contributing given initial state.



Appendix 2.6 Full set of results. Upper bound scenario for PAYG scheme

Table 11: Comparison of net present value of EPW in PFA and PAYG

Upper bound scenario for PAYG scheme

	% of whom $NPV\_PFA_{observed\ r} >= NPV\_PAYG_{upper\ bound}$		% of whom $NPV\_PFA_{r=4\%} >= NPV\_PAYG_{upper\ bound}$	
	Men	**Women**	**Men**	**Women**
All	88%	84%	85%	78%
No education	85%	90%	82%	83%
Primary	91%	88%	89%	82%
Secondary	89%	81%	87%	76%
Degree	85%	65%	77%	51%
cohort17/19	54%	-	54%	0%
cohort20/22	54%	90%	48%	90%
cohort23/25	57%	73%	57%	73%
cohort26/28	86%	79%	83%	78%
cohort29/31	91%	96%	85%	96%
cohort32/34	80%	93%	74%	88%
cohort35/37	98%	96%	96%	84%
cohort38/40	97%	91%	94%	79%
cohort41/43	95%	96%	94%	89%
cohort44/46	95%	85%	94%	78%
cohort47/49	93%	79%	91%	62%
cohort50/52	91%	82%	89%	80%
cohort53/55	92%	86%	90%	84%
cohort56/58	97%	87%	96%	82%
cohort59/61	94%	49%	93%	34%
cohort62/64	34%	63%	25%	57%
cohort65/67	83%	40%	67%	40%

Table 12: Share of individuals that would be eligible for benefits and that would be in maximum accrual in PAYG scheme

Upper bound scenario for PAYG scheme

	Share eligible for benefits		Share in maximum accrual	
	Men	Women	Men	Women
All	58,8%	58,9%	76,7%	52,5%
No education	58,3%	50,9%	66,4%	37,1%
Primary	55,1%	57,7%	81,1%	54,7%
Secondary	59,4%	63,4%	83,9%	62,3%
Degree	75,1%	78,1%	86,2%	74,9%

3 The effect of the Chilean Pension Reform on Wealth Accumulation

Abstract

Chile went through a major pension system reform in 1981, replacing the state managed pay-as-you-go system with a privately-managed fully funded scheme. The reform implied a rather important increase in the net present value of expected pension wealth for most of those who opted-out to the new arrangement. We investigate the extent to which households substitute this increase by decreasing accumulation of other wealth. As the decision to either stay in the old system or to opt-out to the new one was not random, we follow an instrumental variable approach that allow us to overcome the unobserved heterogeneity problem. Using data from the Social Protection Survey we find two suitable instruments that we apply to two different subsamples. The displacement effect between expected pension wealth and non-pension wealth in estimated to be the range of 30%. Among the possible reasons for the incomplete offset are imperfect information, the desire to compensate for new risks faced and habit formation.

3.1 Introduction

Economic theory, in particular the simplest version of the life cycle model, suggests that there should be perfect substitution between savings for retirement and other sorts of wealth accumulation. In other words, the provision of (mandatory) pension plans would reduce one-to-one the incentives to save during working life. However, in reality the offset effect of pension wealth may well differ from the theoretical predictions due to several reasons: individuals may be credit constrained, pension wealth is illiquid and cannot be used as collateral, there may be bequests motives, there may be a discrepancy between individuals' discount factor and rates of return, mandatory pension contributions may have distortionary effects on labour supply, the different tax-treatment of pension

savings and other savings. Thus, the extent of the substitutability of pensions and other wealth is mainly an empirical issue.

To understand the relationship between pension wealth and other wealth is of major importance for public policy, such as the effect of pensions reform on national savings and to shed light on how individuals/households make economic decisions over their life-cycle.

The true effect of pension wealth on other wealth is hard to pin down for various reasons. First of all, it is not common to observe exogenous variation in pension wealth that allows us to measure its impact on other wealth. Secondly, observed cross-section variation in wealth accumulation is explained by both observed and unobserved factors. Is the latter that makes it difficult to identify the true effect of pension wealth on individuals' wealth accumulation behaviour. Last but not least, the lack of appropriate micro-data containing earnings, consumption and assets has obstructed empirical research in the area.

Feldstein (1974) was one of the first ones to look at this issue. Using a time series for the United States he concludes that social security depresses personal savings by 30-50%. Amongst studies that use micro data, Gale (1998) significantly added to the literature by pointing out that the pension offset would be underestimated if pension wealth is not adjusted by a factor that depends on the age of the individual. Using wealth and pension wealth data for the U.S. in 1983 he gets an average offset of between 33% and 68%. Attanasio and Brugiavini (2003) and Attanasio and Rohwedder (2003) use differences-in-differences together with instrumental variables to analyse the displacement effect of pension wealth and savings at a household level for Italy and the United Kingdom, respectively. Both studies also find a significant crowding-out effect.

Evidence on the crowding-out effect for Chile is scarce. Using aggregated time series data Bennett, Loayza, and Schmidt-Hebbel (2001) estimate that households offset between 36% and 88% of the forced pension savings. The

main difference between these two estimated values is that the latter considers consumption of durable goods, thus suggesting that households adjust mainly durable goods as a response to forced higher pension savings. Coronado (1998) uses micro data on earnings and expenditure for 1988 to estimate the effect of the reform on household saving rates. She uses a difference-in-difference approach comparing savings rates of the treatment group, comprised by those in the PFA scheme, to the savings rates of the control group, comprised by those in the PAYG; relative to their self-employed counterparts, who are not forced to contribute to the pension system. The estimated effect of the pension privatisation on household savings is positive and significant, ranging between 7.8 and 18 percentage points for tax payers (the estimate is zero for non-tax payers). However, two issues arise from this study. The first one is that both earnings and consumption data are likely to suffer from measurement error, making savings rates a rather noisy variable. Second, the data set does not allow Coronado to observe in what type of pension system individual are enrolled in, thus she assigns all households with a head under 40 years of age to the treatment group and those between 45 and 65 to the control group, on the basis of evidence that stayers were on average older than individuals that opted-out. Nevertheless, this is only a simple correlation, the reform did not define whatsoever age groups that were and were not affected. Indeed, there are strong reasons to believe that the decision to stay/opt-out is endogenous when explaining non-pension wealth. Not to take into account this problem would yield inconsistent estimations. Furthermore, Coronado does not take into account that the degree to which contributions to pension system affect wealth accumulation depend on expected future benefits.

We use the variation in the net present value of EPW across pension systems found in chapter two to look at the extent to which there is an offset between it and non-pension wealth. The fact that the pension reform changed pension wealth for some groups (and did not for others) makes Chile an interesting case

to investigate the relationship between pension and other wealth. Notice that we use the *stock* of wealth accumulated by each individual two decades after the pension reform, as opposed to using saving rates at any particular period, which is indeed a *flow.* The latter measure is more likely to be subject to time specific or individual specific shocks that may affect the results and thus lead to misleading conclusions

As mentioned before, there may be unobserved factors determining accumulation of both pension wealth and non-pension wealth. Not to take into account this heterogeneity may lead to misleading conclusions about the relationship between the two variables. In this chapter we follow an instrumental variable (IV) approach to identify the effect of pension entitlements on household wealth accumulation. We use two alternative IVs. The first one is an indicator of whether the individual was forced to opt-out to a PFA[45], arguing that having been forced exogenously changed pension wealth. Our second IV exploits the fact that individuals already in the formal labour market at the time of the reform (more precisely, enrolled in the pension system) had the choice to either stay in the PAYG scheme or opt-out to a PFA. On the other hand, individuals yet to join the formal labour market had no choice but to enroll to a PFA. Amongst individuals of 15-24 years of age, those aged between 15 to 19 were mainly out of the labour force, thus had no choice but to join a PFA, whereas most of those aged 20 to 24 where already working so were able to choose between the PAYG scheme and the PFA arrangement. Both IVs exploit the degree of choice individuals had at the time of the reform.

To our knowledge this is the first attempt to analyse the crowding-out effect of pension wealth on other wealth for Chile at a micro level taking care of unobserved heterogeneity. That, the use of employment and contribution histories and the use of fine detail in pension formulas to compute EPW are the main contributions of this chapter.

[45] Individuals reported whetheher they were forced or not to the PFA system in the SPS2002 survey. See footnote 50 in section 3.3.2.3 for details of the question.

The rest of the chapter is structured as follows: the next section gives details of the computation of the net present value of EPW that differ from what is done in chapter two. Section 3.3 begins by presenting a simple theoretical model that forms the basis of our empirical specification. We then raise empirical issues and possible sources of bias and discuss our identification strategy in detail. Section 3.4 presents the empirical results and section 3.5 concludes.

3.2 Computing EPW

This chapter uses the same methodology as in chapter two to obtain earnings and contribution patterns to then compute the net present value of EPW. However, here we compute each individual's net present value of EPW only for the pension system he is actually enrolled in (and not what he would have got had he made the opposite pension system decision as we also did in chapter two). Also, in this chapter we compute EPW as for 2004 and not as for when individuals reach retirement pension age as in chapter two. Moreover, here we use only the *actual* rate of return scenario for pension savings in the PFAs (and not the alternative 4% as we also did in chapter two) and we allocate individuals to the *observed* provider according to the employments details of the EPS (and not to the most frequent provider as we also did in chapter two). In other words, in this chapter we use only *actual* net present value of EPW and not the alternative scenarios we defined in chapter two.

3.3 Theoretical Model and Empirical Implications

3.3.1 Theoretical Framework

According to a simple version of the life-cycle model[46], households (individuals) choose the stream of consumption that maximises their lifetime utility subject to a lifetime budget constraint that comprises labour-earnings, pension benefits and an interest rate. To simplify the analysis, we assume that earnings are

[46] This sub-section closely follows Gale (1998).

exogenously determined (i.e. we do not consider labour supply decisions), that there is no uncertainty in the rates of return, that households do not face liquidity constraints and that they do not have bequest motives. We further assume a CRRA within-period utility function, thus the maximisation problem is the following:

$$\begin{aligned} \max_{\{C_t\}} V &= \int_0^T \frac{C_t^{1-\rho}}{1-\rho} e^{-\delta t} dt \\ &\quad + \lambda \left(\int_0^R E_t e^{-rt} dt + \int_R^T b_t e^{-rt} dt - \int_0^T C_t e^{-rt} dt \right) \end{aligned} \tag{10}$$

where t represents time (or age), C is consumption, ρ is the coefficient of risk aversion, δ is the time preference rate, E is real labour-earnings, r is the real interest rate, b is the real pension benefit, R is the retirement age and T the total life span.

Solving the maximisation problem in (10) yields consumption growth:

$$C_t = C_0 e^{(\frac{r-\delta}{\rho})t} \tag{11}$$

and the initial level of consumption:

$$C_0 = \frac{x}{e^{xT} - 1} \left(\int_0^R E_t e^{-rt} dt + \int_R^T b_t e^{-rt} dt \right) \tag{12}$$

where

$$x = \frac{r - \delta}{\rho} - r$$

It can be seen from equations 11 and 12 that the model predicts a perfect offset between pensions and other wealth: consumption in each period t depends

on the present value of *total* endowment and not on the timing of it (i.e. on whether is of the form of labour earnings or pensions).

Wealth accumulated at any period S before retirement is the sum of all labour earnings up to S minus consumption:

$$W_S = \int_0^S (E_t - C_t) e^{r(S-t)} dt \tag{13}$$

Substituting 12 into 11 and then in 13 yields:

$$\begin{aligned} W_S &= \int_0^S E_t e^{r(S-t)} dt \\ &\quad -Q \left[\int_0^R E_t e^{r(S-t)} dt - \int_R^T b_t e^{r(S-t)} dt \right] \end{aligned} \tag{14}$$

where

$$Q = \begin{cases} \frac{e^{x(t-tr)}-1}{e^{xT}-1} & \text{if } x \neq 0 \\ \\ \frac{t-tr}{T} & \text{if } x = 0 \end{cases} \tag{15}$$

and tr represents the year of the pension reform, thus t-tr is the number of years the individual has been exposed to the new system.

Equation 14 relates other wealth at age S, W_S, to the net present value of earnings up to age S, the net present value of lifetime earnings adjusted by a factor Q, and the net present value of pension wealth also adjusted by Q. The main insight of Gale (1998) is that as $Q \in [0, 1)$,because t-tr<T, the crowding-out effect obtained from equation 14 will be biased towards zero, thus different from the true 100% offset that the model predicts in equations 11 and 12. Gale (1998) also notes that since Q, is increasing in t-tr, the estimated offset rises with the worker's age (actually with the worker's time spent in the reformed

system). In other words, the effect of the unexpected change in pension wealth will be different for individuals at different stages of their working lives. The intuition behind is that younger individuals at the time of the unexpected change in pension wealth have more periods ahead to adjust their consumption path, thus will adjust wealth accumulation in a smooth fashion. On the contrary, an individual that faces an exogenous (say) increase in his pension wealth in the eve of his retirement, does not have many working-periods ahead to adjust his consumption, and hence will offset the pension wealth increase by decreasing other wealth in a more dramatic way.

3.3.2 Empirical Analysis

From equation 14, the empirical specification we use is

$$W_i = \mathbf{X}_i * \boldsymbol{\gamma} + \boldsymbol{\beta} * \mathbf{EPW}_i + \boldsymbol{\epsilon}_i \tag{16}$$

where W_i represents non-pension wealth for individual i, EPW_i computed as described in section 3.2 is adjusted by the Gale's factor and ϵ_i represents the unobservables that affect wealth accumulation.

The control variables included in the vector $\mathbf{X}_i$ are sex, age[47], education dummies and the net present value of adjusted earnings (computed as described in chapter two).

3.3.2.1 Empirical Issues We use two measures of wealth: net financial wealth only and net worth, which comprises both real and net financial wealth. As for real assets we consider housing, other real state, cars, machinery and own business (all correspondingly net of mortgages or debt). Net financial wealth is

[47] As in Attanasio and Brugiavini (2003) and Attanasio and Rohwedder (2003), we could have allowed the effect of the exogenous change in pension wealth to vary with age so as to take into account that individuals at different stages in their life-cycles might face different degrees of liquidity constraints and thus might have different degrees of substitutability between pension wealth and non-pension wealth. However, as our sample is comprised only by individuals that were already working in 1981, age does not vary as much as in a non-restricted sample. In fact, the average age was 33 years old and the standard deviation is 9 years.

the sum of savings in bank accounts, fixed term deposits, mutual funds, shares, state bonds, amongst others; minus financial liabilities.

The adjusting factor Q is determined not only by the year of the reform and the age of the individual but also by the preference parameters, ρ the coefficient of risk aversion and δ the discount rate (see equation 15). As regards, we take three values for ρ (1,2 and 3) and four values for δ (2%, 4%, 6% and 10%), yielding twelve possible combinations of which only 10 are relevant[48]. Following the analysis in Samwick (1998) about the appropriate wealth measure to be used, his estimations of δ are higher when using financial wealth as compared to when using net worth. Thus, if financial wealth is the pertinent wealth measure, we should probably rely on $\delta = 6\%$ or $\delta = 10\%$, while when using net worth the discount rate should be closer to 2% or 4%. In any case, we provide all the sensitivity analysis in the results section.

3.3.2.2 Possible Sources of Bias There are several reasons why our estimates of β in equation (16) may be biased, most of them due to measurement or specification issues. In this subsection we intend to sign these potential problems to gain a better understanding of their impact on our results.

There are three reasons why we may underestimate the effect. Firstly, as mentioned in chapter two, over-optimistic self reports of contribution profiles cause an overestimation of the net present value of EPW. This over estimation implies a downward bias in the estimated pension offset, not least for older workers.

Second, also mentioned in chapter two, the two assumptions we make about retirement options (no early retirement and everyone chooses an annuity rather than a programmed withdrawal) mean an overestimation of the net present value of EPW for those in the PFAs, which implies an underestimation of the pension offset.

[48] Since we assume r=4%, when $\delta = 4\%$ both parameters cancel out and ρ becomes irrelevant.

Thirdly, while our measure of EPW is before taxes, non-pension wealth is after taxes. This dichotomy would result in downward bias of our estimates of the pension offset.

On the other hand, there is one source of overestimation. While our measures of wealth include assets held by the individual and his/her partner; the EPW includes the individual entitlements only[49] and thus does not consider the pension the partner will be entitled to on his/her own right. In other words, we have household-level wealth data but individual-level pension wealth data. Consequently, we underestimate EPW for individuals whose partner also participates in the labour market, is enrolled in the pension system and will draw a pension on his/her own right. The pension offset will be overestimated for this group.

As long as the over and under estimation of EPW is similar across pension systems (which due to data limitations we cannot check) the bias will not be too severe.

The lifecycle model we use in this chapter has some limitations that could also lead us to not to get the true offset effect between pensions and other wealth. In particular, we do not include credit constraints and uncertainty in the analysis. Firstly, both issues could affect the choice of pension scheme: credit constrained individuals could have opted out to the PFA plan motivated by the lower contribution rate (and thus the higher take home wage) and the rate of return uncertainty could have deterred individuals from switching from the PAYG to the PFA scheme. Secondly, both issues could affect the offset between pension wealth and other wealth: individuals that are credit constrained would offset less of the increase in pension wealth as compared to those non-constrained. Likewise, uncertainty would make more risk averse individuals to offset less of the increase in pension wealth for precautionary motives savings

[49] Including the survivors' benefits for the dependants.

as compared to those less risk averse. Thus, by no taking into account these considerations, the estimated offset effect would have an upward bias.

3.3.2.3 Identification Strategy To apply simple OLS to equation 16 on individual data would yield biased and inconsistent estimates of the effect of adjusted EPW on other wealth. There are at least two reasons for that. First, no matter how fine detail on pension formulas we use, our computations of EPW are likely to suffer from measurement error (see section 3.3.2.2). Second, there may be unobserved heterogeneity in at least two aspects: (i) individuals may differ in the expectations and information they had about the reform and this unobserved heterogeneity may be correlated with savings behaviour; and (ii) individuals may differ in their taste for savings thus, for example, those with high wealth may also have high pension wealth. This would be even more evident if the reform did increase the EPW for those who opted-out but they are not a random sample of the population. Consequently, to properly identify the effect of pension entitlements on household wealth accumulation, we use an instrumental variable (IV) approach. We use two alternative IVs. The first one exploits the fact that the reform was undertaken by the economic team of the military government and many people declare to have been forced to opt-out to a PFA[50]. Thus, we use *forced* as an exogenous change in EPW.

Our second IV exploits differences in participation in the labour market across *cohorts* at the time of the pension reform. Individuals already in the formal labour market in 1981 (more precisely, enrolled in the pension system) had the choice to either stay in the PAYG scheme or opt-out to a PFA. On the other hand, individuals yet to join the formal labour market had no choice but to enroll to a PFA. Thus, our second IV exploits the fact that amongst

[50] The EPS2002 inquires about the reasons for opting-out. The alternatives were: (i) To get a higher take home wage, (ii) Private management of pensions funds is better than public management, (iii) I hope to get a higher pension, *(iv) I was forced by my employer*, (v) I was afraid that the PAYG system would have been shut down, (vi) Advertisement of the PFA system, (vii) I computed my RB, (viii) Advice from friends, (ix) Advice from a PFA clerk, (x) To get a higher rate of return, (xi) I retired in the PAYG system but kept contributing to the PFA system.

individuals of 15-24 years of age, those aged between 15 to 19 were mainly out of the labour force, thus had no choice but to join a PFA, whereas most of those in the immediate older cohort (aged 20 to 24) were already working so were able to choose between the PAYG scheme and the PFA arrangement. Thus, the former low-choice group should, on average, have higher EPW than the latter high-choice group.

Our identification strategy, thus, exploits the fact that the reform exogenously increased EPW for some individuals but not for others. The exogeneity that supports both of our instruments relies on the degree of choice individuals had when choosing pension arrangement.

As became apparent in section 3.3.1, an exogenous change in the budget constraint given by the increase in pension wealth should be reflected in a total crowding-out effect in other wealth. Hence we would expect a coefficient β in equation 16 equal to -1. Nonetheless, fundamental differences in the risks individuals face in either pension systems may cause the pension offset not to be complete (see chapter two for a description of the risks in each system). For example, if individuals believe they face higher risks under the PFA system (the rate of return risk or the life expectancy risk) they may increase their savings outside the pension system, which in turn would yield an estimated β lower than $|1|$.

Further, our estimation of the pension offset may be biased if there is non-random heterogeneity in the preference parameters- the discount rate and the elasticity of substitution. For instance, the latter could lead individuals to save for precautionary motives (on top of retirement), which would yield downward-biased estimates of the pension offset. The IV approach used in this chapter does not allow us to identify whether the displacement effect comes from the preferences parameters or from the change in the budget constraint induced by the change in pension wealth. This differentiation would be possible in a structural model, which we leave for future research.

3.4 Results

3.4.1 Forced as IV

Before presenting the results of IV regression of equation 16, we provide some descriptive statistics of the sample and of how EPW and other wealth vary with the "forced" IV. Of the 2,580 non-pensioners in our sample[51], as many as 43% were forced to a PFA. Table 1 gives an overview of the sample. From panel A, around 69% opted out to a PFA and the remaining 31% stayed in the PAYG system. Stayers and those who opted-out are fairly different in the observable characteristics tabulated. For instance, men and more educated individuals are over-represented in the PFAs in comparison with the PAYG plan, supporting the idea that the choice of pension scheme was endogenous. The bottom panel shows average net present value of EPW, net worth and net financial wealth by pension system. Individuals in the PFA scheme have significantly more net present value of EPW and, at the same time, less net worth. This relationship holds even when taking into account some observed heterogeneity. For example, among individuals with primary education those who opted out have a net present value of EPW 3.6 times higher than those who stayed in the PAYG system and, at the same time, have less net worth. Therefore, there is not only wide variation in net present value of EPW by pension system but also there is an inverse relation between it and net worth. Though the latter relationship is only a simple correlation, it suggests the existence of the displacement effect.

[51] Apart from pensioners, we have also dropped from the sample those individuals whose net present value of earnings, net worth and net financial wealth is in the bottom or top percentile of each distribution.

Table 1: Sample characteristics and EPW using Forced as IV, by system

A. Sample Characteristics

	System		
	PAYG	PFA	Total
All	800	1,780	2,580
Men	44.9%	65.8%	59.3%
Women	55.1%	34.2%	40.7%
None	48.4%	23.9%	31.5%
Primary	38.1%	42.2%	41.0%
Secondary	8.8%	18.4%	15.4%
Degree	4.8%	15.4%	12.1%
Age in 1981	38	29	32

B. Mean NPV_EPW, Net Worth and Net Financial Wealth ($millions, 2002)

	NPV_EPW			Net Worth			Net Financial Wealth		
	PAYG	PFA	Total	PAYG	PFA	Total	PAYG	PFA	Total
All	4.8	19.9	15.2	11.2	10.8	10.9	-0.1	-0.3	-0.3
Men	4.3	20.2	16.5	11.3	10.9	10.9	-0.1	-0.3	-0.3
Women	5.2	19.2	13.3	11.2	10.7	10.9	-0.1	-0.4	-0.3
None	3.0	14.1	8.8	8.8	6.5	7.6	-0.1	-0.1	-0.1
Primary	3.7	13.6	10.8	11.7	9.5	10.1	-0.1	-0.3	-0.2
Secondary	4.5	24.7	21.1	13.1	12.3	12.4	-0.6	-0.4	-0.4
Degree	30.8	40.2	39.0	28.5	19.2	20.4	-0.4	-0.8	-0.7

Some concern may arise about the genuine exogeneity of forced, i.e. the validity of the instrument. Indeed, our variable may suffer from measurement error as it was self-reported by individuals in the EPS two decades after the pension reform. Also, the reform could have or could have not met individuals' expectations, which may influence the reasons they give nowadays of why they opted-out to the PFA scheme, so forced could be subjective to some extent which, in turn, could lead to an unknown-direction bias in the responses. For example, someone who now realises he/she would have received a higher (lower) net present value of EPW in the PAYG than in the PFA scheme may declare he was (was not) forced to opt out while in reality he was not (was). Although we cannot directly test this possibility, based on the computations of chapter two for each individual's net present value of EPW in either system (the pension system he is actually enrolled and what he would have had in the opposite pension scheme) we find that for the subsample of the current chapter that are

in the PFA system, an overall, 83% will get a higher net present value of EPW in the PFA than they would have got in the PAYG scheme. This share does not vary across those who were forced and those who were not forced to opt-out, which we interpret as suggestive of that individuals did not report this variable subjectively.

It could also be the case that some individuals were more likely to be forced to opt-out than others. Table 7 in Appendix 3.1 shows a probit regression for the probability to have been forced to opt-out against a set of controls that include several job related characteristics at the time of the reform. The results show that, except for a small effect of age and a marginally significant effect of sex, forced cannot be explained by education level or any job-characteristic, thus giving support to the exogeneity of forced.

Table 2 shows the results on the first stage of the IV estimation, i.e. the reduced form for the net present value of EPW on all covariates plus the instrument. In the interest of space, only the estimated coefficient of the instrument, forced, is reported. Each of the ten rows of table 2 represent the estimation for one particular combination of the preference parameters. The F-test on the significance of the variable forced rejects the null hypothesis that the coefficient is equal to zero, which rules out the possibility of weak identification. Further, we reject the null of underidentification, i.e the instrument satisfies the rank condition. Both, non-weak identification and non-underidentification, are so for all 10 combinations of the preference parameters

In table 3 we report the results from estimating β in equation 16 both by OLS and by IV[52]. While columns 1 and 3 contain the results when using net worth, columns 2 and 4 do so for net financial wealth. Each row represents one of the ten possible combinations of the preference parameters (δ and ρ). As discussed in section 3.3.2.1, when the dependent variable is net worth, then the relevant values for δ are 2% and 4%, while if the outcome we are looking

[52] As EPW is a computed meassure, all standard errors have been bootstrapped.

at is financial wealth then we should use higher values for δ, 6% and 10%. Even though table 3 provides the whole set of results, we will focus only on the relevant combinations for the analysis.

Table 2: First stage regression results, using Forced as IV

Estimated coefficient of Forced

Parametrisation		EPW
δ value	ρ value	
2%	1	4,261,050 (359,295)***
2%	2	4,696,442 (397,245)***
2%	3	4,834,709 (409,348)***
4%	-	5,098,900 (432,529)***
6%	1	5,779,083 (492,449)***
6%	2	5,460,942 (464,390)***
6%	3	5,345,044 (454,180)***
10%	1	6,640,764 (568,507)***
10%	2	6,053,186 (516,648)***
10%	3	5,779,083 (492,449)***
N		2,580

* p<0.1, ** p<0.05, *** p<0.01

The first feature that emerges from the table is the upward bias from the OLS regression. We get positive and significant estimates of between 12% and 14% when net worth is the outcome variable, estimates that are very similar to the findings of Coronado (1998). The estimated coefficients when financial wealth is the dependent variable are also upward biased compared to the IV results but to a much lesser extent. Thus, not taking into account the unobserved

heterogeneity would lead us to conclude that there is a crowding-in effect from pension wealth on private wealth. On the other hand, when we follow the IV approach, we get that there is an average crowding-out effect of between 30% and 36% for net worth. These magnitudes are qualitatively the same, although in the bottom of the range, when compared to the results from Gale (1998) for the United States, from Attanasio and Brugiavini (2003) for their non age interaction specification for Italy and from Bennett et al. (2001) for Chile.

Table 3: Estimated effects of EPW on non-pension wealth using Forced as IV

Parametrisation		OLS		IV	
δ value	ρ value	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
2%	1	0.130	-0.006	-0.362	-0.020
		(0.049)***	(0.003)**	(0.134)***	(0.010)**
2%	2	0.122	-0.005	-0.327	-0.018
		(0.040)***	(0.003)**	(0.131)**	(0.009)**
2%	3	0.119	-0.005	-0.317	-0.018
		(0.039)***	(0.003)**	(0.125)**	(0.009)**
4%	-	0.114	-0.005	-0.300	-0.017
		(0.034)***	(0.002)**	(0.126)**	(0.009)*
6%	1	0.104	-0.005	-0.264	-0.015
		(0.032)***	(0.002)**	(0.112)**	(0.007)**
6%	2	0.108	-0.005	-0.280	-0.016
		(0.033)***	(0.002)**	(0.108)***	(0.008)**
6%	3	0.110	-0.005	-0.286	-0.016
		(0.036)***	(0.002)**	(0.114)**	(0.008)*
10%	1	0.091	-0.004	-0.230	-0.013
		(0.029)***	(0.002)**	(0.096)**	(0.006)**
10%	2	0.099	-0.005	-0.252	-0.014
		(0.031)***	(0.002)**	(0.097)***	(0.007)**
10%	3	0.104	-0.005	-0.264	-0.015
		(0.031)***	(0.002)**	(0.101)***	(0.007)**
N		2,580	2,580	2,580	2,580

Bootstrapped standard errors in parentheses
p<0.1, ** p<0.05, *** p<0.01

The second message we draw from our estimates is that most of the pension offset comes from net worth and very little from financial wealth, though the latter is still marginally significant. These results are not surprising as most individuals in our sample keep real rather than financial assets and as the magnitude of average net worth is considerable higher than of financial wealth (see table 1). Moreover, considering that pensions savings and real assets are both illiquid savings, it is sensible to see them as substitutes.

The estimated coefficients for the other right-hand side variables do have the expected signs and magnitudes. On average, wealth accumulation is increasing in age, in education and in the net present value of earnings. Full regressions results are reported in appendix 3.2.

3.4.2 Cohort as IV

We now turn to the results when we use the 15-19 and 20-24 cohorts as IV. Indeed, 56% of individuals between 20-24 years of age in 1981 could choose between pension arrangements while only 26.2% in the immediately younger cohort had choice. Table 4 describes the sample showing that there are differences between those who opted -out and those who stayed.

As for the case of forced as instrument, the reduced form estimates show that cohort does determine the net preset value of EPW. We formally check for under and weak identification rejecting both for all ten combinations of the preference parameters. Table 5 reports the estimated coefficients for cohort in the first stage regression (also as in the case of forced, only the estimated coefficients for the instruments are displayed. Each row represents the estimation for one of the 10 preference parameters combinations).

Table 4: Sample characteristics and EPW using Cohort as IV, by system

A. Sample Characteristics

	System		
	PAYG	PFA	Total
All	61	2,803	2,864
Men	23.0%	53.9%	53.2%
Women	77.0%	46.1%	46.8%
None	42.6%	17.8%	18.3%
Primary	39.3%	41.6%	41.6%
Secondary	18.0%	23.5%	23.4%
Degree	0.0%	17.1%	16.7%

B. Mean NPV_EPW, Net Worth and Net Financial Wealth ($millions, 2002)

	NPV_EPW			Net Worth			Net Financial Wealth		
	PAYG	PFA	Total	PAYG	PFA	Total	PAYG	PFA	Total
All	6.6	5.9	5.9	9.2	6.6	6.7	0.0	-0.3	-0.3
Men	8.7	6.4	6.4	6.5	6.7	6.7	-0.1	-0.3	-0.3
Women	6.0	5.4	5.4	10.0	6.5	6.6	0.0	-0.3	-0.3
None	4.6	4.5	4.5	5.8	4.0	4.1	-0.1	-0.1	-0.1
Primary	7.4	5.0	5.1	14.4	6.2	6.3	0.1	-0.2	-0.2
Secondary	9.6	6.3	6.3	5.8	6.6	6.6	0.0	-0.3	-0.3
Degree		9.0	9.0		10.5	10.5		-0.6	-0.6

Table 5: First stage regression results, using Cohort as IV

Estimated coefficient of Cohort

Parametrisation		EPW
δ value	ρ value	
2%	1	1,063,476 (155,837)***
2%	2	1,223,484 (178,441)***
2%	3	1,274,339 (185,634)***
4%	-	1,615,865 (234,142)***
6%	1	1,502,527 (217,996)***
6%	2	1,460,711 (212,052)***
6%	3	1,907,984 (276,027)***
10%	1	1,711,431 (247,800)***
10%	2	1,615,865 (234,142)***
10%	3	1,371,187 (199,348)***
N		2,864

* p<0.1, ** p<0.05, *** p<0.01

When we run OLS to equation 16 for this sub-sample, we obtain a positive,

significant and rather high coefficient of 21-27% on the effect of EPW on net worth. However, when we take care of the unobserved heterogeneity problem through the IV regression, we get a point estimate of the pension offset of 100%. The results are displayed in Table 6. However, taking into account the confidence intervals, the results when using *forced* (table 3) and when using *cohort* (table 6) are not statistically different from each other. In other words, both instruments suggest that the offset is not complete.

Table 6: Estimated effects of EPW on non-pension wealth

using Cohorts as IV

Parametrisation		OLS		IV	
δ value	ρ value	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
2%	1	0.270	-0.006	-1.398	-0.014
		(0.106)**	(0.010)	(0.848)*	(0.065)
2%	2	0.236	-0.005	-1.213	-0.012
		(0.089)***	(0.009)	(0.627)*	(0.058)
2%	3	0.227	-0.005	-1.165	-0.011
		(0.089)**	(0.009)	(0.664)*	(0.060)
4%	-	0.211	-0.005	-1.082	-0.011
		(0.082)**	(0.008)	(0.548)**	(0.061)
6%	1	0.180	-0.004	-0.917	-0.009
		(0.074)**	(0.007)	(0.502)*	(0.046)
6%	2	0.193	-0.005	-0.987	-0.010
		(0.078)**	(0.007)	(0.538)*	(0.047)
6%	3	0.198	-0.005	-1.015	-0.010
		(0.073)***	(0.008)	(0.478)**	(0.049)
10%	1	0.152	-0.004	-0.776	-0.008
		(0.059)**	(0.006)	(0.441)*	(0.039)
10%	2	0.170	-0.004	-0.866	-0.009
		(0.065)***	(0.007)	(0.513)*	(0.045)
10%	3	0.180	-0.004	-0.917	-0.009
		(0.074)**	(0.007)	(0.509)*	(0.046)
N		2,864	2,864	2,864	2,864

Bootstrapped standard errors in parentheses
p<0.1, ** p<0.05, *** p<0.01

Our findings for the cohort sample are fairly similar to the pension offset

found by Bennett et al. (2001) with aggregate data for Chile and by Gale (1998) for the LAD regression. Also, considering that the mean age of individuals in our sub-sample is 42 years old in 2004, our estimates are quite similar to the pension offsets found by Attanasio and Brugiavini (2003) for Italy in the specifications where pension wealth is interacted with age[53]. The crowding out for this sub-sample comes entirely from net worth, the estimates on net financial wealth have the right sign but are non-significant.

3.4.3 Possible Reasons for Incomplete Offset

There are at least three possible explanations for the incomplete offset found in this chapter, one arising from the methods used and the other two from economic theory.

As for the methods used, the result could be driven by the first source of measurement error in EPW mentioned in section 3.3.2.2. If individuals are overoptimistic when self-reporting their contribution history we would then overestimate their EPW which would in turn lead us to underestimate the pension offset. As the recall error is more severe for periods far away in the past, the downward bias of the estimated pension offset would be higher for older individuals. In this sense, the estimated effect for the forced sample would be a lower bound.

The second possible reason for our results could be that , provided the risk of shocks to rate of return, the offset will be less than perfect.

Finally, another explanation is found by relaxing the time separability assumption of the utility function. In particular, if we allow for habit formation in consumption, utility would depend not only on contemporaneous consumption but also on the stock of habits, which is in turn influenced by past consumption. The intuition behind this is that habits tend to pull consumption towards the

[53] As in our paper, Gale (1998) uses stock of wealth, thus his and our results are directly comparable in this respect. On the other hand, our results are not strictly comparable to those of either Bennett et al. (2001) and Attanasio and Brugiavini (2003) as they use saving rates rather than the stock wealth as the dependent variable.

level of the habit stock (Carrol, Overland, and Weil (2000)). Indeed, using panel data to control for fixed effects, Carrasco, Labeaga, and López-Salido (2005) find that there is indeed habit formation for food and services. Going back to our framework, if the utility function exhibits time separability, an increase in EPW should be completely offset by a reduction of wealth through higher consumption. However, if we apply the habits intuition, habit forming consumers desire to smooth consumption growth so they will increase consumption to a lesser extent and thus their pension offset would be less than complete.

Although to model habit formation is beyond the scope of this chapter, we try to provide some evidence on it. We focus on house ownership as most of the estimated pension offsetcomes from net worth and most of net worth comes from housing. According to the EPS2004, individuals in the forced sample bought their house when they where 37 years old on average and 45% already owned their houses around the time of the reform[54]. If individuals are habit-formers that derive utility from past consumption of housing, then in spite of the positive shock on pension wealth they would not downsize their house-wealth as they would do if had time separable preferences.

3.5 Conclusions

Chile went through a major pension system reform in the early '80s which induced an important increase in EPW. In the framework of the life-cycle model we study the extent to which households responded to this increase in EPW by decreasing other wealth. The simplest version of the model predicts perfect offset between EPW and non-pension wealth.

We take into account the fact that the degree of substitutability between EPW and other wealth will depend on the stage of the life-cycle individuals were at the time of the reform because this would determine how many remaining

[54] More precicely by 1986. 30% owned their houses by 1981.

periods they have to re-adjust consumption. We do this by adjusting EPW by a factor that is increasing in age.

We use an IV approach that allows us not only to control for the unobserved heterogeneity that is likely to link wealth accumulation and EPW but also to get rid of the measurement error we are likely to face when computing EPW. We use two IVs on different sub-samples, both exploit the degree of choice individuals had when making their staying/opting-out decision. We find that individuals in our older sample offset 30% of the exogenous increase in expected pension wealth and that the substitution is not statistically different to this figure for the younger sample. The crowding out for both samples is mainly through real assets. There are several reasons why the pension offset may differ from 100%, ranging from liquidity constraints to the lack of understanding of the benefit structure to the habit formation theory. In any case, our results are very much in line with the results found by the relevant literature.

Our results have important policy implications, not least nowadays that a second pension reform has just been approved in Chile. The reform will widen the safety net, thus increasing EPW for individuals in the bottom 60% of the income distribution. It will also increase competition, reduce management costs and extend foreign investment limits so as to have higher expected pension fund returns. These three latter measures would increase EPW for middle and high income individuals. Should EPW be increased by the reform, our findings suggest that individuals would decrease their non-pension wealth accumulation. Note however, that the extent of the substitution will depend upon the clarity individuals have of the effects of the pension reform and of the willingness to cover the extra risks they may face. Further, considering that pension savings have a much more generous tax treatment than other savings, different magnitudes of the pension offset for individuals in different points of the income distribution may have significant redistributive effects.

Appendix 3.1. Probit Regression for Forced

Table 7. Probability of being Forced

Man	0.15
	(0.07)**
Age	-0.02
	(0.00)***
None	-0.07
	(0.12)
Primary	0.14
	(0.11)
Secondary	0.09
	(0.12)
Agriculture	-0.41
	(0.40)
Mining	-0.66
	(0.45)
Industry	-0.12
	(0.40)
Construction	-0.37
	(0.40)
Retailing	-0.31
	(0.40)
Transport	-0.29
	(0.41)
Financial Services	-0.28
	(0.43)
Social and Personal Services	-0.10
	(0.40)
Region I	0.51
	(0.41)
Region II	0.12
	(0.41)
Region III	0.06
	(0.48)
Region IV	0.45
	(0.39)
Region V	0.60
	(0.37)
Region VI	0.59
	(0.38)
Region VII	0.36
	(0.38)
Region VIII	0.46
	(0.37)
Region IX	0.45
	(0.38)
Region X	0.74
	(0.38)*
Region XIII	0.49
	(0.45)
Region XIII	0.58
	(0.36)
Self-Employed	-0.87
	(0.58)
Civil Servant	0.09
	(0.57)
Employee	-0.21
	(0.58)
Domestic Worker	-0.54
	(0.59)
Unpaid Family Worker	-0.16
	(0.97)
Blue Collar [a]	0.20
	(0.20)
White Collar [a]	0.08
	(0.20)
Belongs to Union	0.11
	(0.08)
Constant	0.85
	(0.79)

(a) Blue collar and white collar refer, respectively, to workes enrolled to the Social Service Insurance and Private Employees providers from the PAYG system

Appendix 3.2. Full set of results using Forced as instrument. OLS and IV estimates

Table 8: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 2\%$, $\rho = 1$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.130	-0.006	-0.362	-0.020
	(0.045)***	(0.003)**	(0.143)**	(0.010)**
sex	-5.64e+05	57.200.818	-8.07e+05	49.997.305
	(6.45e+05)	-43.759.255	(6.95e+05)	-44.093.694
age	2.53e+05	2.824.411	5.05e+05	10.309.167
	(41165.788)***	(1692.504)*	(83930.722)***	(5337.396)*
primary	3.24e+06	-7.16e+04	4.13e+06	-4.52e+04
	(5.89e+05)***	(33963.669)**	(6.62e+05)***	-37.204.124
secondary	4.15e+06	-1.95e+05	6.22e+06	-1.33e+05
	(9.11e+05)***	(73144.683)***	(1.15e+06)***	(80349.711)*
degree	9.84e+06	-3.99e+05	1.53e+07	-2.38e+05
	(1.50e+06)***	(1.07e+05)***	(2.41e+06)***	(1.39e+05)*
pv_earnings	0.012	-0.001	0.035	-0.000
	(0.005)**	(0.000)***	(0.008)***	(0.001)
cons	-8.49e+06	-2.15e+05	-2.23e+07	-6.23e+05
	(2.36e+06)***	(1.08e+05)**	(4.64e+06)***	(2.99e+05)**
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Table 9: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 2\%$, $\rho = 2$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.122	-0.005	-0.327	-0.018
	(0.040)***	(0.003)**	(0.130)**	(0.009)**
sex	-5.01e+05	54.204.660	-7.33e+05	47.481.201
	(6.41e+05)	-43.557.488	(6.89e+05)	-43.832.054
age	2.56e+05	2.680.382	5.05e+05	9.897.174
	(41275.617)***	-1.689.907	(82881.477)***	(5244.748)*
primary	3.25e+06	-7.16e+04	4.16e+06	-4.52e+04
	(5.89e+05)***	(33950.056)**	(6.63e+05)***	-37.291.795
secondary	4.17e+06	-1.95e+05	6.31e+06	-1.33e+05
	(9.11e+05)***	(73067.563)***	(1.16e+06)***	(80724.942)*
degree	9.84e+06	-3.98e+05	1.55e+07	-2.34e+05
	(1.50e+06)***	(1.07e+05)***	(2.44e+06)***	(1.41e+05)*
pv_earnings	0.010	-0.001	0.031	-0.000
	(0.004)**	(0.000)***	(0.007)***	(0.000)
cons	-8.69e+06	-2.06e+05	-2.23e+07	-5.99e+05
	(2.37e+06)***	(1.09e+05)*	(4.58e+06)***	(2.94e+05)**
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Table 10: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 2\%$, $\rho = 3$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.119	-0.005	-0.317	-0.018
	(0.039)***	(0.003)**	(0.126)**	(0.009)**
sex	-4.83e+05	53.369.289	-7.13e+05	46.748.239
	(6.40e+05)	-43.502.253	(6.87e+05)	-43.762.714
age	2.57e+05	2.639.638	5.05e+05	9.781.185
	(41302.415)***	-1.689.173	(82569.322)***	(5217.421)*
primary	3.25e+06	-7.17e+04	4.17e+06	-4.52e+04
	(5.90e+05)***	(33946.476)**	(6.64e+05)***	-37.315.532
secondary	4.17e+06	-1.95e+05	6.34e+06	-1.33e+05
	(9.10e+05)***	(73044.938)***	(1.16e+06)***	-80.829.537
degree	9.84e+06	-3.97e+05	1.55e+07	-2.33e+05
	(1.50e+06)***	(1.07e+05)***	(2.45e+06)***	(1.42e+05)
pv_earnings	0.010	-0.001	0.030	-0.000
	(0.004)**	(0.000)***	(0.007)***	(0.000)
cons	-8.75e+06	-2.03e+05	-2.22e+07	-5.92e+05
	(2.37e+06)***	(1.09e+05)*	(4.56e+06)***	(2.92e+05)**
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Table 11: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 4\%$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.114	-0.005	-0.300	-0.017
	(0.037)***	(0.002)**	(0.120)**	(0.008)**
sex	-4.53e+05	51.920.183	-6.80e+05	45.439.027
	(6.38e+05)	-43.407.286	(6.85e+05)	-43.645.977
age	2.59e+05	2.567.557	5.05e+05	9.577.565
	(41345.334)***	-1.687.868	(82003.825)***	(5168.196)*
primary	3.25e+06	-7.17e+04	4.18e+06	-4.53e+04
	(5.90e+05)***	(33940.422)**	(6.65e+05)***	-37.356.021
secondary	4.18e+06	-1.95e+05	6.38e+06	-1.33e+05
	(9.10e+05)***	(73004.173)***	(1.16e+06)***	-81.009.063
degree	9.84e+06	-3.97e+05	1.56e+07	-2.31e+05
	(1.50e+06)***	(1.07e+05)***	(2.47e+06)***	(1.43e+05)
pv_earnings	0.009	-0.001	0.027	-0.000
	(0.004)**	(0.000)***	(0.007)***	(0.000)
cons	-8.85e+06	-1.99e+05	-2.22e+07	-5.79e+05
	(2.38e+06)***	(1.09e+05)*	(4.53e+06)***	(2.89e+05)**
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Table 12: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 6\%$, $\rho = 1$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.104	-0.005	-0.264	-0.015
	(0.033)***	(0.002)**	(0.106)**	(0.007)**
sex	-3.91e+05	49.015.585	-6.20e+05	42.627.395
	(6.34e+05)	-43.218.687	(6.80e+05)	-43.425.314
age	2.62e+05	2.412.177	5.04e+05	9.150.920
	(41419.113)***	-1.684.967	(80748.557)***	(5060.330)*
primary	3.25e+06	-7.17e+04	4.20e+06	-4.53e+04
	(5.90e+05)***	(33928.406)**	(6.66e+05)***	-37.435.067
secondary	4.20e+06	-1.95e+05	6.46e+06	-1.32e+05
	(9.10e+05)***	(72913.811)***	(1.17e+06)***	-81.346.879
degree	9.84e+06	-3.95e+05	1.58e+07	-2.28e+05
	(1.50e+06)***	(1.07e+05)***	(2.51e+06)***	(1.45e+05)
pv_earnings	0.008	-0.000	0.023	-0.000
	(0.003)**	(0.000)***	(0.006)***	(0.000)
cons	-9.06e+06	-1.89e+05	-2.21e+07	-5.54e+05
	(2.38e+06)***	(1.09e+05)*	(4.45e+06)***	(2.83e+05)**
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Table 13: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 6\%$, $\rho = 2$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.108	-0.005	-0.280	-0.016
	(0.035)***	(0.002)**	(0.112)**	(0.008)**
sex	-4.17e+05	50.232.121	-6.44e+05	43.841.899
	(6.36e+05)	-43.297.610	(6.82e+05)	-43.515.553
age	2.61e+05	2.479.807	5.04e+05	9.333.961
	(41390.083)***	-1.686.254	(81298.593)***	(5107.338)*
primary	3.25e+06	-7.17e+04	4.19e+06	-4.53e+04
	(5.90e+05)***	(33933.486)**	(6.66e+05)***	-37.402.214
secondary	4.19e+06	-1.95e+05	6.43e+06	-1.32e+05
	(9.10e+05)***	(72953.489)***	(1.16e+06)***	-81.211.147
degree	9.84e+06	-3.96e+05	1.58e+07	-2.29e+05
	(1.50e+06)***	(1.07e+05)***	(2.49e+06)***	(1.44e+05)
pv_earnings	0.008	-0.000	0.025	-0.000
	(0.003)**	(0.000)***	(0.006)***	(0.000)
cons	-8.97e+06	-1.93e+05	-2.22e+07	-5.65e+05
	(2.38e+06)***	(1.09e+05)*	(4.49e+06)***	(2.85e+05)**
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Table 14: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 6\%$, $\rho = 3$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.110	-0.005	-0.286	-0.016
	(0.035)***	(0.002)**	(0.114)**	(0.008)**
sex	-4.28e+05	50.736.316	-6.54e+05	44.328.280
	(6.37e+05)	-43.330.302	(6.83e+05)	-43.553.883
age	2.60e+05	2.506.597	5.04e+05	9.407.703
	(41377.275)***	-1.686.751	(81515.328)***	(5125.975)*
primary	3.25e+06	-7.17e+04	4.19e+06	-4.53e+04
	(5.90e+05)***	(33935.558)**	(6.65e+05)***	-37.388.511
secondary	4.19e+06	-1.95e+05	6.41e+06	-1.32e+05
	(9.10e+05)***	(72969.069)***	(1.16e+06)***	-81.151.996
degree	9.84e+06	-3.96e+05	1.57e+07	-2.30e+05
	(1.50e+06)***	(1.07e+05)***	(2.49e+06)***	(1.44e+05)
pv_earnings	0.009	-0.000	0.026	-0.000
	(0.003)**	(0.000)***	(0.006)***	(0.000)
cons	-8.93e+06	-1.95e+05	-2.22e+07	-5.69e+05
	(2.38e+06)***	(1.09e+05)*	(4.50e+06)***	(2.87e+05)**
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Table 15: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 10\%$, $\rho = 1$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.091	-0.004	-0.230	-0.013
	(0.028)***	(0.002)**	(0.092)**	(0.006)**
sex	-3.44e+05	46.859.429	-5.85e+05	40.225.752
	(6.32e+05)	-43.074.984	(6.78e+05)	-43.274.360
age	2.65e+05	2.270.389	5.02e+05	8.787.382
	(41462.322)***	-1.681.866	(79600.840)***	(4964.097)*
primary	3.26e+06	-7.17e+04	4.22e+06	-4.53e+04
	(5.91e+05)***	(33918.071)**	(6.68e+05)***	-37.494.722
secondary	4.22e+06	-1.95e+05	6.51e+06	-1.32e+05
	(9.10e+05)***	(72828.940)***	(1.17e+06)***	-81.526.021
degree	9.84e+06	-3.94e+05	1.60e+07	-2.25e+05
	(1.50e+06)***	(1.07e+05)***	(2.54e+06)***	(1.47e+05)
pv_earnings	0.006	-0.000	0.020	-0.000
	(0.003)**	(0.000)***	(0.005)***	(0.000)
cons	-9.25e+06	-1.81e+05	-2.20e+07	-5.33e+05
	(2.39e+06)***	(1.09e+05)*	(4.39e+06)***	(2.77e+05)*
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Table 16: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 10\%$, $\rho = 2$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.099	-0.005	-0.252	-0.014
	(0.031)***	(0.002)**	(0.101)**	(0.007)**
sex	-3.72e+05	48.155.652	-6.04e+05	41.722.686
	(6.33e+05)	-43.162.482	(6.79e+05)	-43.363.553
age	2.64e+05	2.360.555	5.03e+05	9.014.897
	(41437.998)***	-1.683.933	(80328.545)***	(5024.761)*
primary	3.26e+06	-7.17e+04	4.21e+06	-4.53e+04
	(5.91e+05)***	(33924.632)**	(6.67e+05)***	-37.458.307
secondary	4.21e+06	-1.95e+05	6.48e+06	-1.32e+05
	(9.10e+05)***	(72883.223)***	(1.17e+06)***	-81.433.025
degree	9.84e+06	-3.95e+05	1.59e+07	-2.26e+05
	(1.50e+06)***	(1.07e+05)***	(2.52e+06)***	(1.46e+05)
pv_earnings	0.007	-0.000	0.022	-0.000
	(0.003)**	(0.000)***	(0.005)***	(0.000)
cons	-9.13e+06	-1.86e+05	-2.21e+07	-5.46e+05
	(2.39e+06)***	(1.09e+05)*	(4.43e+06)***	(2.81e+05)*
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Table 17: OLS and IV (using Forced) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 10\%$, $\rho = 3$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.104	-0.005	-0.264	-0.015
	(0.033)***	(0.002)**	(0.106)**	(0.007)**
sex	-3.91e+05	49.015.585	-6.20e+05	42.627.395
	(6.34e+05)	-43.218.687	(6.80e+05)	-43.425.314
age	2.62e+05	2.412.177	5.04e+05	9.150.920
	(41419.113)***	-1.684.967	(80748.557)***	(5060.330)*
primary	3.25e+06	-7.17e+04	4.20e+06	-4.53e+04
	(5.90e+05)***	(33928.406)**	(6.66e+05)***	-37.435.067
secondary	4.20e+06	-1.95e+05	6.46e+06	-1.32e+05
	(9.10e+05)***	(72913.811)***	(1.17e+06)***	-81.346.879
degree	9.84e+06	-3.95e+05	1.58e+07	-2.28e+05
	(1.50e+06)***	(1.07e+05)***	(2.51e+06)***	(1.45e+05)
pv_earnings	0.008	-0.000	0.023	-0.000
	(0.003)**	(0.000)***	(0.006)***	(0.000)
cons	-9.06e+06	-1.89e+05	-2.21e+07	-5.54e+05
	(2.38e+06)***	(1.09e+05)*	(4.45e+06)***	(2.83e+05)**
N	2.580	2.580	2.580	2.580

* p<0.1, ** p<0.05, *** p<0.01

Appendix 3.3. Full set of results using Cohort as instrument. OLS and IV estimates

Table 18: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 2\%$, $\rho = 1$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.382	-0.006	-1.398	-0.014
	(0.103)***	(0.010)	(0.734)*	(0.068)
sex	-6.82e+05	43.540.271	-2.94e+06	31.887.754
	(4.15e+05)	-43.997.648	(1.08e+06)***	(1.01e+05)
age	1.79e+05	-8.230.260	1.00e+06	-6.426.022
	(80505.504)**	-7.868.450	(3.12e+05)***	-28.536.438
primary	2.04e+06	-1.13e+05	2.07e+06	-1.13e+05
	(3.77e+05)***	(31774.372)***	(4.00e+05)***	(31708.328)***
secondary	1.84e+06	-1.18e+05	1.68e+06	-1.19e+05
	(4.75e+05)***	(43722.279)***	(5.35e+05)***	(45182.422)***
degree	5.06e+06	-4.40e+05	5.94e+06	-4.35e+05
	(7.14e+05)***	(71261.767)***	(8.10e+05)***	(76619.415)***
pv_earnings	0.007	-0.001	0.032	-0.000
	(0.002)***	(0.000)***	(0.011)***	(0.001)
cons	-4.74e+06	3.13e+05	-3.82e+07	2.44e+05
	(3.39e+06)	(3.30e+05)	(1.26e+07)***	(1.15e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

Table 19: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 2\%$, $\rho = 2$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.336	-0.005	-1.213	-0.012
	(0.090)***	(0.009)	(0.638)*	(0.059)
sex	-6.52e+05	41.986.884	-2.91e+06	30.460.803
	(4.14e+05)	-43.935.061	(1.08e+06)***	(1.01e+05)
age	1.82e+05	-8.454.381	1.00e+06	-6.758.571
	(80641.778)**	-7.886.344	(3.10e+05)***	-28.364.875
primary	2.04e+06	-1.13e+05	2.06e+06	-1.13e+05
	(3.77e+05)***	(31775.856)***	(4.00e+05)***	(31711.971)***
secondary	1.85e+06	-1.18e+05	1.69e+06	-1.20e+05
	(4.75e+05)***	(43729.306)***	(5.35e+05)***	(45205.213)***
degree	5.07e+06	-4.40e+05	5.95e+06	-4.35e+05
	(7.14e+05)***	(71297.915)***	(8.10e+05)***	(76642.695)***
pv_earnings	0.006	-0.001	0.028	-0.000
	(0.002)***	(0.000)***	(0.010)***	(0.001)
cons	-4.89e+06	3.24e+05	-3.82e+07	2.59e+05
	(3.40e+06)	(3.31e+05)	(1.25e+07)***	(1.14e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

Table 20: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 2\%$, $\rho = 4$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.323	-0.005	-1.165	-0.011
	(0.087)***	(0.008)	(0.612)*	(0.056)
sex	-6.44e+05	41.575.810	-2.90e+06	30.081.744
	(4.14e+05)	-43.918.508	(1.08e+06)***	(1.01e+05)
age	1.83e+05	-8.513.285	1.00e+06	-6.845.623
	(80677.379)**	-7.891.074	(3.09e+05)***	-28.319.783
primary	2.04e+06	-1.13e+05	2.06e+06	-1.13e+05
	(3.77e+05)***	(31776.254)***	(4.00e+05)***	(31712.982)***
secondary	1.85e+06	-1.18e+05	1.69e+06	-1.20e+05
	(4.75e+05)***	(43731.089)***	(5.35e+05)***	(45211.285)***
degree	5.07e+06	-4.40e+05	5.95e+06	-4.35e+05
	(7.14e+05)***	(71307.487)***	(8.10e+05)***	(76648.981)***
pv_earnings	0.006	-0.001	0.027	-0.000
	(0.002)***	(0.000)***	(0.009)***	(0.001)
cons	-4.93e+06	3.26e+05	-3.82e+07	2.63e+05
	(3.40e+06)	(3.31e+05)	(1.25e+07)***	(1.14e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

Table 21: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 4\%$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.302	-0.005	-1.082	-0.011
	(0.081)***	(0.008)	(0.569)*	(0.052)
sex	-6.31e+05	40.891.231	-2.89e+06	29.449.671
	(4.14e+05)	-43.890.974	(1.08e+06)***	(1.00e+05)
age	1.85e+05	-8.610.897	1.00e+06	-6.989.835
	(80736.240)**	-7.898.942	(3.08e+05)***	-28.245.135
primary	2.04e+06	-1.13e+05	2.06e+06	-1.13e+05
	(3.77e+05)***	(31776.927)***	(4.00e+05)***	(31714.708)***
secondary	1.85e+06	-1.19e+05	1.69e+06	-1.20e+05
	(4.75e+05)***	(43733.938)***	(5.34e+05)***	(45221.333)***
degree	5.07e+06	-4.40e+05	5.95e+06	-4.35e+05
	(7.14e+05)***	(71323.412)***	(8.09e+05)***	(76659.885)***
pv_earnings	0.006	-0.000	0.025	-0.000
	(0.001)***	(0.000)***	(0.009)***	(0.001)
cons	-4.99e+06	3.31e+05	-3.82e+07	2.70e+05
	(3.40e+06)	(3.31e+05)	(1.24e+07)***	(1.14e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

Table 22: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 6\%$, $\rho = 1$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.258	-0.004	-0.917	-0.009
	(0.069)***	(0.007)	(0.483)*	(0.044)
sex	-6.07e+05	39.667.446	-2.86e+06	28.319.774
	(4.13e+05)	-43.842.007	(1.08e+06)***	(1.00e+05)
age	1.87e+05	-8.783.216	1.00e+06	-7.245.808
	(80840.153)**	-7.912.950	(3.07e+05)***	-28.113.994
primary	2.04e+06	-1.13e+05	2.06e+06	-1.13e+05
	(3.77e+05)***	(31778.183)***	(4.00e+05)***	(31717.912)***
secondary	1.86e+06	-1.19e+05	1.70e+06	-1.20e+05
	(4.75e+05)***	(43738.377)***	(5.34e+05)***	(45238.476)***
degree	5.07e+06	-4.40e+05	5.95e+06	-4.35e+05
	(7.15e+05)***	(71351.710)***	(8.09e+05)***	(76682.640)***
pv_earnings	0.005	-0.000	0.021	-0.000
	(0.001)***	(0.000)***	(0.007)***	(0.001)
cons	-5.11e+06	3.39e+05	-3.83e+07	2.81e+05
	(3.41e+06)	(3.32e+05)	(1.24e+07)***	(1.13e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

Table 23: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 6\%$, $\rho = 2$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.277	-0.004	-0.987	-0.010
	(0.074)***	(0.007)	(0.519)*	(0.048)
sex	-6.16e+05	40.150.509	-2.87e+06	28.765.405
	(4.13e+05)	-43.861.274	(1.08e+06)***	(1.00e+05)
age	1.86e+05	-8.715.635	1.00e+06	-7.144.976
	(80799.335)**	-7.907.434	(3.07e+05)***	-28.165.268
primary	2.04e+06	-1.13e+05	2.06e+06	-1.13e+05
	(3.77e+05)***	(31777.675)***	(4.00e+05)***	(31716.631)***
secondary	1.85e+06	-1.19e+05	1.69e+06	-1.20e+05
	(4.75e+05)***	(43736.767)***	(5.34e+05)***	(45231.929)***
degree	5.07e+06	-4.40e+05	5.95e+06	-4.35e+05
	(7.15e+05)***	(71340.585)***	(8.09e+05)***	(76672.868)***
pv_earnings	0.005	-0.000	0.023	-0.000
	(0.001)***	(0.000)***	(0.008)***	(0.001)
cons	-5.06e+06	3.35e+05	-3.83e+07	2.76e+05
	(3.40e+06)	(3.32e+05)	(1.24e+07)***	(1.14e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

Table 24: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 6\%$, $\rho = 4$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.284	-0.005	-1.015	-0.010
	(0.076)***	(0.007)	(0.534)*	(0.049)
sex	-6.20e+05	40.364.262	-2.88e+06	28.962.822
	(4.13e+05)	-43.869.830	(1.08e+06)***	(1.00e+05)
age	1.86e+05	-8.685.525	1.00e+06	-7.100.285
	(80781.190)**	-7.904.987	(3.08e+05)***	-28.188.191
primary	2.04e+06	-1.13e+05	2.06e+06	-1.13e+05
	(3.77e+05)***	(31777.456)***	(4.00e+05)***	(31716.071)***
secondary	1.85e+06	-1.19e+05	1.69e+06	-1.20e+05
	(4.75e+05)***	(43735.986)***	(5.34e+05)***	(45228.920)***
degree	5.07e+06	-4.40e+05	5.95e+06	-4.35e+05
	(7.15e+05)***	(71335.639)***	(8.09e+05)***	(76668.936)***
pv_earnings	0.005	-0.000	0.023	-0.000
	(0.001)***	(0.000)***	(0.008)***	(0.001)
cons	-5.04e+06	3.34e+05	-3.83e+07	2.75e+05
	(3.40e+06)	(3.32e+05)	(1.24e+07)***	(1.14e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

Table 25: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 10\%$, $\rho = 1$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.220	-0.004	-0.776	-0.008
	(0.059)***	(0.006)	(0.409)*	(0.038)
sex	-5.94e+05	38.990.118	-2.85e+06	27.698.852
	(4.13e+05)	-43.815.349	(1.08e+06)***	(1.00e+05)
age	1.88e+05	-8.875.883	1.00e+06	-7.387.194
	(80896.920)**	-7.920.608	(3.06e+05)***	-28.044.544
primary	2.05e+06	-1.13e+05	2.06e+06	-1.13e+05
	(3.77e+05)***	(31778.950)***	(4.00e+05)***	(31719.726)***
secondary	1.86e+06	-1.19e+05	1.70e+06	-1.20e+05
	(4.75e+05)***	(43739.923)***	(5.34e+05)***	(45246.197)***
degree	5.07e+06	-4.40e+05	5.95e+06	-4.35e+05
	(7.15e+05)***	(71367.030)***	(8.09e+05)***	(76701.027)***
pv_earnings	0.004	-0.000	0.018	-0.000
	(0.001)***	(0.000)***	(0.006)***	(0.001)
cons	-5.17e+06	3.43e+05	-3.83e+07	2.87e+05
	(3.41e+06)	(3.32e+05)	(1.23e+07)***	(1.13e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

Table 26: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 10\%$, $\rho = 2$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.244	-0.004	-0.866	-0.009
	(0.065)***	(0.006)	(0.456)*	(0.042)
sex	-6.01e+05	39.361.657	-2.86e+06	28.038.491
	(4.13e+05)	-43.829.889	(1.08e+06)***	(1.00e+05)
age	1.88e+05	-8.825.517	1.00e+06	-7.309.589
	(80865.854)**	-7.916.424	(3.06e+05)***	-28.082.095
primary	2.05e+06	-1.13e+05	2.06e+06	-1.13e+05
	(3.77e+05)***	(31778.517)***	(4.00e+05)***	(31718.731)***
secondary	1.86e+06	-1.19e+05	1.70e+06	-1.20e+05
	(4.75e+05)***	(43739.234)***	(5.34e+05)***	(45242.312)***
degree	5.07e+06	-4.40e+05	5.95e+06	-4.35e+05
	(7.15e+05)***	(71358.692)***	(8.09e+05)***	(76689.843)***
pv_earnings	0.004	-0.000	0.020	-0.000
	(0.001)***	(0.000)***	(0.007)***	(0.001)
cons	-5.14e+06	3.41e+05	-3.83e+07	2.84e+05
	(3.41e+06)	(3.32e+05)	(1.24e+07)***	(1.13e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

Table 27: OLS and IV (using Cohort) regressions. Dependent variables Net Worth and Net Financial Wealth.

Parametrisation: $\delta = 10\%$, $\rho = 4$

	OLS		IV	
	Net Worth	Net Financial Wealth	Net Worth	Net Financial Wealth
npv_epw	0.258	-0.004	-0.917	-0.009
	(0.069)***	(0.007)	(0.483)*	(0.044)
sex	-6.07e+05	39.667.446	-2.86e+06	28.319.774
	(4.13e+05)	-43.842.007	(1.08e+06)***	(1.00e+05)
age	1.87e+05	-8.783.216	1.00e+06	-7.245.808
	(80840.153)**	-7.912.950	(3.07e+05)***	-28.113.994
primary	2.04e+06	-1.13e+05	2.06e+06	-1.13e+05
	(3.77e+05)***	(31778.183)***	(4.00e+05)***	(31717.912)***
secondary	1.86e+06	-1.19e+05	1.70e+06	-1.20e+05
	(4.75e+05)***	(43738.377)***	(5.34e+05)***	(45238.476)***
degree	5.07e+06	-4.40e+05	5.95e+06	-4.35e+05
	(7.15e+05)***	(71351.710)***	(8.09e+05)***	(76682.640)***
pv_earnings	0.005	-0.000	0.021	-0.000
	(0.001)***	(0.000)***	(0.007)***	(0.001)
cons	-5.11e+06	3.39e+05	-3.83e+07	2.81e+05
	(3.41e+06)	(3.32e+05)	(1.24e+07)***	(1.13e+06)
N	2,864	2,864	2,864	2,864

* p<0.1, ** p<0.05, *** p<0.01

4 Moving from a PAYG to a DC Pension Scheme: Does it Boost Participation in the Formal Labour Market?

Abstract

This article exploits the wide variation in the incentives individuals face towards formal work introduced by the Chilean pension reform of the early 80s. Through a non-linear random effects dynamic model that allows for state dependence and unobserved heterogeneity, we estimate the effect of pension system design on individuals' labour market formality decisions. Results indicate that individuals in the new pension scheme are 23 percentage points more likely to be formal than those in the old scheme at any one period t. State dependence is even more important indicating that labour market past decisions do affect future ones. The unobserved heterogeneity is also high and significant but its magnitude is only a fifth of the state dependence. The results on state dependence and initial conditions suggest there is scope for public policy to affect formality decisions.

Since the outcome variable is discrete and given the findings on state dependence, a change in pension system should have a lasting effect on formality. We perform simulations that take into account the dynamics of the model to look at the extent of this persistence. Indeed, we find that the boost in formality caused by the reform lasts throughout the life cycle. The simulated individual in the new pension scheme is 34 percentage points more likely to be formal than the one in the old pension system at the end of the working life.

4.1 Introduction

There is a fairly wide literature on how mandatory pension arrangements affect individuals' decisions on different matters such as retirement age and crowding

out of private savings (see for example Gruber and Wise (2004), Attanasio and Rohwedder (2003), Feldstein (1974), Gale (1998)). While most of the empirical literature focuses on developed countries, it is almost silent for developing economies. Moreover, there is another issue relevant for developing countries (but not so much for developed economies) that may be affected by the design of the pension systems: How participation in the formal labour market is affected by the design of the pension system? Focusing on the case of Chile, this chapter intends to shed light on this subject.

In analysing how social security reforms affect overall labour markets outcomes, Cox-Edwards and Edwards (2002) note that "contributions to social security are often seen as a (partial) tax on labour rather than as deferred compensation or an insurance program". The authors then add that the extent to which the contribution is actually considered a pure tax depends on the nature of the pension system and in particular of the "perceived connection between contributions and benefits". Thus, the switch from a PAYG system to a DC one with individual accounts could well increase the connection and thus at least part of the contribution would be considered as a deferred compensation by workers. Following this argument, the close link between savings during working life and pension formulas should promote participation in the formal labour market (which is actually the claim of the proponents of the reform, see Piñera (2001)). The ample differences between the PFA and the PAYG system design is what we exploit to study the effect of the reform on labour market formality.

On the one hand, the literature on this issue is limited, due not only to the difficulty to find proper variation in pension systems that allows identification but also to the lack of appropriate data. Auerbach, Genoni, and Pages (2007) compare pension system's participation rates across eleven countries in Latin America that vary in their pension system design. The authors estimate, for each country, a probit model for participating in the pension system and then compare cross-country correlations between marginal effects for all the variables

included in the model. Showing that the correlation is "extremely high...and statistically significant" the paper claims that there is no evidence of differences in participation due to differences in the design of the pension systems. However, this approach does not take into account other differences across countries (for example by including a country fixed effect) and does not take care of the endogeneity of many of the right hand side variables included in the analysis. Packard (2001) exploits variation in pension system design and contribution rates across time and countries in Latin America. He finds that both variables have a positive and significant effect on labour market formality.

There are two papers that focus solely on Chile. Corbo and Schmidt-Hebbel (2003) estimate the macro effects of the pension reform in Chile exploiting the variation in contribution rates between the two pension systems in the frame of a two-sector model (formal/informal). They find that the reform lead to an expansion of the formal sector in the range of 3.2% and 7.6%, while the informal sector diminished by 1.1% to 1.3%. Also based on a segmented labour market model but using micro data, Cox-Edwards and Edwards (2002) find that "the reform contributed to an increase in net wages in the informal sector that ranged from 1.7% to 2.1%", suggesting a decrease in informal labour supply.

On the other hand, there is a rich and growing literature on the broader issue of the reasons behind informal work. There are two main approaches, the more traditional "exclusion" view and the alternative "exit" explanation. According to the former, job places in the formal market are scarce, thus less able workers are rationed out from it due to dual markets and rigid institutions. These workers would be queueing and, if had the choice, they would prefer the presumable higher wages and better conditions in the formal market. On the other hand, according to the exit view workers would voluntarily prefer informal jobs given their valuation of flexibility and the costs of formal work (mainly taxes and social security) (See Perry, Maloney, Arias, Fajnzylber, Mason, and Saaveddra-Chanduvi (2007) for a comprehensive analysis of this topic in Latin

America).

Auerbach et al. (2007) and Packard (2007) provide evidence suggesting that the exit interpretation is more relevant for the case of Chile, though the informal sector is indeed heterogenous so there are also non-voluntary informal workers.

In this chapter we define an individual as formal when he contributes to the pension system[55] (see section 4.2.1 for the reasons behind this definition). Based on the EPS 2004 survey, when asked about the reasons for not participating in the pension system (thus for being informal according to our definition), 65% of those not enrolled declare explicit voluntary reasons. On the contrary 24% report not to be able to afford pension savings (either because their income is too low, the contribution rate is too high or the administration fee is too high), and only a 5% does not participate because their jobs are too unstable or have been excluded by their employers[56]. Thus adding up the latter two groups, the incidence of exclusion among nonmembers of the pension system would be 29%[57] (although it is hard to distinguish between real credit constrains and myopia from high preferences for current consumption). Even though these figures are not conclusive, they suggest that the exit hypothesis is indeed relevant in Chile, thus there is scope for individuals to respond to the incentives pension systems pose on formality.

In looking at the extent of how formality is affected by the design of the pension systems we also allow for two sources of persistence, structural (state dependence) and spurious persistence (unobserved heterogeneity). To estimate this model we use a random effects dynamic probit model. Thus, on top of the effect of the pension system, we will be able to disentangle between how

[55] Given the equivalence between formality and pension contributions, this chapter could also be seen as a model of whether the type of pension system encourages more persistence/loyalty in contributions.

[56] Source: Author's calculation based on EPS 2004.

[57] Some caution should the taken when interpreting this evidence as it is based on the subsample of individuals who were not enrolled to the pension system (23% of the 15 years old and older population), thus it does not include people enrolled but not contributing who could also be in the informal market.

current formality affects the propensity to be formal in the future and permanent differences across individuals. To be able to distinguish between these three effects will allow us to shed light for policy design.

The contribution of this chapter is twofold. First, there are no previous attempts, that we are aware of, that estimate the effect of the pension system incentives on labour sectors in a developing country at a micro level. The topic is timely as the magnitude of the informal sector in Chile (and in most Latin American countries) is significant: in 2006 as much as 33.6% of workers were informal[58], which means that they are uninsured against unemployment, do not have paid annual leave, severance payments and a few other work-related benefits[59]. Therefore, it is key understanding the extent to which pension system design affects formality. The topic is also relevant for several countries around the world that have followed or are considering following the Chilean reform. Our results could help policy makers understand better the effects of pension reforms. The second contribution of the chapter is that we use econometric tools that are simple enough to be implemented but at the same time are rich enough to distinguish between the effect of the pension scheme design, state dependence and unobserved heterogeneity.

The chapter proceeds by presenting the empirical approach and the data to estimate the model. Section 4.3 presents the estimation results and section 4.4 takes into account the dynamics of the model by simulating the effect of the pension reform throughout the working life of the individual. Section 4.5 concludes.

[58] Source: National Household Survey, CASEN 2006. http://www.mideplan.cl/final/categoria.php?secid=25&catid=124

[59] However, informal individuals according to our definition could still access health insurance either by enrolling by themselves or as a dependent of a formal worker family member.

4.2 Methods and Data

4.2.1 Methodology

At every one period t the individual decides whether to participate or not in the formal labour market. The individual is considered to be formal when has an employment contract and/or access to the various dimensions of the safety net such as health insurance, pension system, unemployment benefits, paid annual leave, paid maternity leave, severance pay, etc. As all these benefits are bundled, we define an individuals as formal when he contributes to the pension system.

At any period t, the latent decision on formality for individual i is given by:

$$f_{it}^{*} = \alpha + \beta * system_{it} + Z_{it}\Gamma + \rho_{_1} f_{it-1} + c_i + \mu_{it} \tag{17}$$

Assuming $\mu_{it} \mid (Z_{it,_1}\ f_{it-1}, ..., f_{i0}, c_i) \sim N(0,1)$ for $t = 1, ..., T$ we have:

$$P(f_{it} = 1 | system_{it}, f_{it-1}, Z_{it}) = \Phi(\alpha + \beta * system_{it} + Z_{it}\Gamma + \rho_{_1} f_{it-1} + c_i) \tag{18}$$

where $f_{it} = 1$ means that individual i is formal in period t, given that she is a member of $system_{it}$, formality in the previous period,f_{it-1}, individual-specific unobserved heterogeneity c_i and other covariates, Z_{it}. Conditional on c_i, the covariates in Z_{it} are assumed to be strictly exogenous, meaning that once Z_{it} and c_i are controlled for, Z_{is} has no partial effect on f_{it} for $s \neq t$. Equation 18 is a dynamic non-linear model with unobserved heterogeneity.

β is the main coefficient of interest as it captures the effect of the pension system on the individual's decision on formality at any one period t. The fact that the choice of system is irreversible and the difference across systems in the connection between contributions and pensions implicit in the eligibility rules and pension formulas, is what we exploit to identify the effect of the system on participation in the formal labour sector. As mentioned in section 4.1, the closer link between contributions and pensions of the PFA scheme should encourage

formality. In other words, as $system_{it} = 1$ for individuals in PFA, we would expect $\beta > 0$.

As individuals already enrolled in the pension system at the time of the reform had the choice to either stay in the PAYG scheme or to opt-out to the PFA one, then $system_{it}$ in equation (18) is endogenous in the sense that it is correlated with the unobservable μ_{it}. We get round this problem by using a control function where the reduced form of $system_{it}$ depends on all the covariates included in equation (18) and the variable $forced_{it}$, which is the exclusion restriction we need for identification (Heckman and Vytlacil (2007), Imbens and Wooldridge (2007)). *Forced* introduces an exogenous change in *system* by exploiting the fact that the reform was undertaken by the repressive military government in power at the time, thus although in theory individuals could choose between the two pension schemes, in practice as much as 37% of our sample (see next section) declare to have been *forced* to opt-out to a PFA[60]. We give further support to our identification strategy in section 4.3 with the results of the reduced form.

There are two sources of persistence in equation 18, f_{it-1} and c_i. The random variable c_i, which we have assumed to be additive inside the normal cumulative distribution, represents the unobserved differences across individuals that may affect both the decision to which pension scheme belong and the decision to participate in the formal labour market –i.e. our outcome variable. An alternative interpretation for c_i is an individual-specific fixed costs of formal work, such as taste for flexible hours or the (dis)taste for illiquid and mandatory savings in the pension system. Further, the specification allows for state dependence through f_{it-1} so an individual's current propensity to participate in the formal market is *causally* affected by past participation (Heckman (1978), Heckman (1981), Hyslop (1999)). It could also be viewed as the the inertia in the formality decision, the cost of changing sectors or habits. While state dependence captures the "true" or "structural" persistence, c_i captures spurious serial correlation

[60] See footenote 50 for details.

that allows different individuals to have permanent propensities to formality irrespective of their past decisions (Chay, Hoynes, and Hyslop (2006)).

From a policy perspective, it is essential to distinguish between these two sources of persistence. For instance, a policy that encourages individuals to participate in the pension system early in their life cycle would be the relevant one if there is strong state dependence. On the other hand, it is much more difficult to change behavior through policies if the unobserved heterogeneity is the main source of persistence.

To get consistent estimates of (β, ρ, Γ) we would need to integrate out the unobserved effect c which in turn would raise the initial conditions problem, i.e. how to treat the initial observation f_o. To overcome this problem we follow the approach developed by Wooldridge (2005) (based on Chamberlain (1980)) which gains identification through proposing a density for c_i given (f_{i0}, Z_i), where $Z_i = (Z_{i1}, ..., Z_{iT})$[61].

Let

$$\begin{aligned} c_i &= \gamma f_{io} + Z_i\Pi + a_i \\ a_i &\mid (f_{i0}, Z_i) \sim N(0, \sigma_a^2) \end{aligned} \tag{19}$$

The choice of normality of a is convenient given that we are already assuming normality of μ[62].

Plugging equation (19) into equation (18) we get:

[61] Although it is always hard to distinguish between unobserved heterogeneity and state dependence, we believe in our case the very long time-series available that enables to condition on the entire vector Z_i is what allows to discriminate the two sources of persistence.

[62] This parametric assumption on the distribution of the unobserved heterogeneity means we are subject to the usual miss-specification problem, that is inconsistency. Further, as our data is an unbalanced panel (see section 4.2.2) we are specifying the distribution of c_i conditional on different number of periods for Z_{it} for each i, which in turn implicitly makes an assumption on how $\{Z_{it}\}$ evolves.

$$P(f_{it} = 1|system_{it}, f_{it-1}, Z_{it}) = \Phi(\alpha+\beta*system_{it}+Z_{it}\Gamma+\rho_1 f_{it-1}+\gamma f_{i0}+Z_i\Pi+a_i) \tag{20}$$

Equation (20) can be estimated using a random effects probit model where the vector of explanatory variables at time t is $(system_{it}, Z_{it}, f_{it-1}, f_{io}, Z_i)$. The insight from Wooldridge (2005) is that the inclusion of the initial condition and the entire vector Z_i in each time period allows for the unobserved heterogeneity to be correlated with the initial condition and the strictly exogenous variables.

Testing for state dependence (given c_i and Z_{it}), $H_0 : \rho_{_1} = 0$, is interesting in its own right as it would inform us on the inertia of decisions. A positive $\rho_{_1}$ would imply that formality (informality) in the previous period causes a great likelihood of formality (informality) in the current decision. Further, the estimate of γ will shed light on the relationship between the unobserved heterogeneity and the initial condition. We expect this correlation to be positive as individuals with unobserved taste for formality would tend to start their working lives in the formal sector.

The approach we follow here has two main advantages. First, in spite of being fairly rich on its inputs (pension reform evaluation, state dependence, unobserved heterogeneity) it is simple to estimate. Second, average partial effects are easily computed after equation (20) has been estimated[63]. Specifically, consistent average partial effects can be estimated from changes or derivatives of:

[63] Heckman (1981) proposed approximating the conditional distribution of the initial condition avoiding the practical problem of not being able to find the conditional distribution of the initial value. However, as Wooldridge (2005) shows, it is computationally more difficult to obtain marginal effects in nonlinear models.

$$N^{-1}\sum_{i=1}^{N}\Phi(\widehat{\alpha}_a+\widehat{\beta}_a * system_{it} + Z_{it}\widehat{\Gamma}_a + \widehat{\rho}_{1a}f_{it-1} + \widehat{\gamma}_a f_{i0} + Z_i\widehat{\Pi}) \qquad (21)$$

where the 'a' subscript denotes the original parameter divided by $(1+\widehat{\sigma}_a^2)^{1/2}$ and the $\widehat{}$ subscript denotes the maximum likelihood estimates of equation 20.

It should be noted that the approach followed does not allow us distinguish between the two sources of variation in the pension system, that is, we do not separate out the effect of the difference in contribution rates from the effect of the incentives posed by eligibility rules and pension formulas. A structural model would be able to take into account not only these features of the budget constraint but also to distinguish between individuals preferences for each system (and the risks each one brings about). We leave the structural model for future research.

4.2.2 Data

As mentioned in Chapter two, to look at the effect of the pension system incentives on participation we use the Social Protection Survey, EPS, restricting the sample to individuals who were already enrolled in the pension system at the time of the reform, thus those who allegedly were able to choose between the two pension arrangements (although some of them were actually forced to the PFA system). As opposed to chapter three, here we do include pensioners in the analysis.

The covariates included in Z_{it} are sex, age and its square, dummies for education level (none, primary, secondary and college), being married, number of children and year dummies. When estimating equation (20) for the subsample of women we also include whether the partner contributes to the pension system as a right hand side variable (see section 4.3 for further details). The vector

Z_t includes all the variables in Z_{it} for each year except the education dummies which are time invariant and the time dummies that would be redundant.

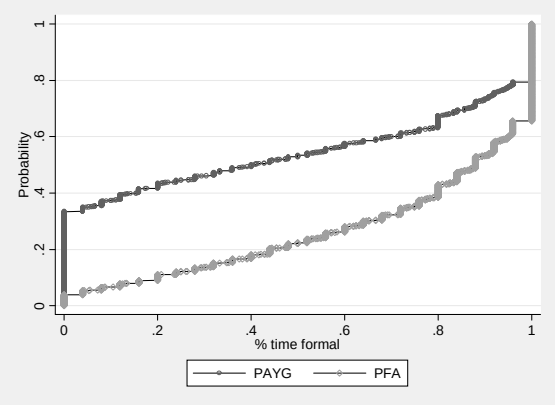
Table 1 contains the summary statistics of the sample we use. The data are a non-balanced panel with 81,611 individual-period observations, representing 3,763 individuals each with an average of 21.7 periods. Panel B shows that 40% of the sample stayed in the PAYG scheme while the remaining 60% opted-out to a PFA. The latter group are, on average, 10.6 years younger than the former. Also, in relative terms, the PFAs attracted more educated individuals and more men than women. Individuals in our sample have been married 87% of the time, regardless of the pension system. As a result of being older, those in the PAYG have had, on average, 0.95 children under 18 years old each period while these figure reaches 1.4 for those in the PFA scheme.

Table 1: Summary statistics of the sample

	System		
	PAYG	**PFA**	**Total**
Panel A			
N groups	1,510	2,253	3,763
N panel	29,588	52,023	81,611
T average per group	19.6	23.1	21.7
Panel B			
System	0.40	0.60	1.00
Age 1981	42.5	31.9	36.2
Men	0.49	0.68	0.60
Women	0.51	0.32	0.40
Less than Primary	0.51	0.27	0.37
Primary	0.34	0.41	0.38
Secondary	0.09	0.18	0.14
College	0.05	0.15	0.11
Married	0.87	0.87	0.87
No. of Children	0.95	1.40	1.22
Panel C			
% of time formal	0.46	0.74	0.63
% formal in t=0	0.58	0.79	0.71

Figure 1: Density of Individual-level Average Formality

By Pension System



The highly non-linear pension formulae in the PAYG scheme may imply that is optimal to have some years on informality (for example if the individual has contributed for more than 30 years or for less than 16 years). Panel C in table 1 contains the statistics for the dependent variable. Individuals have been formal 63% of the time, on average, but there is a noteworthy difference between those in the PAYG and in the PFA scheme, with figures of 46% and 74%, respectively. Figure 1 plots the cumulative distribution of the average time each individual spends in the formal market. It can be seen that the cdf for those in the PFA system first-order stochastically dominates the cdf for those in the PAYG scheme, i.e. the former gives a higher probability of an average time in the formal market equal or better than under the PAYG, for any value of the average time in the formal market. Although a non-causal correlation, these two pieces of evidence-the higher mean and the stochastic dominance- suggest that pension systems' design do affect formality in the labour market.

The last row of Table 1 shows the proportion of individuals that start their working lives in the formal sector, i.e. those for whom the initial condition is formality ($f_{io} = 1$ in equation (20)). There is a significant difference in favor of those enrolled in the PFA, supporting the idea of a positive correlation between the unobserved heterogeneity and the initial condition.

4.3 Results

As aforementioned, to identify the effect of the pension system on labour market formality, β, we follow a control function approach where *system* depends on the vector of covariates included in equation 20 and *forced,* which is excluded from the main equation. The control function approach relies on the same assumptions as instrumental variables, thus in this case, *forced* must not be correlated with the idionsyncratic error μ and must be correlated with the endogenous regressor, *system*. Table 2 contains the reduced form estimates of *system*. While the first columns displays the results for the whole sample, subsequent columns contain the results for subsamples. The magnitude and significance of the estimates for *forced* show a strong role of the variable in the determination of pension system, supporting the identification assumption that *forced* is indeed correlated with *system* (the other assumption is non- testable).

As in chapter three, there may be concern about the possibility that some specific types of individuals were more likely to be forced to opt-out than others, thus invalidating the use of *forced* as an exclusion restriction. There we provided evidence that socio-demographic and job characteristics at the time of the pension system choice (economic sector, blue/collar white collar, employment category, belong to an union and region) do not determine *forced*, thus supporting the exogeneity of the instrument[64].

The main results of the chapter are displayed in Table 3. The third and fourth columns contain, respectively, the estimated coefficients and marginal effects for the random effects estimation of equation 20. Our main coefficient of interest, $\widehat{\beta}$, is positive, significant and economically important: Being in the PFA system increases the probability of being formal in 23 percentage points at any one year t. State dependence has an even higher effect on formality, $\widehat{\rho_1} = 2.66$ (marginal effect of 0.80) meaning that there is high structural persistence in the formality decision. The initial condition is also high and significant but the

[64] See table 7 in pppendix 3.1 in chapter 3.

marginal effect is only a fifth of the magnitude of the state dependence.

Table 2: Reduced form estimates for *system*

	all	women	men	<=30 years old in 1981	>=50 years old in 1981	10 years before retirement
Forced	0.882	0.901	0.867	0.836	0.845	0.899
	(0.003)***	(0.005)***	(0.005)***	(0.005)***	(0.008)***	(0.025)***
$Formal_{t-1}$	0.078	0.072	0.081	0.107	0.035	0.039
	(0.002)***	(0.002)***	(0.002)***	(0.003)***	(0.002)***	(0.003)***
$Formal_{t0}$	0.090	0.060	0.112	0.078	0.078	0.103
	(0.012)***	(0.017)***	(0.017)***	(0.018)***	(0.014)***	(0.026)***
Sex	0.089			0.105	0.101	0.045
	(0.011)***			(0.017)***	(0.013)***	(0.026)*
Age	0.001	0.005	-0.003	0.003	-0.001	0.007
	(0.001)	(0.001)***	(0.001)**	(0.003)	(0.002)	(0.003)**
Age^2	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Primary	0.018	0.048	0.001	0.017	0.014	0.030
	(0.012)	(0.019)**	(0.016)	(0.021)	(0.015)	(0.029)
Secondary	0.094	0.094	0.099	0.082	0.093	0.133
	(0.017)***	(0.025)***	(0.023)***	(0.025)***	(0.021)***	(0.046)***
College	0.115	0.156	0.084	0.140	0.095	0.050
	(0.019)***	(0.027)***	(0.026)***	(0.028)***	(0.022)***	(0.053)
No. of children	-0.001	-0.000	-0.000	-0.007	-0.001	-0.005
	(0.001)	(0.001)	(0.001)	(0.001)***	(0.001)	(0.001)***
Married	0.003	-0.023	0.018	0.005	-0.022	0.064
	(0.003)	(0.009)***	(0.005)***	(0.005)	(0.014)	(0.018)***
Partner formal		0.003				
		(0.008)				
cons	0.066	-0.032	0.221	-0.008	0.221	-0.277
	(0.036)*	(0.054)	(0.051)***	(0.077)	(0.062)***	(0.182)

Note: year dummies and the entire vector Zi included in all regressions. Standard errors in parentheses. p<0.1, ** p<0.05, *** p<0.01

In order to have a benchmark, we estimate equation 20 for the same sample but pooling the data, i.e. not exploiting the panel-feature of the data. The results are displayed in columns one and two of Table 3 and show that the pooled estimated effect for pension system is lower, state dependence is higher and the initial condition is lower than for the random effects model. We report the proportion of the total variance contributed by the panel-level variance component, $\widehat{\theta} = 0.23$. Through a likelihood-ratio test we reject the null that $\widehat{\theta} = 0$, meaning that the panel-level variance is indeed important. In other words, this test formally compares the panel and the pooled model, giving evidence in favor

of the former. Further, allowing for heterogeneity substantially improves the fit of the model as evidenced by the change in log-likelihood. In summary, the unobserved heterogeneity is indeed relevant in explaining individuals' formality decisions and not to take care of it would lead to inconsistent parameters and potentially to misleading conclusions.

Table 3: Pooled and random effects estimates

	Pooled		Panel Data, RE	
	Betas	**Marginal Effects**	**Betas**	**Marginal Effects**
System (PFA=1)	0.47	0.16	0.758	0.227
	(0.036)***		(0.037)***	
$Formal_{t-1}$	2.99	1.01	2.66	0.799
	(0.019)***		(0.023)***	
$Formal_{t0}$	0.22	0.07	0.583	0.175
	(0.020)***		(0.036)***	
Sex	0.18	0.06	0.238	0.071
	(0.017)***		(0.028)***	
Age	0.06	0.02	0.087	0.026
	(0.005)***		(0.007)***	
Age^2	0.00	0.00	-0.001	-0.000
	(0.000)***		(0.000)***	
Primary	0.09	0.03	0.126	0.038
	(0.018)***		(0.031)***	
Secondary	0.15	0.05	0.199	0.060
	(0.025)***		(0.042)***	
College	0.32	0.11	0.438	0.131
	(0.030)***		(0.049)***	
No. of children	-0.01	0.00	-0.012	-0.004
	(0.01)		(0.010)	
Married	-0.19	-0.07	-0.219	-0.066
	(0.056)***		(0.059)***	
cons	-3.24		-4.15	
	(0.156)***		(0.211)***	
N	81,611		81,611	
N groups			3,763	
theta			0.234	
Chi2 comparison			429.38	
ll	-43,396		-14,990	

Note: year dummies and the entire vector Zi included in all regressions. Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

Next, we check whether there is some observed heterogeneity we can account for by estimating equation 20 for different sub-samples. Table 4 present the random effects results for Women and Men. Surprisingly, the effect of *system* at any one period t is higher for women than for men. However, women labour

supply was rather low in Chile in the 80's, thus only women with better job opportunities would participate in the labour market and this selected group would benefit relatively more from the pension reform than an average individual. The same reasoning applies for the higher effect of state dependence and of the initial condition of women: The selected group of women in the labour force would have a stronger habit to be formal and a higher taste for formality, respectively, than an average individual.

Table 4: Random effects estimates

by sex

	Women		Men	
	Betas	**Marginal Effects**	**Betas**	**Marginal Effects**
System (PFA=1)	0.687	0.172	0.793	0.130
	(0.059)***		(0.047)***	
$Formal_{t-1}$	2.76	0.690	2.59	0.425
	(0.039)***		(0.029)***	
$Formal_{t0}$	0.701	0.175	0.483	0.079
	(0.062)***		(0.045)***	
Age	0.121	0.030	0.064	0.010
	(0.012)***		(0.009)***	
Age^2	-0.001	-0.000	-0.001	-0.000
	(0.000)***		(0.000)***	
Primary	0.086	0.021	0.120	0.020
	(0.052)		(0.038)***	
Secondary	0.096	0.024	0.231	0.038
	(0.067)		(0.054)***	
College	0.440	0.110	0.393	0.064
	(0.078)***		(0.063)***	
No. of children	-0.035	-0.009	0.002	0.000
	(0.018)*		(0.012)	
Married	-0.362	-0.090	0.016	0.003
	(0.168)**		(0.076)	
Partner formal	-0.295	-0.066		
	(0.165)*			
cons	-4.05		-3.63	
	(0.296)***		(0.266)***	
N	32,589		49,022	
N groups	1,499		2,264	
theta	0.223		0.218	
Chi2 comparison	136.515		254.602	
ll	-5,519		-9,340	

Note: year dummies and the entire vector Zi included in all regressions. Standard errors in parentheses. p<0.1, ** p<0.05, *** p<0.01

On the other hand, the effects of the family-composition variables bear no

surprises: the *number of children* is a disincentive on formality for women (although only marginally significant) but not for men. Also, while *married* women are less likely to be formal than non married ones, marital status is not relevant for men. We have also included whether the partner is formal as an additional regressor for the women subsample. If the partner is in the formal labour market, then the woman would have health insurance as the husband's dependant which could be a deterrent to work in the formal sector because their own contributions for health insurance would be a pure tax (Galiani and Weinschelbaum (2007)). Indeed we do get that the estimated coefficient on *partner formal* is negative (though marginally significant)[65].

Table 5 display the results when disaggregating the sample by age. The first two columns are for individuals who where rather young at the time of the reform (30 years old or less). We expect the effect of *system* on formality to be larger for this group as they are more likely to benefit from the PFA scheme due to the compound interest formula and the possibility of job mobility. This is indeed the case: $\widehat{\beta^{ME}} = 0.28$, which is higher than the marginal effect for the whole sample and than for the group 50+ years old in 1981, which is actually non-significant (see columns 3 and 4 in Table 5). It is also interesting to see that the state dependence is less important for the young than for the entire sample and for the old sample, which accords with young individuals having less inertia (or less sticky habits) on the formality decision. The last two columns show the results when considering only individuals-periods 10 years before retirement age (65 and 60 for men and women, respectively). Not surprisingly, *system* has a smaller effect for this group as is too late for these individuals to profit from the incentives in the PFA system.

[65] We include this variable only for the women subsample as their participation in the labour market is fairly low. On the other hand, their husbands' participation is rather inelastic so the probability of selection in the marriage market is low.

Table 5: Random effects estimates

by age

	<=30 years old in 1981		>=50 years old in 1981		10 years before retirement	
	Betas	**Marginal Effects**	**Betas**	**Marginal Effects**	**Betas**	**Marginal Effects**
System (PFA=1)	1.19	0.275	0.043	0.011	0.265	0.082
	(0.060)***		(0.128)		(0.044)***	
$Formal_{t-1}$	2.36	0.548	3.62	0.911	2.95	0.914
	(0.032)***		(0.104)***		(0.046)***	
$Formal_{t0}$	0.298	0.069	0.423	0.106	0.508	0.158
	(0.055)***		(0.119)***		(0.068)***	
Sex	0.371	0.086	0.130	0.033	0.195	0.061
	(0.050)***		(0.076)*		(0.033)***	
Age	0.058	0.013	-0.025	-0.006	0.008	0.003
	(0.021)***		(0.064)		(0.039)	
Age^2	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)*		(0.000)***		(0.000)***	
Primary	0.137	0.032	0.102	0.026	0.111	0.035
	(0.061)**		(0.087)		(0.034)***	
Secondary	0.352	0.082	0.070	0.018	0.118	0.037
	(0.073)***		(0.124)		(0.051)**	
College	0.572	0.133	0.100	0.025	0.312	0.097
	(0.088)***		(0.143)		(0.057)***	
No. of children	0.010	0.002	0.115	0.029	-0.005	-0.001
	(0.017)		(0.058)**		(0.022)	
Married	-0.165	-0.038	-1.55	-0.390	-0.592	-0.184
	(0.067)**		(0.779)**		(0.327)*	
cons	-4.03		-0.838		-1.20	
	(0.521)***		(2.13)		(1.19)	
N	31,808		7,799		30,252	
N groups	1,293		506		2,948	
theta	0.289		0.000		0.077	
Chi2 comparison	415		0.001		10	
ll	-6,635		-808		-5,417	

Note: year dummies and the entire vector Zi included in all regressions. Standard errors in parentheses. p<0.1, ** p<0.05, *** p<0.01

It is worth mentioning that the initial conditions problem remains even when we focus on the young sub-sample. Although for this group we do observe the actual initial value (so there is no data censoring), to assume that f_{i0} is independent of c_i is indeed very strong so we still follow Wooldridge (2002) to estimate equation (20).

4.4 Simulations

Up to now we have estimated and analised the effect of the pension system on formality at any one year t. However, since our outcome variable is discrete and

since we have found that state dependence is indeed important, then a change in pension system should have a discontinuous and lasting effect on formality throughout the life cycle. Moreover, because pension benefits at the end of the working life depend on the decisions made over the life-cycle, we need to look at how the one-period estimated effect translates over many periods. Thus, we apply the dynamic nature of our model in equation (20) to simulate the effect for some specific cases.

We start with a man of 25 years old in 1983, with primary education, married with two children, who was formal in period t-1 and who was formal in t=0 (initial condition). We draw 1,000 shocks from a normal bivariate distribution for $c_i + \mu_{it}$ for every period until the individual reaches 65 years old. With these shocks and the estimated coefficients for men, we simulate responses for each age (year) until the end of the individual's working life according to the latent model in equation (17). We do this for someone in the PFA scheme and for someone in the PAYG plan and get the difference in the probability of being formal by pension system. We then bootstrap this difference with 1,000 replications and get confidence intervals.

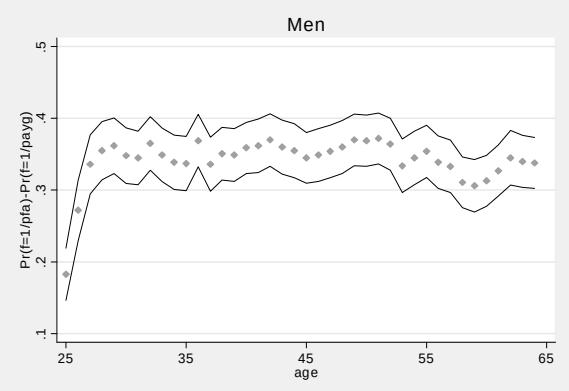
Figure 2 displays the results of this simulation. It shows that, at the beginning of the working life this individual has a 18 percentage points higher probability of being formal if he is enrolled in the PFA scheme, a difference that increases drastically over the first few years and then steadies at around 0.34. The pension reform boosted formality starting in its early years and, due to the state dependence, this effect persists until the end of the working life.

Next, we compare the results of the simulations for individuals who were at different stages of the life cycle at the time of the reform (25, 40 and 55 years old), keeping constant the other characteristics as in the first simulation. The results for men are shown in the left panel of Figure 3. It is striking to see that regardless of the time horizon for retirement, all these individuals reacted sharply to the pension system incentives in the first few years after the

reform. Nonetheless, after those first few years, the simulated 40 year old seems to respond less than the 25 year old, which is not surprising when considering that the younger individual had more time to benefit from the incentives in the PFA scheme. On the other hand, the simulated individual who was only 10 years before retirement (55 years old in 1983) had little time to benefit from the reformed pension system yet he still reacted as sharply as the younger cohort. This result could be explained by selection in the labor market in late stages of the life cycle: only those with better job prospects would remain in the labour market and they are the same ones that were previously discouraged by the non-linearities of the PAYG plan. Thus, the results for this simulated individual should be taken with caution as the reform acts on a selected (with better job-related traits) group.

The results for women and by cohort are displayed in the right panel of Figure 3. The simulated difference for the 40 and 55 year old women is much higher than the difference for the 25 year old, which can be explained by the same selection argument as for the simulated older man.

Figure 2: Simulated difference in probability of being formal



In Figure 4 we show the results of the simulation for two 25 year old men that differ in their initial condition, $f_{i0} = 1$ vis-à-vis $f_{i0} = 0$. Except for the first ten years after the reform, the difference in the probability of being formal is

higher for those who started working in the informal labour market, indicating that the effect of the pension system design is exacerbated for those whose initial condition was informality. In other words, the reform somewhat reverted the correlation between unobserved heterogeneity and the informality initial condition by promoting formality among those who opted out to the new system. The difference in formality is smaller for those who started as formal as they would probably had been formal in subsequent periods anyhow.

Figure 3: Simulated difference in probability of being formal by age in 1983

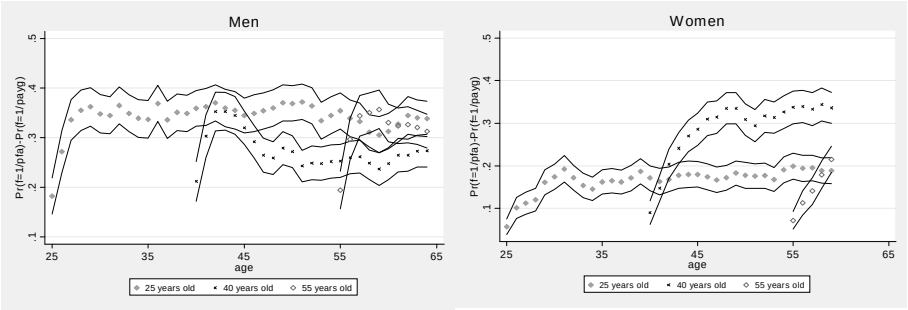
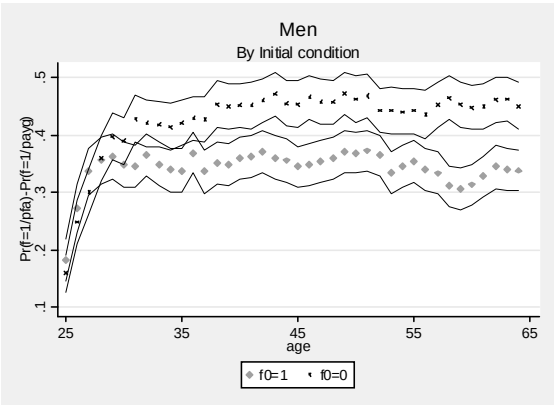
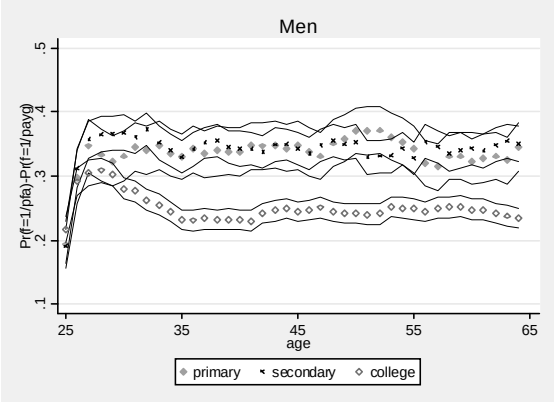


Figure 4: Simulated difference in probability of being formal by initial condition



Finally, to analyse the distributive effects of the pension reform, we simulate individuals with different levels of education. Figure 5 displays the results. On the one hand, individuals with primary and secondary education were equally affected by the reform, with an accumulated difference in the probability to be formal in favor of the PFA system of around 34 percentage points at the end of the working life. On the other hand, the difference in the probability of being formal is significantly lower for those with a degree. Thus, the reform had a relatively lower impact on formality of highly educated individuals as they would have been in the formal market anyhow. These results are in line with the ones found by initial condition: the PFA system encouraged formality exactly of those who would not had been formal under the PAYG pension plan and affected to a lesser extent those who already had preferences for formality, suggesting that the reform affected the marginal individual.

Figure 5: Simulated difference in probability of being formal by education



4.5 Conclusions

There is great debate in developing countries on how to promote formal work and it has been claimed that defined benefit pension systems would do so.

This chapter examines the extent to which the Chilean privately managed DC system with individual accounts boosts participation in the formal market in comparison with a state managed PAYG pension plan. While, the formulae in the PAYG system (min. 16 years, max. 30) suggest that a certain degree of informality may be optimal, the direct link between contributions and benefits in the PFA scheme is expected to encourage formality. We exploit the differences in contribution rates, eligibility rules and pension formulas between the two pension schemes.

To overcome the endogeneity of the individuals' choice of pension system, we use a control function approach. We gain identification exploiting the fact that some individuals were *forced* to opt-out to the PFA scheme. By using a dynamic, nonlinear panel data model with unobserved heterogeneity we are able not only to look at the effect of the pension system on formality but also to disentangle between state dependence (structural persistence) and individual specific unobserved heterogeneity (spurious persistence)

We find that being in the PFA system increases the probability of being formal in 23 percentage points at any one year t. This effect is statistically significant and economically important. State dependence is even more important, with a marginal effect of 80 percentage points indicating high inertia in the formality (informality) decision. The initial condition is also high and significant but the marginal effect is only a fifth of the magnitude of the state dependence. Through an specification test we confirm that the panel-level variance is important, thus the panel data model with random effects is more appropriate vis-à-vis the pooled data specification.

When accounting for observed heterogeneity, we find that the impact of the pension system on formality is higher for women than for men and higher for the young than for the old. The latter result is not surprising when considering that young individuals at the time of the reform had a long time horizon ahead to profit from the compound interest rate and of always positive accrual rates

in the PFA scheme. It is also interesting to see that the state dependence is less important for the young, which accords with young individuals having less inertia (or less sticky habits) on the formality decision.

The results on state dependence and initial condition enlightens policy design. The finding that the effect of the formality decision in the previous period is important and of greater magnitude than the effect of the initial condition indicates that there is scope for policies to encourage formality in early stages of the life cycle. Torche and Wagner (1997) show that individual's valuation of the pension system and health insurance increases with age. This, together with the importance of early contributions in the PFA system and the state dependence found in this article, supports their suggestion of "re-allocating contributions along the life cycle by lowering the cost of formal work in early stages of the life cycle". Other measures policy makers could adopt include default participation programs, matching or higher tax credit on contributions of young workers and savings education programs.

As we find that state dependence is indeed important, then a change in one of the covariates, pension system in our case, has permanent effects on the outcome variable. Therefore, to get a better insight of the any-one-period estimated effect of pension system on the entire working life, we perform simulations that take into account the dynamics of the model. We find that the effect of the pension system on formality is not only relevant in early periods but rather lasts until retirement. At the end of the working life, the simulated 25 year old man in the PFA is around 34% more likely to be formal than the one in the PAYG system. Simulations by initial condition and educational level indicate that the PFA system encouraged formality exactly of those who would not had been formal under the PAYG pension plan and affected to a lesser extent those who already had preferences for formality.

These conclusions are made on the basis that individuals can choose sectors, thus policy makers should look at measures that deepen incomplete or missing

capital and insurance markets and decrease myopia in order to increase formality. The reduction of myopia is particularly relevant, as in this chapter we find that formality decisions are determined to a great extent by state dependence. In this respect, Chile undertook a new reform in 2007 that includes financial incentives to early contributions to the pension system and to gradually incorporate the self-employed in the mandatory pension system. If, on the other hand the main reason for informality is segmented labour markets, then policies should attempt to soften labour market rigidities (Packard (2007) and Prieto (2004)).

5 Conclusions

The Chilean pension reform of the early 1980's replaced the PAYG system for a funded DC scheme managed by private companies, the PFAs. Members of the PAYG system at the time of the reform were allowed to either stay in or to opt out to a PFA. The fact that even nowadays the two opposite designs are operating in parallel provides a great opportunity to understand the effects on individuals' decisions.

This thesis has explored how the pension reform affected individuals' decisions in three aspects. Firstly, using employment histories and precise pension formulas, chapter two provides evidence on whether individuals maximised their pension wealth when choosing between staying in or opting-out. It has been shown that just over half of individuals took the optimal decision, with wide variation across current pension system: while the vast majority currently in the PFAs maximised pension wealth, only a minority currently in the PAYG did. The gap is due to a mixture of the different incentives across systems and individuals in each scheme being rather different on average. Both results-the number of rightly made decisions and the difference across systems-have strong policy implications as many reforms around the world are based on giving indi-

viduals choice in pension savings decisions.

Chapter three exploits the increase in the net present value of expected pension wealth induced by the reform found in chapter two to analyse whether it crowded-out private wealth. The problem of unobserved heterogeneity and measurement error is taken care of through instrumental variables. Two IVs applied to two different subsamples are used, both capture the actual degree of choice that people had when choosing pension plan. The life cycle model, which provides the theoretical framework, predicts a complete off-set between mandatory pension savings and private wealth. However, the estimated pension offset is in the range of 30%, result that could be due to a few reasons such as lack of understanding of the reform, precautionary savings due to uncertainty and non-separation of consumption across periods, i.e. habit formation.

Of the two measures of wealth used –net financial wealth and net worth, which comprises both real and financial wealth-it is found that individuals substitute mainly through real wealth. This result is not surprising when considering firstly that most private savings are in the form of real assets and secondly that both pension savings and real assets are illiquid. The results are robust to different values for the preference parameters.

Not only the proponents of the reform but also recent literature suggests that the closer link between contributions and benefits should encourage participation in the pension system and in the formal labour market. Chapter four looks precisely at this effect by, again, exploiting the ample differences between the PFA and the PAYG's design. A random effects dynamic probit model is estimated, where the probability of participating in the formal labour market in period t is conditional on being a member of a particular pension system, formality in the previous, individual-specific unobserved heterogeneity and other covariates. Thus, apart from the effect of the pension system design it is possible to identify the effect of structural and spurious persistence. Endogeneity of

pension system is taken care of by using a control function, where the exclusion restriction is the actual degree of choice that individuals had.

Results indicate that, as compared to the PAYG scheme, the PFA system indeed boosted participation in the formal labour market at any period t. The estimated effect is not only statistically significant but also economically important, evidence that could be used by developing economies that are thinking of or have already adopted a funded DC scheme.

Further, both sources of persistence are found to play a role on formality decisions, though state dependence is five times higher than individual unobserved heterogeneity. This suggests that there is scope to affect behaviour through policies that promote early participation and that these policies are likely to have permanent effects throughout the life cycle. In fact, the simulations carried out show that the pension reform boosted formality starting in its early years and, due to the state dependence, this effect persists until the end of the working life. Lastly, simulations comparing different types of individuals show that the positive effect of the pension system design on formality is exacerbated for those who would not had been formal under the PAYG pension plan and affected to a lesser extent those who already had preferences for formality as they would probably had been formal in subsequent periods anyhow.

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