Serie Documentos de Trabajo
Superintendencia de Pensiones
Alameda 1449.
Santiago, Chile.

www.spensiones.cl

Did Chileans Maximize Pensions when Choosing between PAYG and DC?

Ximena Quintanilla*

May 2011

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 paper we analyse for whom it was financially 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 to 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. Thus, when faced with the choice of pension system, only over half of individuals took the financially right decision. 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.

JEL codes: G23 H55 J08 J26

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 member of 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. This is the source of variation exploited in this paper to look at the extent to which individuals who had choice made the financially right decision. The decision was likely to be 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 a financially optimal decision as the one that maximises the expected net present value of EPW, we focus first on for whom it was financially optimal to stay in the PAYG scheme and for whom it was financially optimal to emigrate to the DC, and second on whether individuals in our sample actually took the financially optimal decision.

There are two main contributions of this papaer. The first one is that, to our knowledge, 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,

---

[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".

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 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 becomes timely as policy makers are designing policies that allow individuals to choose between different alternatives regarding their 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)).

It must be noted that the empirical approach we follow in this paper does not identify causal relations between pension system design and EPW. We simply analise the sources of variation, compute the net present value of EPW under the two schemes and conclude that the DC scheme brought about a higher net present value of expected pension wealth for most 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. To compare pension wealth in the two systems is the first stage to

then study the causal effect on individuals' responses. This paper is the input for complementary research where we indeed identify the effect of the pension reform on private savings decisions and in participation in the formal labour market.

The rest of the paper is organised as follows: the next section provides 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. Section 3 describes the data sources used and the subsample considered for the analysis. Then, section 4 describes how the net present value of expected pension wealthfor each individual in both systems is computed and, in order to do so, how earnings and contributions patterns for unobserved periods are projected from the observed data. Subsection 4.4 intends to acknowledge the measurement error derived from our computations. Section 5 presents the results of the empirical analysis and section 6 concludes.

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 (2005))

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. (2005)). Eventually, in 1980 the military government radically reformed the pension system, introducing a privately managed, fully funded with 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[2] 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 earning in the main PAYG provider[3], 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 priory in the PFA system but, as mentioned above, are the result of individual savings and the return on those savings. The parameter that is 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 to a benefit in the PAYG system the individual needs at least 800 weeks of contributions and a density of contributions[4] 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

---

[2]There was a new comprehensive pension reform in 2008. However, this paper intends to compare the PAYG and the PFA system as they were before the 2008 reform, i.e. we compute the net present value of expected pension wealth as it would be according to the rules in force up to 2008.

For details of the new pension reform see http://www.spensiones.cl

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

[4]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.

than (roughly) 16 years of contributions will not get a pension from the PAYG system whatsoever. The exact formula that summarises all these features is[5]:

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

$$(1)$$

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

On the other hand, 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 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 [6]. 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[7].

---

[5] 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.

[6] See Appendix B for requirements and formulas of the Recognition Bond.

[7] See Appendix F 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.

Summarising, pensions in the PAYG system are highly non-linear in the number and timing of contributions. On the contrary, pensions in the PFA scheme do not have kinks of any sort. Figure 1 shows these features[8].

From the description on 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 to. 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[9]. 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
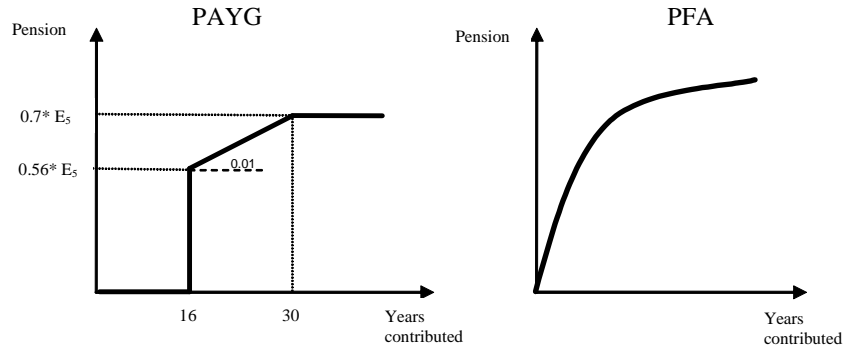
What kinds of risks and to what extent individuals face those risks is the third substantial difference between the Chilean versions of the PAYG and PFA plans[10]. Firstly, while in the former once the eligibility requirements are satisfied, the risk of interrupted careers and periods of low earnings is pooled among

---

[8]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.

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

[10]Yet other 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

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 bare 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).

We now turn to the common features of the two schemes. To contribute is 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 is the employer 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 financially 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 financial dimension, leaving aside other considerations such as differences in risk aversion or time preferences.

─────────────────────────

the pension design, these differences are not relevant for the specific objective of our paper.

3 Data and Sample

3.1 The data

We use two sources of information:

1. The Social Protection Survey, EPS[11], which is a nationwide representative sample of the population. The EPS is a longitudinal survey, with waves conducted in 2002, 2004 and 2006[12]. 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.[13]

   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 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 on 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[14].

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 Great 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[15]. Further details in section 4.2.

---

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

[12] 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).

[13] The EPS is conducted by the University of Chile on behalf of the Ministry of Labour. For further details visit www.proteccionsocial.cl

[14] 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.

[15] 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.

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 market, and more accurately, enrolled to 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.

4 Empirical Approach

The main objective of this paper 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:

$D_i = \begin{cases} 1 \text{ if opted out to PFA} \\ 0 \text{ else} \end{cases}$
$X_i \equiv$ 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

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

For individuals currently in PAYG

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

This is implicitly assuming that there are not pension savings behavioral responses due to the pension system design, which is clearly a very strong assumption[16]. 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: (a) observed scenario, using their observed employment history to allocate them to a pension provider; and (b) upper bound scenario, allocating them to their most frequent observed provider for their entire working life. Thus, the latter scenario is implicitly assuming that had those individuals stayed in the PAYG scheme, they would have had such employment mobility (or at least pension provider mobility) so not to loose vesting periods to be eligible for a benefit in the relevant provider (see section 2 for further details).

In order to calculate an individual's pension wealth when reaching retirement age we need both individual earnings profiles and contribution patterns. We now explain in turn the approaches followed to address these two issues.

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[17]. 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.

---

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

[17]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.

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, its square and the unemployment rate[18]

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.

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

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

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 E.2 in Appendix E 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 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]

---

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

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).

4.3 Computing expected pension wealth

Once we have projected earnings and contribution patterns as explained in sections 4.2 and 4.3, 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 adopt two scenarios for the rate of return: the actual series of the pension funds rate of return (which averaged 10.3% between 1981 and 2004) and the expected yield at the time of the reform (4%)[19]. 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 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[20]. 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, which we compute according to formulas given in Appendix B using estimated contribution patterns and earnings profiles. Once we have pension savings we compute the corresponding expected annuity[21] using the same formula and program actually used in the Chilean system[22]. The formula takes into account variables such as sex and marital status of the claimant, age of the spouse[23], sex-based life expectancy tables[24], among others.

---

[19] 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)).

[20] 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)

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

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

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

[24] 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,

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. 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[25]. 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 to, 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 loose vesting periods to be eligible for benefits in the relevant provider. Consequently, benefits computed under the latter scenario are an upper bound for the PAYG system. Regarding unobserved periods (not in the EPS2004, either before 1980 or after 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 A). We also take into account minimum and maximum values pensions can take[26].

Both the PAYG and the PFA schemes entitle individuals that meet certain requirements and that do not self-finance a minimum threshold 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 is to have made at least 240 contributions. We adjust expected pensions in each system accordingly, i.e. we topped up pensions for those whose benefits are below the threshold and that satisfy the requirements.

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[27] and their corresponding life expectancy[28]. Moreover, as contribution rates to the PAYG and PFA system are substantially different, we compute the *net present*

---

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.

[25] 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.

[26] As defined by Law No. 15,386

[27] We get this information from the EPS

[28] We take average life expectancy from aggregate mortality statistics.

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)).

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)[29]. 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[30]. Figure E.1 in Appendix E shows that the difference between the two series is never greater than 3% in absolute value. Thus, the proportion of individuals who self-reported to have contributed to the pension system in any particular

---

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

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

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.

5 Results

5.1 Pensions in either system (counterfactuals)

We now present the results from the empirical analysis just described. Firstly, Table 1 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 1: Summary statistics for sample used to compare EPW

	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 2 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 to. 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.

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 almost identical outcomes, in what follows we will only present the results using the actually observed employment histories, though the full set of results is available upon request.

Figure 2 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.

Figure 2: Kernel densities for net present value of pension wealth at retirement age in the PFA and in the PAYG system
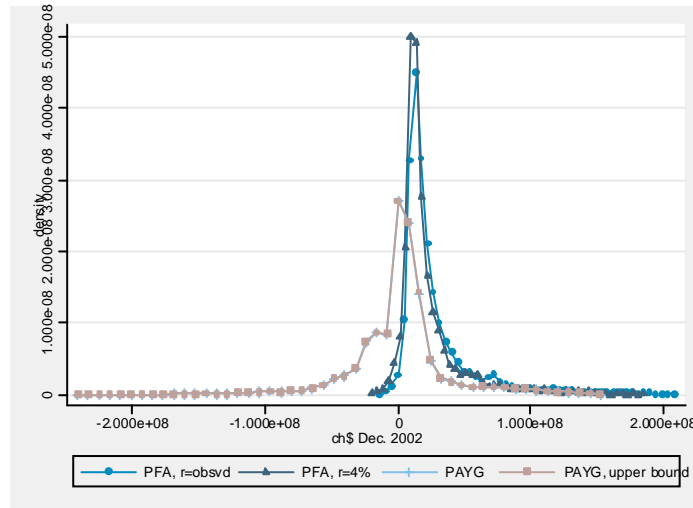

17

Table 2 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 disaggregated 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 2).

Thes 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 2). The drop is no so dramatic as we are comparing not pension benefits but the *net present value of pension wealth,* thus discounting all future benefits and net of 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 3. 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 2 is that the proportion of women that would be better off in the PFA is decreasing in education. Again, this finds explanation in Table 3, 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[31] and to vesting periods[32], just over 1 in 2 women at the bottom of the education distribution would be eligible for benefits 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 2). 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

---

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

[32] 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)

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 of in the PFA fairly stable in education.

In 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 2 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 interests of the early periods of the PFA. Further, even though we show in Appendices B and C 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 of 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 2: Comparison of net present value of EPW in PFA and PAYG

| | % of whom | | % of whom | |
| | NPV_PFA$_{observed\ r}$>=NPV_PAYG | | 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 3: 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%

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[33]. 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, other relevant factors are contribution rates and non-linearities in pension benefits. Regarding the latter, figure 3 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[34].

---

[33]This rate of return also equalises the median of pension benefits.
[34]There is also some clustering at the legal upper cap in pensions in the PAYG systems of ch$776,508 (as for Dec. 2002).

Figure 3: Kernel densities for pensions at retirement age in the PAYG and
PFA system
Using r=7% for the PFA system
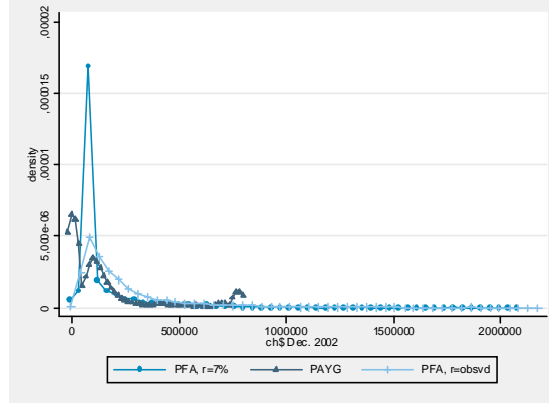
It is worth noting that the analysis in this subsection ignores the interest rate risk in the PFA scheme (as well as other risks such as the lack of portability in the PAYG system). Even though the average real rate of return of the system has been rather high since the DC system outset, individuals are subject to its volatility which is even more important when they are in the eve of retirement. Figure 4 and table F.1 in Appendix F 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.

Figure 4: Real Rate of Return of PFA System
1981-2009
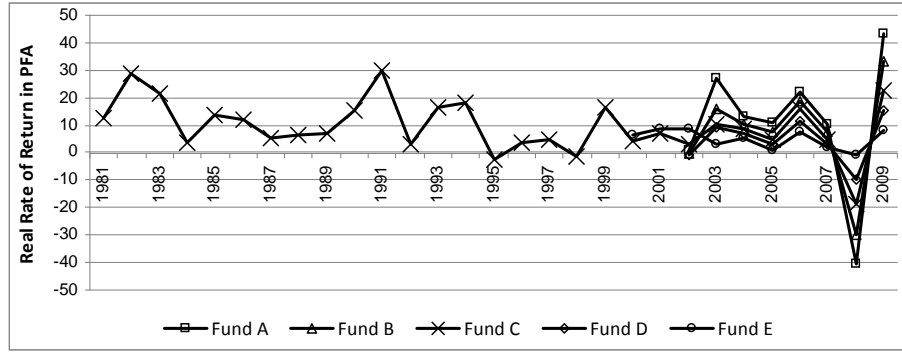
5.2 Pensions in actual system

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 4 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 4: 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%

23

Table 5 provides evidence on who *actually* made the financial "right" 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 made the right decision. 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 chose the financially right pension scheme, of which 37.9% are currently in the PFA and 6% in the PAYG scheme[35].

The above figures leave us with 84% of men and 89% of women currently in PAYG [36] 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 6). 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.

Table 5: Share of men 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		
			PFA	PAYG	All
	Currently in	PFA	37.9%	9.6%	47.5%
		PAYG	46.5%	6.0%	52.5%
	All		84.4%	15.6%	

---

[35] 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.

[36] 28.5/34=83.7% for men, 46.5/52.5=88.5% for women.

Table 6: 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 5 shows that 90% of men and 80% of women[37], averaging 86%, made the right decision. Again, from Table 6 we can see that even though most of those that opted- out of both sexes 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 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, only over half of individuals took the financially right decision. 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 get 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

---

[37] 59.6/66=90% for men, 37.9/47.5=80% for women.

would be in the PAYG arrangement, there are still some individuals-amongst whom women are over represented- for whom the system operating nowadays is inadequate. We take a closer look at this worst-off group in Table 7. When disaggregating the male sample by education we find that most worst-off men 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 loose out in the PFA pension arrangement.

The picture is very different when looking at women. The distribution of women worst-off in the PFA across education levels is much more even, with a fair share in the two top levels (see bottom panel in Table 7). This is extremely worrying as female labour force participation is increasing with time at the same time that family types are changing in the Chilean society, thus making them more likely to rely on their own pensions to finance old age instead of depending on their husbands benefits.

Table 7: 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 also of concern as the PFA is the system new generations of employees have to join, without having any alternatives to choose from.

From the two preceding paragraphs, we conclude that indeed there is scope to improve the pension system to ensure that women and low skill workers from new generations get sufficient provision upon retirement. Regarding the latter 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. In these lines a new pension reform was passed in 2008, which introduced a comprehensive redistributive first pillar to which everybody older than 65 years old and in the 60% poorest share of the population would be entitled. The first pillar will have to components: a Basic Welfare Pension for those that cannot self-finance a pension and a Welfare Pension Complement for those who do self-finance a pension but that is lower than a minimum threshold. The reform also aims to promote participation of young individuals in the pension system through subsidising their contributions for the first 24 months of work. Regarding women, they will with no doubt benefit from the proposed means-tested basic pension. Further, there will be a 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.

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 paper 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 analise for whom it was financially 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. From this, it is possible to conclude that the PFA 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.

The non-linearities in the PAYG system, in particular the cap in the benefits and maximum accrual which affects mostly men, results in that 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 distribution feature inherent in the PAYG plan. Moreover, the non-linearities in pension formulas in the PAYG system lead 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. In 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 induce 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

A   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). People member of a provider and 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)[38]

2. Private Sector Employees provider (Caja de Previsión de Empleados Particulares, EMPART)[39].

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:

---

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

[39] EMPART members are workers whose job requires intellectual rather than phisycal effort. Law No. 10,475.

	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

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

B   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:*

$$RB = 0.8 * \sum_{i=1}^{T} \frac{W_i}{T} * 12 * \frac{\text{No of years contributed}}{35} * A * B$$

$$Where \quad :$$
$$A = 10.35 \text{ if man}$$
$$11.36 \text{ if woman}$$
$$B \equiv \text{factor increasing with age and that varies with sex}$$

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 1 vs. equation1), 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.

C   Sources of variation: Eligibility Rules, Pension Formulas and Individual Traits

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 $[0\%,100\%]$[40]. 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[41].

Finally, we take individuals of different ages in 1981: 20[42], 30, 40, 50, 60 and 64.

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 growth after that age.

As in section 5 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[43]. Since the observed average rate of return is 10.3% and the predicted by the designers of the reform was 4%, these two scenarios indeed produce very different results.

Also as in section 5, we do take into account that some individuals are entitled to the Minimum Pension Guarantee. As a result, under the observed

---

[40] See for example **?** for evidence from administrative data and Arenas de Mesa, Behrman, and Bravo (2004) for evidence from survey data.

[41] See for example Margozzini (1988).

[42] 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.

[43] 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.

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 compare pensions in terms of the replacement rate, which we define as the ratio between the pension and the average earnings of the last 5 years before retirement. Figure C.1 graphically shows the ratio between the RR in the PAYG and PFA schemes

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), that out of the 36 types of individuals analised, 31 get a higher or equal RR in the PFAs than in the PAYG scheme. Of the remaining 5 types that are worst-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 where not on the side of the new system (panels (c) and (d) in Figure C.1). 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, 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 C.1: $\frac{PY^{PFA}}{PY^{PAYG}}$ for different representative individuals and different rate of return scenarios
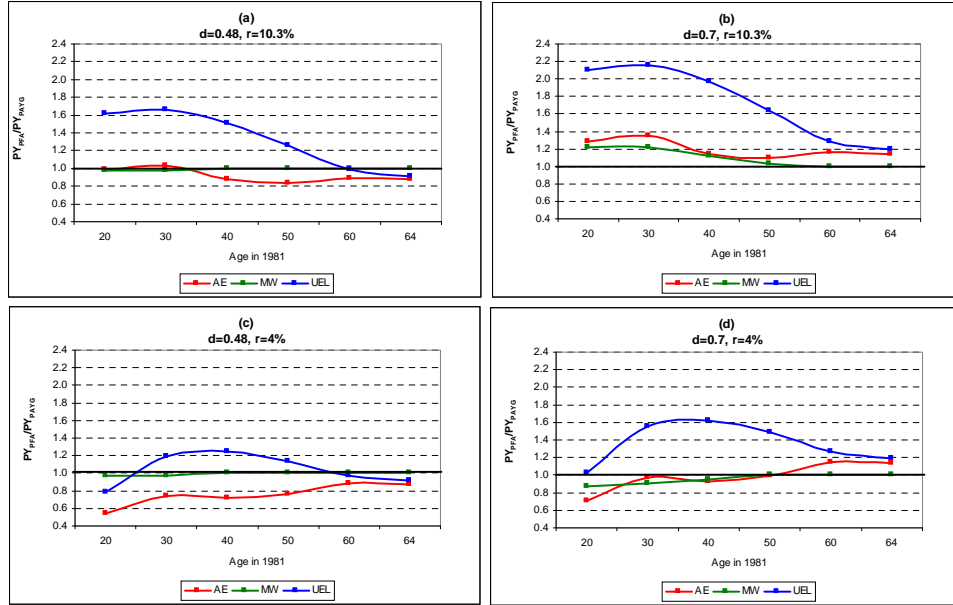
Regardless of the rate of return we use, our results show that all older workers earning either the AW or the UEL with high contribution density should opt-out to an PFA. This finding is driven by both the cap of 70% in the PAYG benefit and the generosity of the RB; and supports our earlier analysis in section B when comparing the RB and PAYG benefit formulas.

Recall, however, than under the assumptions made in this appendix all our individual types 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 would certainly have a benefit (although perhaps rather low) in the PFA scheme. Indeed, as section 5 shows, not even 60% of individuals are eligible to claim a benefit in the PAYG system (see table 3).

Using different types of individuals, we confirm the findings of the empirical section 5 concluding 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) tops up benefits of most low-skilled types of workers, leaving them financially indifferent between the two systems. 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, effect that 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 induce individuals in the middle of their life-cycle at the time of the reform to opt-out to an PFA.

D   Estimating Labour Earnings-Details

Two adjustments were made when estimating group-earning profiles as explained in section 4.2. 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.

E   Figures

Figure E.1. Share of individuals contributing in PFA
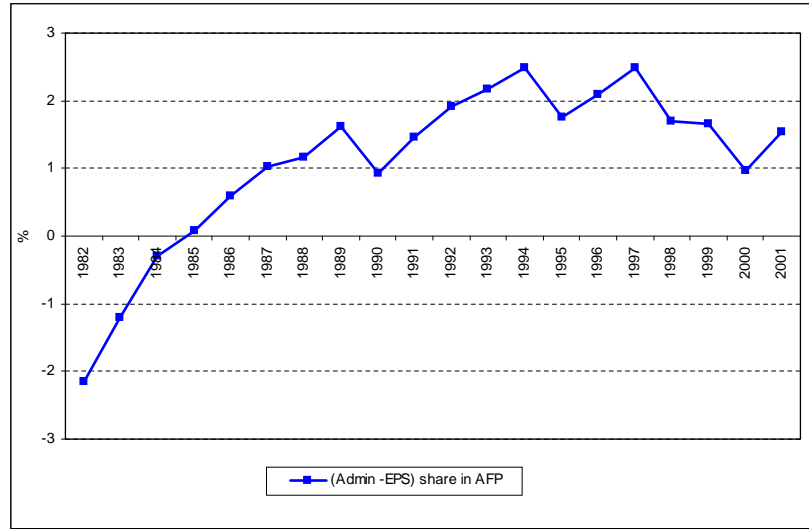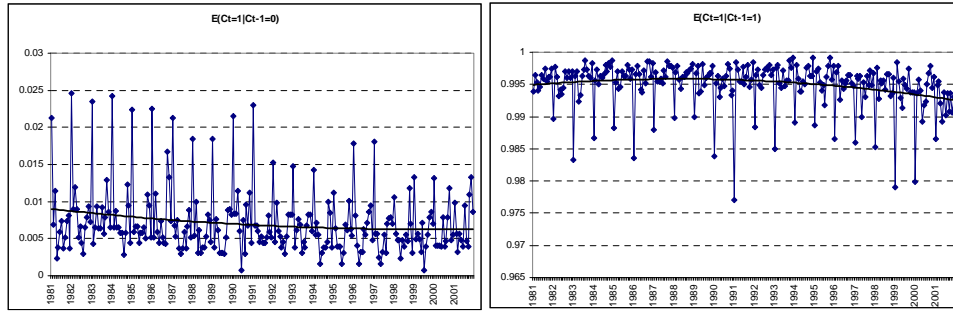(Administrative Data - EPS self reported Data)

Figure E.2. Unconditional probability of contributing given initial state.

F Observed Rate of Return of Pension Funds

Table F.1: 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.

References

Arenas de Mesa, A. (2000): Cobertura Previsional en Chile: Lecciones y Desafíos del Sistema de Pensiones Administrado por el Sector Privado. *Serie Financiamiento para el Desarrollo No 105*. ECLAC.

Arenas de Mesa, A.; J. Behrman; and D. Bravo (2004): Characteristics of and Determinats of Density of Contributions in a Private Social Security System. *University of Michigan Retirement Research Centre, WP 2004-077*.

Attanasio, O. and S. Rohwedder (2003): Pension Wealth and Household Saving: Evidence from Pensions Reforms in the United Kingdom. *The American Economic Review*, Vol. 93(No. 5).

Banks, J.; C. Emmerson; and G. Tetlow (2005): Estimating Pension Wealth of ELSA Respondents. *Working Papers 05/09*. The Institute for Fiscal Studies.

Barrientos, A. (1996): Pension Reform and pension coverage in Chile: Lessons for other countries. *Bulletin of latin American Research*, Vol. 15(No. 3).

Berstein, S.; G. Larraín; and F. Pino (2005): Cobertura, Densidad y Pensiones en Chile: Proyecciones a 20 Años Plazo. *Superintendencia de Pensiones. Documento de Trabajo*, (No. 12).

Blundell, R.; C. Meghir; and S. Smith (2002): Pension Incentives and the Pattern of Early Retirement". *In Social Security Programs and Retirement around the World: Micro-Estimation*. Ed. Gruber and Wise. The University of Chicago Press.

Bound, J.; C. Brown; and N. Mathiowetz (2001): *Handbook of Econometrics, Vol. 5*, Eds. J.J. Heckman and E Leamer. Elsevier Science B. V., chap. Measurement Error in Survey Data.

Brown, J. and S. Weisbenner (2007): Who Chooses Defined Contributions Plans. *NBER Working Papers Series*.

Contreras, D.; E. Puentes; and D. Bravo (2005): Female Labour Force Participation in Greater Santiago, Chile: 1957-1997. A Synthetic Cohort Analysis. *Journal of International Development*, Vol. 17(Issue 2).

Creighton, A. and J. Piggott (2006): *The Oxford Handbook of Pensions and Retirement Income*, Eds. G. Clark and A. Munnell and J.M. Orszag. Oxford University Press, chap. The Structure and Performance of Mandated Pensions.

Edwards, S. (1998): *In Privitazing Social Security*, Ed. M. Feldstein. The University of Chicago Press, chap. The Chilean Pension Reform.

Margozzini, F. (1988): Estimaciones de las Pensiones de Vejez que Otorgará el Actual Sistema de Pensiones. *In Sistema Privado de Pensiones en Chile*. Ed. S. Baeza and R. Manubens. Centro de Estudios Públicos.

Packard, T. (2001): Is There a Positive Incentive Effec from Privatizing Social Security? Evidence from Latin America. *Policy Research Working Paper No 2719*. World Bank.

Pino, F. (2005): Retiros Programados y Nuevas Tablas de Mortalidad. *Superintendencia Pensiones. Serie de Notas Técnicas*, (No. 1).

Piñera, J. (2001): Empowering Workers: The Privatization of Social Security in Chile. *Cato Journal*, Vol. 15(No. 2-3).

Wooldrigde, J. (2002): *Econometric Analysis of Cross Section and Panel Data*. The MIT Press.