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MOVING FROM A PAY AS YOU GO TO A DEFINED CONTRIBUTIONS PENSION SCHEME: DOES IT BOOST PARTICIPATION IN THE FORMAL LABOUR

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Moving from a Pay as You Go to a Defined Contributions Pension Scheme: Does it Boost Participation in the Formal Labour Market?

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Abstract

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

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

JEL codes: H55, J32, J42,

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1 Introduction

There is a fairly wide literature on how mandatory pension arrangements affect individuals' decisions on different matters such as retirement age and crowding out of private savings (see for example Gruber and Wise (2004), Attanasio and Rohwedder (2003), Feldstein (1974), Gale (1998)). While most of the empirical literature focuses on developed countries, it is almost silent for developing economies. Moreover, there is another issue relevant for developing countries (but not so much for developed economies) that may be affected by the design of the pension systems: How participation in the formal labour market is affected by the design of the pension system?. Focusing on the case of Chile, this paper intends to shed light on this subject.

Chile, in 1981, was the first country in the world to privatise its pension system, moving from a traditional state-managed Pay as You Go (PAYG) scheme to a privately managed defined contributions system with individual accounts. The private companies that manage this individual pension savings accounts are called Pension Funds Administrators so we will refer to this system as the PFA scheme. Chile is an interesting case because even though it closed the PAYG scheme to new entrants, it allowed people enrolled in the pension system at the time of the reform to choose between the old and the new scheme. Thus, even nowadays the two very opposite pension designs operate in parallel in the country. Quintanilla (2009b) analyses for whom it was financially optimal (in terms of higher pension) to opt-out to a PFA and for whom to stay in the PAYG system. The paper finds that the reform implied a rather important increase in expected pension wealth: 87% of individuals with choice would have got a higher pension in the PFA system. Further, Quintanilla (2009a) investigates the extent to which households substitute this increase in pension wealth by decreasing accumulation of other wealth. Results indicate a substantial crowding out effect between mandatory pension savings and private wealth.

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

On the one hand, the literature on this issue is limited, due not only to the difficulty to find proper variation in pension systems that allows identification but also to the lack of appropriate data. Auerbach, Genoni, and Pages (2007) compare pension system's participation rates across eleven countries in Latin America that vary in their pension system design. The authors estimate, for each country, a probit model for participating in the pension system and then compare cross-country correlations between marginal effects for all the variables included in the model. Showing that the correlation is "extremely high...and statistically significant" the paper claims that there is no evidence of differences in participation due to differences in the design of the pension systems. However, this approach does not take into account other differences across countries (for example by including a country fixed effect) and does not take care of the endogeneity of many of the right hand side variables included in the analysis. Packard (2001) exploits variation in pension system design and contribution rates across time and countries in Latin America. He finds that both variables have a positive and significant effect on labour market formality.

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

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

In this paper we define an individual as formal when he contributes to the pension system[1] (see section 3.1 for the reasons behind this definition). Based

[1] Given the equivalence between formality and pension contributions, this paper could also

on the EPS 2004 survey, when asked about the reasons for not participating in the pension system (thus for being informal according to our definition), 65% of those not enrolled declare explicit voluntary reasons. On the contrary 24% report not to be able to afford pension savings (either because their income is too low, the contribution rate is too high or the administration fee is too high), and only a 5% does not participate because their jobs are too unstable or have been excluded by their employers[2]. Thus adding up the latter two groups, the incidence of exclusion among nonmembers of the pension system would be 29%[3] (although it is hard to distinguish between real credit constrains and myopia from high preferences for current consumption). Even though these figures are not conclusive, they suggest that the exit hypothesis is indeed relevant in Chile, thus there is scope for individuals to respond to the incentives pension systems pose on formality.

In looking at the extent of how formality is affected by the design of the pension systems we also allow for two sources of persistence, structural (state dependence) and spurious persistence (unobserved heterogeneity). To estimate this model we use a random effects dynamic probit model. Thus, on top of the effect of the pension system, we will be able to disentangle between how current formality affects the propensity to be formal in the future and permanent differences across individuals. To be able to distinguish between these three effects will allow us to shed light for policy design.

The contribution of this paper is twofold. First, there are no previous attempts, that we are aware of, that estimate the effect of the pension system incentives on labour sectors in a developing country at a micro level. The topic is timely as the magnitude of the informal sector in Chile (and in most Latin American countries) is significant: in 2006 as much as 33.6% of workers were informal[4], which means that they are uninsured against unemployment, do not have paid annual leave, severance payments and a few other work-related benefits[5]. Therefore, it is key to understand the extent to which pension system design affects formality. The topic is also relevant for several countries around the world that have followed or are considering to follow the Chilean reform. Our results could help policy makers to understand better the effects of pension reforms. The second contribution of the paper is that we use econometric tools that are simple enough to be implemented but at the same time are rich enough

be seen as a model of whether the type of pension system encourages more persistence/loyalty in contributions.

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

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

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

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

to distinguish between the effect of the pension scheme design, state dependence and unobserved heterogeneity.

The paper proceeds by summarising the main differences between the PAYG and the PFA arrangements in Chile. We focus mainly on contribution rates, the requirements to be eligible to get a benefit and the pension formulae. Section 3 presents the empirical approach and the data to estimate the model and then section 3 the estimation results. In section 4 we take into account the dynamics of the model by simulating the effect of the pension reform throughout the working life of the individual. Section 5 concludes.

2 The PFA and PAYG Pension Schemes in Brief

Chile dramatically reformed its pension system in 1981 going from a PAYG to a PFA scheme. While people already enrolled in the pension system at the time of the reform had the choice to either stay in the old arrangement or to opt-out to a PFA, those yet to join the labour market had no choice but to enroll in a PFA. Individuals who had the choice and actually opted-out to a PFA could not later go back to the PAYG scheme, thus once taken, the opting-out decision was irreversible.

The PAYG and the PFA pension plans in Chile differ mainly in two ambits, the first one relevant during working life and the second upon retirement[6]. While working, the contribution rate to the PAYG scheme is around 19.1% of labour earning in the main PAYG provider[7] whereas it is 12.5% in the PFA, 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.

At retirement age, the way eligibility and pension benefits are calculated differs substantially across 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[8] of no less than 50%. The PAYG is a final salary scheme thus, once the two requirements have been met, the pension benefit starts with a minimum of a 56% of average earnings in the last 60 months. 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

[6] 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

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

[8] 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.

of positive accrual. Note the strict requirement of 800 weeks of contributions to be eligible for the benefit, i.e. individuals with less than (roughly) 16 years of contributions will not get a pension from the PAYG system whatsoever. The exact formula that summarises all these features is[9]:

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

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

On the other hand, at retirement age, the PFA system does not impose any requirement 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 (10% of earnings) netted out of the fix administration fee and the market returns on those savings. Due to the compound interest effect, contributions in early periods are relatively more important in the pension fund than later contributions. Pension savings accumulated in the PFA at retirement age R then are:

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

Then, the pension benefit in the PFA scheme is an always increasing function of labour earnings, periods contributed (participation) and the interest rate. In other words, as long as the rate of return is positive, the accrual rate is always positive[10].

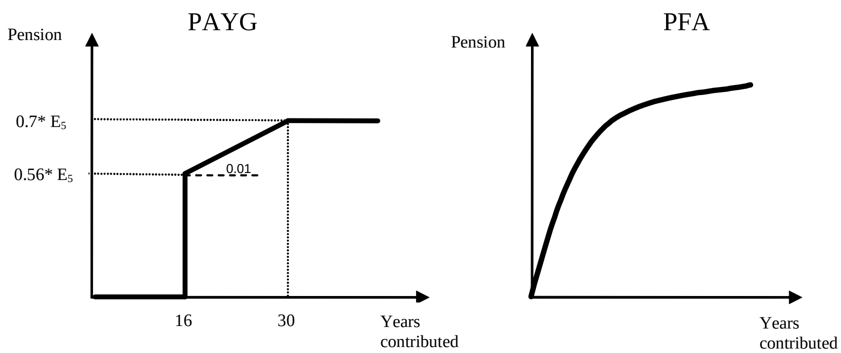
Summarising, pensions in the PAYG system are highly non-linear in the number and timing of contributions. On the contrary, pensions in the PFA scheme do not have kinks of any sort. Figure 1 shows these features[11].

[9] 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.

[10] See table A.1 in the Appendix 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.

[11] 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.

Figure 1



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 or (iii) to contribute no more than 30 years. On the other hand, the close link between contributions and benefits in the PFA scheme (an additional period always has a positive accrual) should encourage individuals to participate. This incentive is even stronger in early periods where contributions matter most.

It is worth mentioning also that while pension savings are fully transportable from one job to the other in the PFA system, they are not to a great extent in the PAYG scheme. The PAYG arrangement has three main providers, roughly organised by economic sector thus if an individual was to change jobs to another sector (and hence provider) she could loose all her vesting periods and accrued benefits in the previous job. While this job-mobility risk could also deter participation in the PAYG system, it is not present whatsoever in the PFA arrangement.

It is the variation in pension system design, namely contribution rates, eligibility and pension formulae, what we exploit to identify the effect of the system on participation in the formal labour sector.

3 Methods and Data

3.1 Methodology

At every one period t the individual decides whether to contribute or not to the pension arrangement in which she is enrolled to. Considering that participating in the pension systems also means participating in the health insurance scheme[12] and, for employees, to be entitled to all the benefits guaranteed by law[13], this decision is roughly the same as participating in the formal labour market[14]. Thus, in this paper we define an individual as formal when he contributes to the pension system.

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

$$f_{it}^{*} = \alpha+\beta * system_{it} + Z_{it}\Gamma + \rho_1 f_{it-1} + c_i + \mu_{it} \quad (3)$$

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

$$P(f_{it} = 1|system_{it}, f_{it-1}, Z_{it}) = \Phi(\alpha+\beta * system_{it} + Z_{it}\Gamma + \rho_1 f_{it-1} + c_i) \quad (4)$$

where $f_{it} = 1$ means that individual i is formal in period t, given that she is a member of $system_{it}$, formality in the previous period,f_{it-1}, individual-specific unobserved heterogeneity c_i and other covariates, Z_{it}. Conditional on c_i, the covariates in Z_{it} are assumed to be strictly exogenous, meaning that once Z_{it} and c_i are controlled for, Z_{is} has no partial effect on f_{it} for $s \neq t$. Equation 4 is a dynamic non-linear model with unobserved heterogeneity.

β is the main coefficient of interest as it captures the effect of the pension system on the individual's decision of formality at any one period t. The fact that the choice of system is irreversible and the difference across systems in the connection between contributions and pensions implicit in the eligibility rules and pension formulas, is what we exploit to identify the effect of the system on participation in the formal labour sector. As mentioned in section 2, the closer link between contributions and pensions of the PFA scheme should encourage formality. In other words, as $system_{it} = 1$ for individuals in PFA, we would expect $\beta > 0$.

As individuals already enrolled in the pension system at the time of the reform had the choice to either stay in the PAYG scheme or to opt-out to the PFA one, then $system_{it}$ in equation (4) is endogenous in the sense that it is correlated with the unobservable μ_{it}. We get round this problem by using a control function where the reduced form of $system_{it}$ depends on all the covariates included in equation (4) and the variable $forced_{it}$, which is the exclusion restriction we need for identification (Heckman and Vytlacil (2007), Imbens and Wooldridge (2007)). *Forced* introduces an exogenous change in *system* by exploiting the fact that the reform was undertaken by the repressive military government in power

[12] But not the other way around, thus an undivudual could get private health insurance without having to participate in the pension system.

[13] Such as paid annual leave, paid maternity leave, severance pay, etc.

[14] The relationship is not one-to-one as the pension system is not mandatory for self-employed workers, so they could be formal in the sence that they do pay taxes but informal according to our definition.

at the time, thus although in theory individuals could choose between the two pension schemes, in practice as much as 37% of our sample (see next section) declare to have been *forced* to opt-out to a PFA[15]. We give further support to our identification strategy in section 4 with the results of the reduced form.

There are two sources of persistence in equation 4, f_{it-1} and c_i. The random variable c_i, which we have assumed to be additive inside the normal cumulative distribution, represents the unobserved differences across individuals that may affect both the decision to which pension scheme belong and the decision to participate in the formal labour market –i.e. our outcome variable. An alternative interpretation for c_i is an individual-specific fixed costs of formal work, such as taste for flexible hours or the (dis)taste for illiquid and mandatory savings in the pension system. Further, the specification allows for state dependence through f_{it-1} so an individual's current propensity to participate in the formal market is *causally* affected by past participation (Heckman (1978), Heckman (1981), Hyslop (1999)). It could also be viewed as the the inertia in the formality decision, the cost of changing sectors or habits. While state dependence captures the "true" or "structural" persistence, c_i captures spurious serial correlation that allows different individuals to have permanent propensities to formality irrespective of their past decisions (Chay, Hoynes, and Hyslop (2006)).

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

To get consistent estimates of (β, ρ, Γ) we would need to integrate out the unobserved effect c which in turn would raise the initial conditions problem, i.e. how to treat the initial observation f_o. To overcome this problem we follow the approach developed by Wooldridge (2005) (based on Chamberlain (1980)) which gains identification through proposing a density for c_i given (f_{i0}, Z_i), where $Z_i = (Z_{i1}, ..., Z_{iT})$[16].

Let

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

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

$$
\begin{aligned}
c_i &= \gamma f_{io} + Z_i \Pi + a_i \\
a_i &\mid (f_{i0}, Z_i) \sim N(0, \sigma_a^2)
\end{aligned} \tag{5}
$$

The choice of normality of a is convenient given that we are already assuming normality of μ[17].

Plugging equation (5) into equation (4) we get:

$$
P(f_{it} = 1 | system_{it}, f_{it-1}, Z_{it}) = \Phi(\alpha + \beta * system_{it} + Z_{it}\Gamma + \rho_1 f_{it-1} + \gamma f_{i0} + Z_i \Pi + a_i) \tag{6}
$$

Equation (6) can be estimated using a random effects probit model where the vector of explanatory variables at time t is $(system_{it}, Z_{it}, f_{it-1}, f_{io}, Z_i)$. The insight from Wooldridge (2005) is that the inclusion of the initial condition and the entire vector Z_i in each time period allows for the unobserved heterogeneity to be correlated with the initial condition and the strictly exogenous variables.

Testing for state dependence (given c_i and Z_{it}), $H_0 : \rho_1 = 0$, is interesting in its own right as it would inform us on the inertia of decisions. A positive ρ_1 would imply that formality (informality) in the previous period causes a great likelihood of formality (informality) in the current decision. Further, the estimate of γ will shed light on the relationship between the unobserved heterogeneity and the initial condition. We expect this correlation to be positive as individuals with unobserved taste for formality would tend to start their working lives in the formal sector.

The approach we follow here has two main advantages. First, in spite of being fairly rich on its inputs (pension reform evaluation, state dependence, unobserved heterogeneity) it is simple to estimate. Second, average partial effects are easily computed after equation (6) has been estimated[18]. Specifically, consistent average partial effects can be estimated from changes or derivatives of:

[17] This parametric assumption on the distribution of the unobserved heterogeneity means we are subject to the usual miss-specification problem, that is inconsistency. Further, as our data is an unbalanced panel (see section 3.2) we are specifying the distribution of c_i conditional on different number of periods for Z_{it} for each i, which in turn implicitly makes an assumption on how $\{Z_{it}\}$ evolves.

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

$$N^{-1}\sum_{i=1}^{N}\Phi(\widehat{\alpha}_a+\widehat{\beta}_a * system_{it} + Z_{it}\widehat{\Gamma}_a + \widehat{\rho}_{1a}f_{it-1} + \widehat{\gamma}_a f_{i0} + Z_i\widehat{\Pi}) \qquad (7)$$

where the 'a' subscript denotes the original parameter divided by $(1+\widehat{\sigma}_a^2)^{1/2}$ and the '$\widehat{\ }$' subscript denotes the maximum likelihood estimates of equation 6.

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

3.2 Data

To look at the effect of the pension system incentives on participation we use the Social Protection Survey, EPS[19], which is a representative random sample of the Chilean population. The EPS is a longitudinal suevey with the first, second and third waves carried out in 2002, 2004 and 2006, respectively[20]. The EPS is also a retrospective-panel dataset in the sense that each interviewee was asked to self-report her contribution and employment history (and its features) from 1980 onwards[21].

We restrict our sample to individuals who were already enrolled in the pension system at the time of the reform, thus those who allegedly were able to choose between the two pension arrangements (although some of them were actually forced to the PFA system).

The covariates included in Z_{it} are sex, age and its square, dummies for education level (none, primary, secondary and college), being married, number of children and year dummies. When estimating equation (6) for the subsample of women we also include whether the partner contributes to the pension system as a right hand side variable (see section 4 for further details). The vector Z_t includes all the variables in Z_{it} for each year except the education dummies which are time invariant and the time dummies that would be redundant.

Table 1 contains the summary statistics of the sample we use. The data is a non-balanced panel with 81,611 individual-period observations, representing

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

[20] 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).

[21] For further details on the EPS visit www.proteccionsocial.cl

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

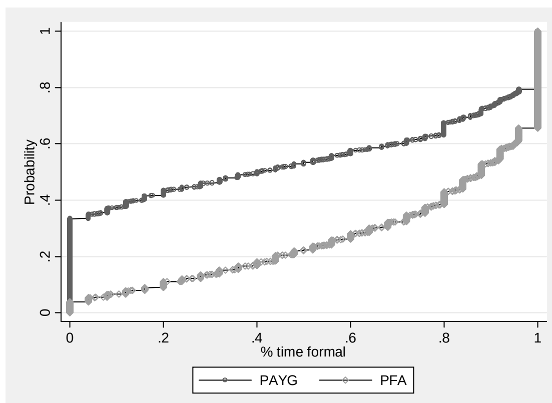
Table 1: Descriptive Statistics of the Sample

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

The highly no-linear pension formulae in the PAYG scheme may imply that is optimal to have some years of informality (for example if the individual has contributed for more than 30 years or for less than 16 years). Panel C in table 1 contains the statistics for the dependent variable. Individuals have been formal 63% of the time, on average, but there is a noteworthy difference between those in the PAYG and in the PFA scheme, with figures of 46% and 74%, respectively. Figure 1 plots the cumulative distribution of the average time each individual spends in the formal market. It can be seen that the cdf for those in the PFA system first-order stochastically dominates the cdf for those in the PAYG scheme, i.e. the former gives a higher probability of an average time in the formal market equal or better than under the PAYG, for any value of the average time in the formal market. Although a non-causal correlation, these two pieces of evidence-the higher mean and the stochastic dominance- suggest that pension systems' design does affect formality in the labour market.

The last row of Table 1 shows the proportion of individuals that start their working lives in the formal sector, i.e. those for whom the initial condition is formality ($f_{io} = 1$ in equation (6)). There is a significant difference in favor of those affiliated to a PFA, supporting the idea of a positive correlation between the unobserved heterogeneity and the initial condition.

Figure 2: Density of Individual-level Average Formality
By Pension System



4 Results

As aforementioned, to identify the effect of the pension system on labour market formality, β, we follow a control function approach where *system* depends on the vector of covariates included in equation 6 and *forced,* excluded from the main equation. The control function approach relies on the same assumptions as instrumental variables, thus in this case, *forced* must not be correlated with the idionsyncratic error μ and must be correlated with the endogenous regressor, *system*. Table 2 contains the reduced form estimates of *system*. The first columns displays the results for the whole sample and subsequent columns the results for subsamples. The magnitude and significance of the estimates for *forced* show a strong role of the variable in the determination of pension system, supporting the identification assumption that *forced* is indeed correlated with *system* (the other assumption is non- testable).

There may be concern about the possibility that some specific types of individuals were more likely to be forced to opt-out than others, thus invalidating the use of *forced* as an exclusion restriction. However, when regressing *forced* on a set of socio-demographic and job-related characteristics at the time of the pension system choice (economic sector, blue/collar white collar, employment category, belong to an union and region) we find that, except for a small effect of age and a marginally significant effect of sex, none of the estimated coefficients are significant, thus supporting the exogeneity of *forced* (see table A.2 in the Appendix).

Table 2: Reduced Form Estimates for *System*

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

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

The main results of the paper are displayed in Table 3. The third and fourth columns contain, respectively, the estimated coefficients and marginal effects for the random effects estimation of equation 6. Our main coefficient of interest, $\widehat{\beta}$, is positive, significant and economically important: Being in the PFA system increases the probability of being formal in 23 percentage points at any one year t. State dependence has an even higher effect on formality, $\widehat{\rho}_1 = 2.66$ (marginal effect of 0.80) meaning that there is high structural persistence in the formality decision. The initial condition is also high and significant but the marginal effect is only a fifth of the magnitude of the state dependence.

Table 3: Pooled and Random Effects Estimates

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

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

In order to have a benchmark, we estimate equation 6 for the same sample but pooling the data, i.e. not exploiting the panel-feature of the data. The results are displayed in columns one and two of Table 3 and show that the pooled estimated effect for pension system is lower, state dependence is higher and the initial condition is lower than for the random effects model. We report the proportion of the total variance contributed by the panel-level variance component, $\widehat{\theta} = 0.23$. Through a likelihood-ratio test we reject the null that $\widehat{\theta} = 0$, meaning that the panel-level variance is indeed important. In other words, this test formally compares the panel and the pooled model, giving evidence in favor of the former. Further, allowing for heterogeneity substantially improves the fit of the model as evidenced by the change in log-likelihood. In summary, the unobserved heterogeneity is indeed relevant in explaining individuals' formality decisions and not to take care of it would lead to inconsistent parameters and potentially to misleading conclusions.

Next, we check whether there is some observed heterogeneity we can account for by estimating equation 6 for different sub-samples. Table 4 present the random effects results for Women and Men. Surprisingly, the effect of *system* at any one period t is higher for women than for men. However, women labour supply was rather low in Chile in the 80's, thus only women with better job opportunities would participate in the labour market and this selected group would benefit relatively more from the pension reform than an average individual. The same reasoning applies for the higher effect of state dependence and of the initial condition of women: The selected group of women in the labour force would have a stronger habit to be formal and a higher taste for formality, respectively, than an average individual.

On the other hand, the effects of the family-composition variables bear no surprises: the *number of children* is a disincentive on formality for women (although only marginally significant) but not for men. Also, while *married* women are less likely to be formal than non married ones, marital status is not relevant for men. We have also included whether the partner is formal as an additional regressor for the women subsample. If the partner is in the formal labour market, then the woman would have health insurance as the husband's dependant which could be a deterrent to work in the formal sector because their own contributions for health insurance would be a pure tax (Galiani and Weinschelbaum (2007)). Indeed we do get that the estimated coefficient on *partner formal* is negative (though marginally significant)[22].

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

Table 4: Random Effects Estimates
By Sex

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

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

Table 5: Random Effects Estimates
By Age

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

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

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

It is worth mentioning that the initial conditions problem remains even when we focus on the young sub-sample. Although for this group we do observe the actual initial value (so there is no data censoring), to assume that f_{i0} is independent of c_i is indeed very strong so we still follow Wooldridge (2002) to estimate equation (6).

5 Simulations

Up to now we have estimated and analised the effect of the pension system on formality at any one year t. However, since our outcome variable is discrete and since we have found that state dependence is indeed important, then a change in pension system should have a discontinuous and lasting effect on formality throughout the life cycle. Moreover, because pension benefits at the end of the working life depend on the decisions made over the life-cycle, we need to look at how the one-period estimated effect translates over many periods. Thus, we apply the dynamic nature of our model in equation (6) to simulate the effect for some specific cases.

We start with a man of 25 years old in 1983, with primary education, married with two children, who was formal in period t-1 and who was formal in t=0 (initial condition). We draw 1,000 shocks from a normal bivariate distribution for $c_i + \mu_{it}$ for every period until the individual reaches 65 years old. With these shocks and the estimated coefficients for men, we simulate responses for each age (year) until the end of the individual's working life according to the latent model in equation (3). We do this for someone in the PFA scheme and for someone in the PAYG plan and get the difference in the probability of being formal by pension system. We then bootstrap this difference with 1,000 replications and get confidence intervals.

Figure 3 displays the results of this simulation. It shows that, at the beginning of the working life this individual has a 18 percentage points higher probability of being formal if he is enrolled in the PFA scheme, a difference that increases drastically over the first few years and then steadies at around 0.34. The pension reform boosted formality starting in its early years and, due to the state dependence, this effect persists until the end of the working life.

Next, we compare the results of the simulations for individuals who were at different stages of the life cycle at the time of the reform (25, 40 and 55 years old), keeping constant the other characteristics as in the first simulation.

The results for men are shown in the left panel of Figure 4. It is striking to see that regardless of the time horizon for retirement, all these individuals reacted sharply to the pension system incentives in the first few years after the reform. Nonetheless, after those first few years, the simulated 40 year old seems to respond less than the 25 year old, which is not surprising when considering that the younger individual had more time to benefit from the incentives in the PFA scheme. On the other hand, the simulated individual who was only 10 years before retirement (55 years old in 1983) had little time to benefit from the reformed pension system yet he still reacted as sharply as the younger cohort. This result could be explained by selection in the labor market in late stages of the life cycle: only those with better job prospects would remain in the labour market and they are the same ones that were previously discouraged by the non-linearities of the PAYG plan. Thus, the results for this simulated individual should be taken with caution as the reform acts on a selected (with better job-related traits) group.

The results for women and by cohort are displayed in the right panel of Figure 4. The simulated difference for the 40 and 55 year old women is much higher than the difference for the 25 year old, which can be explained by the same selection argument as for the simulated older man.

Figure 3: Simulated Difference in Probability of Being Formal

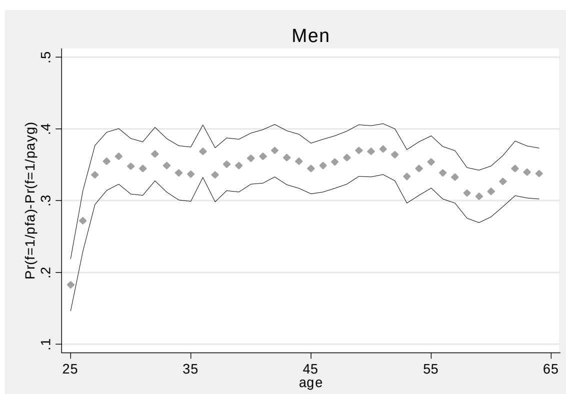
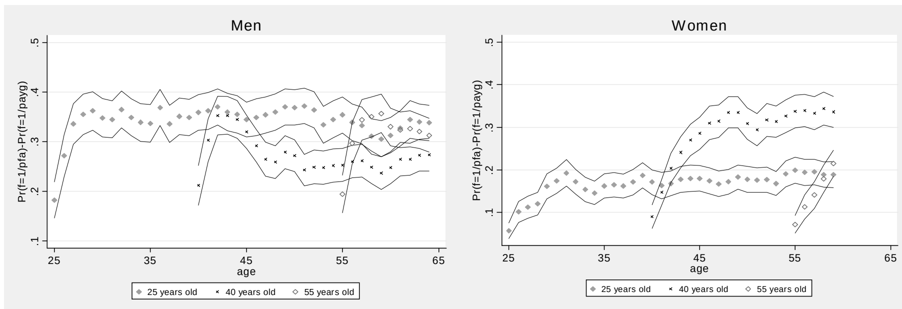
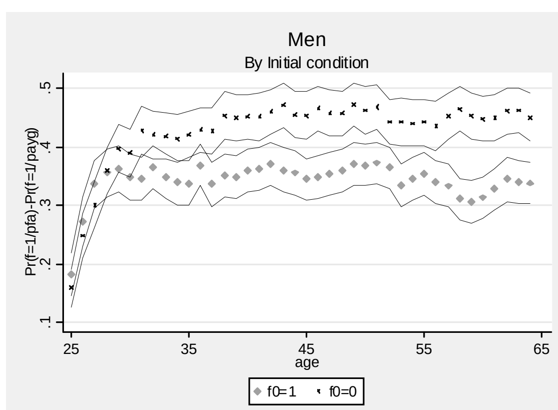


Figure 4: Simulated Difference in Probability of Being Formal
by Age in 1983



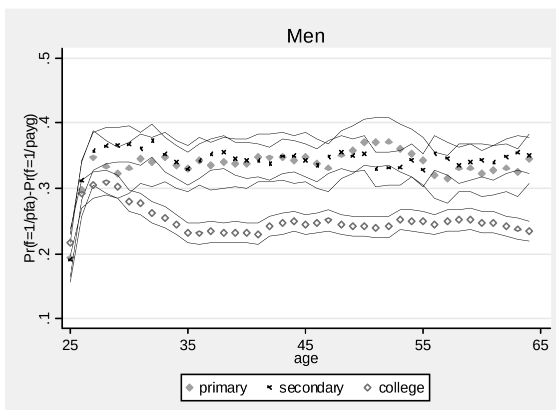
In Figure 5 we show the results of the simulation for two 25 year old men that differ in their initial condition, $f_{i0} = 1$ vis-à-vis $f_{i0} = 0$. Except for the first ten years after the reform, the difference in the probability of being formal is higher for those who started working in the informal labour market, indicating that the effect of the pension system design is exacerbated for those whose initial condition was informality. In other words, the reform somewhat reverted the correlation between unobserved heterogeneity and the informality initial condition by promoting formality among those who opted out to the new system. The difference in formality is smaller for those who started as formal as they would probably had been formal in subsequent periods anyhow.

Figure 5: Simulated Difference in Probability of Being Formal
by Initial Condition



Finally, to analyse the distributive effects of the pension reform, we simulate individuals with different levels of education. Figure 6 displays the results. On the one hand, individuals with primary and secondary education were equally affected by the reform, with an accumulated difference in the probability to be formal in favor of the PFA system of around 34 percentage points at the end of the working life. On the other hand, the difference in the probability or being formal is significantly lower for those with a degree. Thus, the reform had a relatively lower impact on formality of highly educated individuals as they would have been in the formal market anyhow. These results are in line with the ones found by initial condition: the PFA system encouraged formality exactly of those who would not had been formal under the PAYG pension plan and affected to a lesser extent those who already had preferences for formality, suggesting that the reform affected the marginal individual.

Figure 6: Simulated Difference in Probability of Being Formal
by Education



6 Conclusions

There is great debate in developing countries on how to promote formal work and it has been claimed that defined benefit pension systems would do so. This paper examines the extent to which the Chilean privately managed defined contributions system with individual accounts boosts participation in the formal market in comparison with a state managed pay as you go pension plan. While, the formulae in the PAYG system (min. 16 years, max. 30) suggest that a certain degree of informality may be optimal, the direct link between contributions and benefits in the PFA scheme is expected to encourage formality. We exploit the differences in contribution rates, eligibility rules and pension formulae between the two pension schemes.

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

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

When accounting for observed heterogeneity, we find that the impact of the pension system on formality is higher for women than for men and higher for the young than for the old. The latter result is not surprising when considering that young individuals at the time of the reform had a long time horizon ahead to profit from the compound interest rate and of always positive accrual rates in the PFA scheme. It is also interesting to see that the state dependence is less important for the young, which accords with young individuals having less inertia (or less sticky habits) on the formality decision.

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

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

These conclusions are made on the basis that individuals can choose sectors, thus policy makers should look at measures that deepen incomplete or missing capital and insurance markets and decrease myopia in order to increase formality. The reduction of myopia is particularly relevant, as in this paper we find that formality decisions are determined to a great extent by state dependence. In this respect, Chile undertook a new reform in 2008 that includes financial incentives to early contributions to the pension system and to gradually incorporate the self-employed in the mandatory pension system. If, on the other hand the main reason for informality is segmented labour markets, then policies should attempt to soften labour market rigidities (Packard (2007) and Prieto (2004)).

Appendix

Table A.1: Observed 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.

Table A.2. Probability of Being Forced

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

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

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