Optimal enrolment in a pension system and family old-age arrangements

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Abstract

The aim of this paper is to asses the role of old-age family arrangements and life-cycle considerations in the enrolment and contribution behaviour to the pension system. A rich Peruvian dataset on beliefs, preferences and attitudes to risk, allows us to find econometric evidence -with a multinomial logit model- suggesting that both dimensions are complementary to better understand the low enrolment and contribution rates. Furthermore, we stress the possible limitations of success of pension policies directed to increase the enrolment and contribution rates in the pension system.

JEL classification: H55, J14, G22, G23

Keywords: pensions, family arrangements, mortality, pension reform, Peru.

1. Introduction

Some developing countries have reformed their pension systems in order to provide social protection to the elderly. For instance, during the last 30 years a number of Latin American countries have converted their pension systems into individual account based systems characterized by strong private sector participation in the management of pension funds. One of the main limitations of this reform is that the share of the population effectively covered by the pension system has hardly increased (Rofman and Lucchetti, 2006). This means that a significant number of individuals will not have a pension to cover their expenses in old age. Nevertheless, in those countries family support from adult children allows to cope with the loss of income and health deterioration in old age[1]. The existence of these informal family arrangements may be one of the reasons behind the low levels of enrolment in the pension system.

However, it is still possible that, given the parameters of the pension system, the individual chooses optimally not to enrol based solely on her preferences for risk and inter-temporal consumption. Life-cycle considerations may contribute to understanding the individual's decision to enrol in a pension scheme. It can be assumed that the decision to enrol in a pension scheme amounts to the decision to acquire an annuity[2]. If the only source of uncertainty is the date of death, there are no bequest motives, markets are complete and annuities are actuarially fair, then the basic life-cycle model (Yaari, 1965) predicts full annuitization. Thus, the individual must purchase an annuity to smooth consumption over time and overcome unexpected length of lifespan. However, markets are far from complete in developing countries, and actuarially fair pensions are inexistent due to high administrative fees and mortality tables with underestimated mortality introduced with the pension reform (Palacios and Rofman, 2001). Thus, we may expect low levels of enrolment in the pension system regardless of the existence of family arrangements. Overall, it is difficult to establish a precise relationship between low enrolment and family arrangements.

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[1] There is a large amount of literature that stresses the importance of family and particularly child support to the parents in old age. For example, see Hoddinott (1992), Cox et al (1998), Jellal (2002), Cox and Fafchamps (2008) and Cameron and Cobb-Clark (2008).

[2] Indeed, in the new Latin American private pension systems the individual accrues her contributions and returns in an own account until retirement age; and at this age she has to purchase an annuity with all the accumulated resources.

If we assume that informal family arrangements and pension enrolment are substitutes, then, to what extent is it appropriate to create a pension system? Chetty and Looney (2006) show that the introduction of social insurance in developing countries may result in welfare gains if households are highly risk averse. In developing economies, consumption may fluctuate only slightly as households are able to smooth consumption during income shocks by using family arrangements; hence, the introduction of social insurance might be redundant. However, the authors point out that households firmly want to smooth consumption during shocks due to their high risk aversion, even at the expense of important welfare costs (e.g. children taken out of school). In such a case, social insurance in developing economies might limit the magnitude of welfare losses and also enhance health and education conditions (Morduch, 1995). In the same vein, Davidoff et al (2005) argue in favour of compulsory annuitization in the context of incomplete annuity markets, which is also applicable to developing countries. They indicate that low annuity demand might be caused by individual behavioural considerations, and therefore compulsory annuitization could increase welfare.

Accordingly, the role of family arrangements on the enrolment in pension systems must be analysed jointly with the characteristics of the pension reform and its effects on the optimal decision to enrol. For instance, Kotlikoff and Spivak (1981) make use of indirect utility functions to calculate the increment on the initial wealth needed to leave an individual who has not acquired an annuity as well off she would be with no additional wealth but with a purchased annuity. These authors find that the family can partially substitute a fair annuities market by pooling risks. Similarly, Brown (2001) analyses how the differences in preferences for risk, mortality, health and marital status of individuals affect the decision to annuitize. However, whilst Kotlikoff and Spivak (1981) use only calibration, Brown (2001) combines survey data information with parameters elicited from the data. The approach used by Brown (2001) is more thorough and specific for a given reality but it is quite demanding on information; particularly it requires perceptions of risk and subjective mortality by the individuals, apart from the common set of demographic variables. However, those studies do not explore the influence of informal family arrangements on the demand for annuities. Interestingly, the Social Risk Management Survey (PRIESO, a survey and large-scale field experiment conducted by the World Bank in Peru in 2002) includes information on risk and mortality perceptions and *proxies* on informal family arrangements. Thus, this data offers the opportunity to study the interplay between pension enrolment and old-age family support which is extended in Peru[3]. In addition, studying the case of Peru is interesting as this country is part of a wave of structural pension reforms undertaken in the 90's in Latin America. Our hypothesis is that apart from life-cycle considerations, old-age family support has a role to explain the low enrolment levels. The old-age arrangement competes with the formal social security and hence dampens the participation in the pension system.

In Peru there are two pension systems "competing" each other. When entering the labour market, the individual must choose between the private system (SPP) -based on individual capitalization accounts- and the public system (SNP), which is a DB system. Furthermore, only the employees who work in the formal sector are mandated to enrol in the pension system, and for the rest the enrolment is voluntary. At the time of the application of PRIESO, the share of labour force enrolled in the SPP and SNP was 27.2% and 8.3% respectively.

Given the institutional arrangement of the Peruvian pension system, we consider three possible outcomes about the decision of enrolment: enrolment in the SPP, enrolment in the SNP and no enrolment. In order to analyse the rationality of individuals, we can calculate the additional percentage of increase or decrease in income required to make the individual indifferent between enrolment and not enrolment. For instance, if the individual is not enrolled in any of the pension systems, we calculate the percentage of income required to leave this individual as well off she would be enrolled but without this income increase. Analogously, we also obtain the same measure when the individual is already enrolled. We call this measure the income equivalent variation (*IEV*). The *IEV* allows us to observe how the person values the option of enrolling with respect to the option of not-enrolling, and indirectly we can also know how she values relatively the SPP and SNP.

Once the *IEV* is computed for each individual in the PRIESO sample, we compare it with the actual status of the individual enrolment and analyse the consistency of the choice. It is expected that some choices will not seem optimal due to aspects that we are unable to control purely with the *IEV*. To overcome this, we run multinomial regressions with the dependent variable indicating the enrolment status of the individual (SPP, SNP or

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[3] Previous studies with Peruvian data show that individuals expecting receive pensions are less interested to enter into old-age support arrangements such as monetary and time transfers within the household (Cox et al, 1998). Similarly, Li and Olivera (2009) find evidence for a relation of substitution between informal family arrangements and enrolment in the Peruvian pension system.

not enrolled) and including the *IEV*, demographics and *proxies* of family old-age support as independent variables. In the calibration of the *IEV* we are able to use some parameters elicited from the data such as the risk aversion and the subjective mortality.

The novelty of this analysis is that it allows us to consider institutional aspects of the pension reform that may be changed in a discretionary way by the authority (e.g. mortality tables, contribution and interest rates, fees, etc.) and individual characteristics such as preferences for risk, expectations, subjective mortality and family old-age support. The rest of the paper is organized as follows. Section 2 presents the background of the Peruvian pension system. The theoretical framework and the calibration strategy are set out in section 3. Section 4 deals with the data and elicitation of parameters. Section 5 shows the empirical results. And finally, section 6 concludes.

2. Background: the Peruvian pension system

Since June 1993, the Peruvian pension system is formed by two competing systems, the National Pension System (SNP) and the Private Pension System (SPP). Different from other countries that completely or partially replaced their old public DB systems, Peru launched the SPP as a fully funded pension system based on individual capitalization without dismantling the SNP. Under the most popular classification for pension reforms in Latin America[4], the Peruvian reform is categorized as a parallel reform type since it allows the coexistence and "competition" between the SPP and SNP.

The SNP is a DB system type that offers a pension calculated under pension rules. Among these rules are a minimum period of 20 years of contribution, minimum and maximum values of the pension, and a replacement ratio that depends on the number of contributions and the birth cohort of the pensioner. As a DB pension system, the sustainability of the SNP relies heavily on the relation between contributors and pensioners. In contrast, the SPP is a self-financed system based on individual capitalization. Each insured has to choose one of the Pension Fund Administrators (AFP) and to open an own and non-transferable individual account where her contributions and the returns earned in the pension fund are accumulated through her labour life. Those

[4] According to Arenas de Mesa and Mesa Lago (2006), the types of pension reform are i) Substitutive, where the PAYG system is fully replaced by a fully funded system (Bolivia, Chile, Dominican Republic, El Salvador and Mexico), ii) Mixed, where the PAYG and the fully funded system are complementary, with both providing a share of the pension to the insured (Argentina, Costa Rica and Uruguay), and iii) Parallel (Colombia and Peru).

firms are in charge of investing the contributions and managing the pension funds. At the retirement age, the insured is mandated to buy an annuity from an insurance company with the total balance of her individual account or to acquire monthly programmed withdrawals managed by the AFP. Furthermore, the insured may also choose a combination of an annuity with some years of programmed withdrawals.

In both systems the retirement age is 65 for women and men, though early retirement is possible under certain requisites. Likewise, the contribution rate is a fixed percentage of the total monthly salary. Currently this rate is 13% and 10% for the SNP and SPP respectively, though the SPP's contribution rate was 8% at the time of the application of the survey PRIESO. The AFP charges an administrative fee and collects the insurance premium as a percentage of the insured's salary. The former concept is the payment for managing and investing the pension funds, collecting contributions and other administrative responsibilities, whilst the latter is given to an insurance firm that covers the risks of disability and death. The administrative fee and insurance premium were 2.28% and 1.27% on average, respectively.

The workers have to choose only one of these systems to contribute and receive a pension. Within the SPP, an insured can shift from one AFP to another. Furthermore, those workers who are enrolled in the SNP can shift to the SPP but the contrary is not possible. The intention behind this regulation is related to the financial deficit of the SNP and the interest of the pension reform designers to strengthen the SPP. In order to compensate the insured that shifts from the SNP to the SPP, the State entitles a Recognition Bond for the contributions that the insured made to the SNP. Some legal requirements have to be fulfilled to obtain this bond, which can be 1992 or 1996 type depending on the year used to account backwards for past contributions. The value of the bond is actualized by the price index up to the date of retirement, and only at this date the bond is paid and deposited in the individual pension account.

As a typical DB system, the SNP offers a minimum pension to all insured who fulfil some requisites. In contrast, the SPP offers a limited minimum pension guarantee that is only reachable for individuals born before 1945, with earnings at the level of the minimum legal income or higher and contributions for at least 20 years to any pension system[5]. In general, the SNP may be preferred by low income earners who might obtain at least a

[5] This regulation was valid between December 2001 and March 2007. At that moment, the birth date requisite was abolished, but the minimum guarantee was restricted to persons that shifted from the SNP to the SPP.

minimum pension, whilst the SPP may be favoured by medium and high income workers. Additionally, the timing of the reform also plays an important role. Those insured that were close to fulfil the requirements to retire and obtain a pension in the SNP (mainly the older ones) might have chosen keeping enrolled there because the SPP did not offer them a certain pension and/or a fair Recognition Bond. Therefore, the younger insured were more attracted to shift from the SNP to the SPP. In addition, a young individual might prefer to enrol in the SPP because she will capitalize her pension balance more and hence may obtain a larger benefit.

3. Theoretical framework and calibration

We use a life-cycle approach to model the decision to enrol or not in any pension system by adapting the models presented in Kotlikoff and Spivak (1981) and Brown (2001) to include the characteristics of the Peruvian pension system. We consider the decision of enrolling as one of annuitize. If the exact age of death is unknown for the individual, then she could be interested to enrol in one of the pension systems in order to obtain enough streams of income (in the form of a pension) from her retirement date until her death. We also assume that the date of death is the only source of uncertainty and that there are no bequests; therefore, the individual wishes to consume all her resources until her death. For simplicity, we assume that the individual earns a constant stream of income Y over her labour span until retirement. At age x, the individual must maximise her inter-temporal expected utility:

$$E(U) = \sum_{t=0}^{D-x} {}_{x}p_t U(C_t)\alpha^t \quad (1)$$

D is the maximum survival age. C_t is the consumption in time t, δ is the individual subjective rate of time preference, with $\alpha = 1/(1+\delta)$, and ${}_{x}p_t$ is the probability of survival from age x to age $x+t$. If the individual does not enrol in a pension system, the optimal consumption plan is obtained from the maximization of equation 1 subject to the next restriction:

$$\sum_{t=0}^{D-x} C_t Z^{-t} = \sum_{t=0}^{R-x-1} YZ^{-t} \quad (2)$$

R is the age of retirement and r is the discounting interest rate, with $Z = (1+r)$. The discounted consumption plan in the left-hand side of 2 must be financed with all discounted resources earned between ages x and R. If the individual intends to enrol in the SPP, she should maximise equation 1 subject to:

$$\sum_{t=0}^{D-x} {}_x p_t C_t Z^{-t} = \sum_{t=0}^{R-x-1} Y(1-a-c_{spp})Z^{-t} + \sum_{t=R-x}^{D-x} P_{spp} Z^{-t} \tag{3}$$

$$P_{spp} = \frac{CIC_R}{CRU_R} = \frac{\sum_{t=0}^{R-x-1} c_{spp} Y(1+\tilde{r})^t}{A_R} \quad \text{and} \quad A_R = \sum_{j=0}^{D-R} \frac{{}_R p_j}{(1+\hat{r})^j} \tag{3'}$$

Where a is the administrative fee (plus the insurance premium) paid to the pension fund manager, c_{spp} is the contribution rate applied to the salary and P_{spp} is the retirement pension. Equation 3 indicates that all resources received during labour life and retirement must finance the consumption plan C_t. Differently from the case of not-enrolling, this consumption plan incorporates the basic characteristic of an annuity: the probability of survival is included in order to smooth consumption through labour life and retirement. This means that, given the probabilities of survival, the individual is able to consume all her wealth through her life-span. The computation of the pension follows the formula indicated in equation 3′. During labour life the individual accumulates resources in her pension fund account which earns an interest rate of $\tilde{r}$. The individual must compulsorily acquire an annuity from an insurance company with the total pension fund balance put in front at the retirement age (CIC_R). A_R is the annuity price and $\hat{r}$ is the interest rate offered by the insurance firm to the individual. The larger this interest rate, the lower the annuity price, the larger the pension. The price of the annuity for an individual who has spouse must be calculated in such a way that it allows the widow receives a survival pension after the death of the pensioner. In the next formula, ψ is the percentage of the pension that the widow will receive, ${}_y q_i$ is the probability of survival from age y to age $y+i$ for the widow.

$$A_R = \sum_{j=0}^{D-R} \frac{{}_R p_j}{(1+\hat{r})^j} + \psi \sum_{i=0}^{D-y} \frac{{}_y q_i}{(1+\hat{r})^i} (1 - {}_R p_i) \tag{3''}$$

Instead of enrolling in the SPP, the individual may choose the SNP, so that she maximises equation 1 subject to the next restriction:

$$\sum_{t=0}^{D-x} {}_x p_t C_t Z^{-t} = \sum_{t=0}^{R-x-1} Y(1-c_{snp})Z^{-t} + \sum_{t=R-x}^{D-x} P_{snp} Z^{-t} \tag{4}$$

$$P_{snp} = Min\{Max(\beta Y; P_{\min}); P_{\max}\} \tag{4'}$$

The individual must contribute the unique share c_{snp} of her salary. The computation of the pension P_{snp} follows the typical benefit rules in a DB system: the insured receives at least a minimum pension (P_{min}) with a ceiling of P_{max}. Between the limits, the insured can reach a pension of value βY, with β being the replacement ratio. The value of β is calculated for every insured according to the regulation (see the appendix). In addition to the restrictions shown for enrolling into the SPP or SNP, we also have that $a, c_{spp}, c_{snp}, \beta \in (0,1)$ and $a + c_{spp} \in (0,1)$.

Once the optimal consumption plans are found for each choice, we obtain the indirect utilities as functions of income. $V_0(Y)$, $V_{spp}(Y)$, $V_{snp}(Y)$ are the indirect utilities for not-enrolling, enrolling in the SPP and in the SNP, respectively. We calculate the percentage of income required to leave an individual who is actually not enrolled as well off she would be enrolled but without this additional income. We call this measure the income equivalent variation (IEV). Thus, $IEV = \Delta Y / Y$ and its calculation is derived from:

$$V_0(Y(1+IEV_{spp})) = V_{spp}(Y) \tag{5}$$

$$V_0(Y(1+IEV_{snp})) = V_{snp}(Y) \tag{6}$$

For an individual that is already enrolled in the SPP, the procedure to calculate the IEV is similar. First, the individual finds the two optimal plans of consumption: i) she leaves the SPP at age x, so that she maximizes the equation 1 subject to equation 7; ii) she keeps enrolled to SPP, so that she maximizes equation 1 subject to equation 8. Second, the IEV are computed for each case with the equation 5 evaluated with the corresponding indirect utilities.

$$\sum_{t=0}^{D-x} C_t Z^{-t} = \sum_{t=0}^{R-x-1} YZ^{-t} + \sum_{t=R-x}^{D-x} P_{spp} Z^{-t} \tag{7}$$

$$P_{spp} = \frac{CIC_x (1+\tilde{r})^{R-x-1} + BR}{A_R} \tag{7'}$$

$$\sum_{t=0}^{D-x} {}_x p_t C_t Z^{-t} = \sum_{t=0}^{R-x-1} Y(1-a-c_{spp}) Z^{-t} + \sum_{t=R-x}^{D-x} P_{spp} Z^{-t} \tag{8}$$

$$P_{spp} = \frac{c_{spp} Y \sum_{t=0}^{R-x-1} (1+\tilde{r})^t + CIC_x (1+\tilde{r})^{R-x-1} + BR}{A_R} \tag{8′}$$

Equation 7′ indicates that the pension received by the individual at retirement age is composed by i) the resources and returns accumulated in her pension account (CIC_x) until she stops to contribute (i.e. age *x*), ii) the returns earned by these resources in the pension fund until the retirement age and iii) the value of the Recognition Bond (*BR*). Equation 8′ shows that the pension is formed by all resources and returns accumulated by the individual since her enrolment date until the retirement age plus the *BR*.

Analogously, a person enrolled in the SNP must find the consumption plans if she leaves or keep enrolled in the SNP. In the first case, this person maximizes equation 1 subject to 9; and in the second case, the consumption constraint is equation 10. We obtain the *IEV* by evaluating equation 6 with the corresponding indirect utilities.

$$\sum_{t=0}^{D-x} C_t Z^{-t} = \sum_{t=0}^{R-x-1} Y Z^{-t} + \sum_{t=R-x}^{D-x} P_{snp} Z^{-t} \tag{9}$$

$$\sum_{t=0}^{D-x} {}_x p_t C_t Z^{-t} = \sum_{t=0}^{R-x-1} Y(1-c_{snp}) Z^{-t} + \sum_{t=R-x}^{D-x} P_{snp} Z^{-t} \tag{10}$$

The only difference between equation 10 and 4 is the calculation of P_{snp} (see the appendix). Similar to Kotlikoff and Spivak (1981) and Brown (2001), we assume a CRRA utility function, which holds the standard assumption of inter-temporal separability[6]. And this is $U(C_t) = C_t^{1-\gamma} / 1-\gamma$, where γ is the parameter of relative risk aversion.

[6] Brown (2001) points out that this formulation rules out a number of alternatives such as habit formation, hyperbolic discounting, or the ability to separate out the effects of inter-temporal substitution and risk aversion. However, this is standard in the literature and it is less demanding on computing resources, particularly if we have to compute one or two IEV's for each individual in the sample for each simulation we run.

4. Data and elicitation of parameters

4.1 Data

The data used is the Social Risk Management Survey (PRIESO), which is a combined survey and large-scale economic field experiment conducted by the World Bank and applied in Peru in May 2002. It includes 1,002 individual respondents randomly drawn from the list of Lima-dwelling, working respondents from the *Encuesta Nacional de Hogares* (ENAHO) applied in the third quarter of 2001 (during August and September). However, when the interviewers could not contact the same individual who answered in ENAHO they replaced this person with another household member or with a member from other household. Unfortunately, the interviewers did not register the name and the gender of the replacement. Since the gender is an important variable that may affect individual decisions, we drop from the sample the observations that presumably are replacements[7]. This produces a new sample of 789 individuals, which resembles the original sample in terms of distributions and means of key variables such as age and enrolment status. Likewise, we only consider the respondents who are not-enrolled or enrolled in the SPP or SNP, and exclude few cases that answered to be enrolled in other pension system. The respondent's current age has to be at least 20 because the official mortality table starts at that age. Furthermore, we exclude the respondents who are over 65 years old because the legal retirement age is 65. We also drop the individuals without information on income. After all these selections the sample consists of 638 individuals, which is composed by 173 not-enrolled and 465 enrolled in any pension system (331 in the SPP and 134 in the SNP).

4.2 Parameterization

4.2.1 Risk aversion

The risk aversion parameter is estimated from the response of the individuals in an experiment of PRIESO[8]. Each respondent has to choose to invest in firm A, which offers a gamble composed by a low return of 8 Soles and a high return of 20 Soles (both with 50% of probability), or in firm B that offers a fixed return. The interviewer considers, first, a fixed amount of S/.8 for the firm B. If the respondent chooses the gamble, the interviewer

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[7] Since the age is asked in both surveys and there are not more than 10 months of difference between the dates of their application, we only keep the observations where the age given in PRIESO minus that of ENAHO is 0 or 1 at most.

[8] See Barr and Packard (2005) for more details on the experiment and the survey data of PRIESO.

must register the answer, increase the fixed amount by one extra Sol and ask again for the respondent's choice. This process continues until the respondent accepts the fixed amount proposed, which can be thought of as the certainty equivalent. We infer the value of the risk aversion parameter by using the assumed CRRA utility function and the property $U(ce) = \theta U(x_1) + (1-\theta)U(x_2)$, where *ce* is the certainty equivalent and θ=0.5. Table 1 shows the mean of the certainty equivalent calculated for enrolment status in the sample and the corresponding elicited risk aversion parameters.

TABLE 1: CERTAINTY EQUIVALENT AND RISK AVERSION PARAMETERS

	Certainty equivalent	Risk aversion parameter
Not enrolled	12.958	0.769
SPP	13.276	0.536
SNP	13.402	0.443
Total	13.221	0.576

The mean of the certainty equivalent in the sample is 13.221 and the risk aversion parameter is 0.576, but there are differences among groups. The no-enrolled have less tolerance to the risk, which seems counterintuitive as the persons more risk averse are the ones who find more advantages in an insurance scheme. However, the availability of old-age support and other aspects like actuarial fairness, pension fees and discount interest rates can make the option of enrolment less attractive.

4.2.2 Mortality

At the time of application of PRIESO, the official mortality tables were the RV-85 and B-85 (both include different tables for men and women). The RV-85 is used to calculate the survival probabilities of the entitled pensioner whilst the B-85 is used for the beneficiaries of the pensioner (widow, non-adult children and parents). A spouse is the only possible pension beneficiary that we consider in the computation of the annuity price, and ψ = 0.42 which is the default percentage for a widow or widower. In the sample, within the group of heads of household younger than 65, the age difference between a male head and his spouse is 3.07. Thus, the computation of the annuity price will assume that a male entitled pensioner is 3 years older than his wife, and a female entitled pensioner is 3 years younger than her husband.

The insurance companies have to use the official mortality tables to calculate the annuity price, because they cannot foresee the exact mortality profile for each individual.

However, the optimal consumption path and enrolment choice may rely more on an individual perception about the own mortality profile. If this is the case, we should use individual subjective probabilities of surviving for all equations except for those used to calculate the annuity price. In PRIESO, individuals answer the question "until what age do you think you will live?" which may be used to measure life expectancy. Applying standard actuarial formulas and using a widely used Gompertz type mortality function (similar to the one used by Brown (2002) to estimate mortality tables), we are able to estimate a new set of mortality tables based on the subjective answers. See the appendix for the details of this estimation. With this information, we are able to build mortality tables for the three groups: those enrolled in the SPP, the SNP and those who are not enrolled[9].

FIGURE 1: PROFILE OF OFFICIAL AND SUBJECTIVE SURVIVAL PROBABILITY BY ENROLMENT STATUS

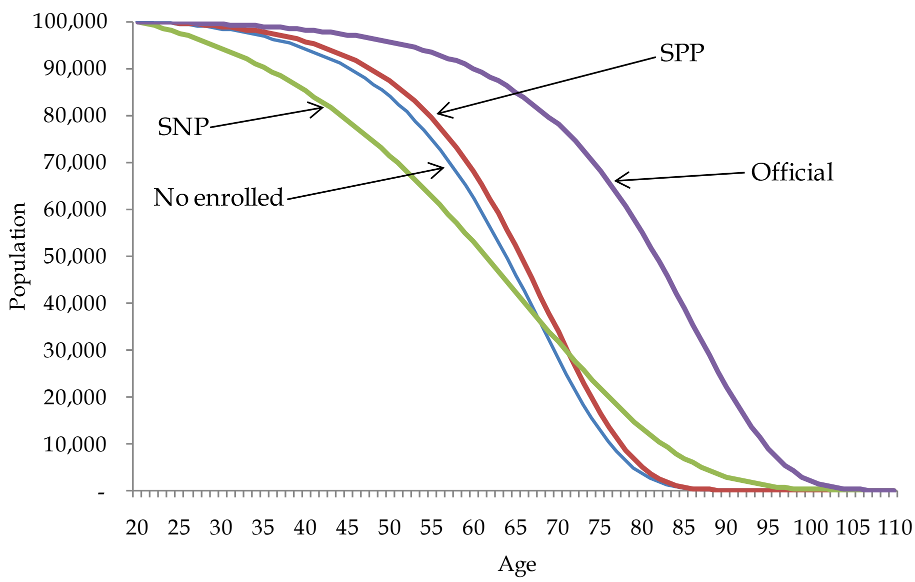


Figure 1 show the discrepancies between the subjective and official mortality probabilities. By using the subjective and official mortality tables, one can see how a hypothetical population of 100,000 individuals at the initial age of 20 decreases as they become older and more exposed to the mortality risk. Clearly, the individuals of all groups

[9] Due to data limitations, it is not possible to build mortality tables by sex within each group of enrolment status. The official survival curve depicted in the figure comes from averaging the official survival of women and men.

believe that their mortality is higher than it is assumed in the official tables[10]. The table 2 reports some survival probabilities calculated by enrolment status and at different ages. For instance, according to the official mortality table, a 25 years old person has a probability of 0.852 to survive until age 65, but the individuals believe that this number is much lower: 0.462, 0.525 and 0.435 for those who are not enrolled, enrolled in the SPP or the SNP, respectively. Furthermore, the individuals of the SPP believe that their survival probability is higher than that of the other groups, which can be explained by the fact that the affiliates to the SPP are the workers with better incomes and jobs.

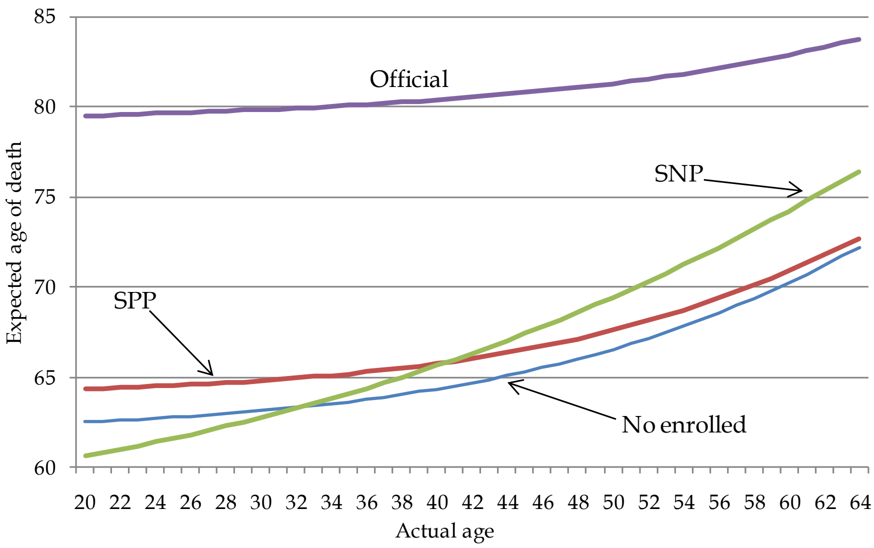
TABLE 2: SURVIVAL PROBABILITY

	Official	Subjective		
		No enrolled	Enrolled in SPP	Enrolled in SNP
for a 25 years old person:				
up to 45	0.974	0.906	0.928	0.809
up to 65	0.852	0.462	0.525	0.435
up to 85	0.389	0.005	0.007	0.070
for a 45 years old person:				
up to 45	1.000	1.000	1.000	1.000
up to 65	0.875	0.510	0.565	0.537
up to 85	0.399	0.005	0.007	0.086

The differences between the expected life expectancy computed with the official and subjective mortality tables are striking. Figure 2 shows that a 20 years old individual expects to live up to the age of 63.5, 64.3 and 60.6 years if this person is not enrolled, enrolled in the SPP or the SNP, respectively. In contrast, the official mortality considers that this individual should live up to the age of 79.5 years. In general, the workers of the SNP exhibit a lower survival profile than the other groups; but at more advanced ages (from 41 years old) they believe that they will live longer than the other groups. With these results, it is expected that the individuals who are actually not enrolled find less advantages to participate in any pension system as the age of retirement is only at 65 years, and the annuities are computed with a much lower mortality than the one that is subjectively perceived.

[10] This is not surprising. Palacios and Rofman (2001) find a significant difference between the implicit mortality of the tables used in the pension systems and that of the tables used by the national institutes of statistics in Argentina, Chile, Colombia and Peru. Peru shows the largest discrepancy.

FIGURE 2: EXPECTED AGE OF DEATH IMPLIED BY OFFICIAL AND SUBJECTIVE MORTALITY TABLES



4.2.3 Interest rates

Since the optimization programs implicitly presuppose no growth on prices, a pension fund interest rate free of price changes is assumed. This is 5%, which is below the average of the yearly real pension fund calculated in each month between the beginning of the SPP and the application of PRIESO (6.1%). The discounting interest rate and the time preference rate are also equal to the pension fund interest rate, i.e. 5%. Information on annuity interest rates in the Peruvian insurance market is hardly available. We set it as 4.6%, which is the default rate specified in the regulation to evaluate the entitlement of some benefits (e.g. early retirement and minimum pension in the SPP).

4.2.4 Parameters of the pension systems

The contribution rates in the SPP and SNP were 8% and 13% of the salary respectively. Additionally, the individuals enrolled in the SPP have to pay an administrative fee and insurance premium, which both were 3.55% on average during May 2002. The maximum and minimum monthly pensions offered in the SNP were S/. 484 and S/. 1,000. In order to calculate the benefits in both pension systems, we need to make an assumption on the number of contributions actually paid to the pension system. We use the same value as in Olivera (2010) who set this equal to 0.51, which is the average contribution density in the

SPP[11]. Therefore, this is the contribution density assumed in the computations of the benefits in the SPP. This assumption is also used in computation of the SNP benefits as there is no information available on contribution density in the SNP[12]. An individual contributing roughly half of her working life is not far from more accurate figures of other similar pension systems, such as Chile (Arenas de Mesa et al, 2008). Furthermore, we use the legal retirement age of 65 as the unique age to retire in our calculations. Although early retirement is possible under certain restrictive conditions in both systems, we rule out this possibility in order to simplify our computations and to keep focus on the characteristics that affect the enrolment decision. Finally, the value of the pension fund balance and the BR at the time of the application of PRIESO must be imputed for each individual (see the appendix for the details).

5. Empirical results

5.1 Calibration results of *IEV*

The *IEV* is computed for each individual in the sample considering their own characteristics and using the corresponding group-specific beliefs of risk and mortality. If the individual is enrolled in one of the pension systems, the *IEV* is directly computed from the comparison between the indirect utility of being enrolled and leaving off the pension system. If the individual is not enrolled in any system, there will be two *IEV*; each of them computed with the option of enrolling in the SPP or the SNP.

According to the assumed life-cycle approach, the individual will find it optimal to acquire an annuity (i.e. enrol in the pension system) in a fair annuity market. But the annuities are not fair in the pension system as there are fees charged in the SPP and pension rules in the SNP. Another source of unfairness is the discrepancy between the mortality used by the insurance firms to calculate the annuity price and the subjective mortality considered by the individual in the optimization process. All these factors might erode the attractiveness of the enrolment and make it optimal not to enrol.

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[11] The contribution density is the quantity of workers who effectively contributed over the total of enrolled workers in the same month, excluding those who never contributed.

[12] The way the contribution density in the SPP enters into the equations is by multiplying it with the contribution rate c_{spp} where this appears. The contribution density in the SNP enters into the pension rules specified in the appendix.

TABLE 3: *IEV* MEANS

Status	*IEV* (1)	*IEV* (2)	*IEV* (3)
Non-enrolled			
Option: SPP	0.055	0.140	0.168
Option: SNP	0.077	0.161	0.161
Average	0.066	0.150	0.164
Enrolled in SPP	0.083	0.155	0.230
Enrolled in SNP	0.531	0.726	0.726
Total*	0.172	0.274	0.316

(1) It uses only the official mortality; (2) the survival probabilities are computed with the subjective mortality; (3) the survival probabilities and annuity prices are computed with the subjective mortality.
*It uses the average *IEV* of the non-enrolled.

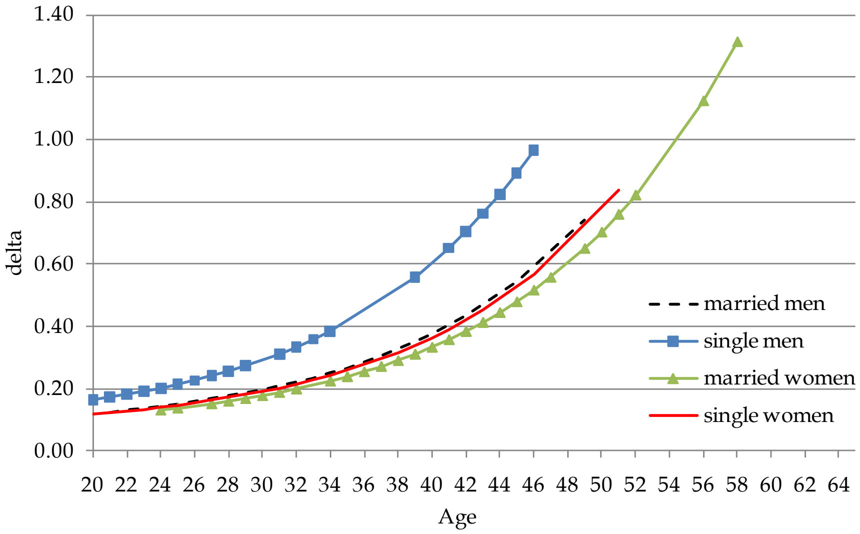
The table 3 shows the means of alternatives measures of the *IEV*. In the first column, the survival probabilities and the annuity price -needed for the computation of the *IEV*- are both calculated with the official mortality tables. Overall, the individuals have an *IEV* average of 0.172, meaning that they will be indifferent between one Nuevo Sol of annuitized wealth (participating in any pension system) and 1.172 of non-annuitized wealth. In the second column, the survival probabilities are calculated with the subjective mortality and the annuity price is calculated with the official mortality table. In the third column, the subjective mortality and the annuity price are both calculated with the subjective mortality. Without subjective mortality, we would only be able to use *IEV*1 which is equivalent to assuming that the mortality of the individuals follows the mortality of the official tables (like in Brown, 2001). However, by exploiting the information on subjective mortality computed from PRIESO, we can calculate *IEV*2 which is a more accurate measure for the *IEV*. The difference between *IEV*2 and *IEV*1 shows that the underestimation of *IEV* might have been significant if we would not be able to use subjective mortality. If the insurance companies would use the subjective mortality to calculate the annuity prices, the annuities would be perceived as actuarially fair. The reason is that the companies could offer annuities that perfectly match the expected survival probability of the individual. The comparison between *IEV*3 with *IEV*2[13] illustrate some how the size of the actuarial unfairness. The *IEV*2 is the preferred measure because this is the best approximation of the perceived value of the pension system for the individuals, and it is this perception that will determine their decision. Thus, *IEV*2 is the value for the *IEV* that will be used henceforth.

[13] That comparison is not relevant for those individuals enrolled in the SNP since there are no annuity prices in that system.

According to the construction of the IEV, a negative (positive) value implies that the choice of not-enrolment (enrolment) is the optimal. However, no individuals in the sample have a negative IEV, which reveals that the option of enrolment should be optimal for everyone. Within the 173 individuals of the sample who are not-enrolled, 124 have an IEV evaluated with the option of enrolling in the SPP higher than the one that they will have if they were enrolled to the SNP. It means that all the individuals who are non-enrolled should be affiliated to any pension system; 124 in the SPP and 49 in the SNP. Therefore, there must be some aspects apart from life-cycle considerations affecting the decision to participate in social security. Our hypothesis is that family old-age support is part of the explanation of the resistance of individuals to insurance in social security.

It is worth to mention that one limitation of the simulation of the IEV is that it is not possible to elicit the individual subjective rate of time preference from the data, so that we use $\delta = 0.05$ for each individual. If this rate is higher, the individual values the future less, so that the option of enrolment may become less attractive in comparison to the option of not enrolment. The assumption of a unique value of δ could be one of the reasons why all the non-enrolled workers should be, in fact, enrolled according to the optimization program. In order to asses this limitation, we can compute the δ needed to make each individual -who is actually non-enrolled- indifferent with respect to the option of enrolment. The average of δ to make a non-enrolled worker indifferent between no-enrolment and enrolment in the SPP is 0.316. This figure is 0.138 when the worker considers the option of the SNP. Figure 3 shows the heterogeneity of the δ needed to make an individual indifferent between the enrolment in the SPP and remaining non-enrolled.

FIGURE 3: RATE δ NEEDED FOR INDIFFERENCE BETWEEN ENROLMENT IN THE SPP AND NO ENROLMENT (SAMPLE OF NON ENROLLED INDIVIDUALS)



Given that there are no ways in the data to calculate the individual subjective rate of time preference, we keep our assumption of a unique rate for all the individuals at the standard level of $\delta = 0.05$. Further regressions will help to better understand the enrolment decision.

Furthermore, it is observed that there are important differences among the non-enrolled that should optimally choose the SPP or the SNP. In table 4, we observe that those who prefer the SNP are mainly men, younger, unmarried and earn lower incomes. The differences of the means of age, sex and marital status between the two groups are significantly different from zero (at the 0.01 level). The income of the group who should enrol in the SPP is significantly larger than that of the SNP at the 0.158 level of significance. Due to the minimum periods of contributions needed to obtain a pension in the SNP, the younger persons are the ones who may find it optimal to enrol in that scheme. And these individuals are also more likely to still be unmarried. Individuals with lower incomes may prefer a system like the SNP since it offers a minimum pension, whilst the earners of higher incomes may prefer the individual capitalization system.

TABLE 4: VARIABLES' MEANS FOR INDIVIDUALS WHO ARE NOT ENROLLED

	Age	Male	Married	Income
Should chose SPP	36.766	0.395	0.597	627.44
Should chose SNP	22.633	0.612	0.143	471.12
Total	32.763	0.457	0.468	583.17

5.2 Participation in any pension system

We model the enrolment choice with a multinomial logit regression (MNL) where the choices are 1) no enrolment, 2) enrolment in the SPP and 3) enrolment in the SNP. The individual attaches a utility level (u_{i1}, u_{i2} and u_{i3}) to each of these options according to her personal characteristics, preferences and family old-age support, which are contained in the variable IEV_i and in a 1xK vector X_i[14]. Hence,

$$u_{ij} = IEV_i\theta_j + X_i\beta_j + \varepsilon_{ij} \quad , \quad j = 1,2,3 \tag{11}$$

[14] In the case of non-enrolled persons, the individuals have two IEV corresponding to each pension plan. In our MNL model we must consider only one individual variable common to all the options. In the regression, we consider the average between the two computed IEV for those individuals. Considering only one of the IEV measures in the MNL regressions would take in account the characteristics of only one of the pension plans.

The subscript i indicates the individual and the subscript j denotes the choice. β_j is a $Kx1$ vector. It is assumed that the error term ε_{ij} is extreme value distributed so that the differences in this term follow a logistic distribution. The level of u_{ij} is never observed but we can only observe the choice made by the individual and infer how she ranks these options. For example if no enrolment is chosen, then u_{i1} should be greater than u_{i2} and u_{i3}. Given that the partial effects of the multinomial are complicated and even the direction of the effect is not entirely determined by β_{jk}, we will look at the odds ratios. The base outcome is no enrolment, so that we can assess the odds of being enrolled in the SPP versus not being enrolled, and the odds or being enrolled in the SNP versus not being enrolled. Furthermore, the standard errors considered in the regression are robust. The descriptive statistics of the sample divided by enrolment status are in table 5.

TABLE 5: DESCRIPTIVE STATISTICS

Variable	No enrolled		Enrolled in SPP		Enrolled in SNP		Total	
	mean	std. dev.	mean	std. dev.	mean	std. dev.	mean	std. dev.
IEV	0.150	0.130	0.155	0.183	0.726	1.062	0.274	0.558
Educ: primary (reference)	0.139	0.347	0.039	0.195	0.157	0.365	0.091	0.288
Educ: secondary	0.561	0.498	0.353	0.479	0.478	0.501	0.436	0.496
Educ: vocational	0.139	0.347	0.230	0.421	0.157	0.365	0.190	0.392
Educ: university	0.127	0.334	0.369	0.483	0.201	0.403	0.268	0.443
Transfers	0.098	0.299	0.042	0.202	0.045	0.208	0.058	0.234
Expected sons	1.254	0.949	1.278	0.850	1.336	1.090	1.284	0.931
Expected daughters	1.249	0.857	1.172	0.903	0.985	0.884	1.154	0.890
Expect to live in child's home	0.324	0.469	0.224	0.417	0.254	0.437	0.257	0.437
Expect to be cared by child	0.769	0.423	0.758	0.429	0.739	0.441	0.757	0.429
Household size	5.480	2.425	5.184	2.149	5.000	2.471	5.226	2.299
Assets (10,000s)	2.713	9.891	4.169	11.468	3.080	6.362	3.545	10.170
Savings (10,000s)	0.020	0.089	0.123	0.471	0.051	0.236	0.080	0.363
Liquidity preference	0.289	0.455	0.121	0.326	0.246	0.432	0.193	0.395
Old age share	0.174	0.142	0.145	0.119	0.119	0.110	0.148	0.125
Serious illness: not a chance (ref.)	0.318	0.467	0.329	0.471	0.201	0.403	0.299	0.458
Serious illness: less likely	0.480	0.501	0.453	0.499	0.500	0.502	0.470	0.500
Serious illness: likely	0.185	0.389	0.202	0.402	0.261	0.441	0.210	0.408
Serious illness: very likely	0.017	0.131	0.015	0.122	0.030	0.171	0.019	0.136
Observations	173		331		134		638	

There are important differences among the groups. The most educated are the individuals enrolled in the SPP, and the least educated are the no enrolled. The descriptive statistics include a set of *proxies* related to the existence of old-age family support. The dummy variable *transfers* measures if the individual received transfers or remittances from other homes or persons during the last 6 months. *Expected sons* and *expected daughters* indicate the total number of sons and daughters that the individual expects to have. We take advantage from two questions in PRIESO related to future plans of the respondent about her expected living arrangements and care during old age. The dummy *expect to live* *in child's home* indicates if the individual expects to live in one of her children's home when she gets older; and *expect to be cared by child* refer to the expectation to be taken care of by any of the children when the individual will be no longer able to care by herself. The *household size* is the number of members in the individual's household. The variable *assets* measures the total amount of assets (home, property, vehicles, equities, livestock, etc.) held by the individual at her own valuation in Nuevos Soles. Similarly, *savings* indicates the total amount of savings held by the individual (current and savings accounts, fixed term deposits, mutual funds and savings life insurance). There are important differences in assets and savings by status of enrolment. The affiliates of the SPP hold in average more assets and savings than the affiliated to SNP and the non-affiliates. *Owning a house* denotes the property of a house. *Liquidity preference* is a dummy variable which indicates that the individual would prefer to spend her savings –instead of investing in other means- if she were freed from the mandate of contributing to a pension plan. Interestingly, the not enrolled individuals show a higher preference for liquidity which is consistent with their non-participation in any pension plan. *Old age share* is the ratio of the retirement period over the lifespan, which is built with the expected age of retirement and death of the individual. The last four variables of table 5 refer to the subjective probability that the individual will have a serious illness within the next year. This variable is a *proxy* for health heterogeneity that might affect the decision to annuitize (Brown, 2001).

The results of the MNL regression are in table 6. If the coefficients are greater than 1, then a rise of the corresponding explanatory variable increases the predicted probability of the outcome relative to the option of no enrolment. The coefficients less than one indicate the opposite.

TABLE 6: MULTINOMIAL LOGIT MODEL OF ENROLMENT (ODDS RATIOS)

Variable	Enrolment in SPP		Enrolment in SNP	
	Odds ratio	Std error	Odds ratio	Std error
IEV	1.984	2.968	295.827 ***	534.336
Educ: secondary	2.159 **	0.815	1.796	0.873
Educ: vocational	5.871 ***	2.570	2.895 *	1.584
Educ: university	8.532 ***	3.751	3.363 **	1.877
Transfers	0.402 **	0.178	0.294 *	0.197
Expected sons	1.123	0.142	1.045	0.175
Expected daughters	0.999	0.135	0.665 **	0.132
Expect to live in child's home	0.847	0.210	0.758	0.263
Expect to be cared by child	1.350	0.367	1.022	0.348
Household size	0.953	0.047	0.961	0.066
Assets	0.993	0.012	0.959 *	0.024
Savings	2.893 **	1.522	2.195	1.343
Liquidity preference	0.417 ***	0.109	0.790	0.250
Old age share	0.283	0.250	0.089 **	0.106
Serious illness: less likely	1.044	0.266	0.993	0.331
Serious illness: likely	1.416	0.447	1.205	0.498
Serious illness: very likely	1.445	1.252	1.230	1.976
Observations	590			
Pseudo R2	0.205			
Log Likelihood	-478.618			

Base outcome is no enrolment. *** Significant at 1%, ** at 5%, * at 10%.

Some tests are performed to asses the appropriateness of the model specification. F-tests allow us to reject the hypothesis that all the odds ratios are jointly one. Moreover, the odds ratios of the two outcome equations are jointly different from each other, which brings support to the hypothesis that there are significant differences between the factors affecting the enrolment in the SPP and SNP. A common problematic feature of the MNL is the assumption of Independence of Irrelevant Alternatives (IIA), but the implementation of generalized Hausman tests does not allow us to reject the null hypothesis that IIA holds. The Hausman tests were performed comparing the results of the MNL with i) those of a logit of enrolment in SPP versus no enrolment and with ii) those of a logit of enrolment in SNP versus no enrolment. In the first case the *p-value* was 0.99 and in the second case it was 0.76, so that we fail to reject the IIA. In addition, the same results arise from changing the base outcome.

The coefficient of IEV indicates that the odds of no enrolled individuals to become enrolled in any pension plan increases with the value of IEV, although this effect is significant only for the affiliation in the SNP. This means that factors affecting positively the IEV value, such as higher pension fund returns, lower commissions or more generous pension rules, may raise the probability of enrolment. The education affects positively the odds of opting for any pension plan, but the effects are larger on the odds of enrolment in the SPP.

From the set of *proxies* of old-age family support, only *transfers* is significant for both the SPP (*p-value* = 0.039) and SNP (*p-value* = 0.067). The individuals receiving transfers might be engaged in a sort of family arrangement so that they are less interested in pension enrolment. The expected number of daughters affects negatively the odds of enrolment in any pension plan but only significantly in the enrolment in the SNP. In general, a high number of expected children may be associated to an old-age insurance motive, so that the results suggest the existence of a substitution relation between social security and old-age family arrangements[15]. The assets and savings are included in the regression in order to assess their possible role of substitution with the pension enrolment. Their effects are similar for both pension systems. The assets reduce the odds of enrolment, and the savings increase it; although the savings are only significant in the equation of the SPP while the assets are significant only in the equation of the SNP. This could be viewed as individuals considering assets as substitutes of pensions, and savings as complements. The negative effect of assets on the enrolment is comparable to the negative effect of wealth in the annuitization decision found by Brown (2001). He points out that given an annuity is mainly intended to cover the risk of outliving one's resources, a wealthier individual finds that risk less important, so that she will be less prone to acquire an annuity –or enrol in any pension plan as in our case. Furthermore, individuals with more assets can perceive themselves as more savvy investors, so that they can believe that they are able to obtain better returns in old-age by investing in other assets different from pension plans. And finally, intended bequests may play a role in the decision of opting for a pension plan.

Liquidity preference affects negatively the odds of enrolment and it is highly significant in the equation of enrolment in the SPP. An individual that is willing to expend her pension savings instead of looking for another way to save is clearly less prone to affiliate in any pension plan. That variable may denote liquidity constraints or may be thought as a *proxy* of the subjective rate of time preference. In any case, its negative influence on the odds of enrolment is intuitive. *Old age share* affects negatively the enrolment in any pension plan but it is significant only for the SNP equation. The individual will be less interested in opting for a pension plan if she believes that the length of her old-age with

[15] Although some endogeneity could be present in the variable for transfers, we rule out this possibility based on the econometric findings of Li and Olivera (2009) who assess the probability of enrolment in the SPP and the effect of old-age family arrangements. Furthermore, see chapter 5 of this thesis for a discussion on the relation between fertility and old-age family arrangements.

respect to her life-span is larger. This result seems contradictory to the prediction of full annuitization by a lifecycle model as discussed before. However, recall that other covariates are at work: liquidity preference and other means to save for old-age (family arrangements and assets). Furthermore, the fact that the non enrolled individuals perceive themselves as having a larger old-age span and still decide not to enrol, brings support to the idea that there are other strong substitutes for pension participation.

Although not conclusive, the results allow us to accept that old-age support plays a role in the decision to enrol and that this explanation can be complementary with a life-cycle approach. A likelihood ratio test conducted between the model with the full list of covariates and the same model but without the variable *IEV* may be illustrative about the importance of keeping the life-cycle characteristics to explain the decision of enrolment. The null hypothesis that *IEV* is zero is decisively rejected with a LR(2)=122.04. Thus, it is also important to include life-cycle considerations in our attempt to explain enrolment decisions.

5.3 Contributing to the pension plan

Although our primary interest is in the explanation of the enrolment in the pension system, it is also important to analyse the contribution behaviour once the individual decided to enrol. Indeed, the quantity of contributions will determine to a great extent the amount of future benefits; particularly in the SPP[16]. Table 7 show the results of two separate logit regressions for the SPP and SNP where the dependent variable is one if the affiliate is contributing at the time of the application of PRIESO, and zero otherwise. The coefficient of *IEV* is only significant and positive in the SPP equation, so that variables like the pension fund returns and annuity interest rates will impact positively on the contribution to the SPP. On the other hand, the administrative fees and the actuarial unfairness due to the official mortality table will impact negatively on the contribution. Contrary to the equations of the enrolment decision, there are no clear effects of education on the contribution. The expectation to live in one of the children's home is significant for the enrolled in the SNP, while the household size is significant for the ones enrolled in the SPP. These variables affect negatively the probability of contribution, which brings support to the idea of substitution between family old-age insurance and pension. Intuitively, the *liquidity preference* affects negatively and significantly both the contribution

[16] A individual who does not contribute still belongs to the pension system. The more an individual contributes, the larger is her pension.

in SPP and SNP. Interestingly, the *old age share* impacts positively and significantly on the contribution (*p-value* = 0.046 and *p-value* = 0.054 in the SPP and SNP, respectively), which differs from the negative effect found in the enrolment decision. Once the individual is enrolled, she will contribute longer if she believes that her old-age span is relatively longer. Indeed, the coefficient of *old age share* is the most important in the equation of contribution to the SNP; an increase of 1% produces an increase of 1% in the probability of contributing to the SNP.

TABLE 7: LOGIT MODELS OF CONTRIBUTION IN THE PENSION SYSTEM (MARGINAL EFFECTS)

Variable	Contributing in SPP		Contributing in SNP	
	dF/dx	Std error	dF/dx	Std error
IEV	0.414 **	0.210	-0.043	0.045
Educ: secondary	0.007	0.080	-0.363 ***	0.128
Educ: vocational	0.063	0.060	-0.236	0.185
Educ: university	0.002	0.085	0.002	0.196
Transfers	-0.167	0.156	-0.166	0.282
Expected sons	-0.005	0.021	-0.044	0.051
Expected daughters	-0.008	0.017	0.027	0.069
Expect to live in child's home	0.011	0.037	-0.283 **	0.121
Expect to be cared by child	0.017	0.042	-0.060	0.117
Household size	-0.011 *	0.006	0.015	0.024
Assets	0.000	0.002	-0.001	0.007
Savings	0.007	0.032	0.044	0.249
Liquidity preference	-0.328 ***	0.089	-0.240 **	0.122
Old age share	0.278 **	0.139	1.003 *	0.520
Serious illness: less likely	-0.005	0.033	0.142	0.141
Serious illness: likely	0.032	0.042	0.012	0.149
Serious illness: very likely	-0.326	0.201	0.170	0.205
Observations	308		125	
Pseudo R2	0.184		0.165	
Log Likelihood	-98.577		-71.403	

Dependent variable is 1 if the individual contributes to the pension plan, 0 otherwise.
Marginal effects at sample means. *** significant at 1%, ** at 5%, * at 10%.

5.4 Pension policies

A pension policy may be defined as a change in one or more of the parameter values used to compute the *IEV*. The policy may be a direct intervention in the pension system or the effect of a broader policy. An increase of the minimum pension or more generous pension rules are examples of the first type of policy, whilst the increase of the pension fund return as a result of better regulation of capital markets or the decrease of administrative fees due to tax incentives are examples of the second type. From the previous results, it is possible to conclude that these policies can have significant effects only on the contribution behaviour in the SPP and the enrolment in the SNP. For example an increase of the pension fund return and the decrease of the administrative fees will increase the *IEV* and hence the probability of contributing in the SPP as well. The odds of enrolment in the SNP may increase, for instance, with more generous pension rules like a larger minimum pension.

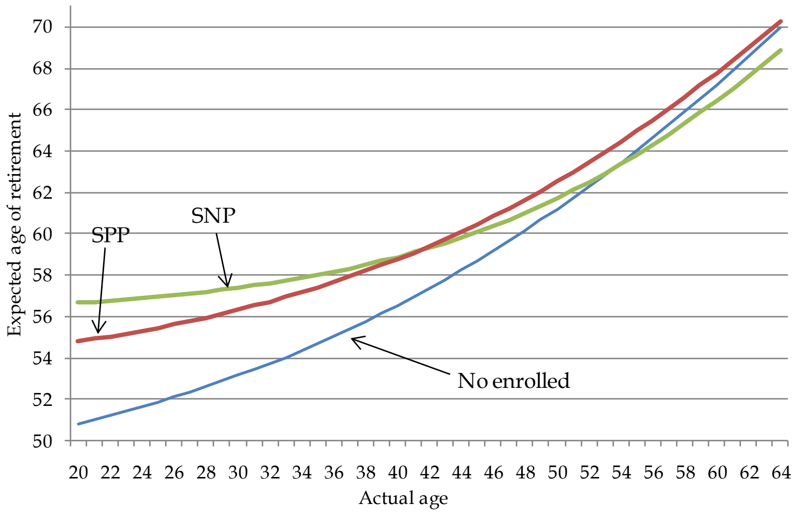
It is worth to note that beyond the features of the pension system, there are important limitations to increase the enrolment, which are hardly affected by pension policies. For example, from the data we observe that individuals strongly prefer other means of old-age savings that can be more liquid and flexible than the pension plans. Table 8 shows that if the individuals were allowed to invest in other means different from pension plans, just a few will opt for a mean similar to the pension plan. An important share of them will prefer to invest in own business. Another striking result observed in table 8 is that an overwhelming majority (73%) of the no-enrolled and no-contributors have no savings or prefer to spend the pension savings instead of saving for old-age. Obviously, if individuals have no capacity to save or face important liquidity constraints, the chances of success of any pension policy decrease.

TABLE 8: IN WHICH OTHER MEANS WOULD YOU INVEST YOUR SAVINGS, IF YOU WERE NOT REQUIRED TO CONTRIBUTE TO A PENSION PLAN?

	Contributors			No contributing & no enrolled			
	SPP	SNP	Total	SPP	SNP	No enrol.	Total
Don't have savings				33.3	55.0	40.5	42.4
Do not invest, but spend it	8.4	17.6	10.3	35.6	33.3	28.9	30.9
Savings account or other deposits in soles	12.6	13.5	12.8	11.1	3.3	4.6	5.4
Savings account or other deposits in dollars	26.2	12.2	23.3	8.9	1.7	5.8	5.4
Buying real estate	18.9	21.6	19.4	0.0	0.0	0.6	0.4
In own business	49.3	48.6	49.2	15.6	13.3	17.3	16.2
Lending to family and friends with interest	1.4	0.0	1.1	2.2	1.7	2.9	2.5
Buying stocks or other securities	3.5	5.4	3.9	0.0	0.0	0.0	0.0
Company pension plan, not AFP	0.7	2.7	1.1	0.0	0.0	0.0	0.0
Life, disability or life annuity, not AFP	5.6	4.1	5.3	0.0	0.0	0.0	0.0
Other	3.8	4.1	3.9	6.7	10.0	9.8	9.4
N	286	74	360	45	60	173	278

Beliefs, correct or incorrect, may limit the effects of pension policies. Individuals believe that their life expectancy is much lower than the age estimated with the official mortality tables (see figure 2). From the age of 33, the no enrolled individuals are the ones who have the lowest life expectation. For instance, a no enrolled individual of 33 years old believes that she will live up to 63.4 years old whilst the official table estimates this as 80 years. Given that the retirement age is 65, it is clear that a short perspective of life discourages the enrolment. Using the same methods to build the subjective mortality table and the expected life expectancy, we can construct the profiles of the expected age of retirement. This is possible thanks to a question in PRIESO asking "up to what age will you work to earn income?". In figure 4 it is observed that the no enrolled individuals are the ones who believe that they will retire earlier. Only at very advanced ages individuals believe that they will retire at the legal retirement age. The significant difference between the legal retirement age and the expected retirement age –which can be up to 14 years- reduces the attractiveness of a pension system that mandates the retirement only at 65 years old.

FIGURE 4: EXPECTED AGE OF RETIREMENT IMPLIED BY SUBJECTIVE ANSWERS



6. Conclusions

Despite the structural pension reform to establish individual accounts pension systems across Latin America, the enrolment and contribution in the pension plans have not increased. Our hypothesis is that the existence of old-age family arrangements may be one of the reasons behind the low levels of enrolment and contribution rates. We analyse the case of Peru as representative of the Region, given the prominence of traditional means of old-age support and the availability of specific data measuring risk attitudes, beliefs and preferences over the pension plans.

We find econometric evidence suggesting that life-cycle considerations and old-age family insurance *proxies* contribute together to explain the enrolment and contribution behaviour. The life-cycle factors are summarized in the utility based measure *IEV* (Income Equivalent Variation), which is computed for each individual in the sample. The *IEV* is the percentage of income required to leave an individual indifferent between the choice of enrolment and not-enrolment. It is found that *IEV* affects significantly and positively the enrolment in the SNP and the contribution behaviour in the SPP. Furthermore, the pension policies (pension fund returns, fees, pension rules, etc) can affect the behaviour of individuals through the *IEV*.

Finally, the data –rich in variables of beliefs and attitudes- allows us to draw attention to the limitations of policies intended to expand the participation and contribution to pension plans. A considerable majority of non enrolled individuals have no capacity to save or face important liquidity constraints, so that the chances of success of any pension policy decrease. Furthermore the beliefs about the expected retirement and death age are much lower than what is considered in the official tables. The attractiveness of a pension plan decreases for an individual who expects to live not too long and to work up to an age much lower than the compulsory retirement. All these aspects will –finally- discourage the individual from taking a pension plan.

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Appendix

A1. Computation of the pension in the SNP

Recall that $P_{snp} = Min\{Max(\beta Y_t; P_{min}); P_{max}\}$ and $P_{snp} > 0$ if β > 0, otherwise $P_{snp} = 0$. According to the SNP regulations that were in force up to 2002, the calculation of the value of β depends on the enrolment status and age of the individual (see next table).

VALUES OF β TO CALCULATE THE PENSION IN SNP

a) The Individual is not enrolled in any pension system and plan to enrol in the SNP:		
x	If $T_1 = (65\text{-}x)\varepsilon_{snp} - 20 \geq 0$	If $T_1 < 0$
≤29	Min[(0.30+0.02T$_1$);1]	0
30-39	Min[(0.35+0.02T$_1$);1]	0
40-49	Min[(0.40+0.02T$_1$);1]	0
50-54	0	0
≥55	0	0
b) The Individual is enrolled in the SNP and plan to remain there:		
x	If $T_2 = [(x\text{-}x')+(65\text{-}x)]\varepsilon_{snp} - 20 \geq 0$	If $T_2 < 0$
≤29	Min[(0.30+0.02T$_2$);1]	0
30-39	Min[(0.35+0.02T$_2$);1]	0
40-49	Min[(0.40+0.02T$_2$);1]	0
50-54	Min[(0.45+0.02T$_2$);1]	0
≥55	Min[(0.50+0.04T$_2$);1]	0
c) The Individual is enrolled in the SNP and plan to leave off:		
x	If $T_3 = (x\text{-}x')\varepsilon_{snp} - 20 \geq 0$	If $T_3 < 0$
≤29	Min[(0.30+0.02T$_3$);1]	0
30-39	Min[(0.35+0.02T$_3$);1]	0
40-49	Min[(0.40+0.02T$_3$);1]	0
50-54	Min[(0.45+0.02T$_3$);1]	0
≥55	Min[(0.50+0.04T$_3$);1]	0

Where:

x' : Age at which the individual enrolled in SNP.

ε_{snp}: Contribution density in SNP (share of contributions actually paid, $\varepsilon_{snp} \in [0,1]$)

A2. Subjective mortality table

A mortality table considers a hypothetical population that extinguish through the years. For instance, the table RV-85 assumes an initial population of 100,000 individuals living between the 20 and 110 years old. All the hypothetical population disappears beyond the maximum age. The key variable in a mortality table is l_j, which is the number of living individuals at age j. The actuarial formula for the expected life expectancy at age x is

$e_x = \sum_{j=x}^{109} l_j / l_x$, therefore an individual of age x expects to live until the age $x + e_x$. Rearranging terms, it is possible to obtain:

$$l_x = \prod_{j=21}^{x} \frac{(e_{j-1} - 1) l_{20}}{e_j} \qquad \forall 21 \le x \le 109$$

First, we average the additional expected (e_x) years of surviving by age x. It is used the first sample of 789 respondents in order to have better estimates. These means are adjusted by a Gompertz type function $e_x = h^{z^x}$, where h and z are the parameters to estimate. The $\hat{e}_x$ are plugged into the previous equation to obtain the values of l_x for each age. Since the l_x are far from showing a smooth declining as a typical mortality table, we adjust the results with a Gompertz mortality function: $l_x = sg^{c^x}$ (the same used in the table RV-85)where s, g and c are parameters to estimate. The results of the non-linear regression are:

ESTIMATES OF EX

	No enrolled		SPP		SNP	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
h	97.8172	9.7547	100.5990	8.0804	72.4268	10.7974
z	0.9921	0.0007	0.9926	0.0005	0.9939	0.0009
R^2	0.9808		0.9832		0.9561	
N	39		45		42	

Dependent variable: e_x

ESTIMATES OF LX

	No enrolled		SPP		SNP	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
s	107928.1	953.8	107457.0	857.2	110985.2	873.6
g	0.9985	0.0006	0.9991	0.0004	0.9721	0.0026
c	1.1008	0.0065	1.1073	0.0078	1.0554	0.0015
R^2	0.9993		0.9994		0.9999	
N	45		45		45	

Dependent variable: l_x

A3. Pension funds and Recognition Bond (BR)

We need the individual pension funds balance to calculate the benefits in the SPP (equations 7′ and 8′). Unfortunately, this information neither is available in PRIESO nor is accessible from the pension funds regulator due to its financial and confidential nature. Thus, we must impute the balances for each individual enrolled in the SPP. The procedure is simply; we use the salary of each individual to compute how many pension fund shares bought monthly between the date she enrolled in the SPP and May 2002. In that "purchase" of shares, we consider the corresponding contribution rates that were valid during the period, a contribution density of 0.51 and a yearly growth rate of salaries of 8.6%. This is the salary growth rate of blue-collars and white-collars of the private sector in Lima Metropolitana between August 1993 (starting date of the SPP) and June 2002. We apply this rate to the salary backwards from May 2002 to the date the individual enrolled in the SPP. Finally, the individual pension fund balance is the quantity of accumulated shares valued at the share price of May 2002.

We also need to impute the value of the BR to those workers who shifted from the SNP to the SPP. However, not all the workers who shifted pension systems can receive one of the BR types; they have to fulfil the corresponding regulations. For instance, to be entitled a BR type 92, the individual had to contribute at least 48 months before December 1992. Therefore, we only calculate the value of the BR for those individuals who, given their date of enrolment in the SNP and the assumed contribution density of 0.51 might have at least 48 contributions. According to the regulation, the value of the BR is determined as BR=0.1831*Y*M, where Y is the average monthly income in 1992 and M is the number of legally recognized contributions made in the SNP before December 1992. Again, we use the assumed salary growth rate of 8.6% and the contribution density of 0.51 to find Y and M respectively, and calculate the value of BR. Since this value is at December 1992 prices, we apply the price index accordingly to obtain the BR at prices of May 2002. The procedure used to obtain the BR type 96 is rather similar.