Welfare, inequality and financial consequences of a multi-pillar pension system

Javier Olivera
Department of Economics,
Catholic University of Leuven

This version 02 August, 2011

Abstract

The distributional impact of the structural pension reform in Latin American countries has been largely absent in the economic debate. However, this reform may widen inequality in old-age and reduce welfare. In this paper we study the consequences of implementing a multi-pillar system in one of these countries. We use available administrative records for Peruvian workers to estimate inequality in pensions, pension debt and welfare. Overall, our results show that the pension debt and inequality can be substantially reduced without welfare losses.

JEL classification: H55, H63, I30, G23.
Keywords: Pension reform, pension inequality, social security, Latin America, Peru.

I am grateful to Erik Schokkaert for his helpful comments and to the Economic and Social Research Consortium of Peru for supporting financially an earlier report (Project ACDI-IDRC 2007-PM 35).
Address: Naamsestraat 69, Leuven. 3000. Belgium.
Fax: +3216326796. Telephone: +3216326654. e-mail address: javier.olivera@econ.kuleuven.be.

1. Introduction

A number of Latin American countries transformed during the 90's their public pension systems into private individual capitalization systems. Some countries completely replaced their old pension system by a system based on individual capitalization and privately managed (Bolivia, Chile, Dominican Republic, El Salvador and Mexico). Others kept the public system which competes with the new private system (Colombia and Peru) whilst other countries assigned the role of first pillar to the public system and created a private system as a second pillar (Argentina, Costa Rica and Uruguay) in an integrated system. These models are categorized as substitutive, parallel and mixed, respectively (Arenas de Mesa & Mesa-Lago, 2006).

The emphasis of this reform was on the spillovers in the financial markets, public debt and growth. The policy and academic debate are concentrated in those issues and in some other important aspects such as competition and enrolment rates. As it is stressed in Arza (2008) and Barr & Diamond (2009) there is little analysis on distributional and welfare consequences. However, these effects may be large and intensify inequality in those countries, which is worsened by the fact that only a small fraction of population is covered by the pension system (see last column of table 1).

TABLE 1: SOME INDICATORS BY COUNTRY

Country	Reform Year	Gini coefficients				Fiscal cost (% GDP)	Coverage (% of EAP)
		Survey Year	Labour income [a]	Pensions [b]	Δ in Gini [a-b]		
Argentina	1994	2006	0.444	0.336	0.108	-2.5	20.7
Bolivia	1997	2005	0.562	0.259	0.303	-3.5	10.5
Colombia	1994	2004	0.513	0.405	0.108	-1.6	22.2
Costa Rica	2001	2006	0.454	0.559	-0.105	0.0	46.6
Dom. Rep.	2003-2006	2006	0.484	0.486	-0.002	n.a.	14.5
El Salvador	1998	2005	0.468	0.392	0.076	-1.4	20.1
Mexico	1997	2006	0.509	0.489	0.020	-0.5	28.0
Peru	1993	2006	0.519	0.339	0.180	-0.7	12.0
Uruguay	1996	2005	0.501	0.449	0.052	-4.0	58.8

Source: Gasparini et al (2009) for Gini coefficients; the Gini for Peru is based on own calculations using Enaho-2006 at national level. Arenas de Mesa & Mesa-Lago (2006) for coverage of Economically active population (active contributors to private and public systems, at 2004) and fiscal costs (Current pension deficit: benefit expenditure minus contribution revenue financed by Government transfers, at 2001).

Given that the pension is a direct function of labour income in an individual capitalization system, the reformed pension system will reproduce labour income differences into pensions. In this sense, the potential amplification of inequality during old-age may be approximated by the difference between the Gini coefficients for labour income and pre-reform pensions (see table 1). In almost all countries there is a threat of wider pension inequality. Bolivia, Peru, Argentina and Colombia are the countries that might face the most dramatic change in inequality during old-age. Arza (2008) also stresses the transmission and exacerbation of inequality of the Latin American pension systems through an assessment of some hypothetical pension designs. However, it is still necessary to analyse more precisely inequality in pensions and study how this interplays with other policy objectives. The reduction of the actuarial liability of pension is a key objective for policy-makers (see the large current fiscal costs of pensions in table 1). Making clear the trade-offs between inequality, actuarial liability and welfare stresses the different roles of pension policies and is more appealing for policy-makers. This can be quite demanding on specific information such as administrative records of workers and pensioners, which is hardly available and disclosed by governmental authorities. Although it would be ideal to make a cross-country analysis, one case may provide enough insights to highlight the distributional consequences of the pension reform in Latin America.

We study the case of Peru as we have access to unique administrative data samples of workers and pensioners. Our objective is to analyse the effects of the current and an alternative pension design in three dimensions: inequality in pensions, pension debt and welfare. To do so, we generate counterfactual distributions of pensions derived from a hypothetical multi-pillar pension system and compare them with the actual distribution. Overall, the results show that the pension debt and inequality can be substantially reduced without welfare losses. In addition, we find that old-age poverty can be significantly reduced.

In the next section we outline the Peruvian pension system. In section 3, the hypothetical multi-pillar pension is presented together with the methodology to estimate pensions and actuarial liability. Section 4 is devoted to present and discusses the effects of this system on the actuarial liability, inequality, welfare and poverty. Section 5 concludes.

2. An outlook of the Peruvian pension system

Peru created in 1993 the Private Pension system (SPP), which is a system based on individual capitalization, without dismantling its old defined benefit system (the National Pension System, SNP)[1]. Workers have to choose only one of these two systems. If SNP is chosen, the insured is able to shift to the SPP later on, but the contrary is not permitted. An

[1] The SPP is supervised by the Superintendence of Banking and Insurance (SBS) and the SNP is administrated by the Bureau of Pensions (ONP).

individual who chooses the SPP must choose one of the pension funds administrators (AFP). If an insured moves from the SNP to SPP, the State entitles a recognition bond (BR) in order to compensate for the contributions made to the SNP, but only if some legal requirements are fulfilled. This means that the BR will be granted only to the individuals who belong to the transition period between the PAYG and the individual capitalization system. Furthermore, the SNP offers a pension with a minimum and maximum value while in the SPP only few workers could be eligible to obtain a minimum pension if they comply with some exigent requirements.

The creation of the SPP attracted a considerable number of insured from the SNP and new workers who preferred to enrol in the new system. This, in turn, weakened the financial sustainability of the SNP. Under current parameters, the SNP's dependency ratio should be 4.4 contributors for each pensioner in order to keep the system balanced; however, this ratio is only 1.3[2]. This explains the large actuarial deficiency (when the actuarial liability is greater than the present value of contributions), which amounts to US$26 billion, i.e. 23% of GDP. Note that this considerable debt corresponds only to pensioners and insured of the SNP, who represent a small fraction of Peruvian population (7.4% of total population).

The reform has generated a considerable debt. Apart from the mentioned actuarial deficiency, there is US$4,700 million in current terms corresponding to recognition bonds; and US$2,137 million in actuarial terms due to the implementation of the Law 28891[3] (MEF, 2008 & 2007). One could consider that fiscal spending on pensions is valuable due to its positive effects on preventing old people falling into poverty, but this is not necessarily the case in Peru. Only salaried employees of the formal sector are mandated to enrol in the pension system, which means that self-employed, employers and other types (in the formal or informal sector) can choose voluntarily to enrol or not. Since the informal sector in Peru is huge (55% of labour force in 2007 (ILO, 2009)) and incomes are low, pension enrolment may not be an optimal choice for these workers; hence the enrolment rate is small. It means that the public expenditure on pensions has no effect on preventing poverty for an important fraction of the population.

[2] Although the Government can modify parameters and pension rules within reasonable limits, the imbalance is so large that these policies are not possible to put in practice. For instance, if the contribution rate is the unique adjustable parameter, this would rise up to the unrealistic rate of 43.8% to balance the system.

[3] Under restricted circumstances, the Law 28891 (*Ley de desafiliación*) –from 2007- allows the insured to return to the SNP.

3. A reform proposal

Looking for policy options, we favour the recommendations made by the World Bank (Holzmann et al, 2005; World Bank, 1994) to create a multi-pillar pension system, based on three pillars: i) a mandatory public pillar, ii) a funded pillar with mandatory individual capitalization accounts, and iii) a funded pillar with voluntary individual accounts. Under the first pillar, all insured receive a minimum pension. The second pillar allows insured to capitalize contributions according to their income level. The goal of the third one is to allow the insured to further raise their expected pension if they are able to save more[4].

3.1 Description

The multi-pillar pension system can be implemented as the merging between the SNP and SPP. The number of years contributed to any pension plan must be taken into account for the evaluation of the entitlement of a minimum pension. Additionally, the insured of the SPP are allowed to keep the pension balance generated up to the date of the reform. In the new system each insured has to contribute a rate α from his wage to his individual account and a rate β to the solidarity fund. The aim of this fund is to finance the minimum pension scheme. The requisites to obtain a minimum pension are the same as in the SNP: 20 years of contributions over a reference wage with at least a value equal to the legal minimum wage. At retirement age, the pension is computed with the pension balance. If the pension is lower than the minimum pension, then additional resources are added from the solidarity fund until the pension equals the minimum pension value. This means that this guarantee is targeted and redistributive.

The reform is intended to reduce the actuarial deficiency, which in turn may improve the allocation of public expenditures. The Government has to make significant amounts of current transfers to finance the SNP[5]. It means that tax revenues -paid by all workers regardless of whether they are enrolled in the pension system- are used to pay the pensions of some, which reinforces inequality (Arza, 2008). This is particularly critical due to the fact that the group of enrolled workers is much more advantaged (higher incomes, better education, stable contracts, etc) than the non-enrolled.

---

[4] It is worth to mention that a multi-pillar system may diversify risks better. The factors that affect labour variables and hence the first pillar are not perfectly correlated with factors that affect financial variables, which in turn determine the pension funds performance in the second pillar (Holzman et al, 2005; Lindbeck and Persson, 2003).

[5] Only in 2007, the SNP's pension roll assumed by the State was S/. 2,455 million, i.e. 0.73% of the GDP.

The simulation of the reform consists of i) computing the pensions of all insured in the SNP, SPP and the hypothetical multi-pillar system; and ii) computing the corresponding actuarial liabilities. Different values for α and β are used in order to obtain different scenarios of reform. For comparison reasons we must choose values for α and β such that $\alpha+\beta$ =10%[6]. The actual and counter-factual distributions of pensions and actuarial debt allow us to make welfare and inequality comparisons. In the simulations, we consider the possible death of individuals according to the official mortality tables, but the enrolment of new workers is not considered. In terms of micro-simulation techniques, this exercise is similar to one of static simulation. The inclusion of new workers arriving into the pension system would demand to make simulations on fertility, labour supply and the decision of enrolment, which is beyond the scope of this study. We believe that the actual design of our simulation exercise is sufficient to highlight the trade-offs between inequality, pension debt and welfare.

3.2 Data

We use two representative samples of the insured registered up to December 2006 in the SPP and SNP; so the simulations are made to that date. The samples contain information on wage, age, gender, age of enrolment in the SPP, pension balance, BR value and its corresponding number of contributions. The samples of the SPP and SNP are random and stratified according to gender and age group (in the SPP, the age of enrolment is an additional stratum). Even this information has a delay of four years with respect to the current year, this is still relevant to analyse the Peruvian pension system as no structural reforms have been undertaken since December 2006. Indeed, the distributions of affiliates by age and gender have not varied importantly. After dropping records with inconsistent and missing information, the sample size in the SPP and SNP is 31,719 and 26,168 individuals, respectively[7]. Once simulations are computed for the samples, we use the sample weights to extrapolate the results to the level of the total insured population.

---

[6] The contribution rate in the SPP and SNP is 10% and 13% of salary, respectively. In addition, the AFP charges an administrative fee and collects the insurance premium that covers the risks of disability and death. The fee and insurance premium are 1.81% and 0.88% on average, respectively. Overall, the insured of the SPP and SNP pay a rather similar percentage of their wage.

[7] We estimate the enrolment age of the SNP's insured since this variable is not included in our sample. For this purpose, we use the database PRIESO (conducted by the World Bank in Lima Metropolitana during May 2002, see Barr and Packard (2005)). The dependent variable was the enrolment age and the independent variables were the current age (at May 2002) and its square, broken by gender. The corresponding coefficients were used to impute the enrolment age for the individuals of our SNP sample. We prefer this method to that of assuming a fixed number of

3.3 Computation of pensions

The pensions P_{ik}^{snp} in the SNP are computed according to its pension rules. In the SPP and multi-pillar system, the computation of pensions follows a simple capitalization process. The number of contributions made to any system is of special interest for the entitlement of a minimum pension. Expressions 1 to 4 calculate the number of contributions and pensions in the system *j* (*j*=SNP, SPP, MIX (multi-pillar)). The subscripts i and k refer to a particular individual and his age at December 2006, respectively. k_j indicates the age at which the individual enrolled in the pension system *j*.

$$\text{for SNP:} \quad \tilde{A}_{ik}^{snp} = t_0^{snp}(k - k_{snp}) + t_1^{snp}(65 - k) \tag{1}$$

$$\text{for SPP:} \quad \tilde{A}_{ik}^{spp} = A_{ik}^{BR} + t_0^{spp}(k - k_{spp}) + t_1^{spp}(65 - k) \tag{2}$$

$$\text{for MIX:} \quad \tilde{A}_{ik}^{mix} = A_{ik}^{BR} + t_0^{j}(k - k_{sis}) + t_1^{mix}(65 - k) \quad \textit{with j=SNP; SPP} \tag{3}$$

$$A_{ik}^{j} = \begin{cases} \tilde{A}_{ik}^{j} & if \quad \tilde{A}_{ik}^{j} \geq 20 \\ 20 & if \quad \tilde{A}_{ik}^{j} < 20 \quad \& \quad 65 - k_j \geq 20 \\ \tilde{A}_{ik}^{j} & if \quad \tilde{A}_{ik}^{j} < 20 \quad \& \quad 65 - k_j < 20 \end{cases} \tag{4}$$

A_{ik}^{j} is the number of contributed years between k_j and 65 (the retirement age); t_0^j is the overall density of contributions between k_j and k; t_1^j is the overall density of contributions between k and 65; A_{ik}^{BR} is the number of years contributed to the SNP recorded in the BR. The density of contributions is the share of years contributed in a given period of years; hence its value is between 0% and 100%. Since it is not possible to estimate densities for each individual, we assume an overall density of contributions for each system j (t_0^j and t_1^j). According to expression 4, we assume that the insured will contribute at least 20 years up to retirement (if his age allows it) in order to reach the minimum amount of years needed to be entitled a minimum pension. The computation of the pension in the SPP follows a monthly capitalization process and includes the calculation of the annuity price:

$$P_{ik}^{spp} = \frac{\frac{14}{12} Y_{ik} \times 10\% \times d_{ik}^{spp} \frac{[(1+\tilde{r})^{65-k} - 1]}{(1+\tilde{r})^{1/12} - 1} + CIC_0 (1+\tilde{r})^{65-k} + BR_{ik}}{CRU_{65,y}} \tag{5}$$

---

contributions for all insured (which is used by the ONP to calculate the SNP's actuarial liability) because there are important differences in the enrolment age by gender and cohort.

$$d_{ik}^{spp} = \frac{A_{ik}^{spp} - A_{ik}^{BR}}{65 - k_{spp}} \tag{6}$$

$$CRU_{65} = 12\left(\sum_{x=0}^{M-65} \frac{p_{65,65+x}}{(1+\hat{r})^{x}} - \frac{11}{24} \right) \tag{7}$$

$$CRU_{65,y} = CRU_{65} + 12\theta_{spp}\left(\sum_{i=0}^{M-y} \frac{q_{y,y+i}(1 - p_{65,65+i})}{(1+\hat{r})^{i}} \right) \tag{8}$$

P_{ik}^{spp} is the retirement pension; Y_{ik} represents the monthly wage (there are 14 payments a year); CIC_0 is the pension balance accrued up to December 2006; BR_{ik} denotes the recognition bond valued at December 2006; $\tilde{r}$ is the yearly pension fund return rate; $CRU_{65,y}$ is the annuity price at retirement age (including a spouse of y years old) and d_{ik}^{spp} is a measure more individualized for the density of contributions between current age and retirement age. To calculate the annuity price, we need $p_{65,65+x}$, which is the probability of survival from age 65 to 65+x according to the official mortality table; M is the maximum survival age; $\hat{r}$ is the annuity discount rate; θ_{spp} is the percentage of the husband's pension that the widow will receive and $q_{y,y+i}$ represents the widow's probability of survival from age y to age y+i.

Finally, provided that P_{min}^{mix} is the minimum pension in the multi-pillar system, the final value of the pension P_{ik}^{mix} is computed as:

$$Pc_{ik}^{mix} = \frac{\frac{14}{12} Y_{ik} \times \alpha \times d_{ik}^{mix} \frac{[(1+\tilde{r})^{65-k} - 1]}{(1+\tilde{r})^{1/12} - 1} + CIC_0 (1+\tilde{r})^{65-k} + BR_{ik}}{CRU_{65,y}} \tag{9}$$

$$d_{ik}^{mix} = \frac{A_{ik}^{mix} - A_{ik}^{BR}}{65 - k_j} \qquad \textit{with } j\textit{=SNP; SPP} \tag{10}$$

$$P_{ik}^{mix} = \begin{cases} Pc_{ik}^{mix} & if \quad Pc_{ik}^{mix} > P_{\min}^{mix} \\ P_{\min}^{mix} & if \quad Pc_{ik}^{mix} \le P_{\min}^{mix} \quad \& \quad A_{ik}^{mix} \ge 20 \\ Pc_{ik}^{mix} & if \quad Pc_{ik}^{mix} \le P_{\min}^{mix} \quad \& \quad A_{ik}^{mix} < 20 \end{cases} \tag{11}$$

The actuarial liability is the capital needed to address the payment of current and future pensions. This payment is contingent on the death date of current and future insured and pensioners. In a defined benefit system like the SNP and in a multi-pillar system, these payments should be compared with the present value of contributions in order to know the final balance. The methodology of the computation of actuarial liabilities is described in the appendix.

3.4 Parameters

a) Mortality

It is necessary to use a unique set of mortality tables in the computation of the actuarial liabilities for comparative purposes. We adopt the official tables currently used in the SPP, i.e. the RV-2004 for pension holders and the B-85 for beneficiaries. It is assumed that each insured has a spouse; with the males being 4 years older than females[8].

b) Interest rates

The simulation of actuarial liabilities implicitly assumes no inflation so that the pension fund return rate is assumed free of price changes. We assume a conservative value of $\tilde{r} = 6\%$, which is the same as in other studies showing long-term projections for the Peruvian pension system (Moron and Carranza (2003) and Bernal et al (2008)). According to available data, the gross average of the annuity's discount interest rate ranges between 4.7% and 4.9%[9]. Furthermore, the interest rate specified in the regulation for evaluating the entitlement of some benefits (e.g. regular and special early retirement and minimum pension in the SPP) is 4.6%. Therefore, given the low discrepancy among all these values, we assume $\hat{r} = 4.6\%$. The discount interest rate (r) is needed to find the present value of a life annuity, and consistently we must use the same interest rate to estimate the actuarial liability and the present value of contributions, hence $r = \hat{r} = 4.6\%$. Other authors that estimate actuarial liabilities for Latin American countries use similar rates; Zvinieni and Packard (2002) use a discount rate of 4%, Holzmann et al (2004) use values between 2% and 5%. For Peru, MEF (2008) and Bernal et al (2008) use a discount rate of 4%.

c) Parameters of the pension systems

According to available information, the monthly average of the share of individuals effectively contributing in the SPP was 51.1% between 1998 and 2008. In the SNP, the corresponding figure was 47.1% between 2000 and 2007. Given the unavailability of more

[8] The average age difference between the heads of household under 65 years and their wives is 3.6 according to the National Household Survey of 2006 (ENAHO-2006).

[9] These figures correspond to annuities (life, deferred and guaranteed types) in Dollars and obtained at the legal retirement age in Dec-2006, Dec-2007 and Oct-2008. The information on annuities in Dollars is enough to have an idea on the value of the interest rate because the majority of retirees choose this currency (around 98% of the annuities were given in Dollars).

information on contribution density, it is assumed for simplicity that all insured of the SPP, SNP and multi-pillar had and will have a density contribution of 50%[10]. This assumption is not far from more accurate figures estimated in other funded pension systems such as in Chile and Argentina (Arenas de Mesa et al, 2008; Bertranou and Sánchez, 2003).

The minimum pension in the SPP and SNP is S/.484 a month. The SNP also offers a minimum pension for beneficiaries (the insured's spouse), which is S/.315. All these values are also assumed for the multi-pillar system. Moreover, the maximum pension offered in the SNP is S/.1,000. In the SNP, the widow receives a survival pension equivalent to 50% of the spouse's pension ($\theta_{snp} = 50\%$); although the widower may receive a survival pension under some very restrictive conditions, we assume that he does not receive it. In the SPP and multi-pillar system $\theta_{spp} = \theta_{mix} = 42\%$, regardless of the sex of the spouse.

4. Effects of the reform

4.1 Actuarial liability

The estimation of the actuarial liability is extremely sensitive to assumptions, pension rules and parameters. The evolution of the SNP's actuarial liability not only responds to the dynamic of pensions, incomes, contributors and pensioners, but also to some changes in the estimation methodology[11] (see table 2).

TABLE 2:ACTUARIAL LIABILITY OF THE SNP (US$ MILLIONS)

Year	Pensioners (a)	Insured (b)	Present value of contrib. (c)	Net position (a)+(b)-(c)	"Pension debt" (b)-(c)
ONP's estimation:					
2004	8,846	15,449	6,579	17,717	8,870
2005	9,390	16,239	7,142	18,487	9,097
2006	10,606	19,318	9,360	20,564	9,958
2007	12,653	24,272	11,038	25,887	13,234
Author's estimation:					
2006	n.a.	14,255	4,550	n.a.	9,704

Sources: ONP's summary of annual economic study of pension reserves and author's simulation.

[10] It means that $t_0^{snp} = t_1^{snp} = t_0^{spp} = t_1^{spp} = t_1^{mix} = 50\%$.

[11] From 2007 the ONP changed its official mortality table, moving from the RV-85 and B-85 to the SP-2005, which implies a higher longevity. In the new table, 65 year old males and females are expected to live 18.06 and 24.79 additional years, respectively; while in the old tables these figures were 17.15 and 20.71, respectively. Moreover, in 2007 the ONP changed the assumption of years contributed, moving from 33 to 27 years.

There are important differences between the results of our estimation and ONP's. The main reasons for this discrepancy are i) our discount rate is 4.6%, while the ONP uses 4%; ii) we assume a contribution density of 50%, which implies an average of 20.9 years contributed in our SNP sample; this sharply contrasts with the 33 years supposed by the ONP; iii) we use the mortality table RV-2004, while ONP uses the table RV-85 (up to 2006); iv) in our sample, we do not include the insured with missing information on age; while the ONP supposes they are 41 and 43 years old; v) we assume that the age difference between spouses is 4 years while the ONP assumes 7 years. The simulation uses the same exchange rate by ONP in 2006, i.e. S/.3.194 per Dollar. We prefer our assumptions to the ones of the ONP because they are more realistic and are compatible with the assumptions employed in the simulation of the actuarial liability in the SPP and the multi-pillar system.

The actuarial liability for current SNP's pensioners is not estimated because the multi-pillar reform will not affect current pensions. Accordingly, the concept of "pension debt" will be henceforth the difference between the actuarial liability of insured workers and the present value of their contributions. This is precisely the concept expressed in the last column of Table 2. Our estimation of pension debt is US$9,704 billion (10.4% of GDP), not far from ONP's. We must add to this amount the actuarial liability corresponding to SPP's minimum pensions in order to obtain the debt of the pension system as a whole. Thus, before any reform, the total pension debt amounts US$10,296 (see table 3).

TABLE 3: PENSION DEBT WITH AND WITHOUT REFORM (US$ MILLIONS)

No Reform									
a. Present value of contrib..	4,550								
b. Act. liability for SNP insured	14,255								
c. Act. liability for SPP insured	592								
d. Pension debt: c+b-a	10,296								
With Reform	*Contribution rate to individual account*								
	α=1%	*α=2%*	*α=3%*	*α=4%*	*α=5%*	*α=6%*	*α=7%*	*α=8%*	*α=9%*
e. Present value of contrib.	20,763	18,456	16,149	13,842	11,535	9,228	6,921	4,614	2,307
f. Act. liability for insured	21,204	19,803	18,522	17,354	16,284	15,305	14,412	13,595	12,848
g. Pension debt: f-e	441	1,347	2,373	3,512	4,749	6,077	7,491	8,981	10,541
Debt reduction: d-g	9,855	8,949	7,923	6,784	5,547	4,219	2,805	1,315	-245

Source: Author's simulation.

Table 3 shows the reform's effect on pension debt under different combinations of contribution rates α and β, subject to $\alpha + \beta = 10\%$. Each column exhibits the estimated value of the pension debt and the amount of savings due to reform. For instance, in the first column, 9% of salary is contributed to the solidarity fund and only 1% to the individual account; i.e. the multi-pillar system would be close to work as a defined benefit system. In this scenario, the pension debt is reduced to only US$441 million, so the State may save up to US$9,855 million, which is equivalent to 10.5% of GDP. Although this is an extreme scenario, it is instructive. If the contribution rate to the individual accounts is higher, as shown in the other columns of the table, the State may still obtain substantial savings. The other extreme case is shown in the last column of table 3. In that scenario the multi-pillar system would be similar to the SPP with only a small contribution rate to the solidarity fund (1%), although with a guaranteed minimum pension scheme. This alternative slightly raises the pension debt by US$245 million instead of generating savings.

A social planner only interested in reducing the pension debt will chose the scenario with the lowest contribution rate for the individual account. Although this choice might lead to less inequality among pensioners, it could also imply some adverse consequences in welfare. The next section explores these issues.

4.2 Equity and welfare

Apart from reducing the pension debt, the reform also has distributional and welfare effects. The effect on the distribution of pensions is quantified by the Gini coefficient (*G*). While this indicator is widely used to measure income inequality, its normative characteristics are not explicit. In contrast, the Atkinson index (Atkinson, 1970) is built on an explicit ethical basis since it takes into account the inequality aversion of the planner (Lambert et al, 2008). This index is defined as $I(e)$; and e is the parameter of inequality aversion of the social planner.

In the context of pension systems, the Atkinson index may be interpreted as the fraction of national income of pensions which can be lost in order to achieve equality in the distribution of pensions. Or in other words, it is the price that the planner is willing to pay for complete equality. If $e \to 0$, the planner is neutral to inequality and the index tends to zero, thus it is not willing to sacrifice pension amounts in exchange for perfect equality. However, a planner more averse to inequality exhibits an index that tends to 1, so that it tolerates large losses in the pensions in exchange for greater equality.

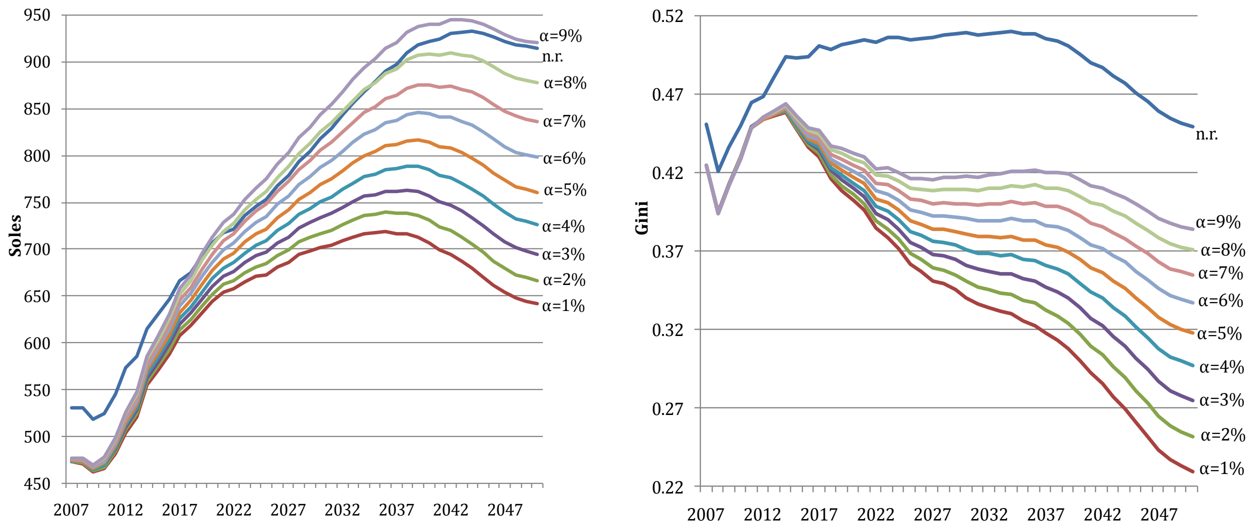
With regard to the effects on welfare, the planner should be able to build social welfare functions (SWF) with the resulting pension distributions from the hypothetical reform, and then rank them. As pointed in Lambert (2001), the SWF must be increasing in the income mean and decreasing in the inequality index. Thus, if μ indicates the pension mean, then the SWF built with the Gini coefficient and Atkinson index are:

$$W_G = \mu(1-G) \tag{12}$$

$$W_{I(e)} = \mu(1-I(e)) \tag{13}$$

As a result of the simulations we obtain yearly pensions between 2007 and 2050, therefore the average pension and distributional and welfare indexes are also computed by year. Since each generation of pensioners shows different probability of survival through the simulation period, we must use a sort of weight to aggregate pensions of all existing pensioners in each year. This weight is simply the probability of survival from age 65 until each subsequent year, extracted from the mortality table. Figure 1 shows the evolution of the average pension and the corresponding Gini coefficient[12]. The pensions grow through the period as a consequence of the capitalization process, particularly for the younger generation of insured that has more time to capitalize. At the beginning, the pensions computed without reform are higher than those of any other reform scenario, but since year 2019 the scenario with α=9% shows the highest pensions. In the case of the Gini, the scenario of no reform is always more unequal.

FIGURE 1: PENSION MEAN AND GINI COEFFICIENT PER YEAR



Source: Author's simulation. n.r. = no reform.

In order to ease the comparison of pension distributions from different scenarios and make explicit the trade-offs with the pension debt reduction, we use the averages of the

12 In this figure and henceforth, pension average and inequality and welfare measures refers to insured who retire at 65 years old.

pension mean and inequality and welfare indexes of the whole simulation period[13]. Table 4 shows inequality measures for each pension distribution derived for different values of *α*.

TABLE 4: INEQUALITY INDEXES

No Reform	Pensions				Wages				
	SNP	SPP	Total		SNP	SPP	Total		
Mean	566.2	827.2	775.9		1003	1562.1	1446.4		
Gini	0.117	0.563	0.488		0.397	0.507	0.496		
I(e=0.1)	0.004	0.062	0.050						
I(e=0.5)	0.018	0.270	0.215						
I(e=1.0)	0.010	0.313	0.204						
I(e=2.0)	0.057	0.696	0.634						
I(e=2.5)	0.067	0.770	0.725						
With Reform	Pensions								
	α=1%	*α=2%*	*α=3%*	*α=4%*	*α=5%*	*α=6%*	*α=7%*	*α=8%*	*α=9%*
Mean	640.6	655.1	670.5	686.9	704.0	721.8	740.3	759.5	779.2
Gini	0.351	0.361	0.371	0.380	0.390	0.398	0.406	0.414	0.421
I(e=0.1)	0.036	0.037	0.038	0.039	0.040	0.041	0.042	0.042	0.043
I(e=0.5)	0.156	0.159	0.163	0.166	0.170	0.173	0.177	0.180	0.183
I(e=1.0)	0.199	0.190	0.184	0.179	0.175	0.171	0.168	0.165	0.162
I(e=2.0)	0.659	0.621	0.600	0.588	0.580	0.575	0.571	0.569	0.568
I(e=2.5)	0.814	0.764	0.736	0.717	0.704	0.695	0.688	0.683	0.679

Source: Author's simulation.

It is interesting to note how different the two pension systems transmit inequality from labour to retirement. For instance, in the SNP the Gini coefficient for wages drops from 0.40 to 0.12; this is simply explained by the system design in which the pension value must be within a minimum and maximum value. In contrast, in the SPP the wage inequality is transmitted to pensions, which is due to the individual capitalization scheme[14]. The multi-pillar system always reduces pension inequality when the distributional effect is analyzed with the Gini coefficient; and the inequality monotonically decreases as *α* lowers. The same results are observed for the Atkinson index until *e*=0.5. Higher values of the aversion to inequality lead to changes in the ranking of pension distributions. The best distribution in the ranking is the one that shows less inequality according to the planner's view. For this reason, a distribution may exhibit different positions for two planners that differ in their aversion to inequality. For example, a planner very averse to inequality (*e*=2.5) prefers the scenario with a contribution rate *α*=9%, and a less averse planner (*e*=0.5) prefers *α*=1%.

[13] Although also arbitrary, the social planner may use other reference points such as pick up a particular year of the simulation period or the very last year. At least, the average over the whole simulation period includes all the changes in pensions and inequality over a considerable period.
[14] Without weighting pensions with the survival probability, the Gini coefficient for pensions in the SPP is 0.509, i.e. the transmission of inequality is almost perfect.

Note that the pension distribution with α=1% is at the worst position of the ranking when the planner is highly inequality averse. However, this result is not entirely unexpected. As the aversion to inequality increases, it gives more weight to the bottom of the pension distribution; therefore, a distribution with more inequality at the end of the scale would be worst ranked (Atkinson, 1970). At the bottom of the pension distribution there are insured who obtain a minimum pension and who obtain a pension below such value; for the latter the pension value is even lower when the contribution rate to individual capitalization is low. This in turn leads to greater inequality at the bottom of the distribution. This is precisely what we observe through the coefficient of variation calculated in each decile of the pension distributions of table 5. Looking at the bottom of the pension distributions, there is less variation among the pensions as α increases. It is also noticeable that the reform prevents many pensioners of receiving a pension below the minimum. Without implementing the reform, 30% of the pensioners may receive a pension below the minimum; but that percentage would be only 2.8% if the reform were implemented.

TABLE 5: COEFFICIENT OF VARIATION OF PENSIONS AND % OF INSURED WITH MINIMUM PENSION

	No reform			With reform								
	SNP	SPP	Total	α=1%	α=2%	α=3%	α=4%	α=5%	α=6%	α=7%	α=8%	α=9%
Coefficient of variation (x100):												
Decile 1 (poorest)	0.0	38.5	37.8	49.1	48.4	47.6	46.9	46.2	45.6	45.0	44.4	43.8
Decile 2	0.0	11.0	11.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decile 3	0.0	7.1	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decile 4	0.0	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decile 5	0.0	5.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Decile 6	0.0	5.6	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.8	5.2
Decile 7	0.0	6.4	6.5	0.0	0.0	0.0	0.7	3.6	6.3	6.9	6.8	6.7
Decile 8	0.2	9.0	8.1	2.6	6.0	8.7	9.0	8.8	8.6	8.5	8.4	8.4
Decile 9	12.6	14.5	15.3	15.9	16.1	15.9	15.6	15.5	15.4	15.3	15.1	15.0
Decil 10 (richest)	8.0	73.6	78.0	87.2	85.2	83.4	82.0	80.8	80.0	79.3	78.7	78.3
Total	26.6	147.5	146.0	117.9	120.6	123.3	125.8	128.2	130.5	132.5	134.3	136.0
Percentage of insured with minimum pension:												
< min. pen.	0.0	37.6	29.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
= min. pen.	79.6	3.6	19.2	74.5	71.9	69.0	65.9	62.7	59.5	56.3	53.1	50.1

Source: Author's simulation.

Moreover, the planner is able to rank the resulting pension distributions according to its welfare implications. A SWF is computed for each α. For instance, by using the Gini criterion the contribution rate α=9% offers the best effects on welfare; and as this rate decreases, the position of the SWF in the ranking decreases (see table 6). The SWF corresponding to the current scenario (without reform) is at the bottom of the ranking.

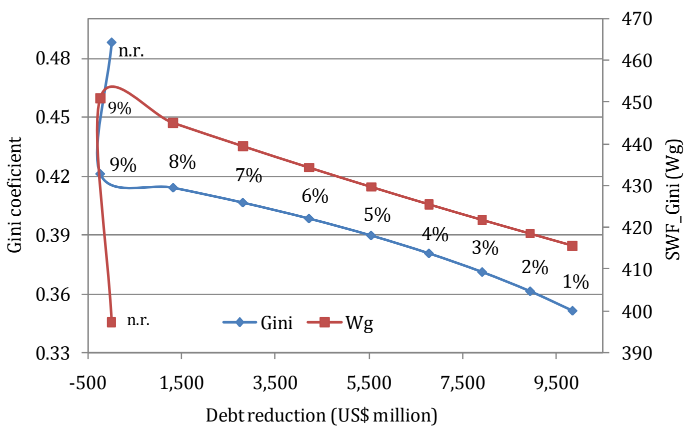
TABLE 6: RANKING OF SOCIAL WELFARE FUNCTIONS

SWF	α=1%	α=2%	α=3%	α=4%	α=5%	α=6%	α=7%	α=8%	α=9%	(No reform)
Gini	9	8	7	6	5	4	3	2	1	10
I(e=0.1)	10	9	8	7	6	5	4	3	1	2
I(e=0.5)	10	9	8	7	6	5	3	2	1	4
I(e=1.0)	10	9	8	7	6	5	4	2	1	3
I(e=2.0)	10	9	8	7	5	4	3	2	1	6
I(e=2.5)	10	9	8	7	6	4	3	2	1	5

Source: Author's simulation.

The ranking of the scenarios changes only slightly if the values of the SWF are measured with the Atkinson criterion, except for the current scenario of no reform, which presents a rather different position to that found with the Gini criterion. Since the effect of the average pension on the SWF is larger than the effect of greater inequality, the scenario of no reform is not ranked too badly. As the planner dislikes inequality at the bottom of the distribution with the Atkinson index, lower values of α are less preferred. Overall, there are important consequences of the reform on the pension debt, pension inequality and welfare. It is worth to present these effects all together in order to observe trade-offs for policy-making.

FIGURE 2: DEBT REDUCTION, INEQUALITY AND WELFARE (GINI CRITERION)

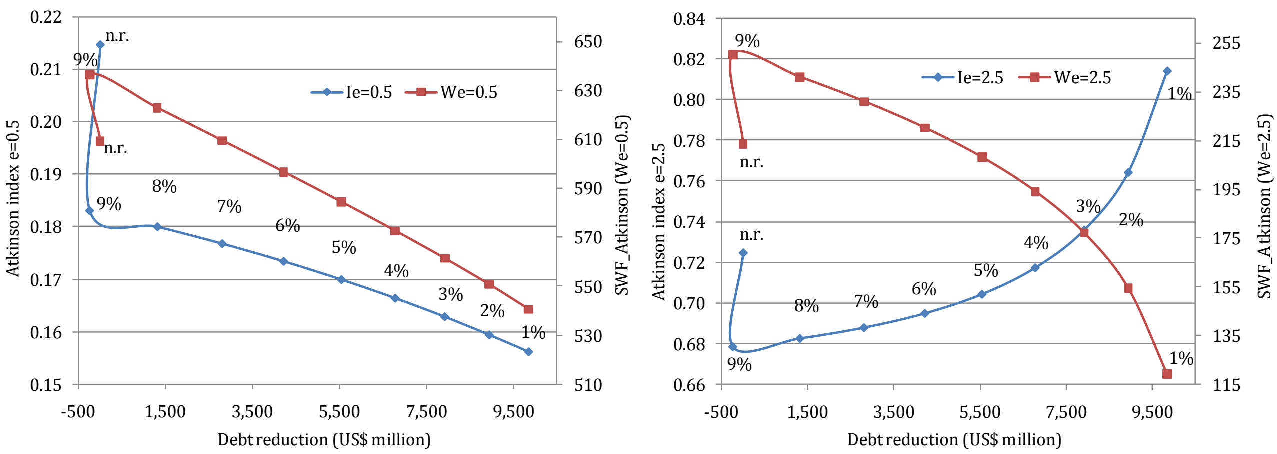


Source: Author's simulation. n.r.=no reform.

Figure 2 shows the effects of reform on pension debt, inequality and welfare according to the Gini criterion. As noted, any scenario of reform involves improvements in welfare and equity with respect to the current situation. If the planner is only interested in the effects on welfare, then he chooses the contribution rate α=9%, given that this scenario offers the highest level of welfare. However, this scenario increases the pension debt by US$245 million. In contrast, a planner more concerned with achieving greater reductions in the pension debt will choose a lower rate of contribution to the individual account, which will reduce inequality in pensions as well. Finally, if the criterion for choosing a scenario is to keep pensioners –in general- as well off as they would be with no reform, then the contribution rate α should be only 1%, which in turn implies the largest reduction of debt and the most equal pension distribution.

These results change when using the Atkinson criterion. According to the left panel of figure 3 (with *e*=0.5), the planner favours a contribution rate α slightly lower than 7% as this rate ensures at least the same welfare as in the no reform situation. Furthermore, it saves US$2,800 million and reduces inequality. Similarly, in the right panel (with *e*=2.5) the α preferred by the planner is between 5% and 6%; it generates savings between US$4,200 and US$5,500 million and also reduces inequality. However, if the first goal of the planner is to reduce inequality, then he prefers a contribution rate of α=9%.

FIGURE 3: DEBT REDUCTION, INEQUALITY AND WELFARE (ATKINSON CRITERION)

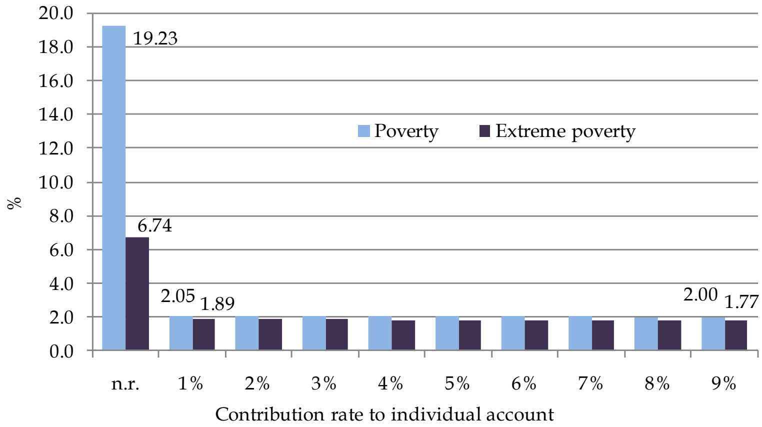


Source: Author's simulation. n.r. = no reform.

The reform can affect the old-age poverty rates as well. Under the assumption that the pension is the only income source during old-age, it is possible to find the share of retired with pensions under the poverty and extreme poverty line. Without reform, 19.2% and 6.7% of the retired would be poor or extreme poor, respectively[15]. Both these percentages drop significantly to around 2% with any of the reform scenarios analysed (see figure 4).

[15] As the simulations consider a pensioner with a spouse, the pension is compared with the double of the poverty or extreme poverty line; these lines were S/.226 and S/.119 per capita, respectively.

FIGURE 4: RETIRED WITH PENSIONS BELOW THE POVERTY LINE



Source: Author's simulation. n.r.=no reform.

4.3 Sensitivity analysis

Although the values assumed for the parameters of the simulation are based mainly on empirical evidence, it is instructive to show the sensibility of the simulation's results to changes on some parameter values. Perhaps, the pension fund return rate $\tilde{r}$ and the density of contributions (t_1) assumed are the most debatable values. In the appendix it can be observed how the results on pension debt reduction, welfare and inequality vary due to changes on $\tilde{r}$ and t_1. We allow $\tilde{r}$ to vary between 4% and 8%, and t_1 between 30% and 70%. As we observe in tables A1 to A3, the results are much more sensitive to changes of the pension fund return rate than to density of contributions. A multi-pillar system leads to larger savings in pension debt when the pension fund return is higher. For instance, if the return rate is more than 6%, all things equal, a reform always produces reductions in the debt, whatever the value of α. In contrast, lower return rates limit the values of α that leads to debt decrease (see the cases of return rates of 4% and 5% in table A1). The same relations are observed for changes in the density of contributions, although the size of the variation in pension debt is smaller. This exercise is also interesting for policy makers because it allows identifying additional policies for enhancing gains from the reform; for example, policies oriented to encourage contribution and pension fund returns helps to obtain better results.

As expected, higher pension fund returns lead to larger pensions but also wider pension inequality. However, the welfare position corresponding to the scenario of no reform improves with the pension fund return. This in turn, imposes limits for the value of α under which pensioners may be as well off as they would be with no reform. For instance the scenario of no reform is ranked in fourth place (under Gini criterion) when the pension fund return is 8%, thus α must be larger than 6% in order to obtain a pension distribution with at least the same welfare level. Changes in density of contributions lead to the same relations in distributional and welfare measures but with less importance.

4.4 The third pillar

So far the analysis of the multi-pillar system has focused on the effects of first and second pillar as these are mandatory and are the basis on which the new pension system is sustained. The third pillar is voluntary and is intended for workers willing to save more in order to obtain better pensions. In general, low-income individuals might not be interested in this scheme because they must allocate their limited resources on more immediate needs. The third pillar should be designed to alleviate rigidities of first and second pillar (Holzmann et al, 2005). This may attract individuals who are already enrolled in the pension system, and even those who are not insured (e.g. professional self-employed workers) and willing to participate if incentives are adequate in their view.

A possible scheme is fixing a wage ceiling to charge the AFP's administrative fee. So, the insured that earn more than that ceiling and choose the third pillar will pay the fee only up to the ceiling. In addition, the AFP may establish other fee schema for those who earn more than the ceiling or who are not enrolled in the pension system. It is expected to find resistance in the AFP as the main portion of its revenues relies on the fees charged to high-income insured. But it is also true that the proposed multi-pillar system would increase significantly the number of its contributors (those coming from SNP) and revenues. In December 2006, there were 1.4 and 0.57 million contributors in the SPP and SNP respectively; which means that, at the reform date, the number of AFP contributors would rise by 40%. This increase contrasts sharply with the yearly growth rate of the number of contributors noticed until December 2006, which was only 8.2%. Furthermore, if we keep the administrative fee (in average this is 1.8075% of wages), the multi-pillar system would allow the AFP to increase its revenues by 23%, which is larger than the yearly growth rate of AFP revenues (8.1% between 1997 and 2006). Table 7 shows the potential gains for the AFP.

TABLE 7: ADMINISTRATIVE FEE REVENUES (S/. MILLIONS, DEC-2006)

With Reform		
Administrative fee revenues from SNP's insured	116.5	
Administrative fee revenues from SPP's insured	505.7	
Total administrative fee revenues	622.2	
With reform and third pillar		
Variation in total administrative fee revenues:	with marg. rate=0.0%:	with marg. rate=0.9%:
With wage ceiling of S/. 6,000	-38.1	39.2
With wage ceiling of S/. 7,000	-17.9	49.3
With wage ceiling of S/. 8,000	-1.9	57.3
With wage ceiling of S/. 9,000	10.5	63.5
With wage ceiling of S/.10,000	21.0	68.7

Source: Author's simulation, SBS and ONP.

The AFP's revenues may potentially increase by S/.116.5 million with the multi-pillar system without the third pillar. Imposing a wage ceiling of S/.6,000 a month would reduce revenues by 38 million. As the wage ceiling rises, the AFP find a positive variation in its total revenues. For instance, a ceiling of S/.10,000 would increase revenues by S/.21 million. The second column of table 7 shows the variation on AFP's revenues if the fee scheme of the third pillar is varied slightly. Instead of charging no fee beyond wage ceiling, the AFP could charge half the fee, i.e. 0.90375%. By this way, the revenues are reduced less than in the first fee scheme. For example, a ceiling of S/.10,000 would raise revenues by S/.68.7 million.

Although the arrival of insured from the SNP increases AFP's administrative costs, this increase should not be directly proportional to the number of new insured due to the existence of economies of scale in the pension fund industry (Galarza & Olivera, 2001). Therefore, it is feasible to set a fee schedule for the third pillar without an increase of fees. In addition, the third pillar would be open to non-enrolled workers and insured who earn less than the ceiling, which would allow AFP to collect extra fees and revenues. The setting of this fee may also serve as an additional vehicle for competition among AFP.

On the other hand, the AFP would no longer have a system competitor (the SNP) for recruiting new workers, which ensures a better and broader base of contributors. Moreover, the AFP are very profitable firms that already recovered their initial investment as is seen in their high profits and large levels of Return on Equity obtained during last years, even higher than in other Latin American pension systems (World Bank, 2004). Among Peruvian industries, the AFP industry is the sector with best returns (Gerens, 2006).

4.5 Organizational aspects of the reform

Organizational aspects of the reform are beyond the scope of our proposal but may have interesting effects. For example, insured of the SNP could choose any AFP or could be "assigned", by any criterion, to each of these firms. In the first case, firms would compete for those insured (there are more than 600,000 contributors in the SNP at Dec-2007). However, there exists the risk that the competition would be channelized through advertising expenses, sellers or gifts -which increases the administrative costs- instead of reducing fees. The second case prevents the increase of administrative costs but does not ensure the reduction of fees. Another option is to offer the entire group of SNP insured to a new AFP through a tender choosing the offer with the lowest fee. Some companies might be interested in this scheme as they can avoid the high sunk costs of starting business, which are typical in the pension funds industry. The offered fee should be lower than that of the rest of AFP and hence press to bring down the overall fees. We do not address the design characteristics of the tender, but this should minimally include clauses of temporal loyalty for the SNP's insured and the commitment of not raising the fee agreed for a certain period. Although politically risky and controversial, the State might create a governmental AFP with the automatic inclusion of all insured from the SNP. Its management and regulation would be identical to those of the AFP. In this case, the fee charged by the Government might work as a mechanism to reduce fees of the other AFP.

Undoubtedly, a multi-pillar system opens up many possibilities to improve the pension system in areas, particularly in the fee charged by the AFP. In this sense, another form to organize the reform might just be the negotiation between the AFP and the State with the aim to reduce the fee in exchange for the insured of the SNP. Regarding the solidarity fund, it may be administrated by the AFP or other firms specialized in funds management. Again, a tender offer for this fund could enhance conditions for its administration.

5. Conclusion

The muti-pillar system has three important effects. First, pension inequality is notably reduced, which breaks the transmission of inequality from labour income to pensions. Second, the system is welfare enhancing, although this depends on the chosen value of the contribution rate. And in third place, pension debt is importantly reduced. The key aspect of the results is that the multi-pillar system shows improvements in all these three issues. In addition, it has been shown that this kind of system prevents retired to fall in poverty. However, we acknowledge the existence of possible behavioural adjustments which can influence our results. For example, the implementation of a general minimum pension scheme can deter workers of contributing more than the period required to access to this guarantee. Furthermore, the obligation to contribute to the solidarity fund can encourage the top income earners to move to labour contracts without the mandate to contribute to any pension system. All these effects are interesting and can potentially affect our results but we are unable to address them due to data limitations.

As minimum pensions would be financed with contributions from insured rather than transfers from the Treasury, the State could allocate its resources to other social programs, which would enhance the social spending. Furthermore, the implementation of a minimum pension scheme gives the same rights to all insured whether these come from SPP or SNP. The proposed third pillar may attract high-income insured and workers who are not obliged to enrol in the pension system due to rigidities of the first and second pillar. It is expected that the AFP will not increase their fees due to the existence of economies of scale in the pension fund industry and the fact that the SNP will no longer be a competitor. Indeed, the creation of a third pillar is another mean for promoting competition among AFP. For these reasons, the implementation of a multi-pillar pension system may also be thought of as an opportunity to bring down the administrative fees.

References

Arenas de Mesa & Mesa Lago (2006) The Structural Pension Reform in Chile: Effects, Comparisons with other Latin American Reforms, and Lessons, Oxford Review of Economic Policy, 22(1), pp.149-167.

Arenas de Mesa, A., D. Bravo; J. Behrman; O. Mitchell & P. Todd (2008) The Chilean Pension Turns 25: Lessons from the Social Protection Survey, in: S. Kay & T. Sinha (Eds.) *Lessons from Pension Reform in the Americas*, pp.23-58 (New York: Oxford University Press)

Arza, Camila (2008) Pension Reform in Latin America: Distributional Principles, Inequalities and Alternative Policy Options, Journal of Latin American Studies, 40(1), pp. 1-28.

Atkinson, A.B. (1970), On the measurement of inequality, Journal of Economic Theory, 2, pp. 244-263.

Barr, N. & P. Diamond (2009) Reforming pensions: Principles, analytical errors and policy directions, International Social Security Review, 62(2), pp. 5-29.

Barr, A. & T. Packard (2005) Seeking solutions to Vulnerability in Old Age: Preferences, constraints, and alternatives for coverage under Peru's pension system, The Centre for the Study of African Economies Working Paper Series, N° 239.

Bernal, N., Muñoz, A., Perea, H., Tejada, J. & Tuesta, D. (2008) *Una mirada al Sistema Peruano de Pensiones. Diagnóstico y Propuestas*, (Lima: Grupo BBVA, Editorial Norma)

Bertranou, F. & A. Sánchez (2003) Características y determinantes de la densidad de aportes a la seguridad social en la Argentina 1994-2001, in *Historias Laborales en la Seguridad Social, Serie de publicaciones de la Secretaría de Seguridad Social*, Año I, Nº1, Ministerio de Trabajo, Empleo y Seguridad Social, Argentina.

Galarza, B. & J. Olivera (2001) La Industria del Sistema Privado de Pensiones en el Perú, SBS Documentos de Trabajo No. 02/2001, Superintendencia de Banca y Seguros.

Gasparini, L., G. Cruces, L. Tornarolli & M. Marchionni (2009) A Turning Point? Recent Developments on Inequality in Latin America and the Caribbean, CEDLAS, working paper No. 81.

Gerens (2006) *Estudio competitividad internacional y rentabilidad de las empresas en el Perú*, (Lima: Gerens)

Holzman, R.; Palacios, R. & Zviniene, A. (2004) Implicit Pension Debt: Issues, Measurement and Scope in International Perspective, Social Protection Discussion Paper Series No. 0403, World Bank.

Holzmann, R., R. Hinz & staff of the World Bank (2005) *Old-Age Income Support in the 21st Century: An International Perspective on Pension Systems and Reform*, (Washington: World Bank)

ILO (2009) *2008 Labour overview. Latin America and the Caribbean*, (Lima: International Labour Office, Regional Office for Latin America and the Caribbean).

Lambert, P.J. (2001) *The Distribution and Redistribution of Income*, 3rd Edition, (Manchester: Manchester University Press).

Lambert, P.J., D. Millimet & D.J. Slottje (2008) Inequality Aversion, Income Inequality, and Social Policy in the US: 1947 – 1998," in: G. Betti & A. Lemmi (eds.), *Advances on Income Inequality and Concentration Measures: Collected Papers in Memory of Corrado Gini and Max O. Lorenz*, pp. 295-323 (New York: Routledge Publisher).

Lindbeck, A. & M. Persson (2003) The Gains from Pension Reform, Journal of Economic Literature, 41(1), pp. 74-112.

MEF (2007), Informe anual de deuda pública 2007, Ministerio de Economía y Finanzas. Dirección Nacional de Endeudamiento Público.

MEF (2008), Informe final de la comisión técnica (Ley 28991 DS 051-2007-EF). Plan de mejoras al SNP y SPP que permitan asegurar su coexistencia en el mediano y largo plazo y propuesta de nueva política de inversiones del FCR.

Morón, E. & E. Carranza (2003) *Diez años del Sistema Privado de Pensiones: avances, retos y reformas* (Lima: Universidad del Pacifico).

World Bank (1994) *Averting the Old-Age Crisis: Policies to Protect the Old and Promote Growth,* (New York: Oxford University Press).

World Bank (2004) Peru: Restoring the Multiple Pillars of Old Age Income Security, Human Development Department, Report N°27618-PE.

Zvinieni, A & T. Packard (2002) A Simulation of Social Security Reforms in Latin America: What Has Been Gained?, Background Paper for Regional Study on Social Security Reform, Office of the Chief Economist, Latin America and Caribbean Regional Office, World Bank.

Appendix

I. Computation of the actuarial liability

A. Actuarial liability for insured of the SNP

For insured ≤65 years old:

$$RA_{ik}^{snp} = P_{ik}^{snp} \times CRU_{65,y} \quad \text{(A1)}$$

$$RA_{k}^{snp} = p_{k,65} \times \sum_{i=1}^{N_k} RA_{ik}^{snp} \quad \text{(A2)}$$

$$RA_{\leq 65}^{snp} = \sum_{k=21}^{65} RA_{k}^{snp} (1+r)^{k-65} \quad \text{(A3)}$$

For insured >65 years old:

$$RA_{ik}^{snp} = P_{ik}^{snp} \times CRU_{k,y} \quad \text{(A4)}$$

$$RA_{k}^{snp} = \sum_{i=1}^{N_k} RA_{ik}^{snp} \quad \text{(A5)}$$

$$RA_{>65}^{snp} = \sum_{k=66}^{T} RA_{k}^{snp} \quad \text{(A6)}$$

And the total actuarial liability in SNP is:

$$RA_{snp} = RA_{\leq 65}^{snp} + RA_{>65}^{snp} \quad \text{(A7)}$$

where:

RA_{ik}^{snp} : Actuarial liability for an individual i of age *k*.

RA_{k}^{snp} : Actuarial liability for all individuals of age *k*.

N_k : Number of individuals of age *k* in the sample.

$RA_{\leq 65}^{snp}$: Actuarial libiliality for all individuals of age *k*≤65.

r : Discount rate.

According to equations A4-A6, insured older than 65 years retire immediately. Although not explicit in equation A7, we also consider in our calculations of RA_{snp} the actuarial liability of the survivors of the insured who die before retirement age.

B. Actuarial liability for insured of the SPP

Although the minimum pension ($P_{\min}^{spp}$) of the SPP is restricted to a small fraction of its insured, we must quantify the corresponding actuarial liability of these future payments:

For insured ≤65 years old:

$$RA_{ik}^{spp} = S_{\min}^{spp} \times (P_{\min}^{spp} - P_{ik}^{spp}) \times CRU_{65,y} \quad \text{(A8)}$$

For insured >65 years old:

$$RA_{ik}^{spp} = S_{\min}^{spp} \times (P_{\min}^{spp} - P_{ik}^{spp}) \times CRU_{k,y} \quad \text{(A11)}$$

$$RA_k^{spp} = p_{k,65} \times \sum_{i=1}^{N_k} RA_{ik}^{spp} \qquad (A9)$$

$$RA_{\leq 65}^{spp} = \sum_{k=21}^{65} RA_k^{spp} (1+r)^{k-65} \qquad (A10)$$

$$RA_k^{spp} = \sum_{i=1}^{N_k} RA_{ik}^{spp} \qquad (A12)$$

$$RA_{>65}^{spp} = \sum_{k=66}^{T} RA_k^{spp} \qquad (A13)$$

Where $S_{\min}^{spp}$ takes value 1 if $P_{\min}^{spp} > P_{ik}^{spp}$ and the insured fulfils legal requirements to obtain a minimum pension; and zero, otherwise.

C. Present value of contributions for insured of the SNP

Since we retire workers at 65, the only contributors are the 64 years old or younger insured. The present value of contributions (VP^{snp}) is the expected discounted value of all contributions made by the insured until they retire (our youngest insured in the sample is 21 years old):

$$VP_k^{snp} = (14 \times 0.13) \sum_{x=1}^{65-k} \sum_{i=1}^{N_k} d_{ik}^{snp} \times Y_{ik} \times p_{k,k+x} \times (1+r)^{-x} \qquad (A14)$$

$$VP^{snp} = \sum_{k=21}^{64} VP_k^{snp} \qquad (A15)$$

D. Actuarial liability for insured of the new multi-pillar system

This computation is similar to that carried out for the SPP's insured. We also assume that the multi-pillar system provides a minimum pension for survivors, and that they always meet the legal requirements to obtain this benefit. Finally, we consider that the insured older than 65 (at December 2006) receive the larger pension resulting from the comparison between the multi-pillar pension and the original system's pension. This assumption is necessary to not affect the rights of workers who have already reached retirement age.

E. Present value of contributions for insured of the new multi-pillar system

$$VP_k^{mix} = (14 \times \beta) \sum_{x=1}^{65-k} \sum_{i=1}^{N_k} d_{ik}^{mix} \times Y_{ik} \times p_{k,k+x} \times (1+r)^{-x} \qquad (A16)$$

$$VP^{mix} = \sum_{k=21}^{64} VP_k^{mix} \qquad (A17)$$

II. Sensitivity analysis

TABLE A1: SENSITIVITY OF PENSION DEBT REDUCTION (US$ MILLIONS)

	Contribution rate to individual account								
	α=1%	*α=2%*	*α=3%*	*α=4%*	*α=5%*	*α=6%*	*α=7%*	*α=8%*	*α=9%*
Pension fund return rate									
4%	6,851	5,774	4,627	3,416	2,142	814	-567	-2,003	-3,491
5%	8,331	7,349	6,278	5,120	3,882	2,568	1,182	-268	-1,782
6%	9,855	8,949	7,923	6,784	5,547	4,219	2,805	1,315	-245
7%	11,300	10,454	9,456	8,325	7,072	5,713	4,256	2,712	1,085
8%	12,618	11,832	10,857	9,716	8,433	7,025	5,499	3,873	2,164
Density of contributions (t_1)									
30%	9,060	8,218	7,264	6,205	5,054	3,818	2,500	1,109	-350
40%	9,265	8,401	7,425	6,344	5,171	3,911	2,571	1,156	-326
50%	9,855	8,949	7,923	6,784	5,547	4,219	2,805	1,315	-245
60%	11,533	10,524	9,367	8,075	6,667	5,149	3,536	1,837	63
70%	13,723	12,581	11,254	9,765	8,135	6,376	4,510	2,547	491

Source: Author's simulation

TABLE A2: SENSITIVITY OF INEQUALITY AND WELFARE MEASURES TO PENSION FUND RETURN RATE ($\tilde{r}$)

	No reform	Contribution rate to individual account								
		α=1%	*α=2%*	*α=3%*	*α=4%*	*α=5%*	*α=6%*	*α=7%*	*α=8%*	*α=9%*
Pension mean										
4%	628.2	571.6	580.7	590.5	600.8	611.6	622.8	634.5	646.6	659.2
5%	694.4	601.0	612.4	624.6	637.4	650.9	665.0	679.7	694.9	710.6
6%	775.9	640.6	655.1	670.5	686.9	704.0	721.8	740.3	759.5	779.2
7%	876.5	694.2	712.7	732.4	753.1	774.7	797.2	820.4	844.2	868.7
8%	1001.1	765.8	789.3	814.1	840.2	867.3	895.4	924.3	953.9	984.2
Gini coefficient										
4%	0.471	0.288	0.297	0.306	0.315	0.324	0.333	0.342	0.351	0.359
5%	0.479	0.317	0.327	0.337	0.346	0.356	0.365	0.374	0.383	0.391
6%	0.488	0.351	0.361	0.371	0.380	0.390	0.398	0.406	0.414	0.421
7%	0.499	0.388	0.397	0.406	0.415	0.423	0.430	0.437	0.443	0.449
8%	0.515	0.425	0.433	0.441	0.448	0.455	0.461	0.466	0.471	0.475
Atkinson index (e=0.5)										
4%	0.202	0.128	0.130	0.133	0.136	0.139	0.143	0.146	0.150	0.153
5%	0.208	0.141	0.144	0.147	0.150	0.154	0.158	0.161	0.165	0.168
6%	0.215	0.156	0.159	0.163	0.166	0.170	0.173	0.177	0.180	0.183
7%	0.222	0.173	0.177	0.180	0.183	0.186	0.190	0.192	0.195	0.198
8%	0.231	0.192	0.194	0.197	0.200	0.203	0.205	0.207	0.210	0.211
Atkinson index (e=2.5)										
4%	0.709	0.805	0.746	0.712	0.688	0.671	0.659	0.649	0.642	0.637
5%	0.715	0.808	0.753	0.722	0.701	0.686	0.675	0.667	0.661	0.656
6%	0.725	0.814	0.764	0.736	0.717	0.704	0.695	0.688	0.683	0.679
7%	0.737	0.825	0.779	0.754	0.737	0.726	0.717	0.711	0.706	0.702
8%	0.779	0.874	0.838	0.816	0.799	0.787	0.778	0.770	0.764	0.759
Ranking of SWF with Gini										
4%	10	9	8	7	6	5	4	3	2	1
5%	10	9	8	7	6	5	4	3	2	1
6%	10	9	8	7	6	5	4	3	2	1
7%	7	10	9	8	6	5	4	3	2	1
8%	4	10	9	8	7	6	5	3	2	1
Ranking of SWF with Atkin. e=0.5										
4%	9	10	8	7	6	5	4	3	2	1
5%	6	10	9	8	7	5	4	3	2	1
6%	4	10	9	8	7	6	5	3	2	1
7%	2	10	9	8	7	6	5	4	3	1
8%	2	10	9	8	7	6	5	4	3	1
Ranking of SWF with Atkin. e=2.5										
4%	7	10	9	8	6	5	4	3	2	1
5%	6	10	9	8	7	5	4	3	2	1
6%	5	10	9	8	7	6	4	3	2	1
7%	4	10	9	8	7	6	5	3	2	1
8%	3	10	9	8	7	6	5	4	2	1

Source: Author's simulation

TABLE A3

SENSITIVITY OF INEQUALITY AND WELFARE MEASURES TO DENSITY OF CONTRIBUTIONS (t_1)

	No reform	Contribution rate to individual account								
		α=1%	*α=2%*	*α=3%*	*α=4%*	*α=5%*	*α=6%*	*α=7%*	*α=8%*	*α=9%*
Pension mean										
30%	764.6	639.3	652.8	667.3	682.6	698.6	715.3	732.7	750.7	769.2
40%	768.1	639.7	653.5	668.3	684.0	700.3	717.4	735.1	753.4	772.3
50%	775.9	640.6	655.1	670.5	686.9	704.0	721.8	740.3	759.5	779.2
60%	795.5	642.0	657.9	675.0	693.0	712.0	731.9	752.4	773.7	795.5
70%	821.6	643.8	661.5	680.6	700.9	722.3	744.7	767.9	791.9	816.5
Gini coefficient										
30%	0.487	0.351	0.361	0.370	0.379	0.388	0.396	0.404	0.412	0.419
40%	0.487	0.351	0.361	0.370	0.380	0.389	0.397	0.405	0.412	0.419
50%	0.488	0.351	0.361	0.371	0.380	0.390	0.398	0.406	0.414	0.421
60%	0.490	0.352	0.363	0.373	0.383	0.393	0.402	0.411	0.418	0.426
70%	0.491	0.352	0.364	0.376	0.387	0.397	0.407	0.415	0.423	0.431
Atkinson index (e=0.5)										
30%	0.214	0.156	0.160	0.163	0.166	0.170	0.173	0.176	0.179	0.182
40%	0.214	0.156	0.160	0.163	0.166	0.170	0.173	0.176	0.180	0.183
50%	0.215	0.156	0.159	0.163	0.166	0.170	0.173	0.177	0.180	0.183
60%	0.215	0.156	0.160	0.164	0.167	0.171	0.175	0.178	0.182	0.185
70%	0.216	0.156	0.160	0.164	0.169	0.173	0.177	0.180	0.184	0.187
Atkinson index (e=2.5)										
30%	0.740	0.840	0.792	0.763	0.744	0.730	0.720	0.712	0.706	0.702
40%	0.731	0.826	0.776	0.748	0.729	0.715	0.705	0.698	0.692	0.688
50%	0.725	0.814	0.764	0.736	0.717	0.704	0.695	0.688	0.683	0.679
60%	0.722	0.805	0.755	0.728	0.710	0.698	0.690	0.683	0.679	0.675
70%	0.720	0.797	0.748	0.722	0.705	0.694	0.687	0.681	0.677	0.674
Ranking of SWF with Gini										
30%	10	9	8	7	6	5	4	3	2	1
40%	10	9	8	7	6	5	4	3	2	1
50%	10	9	8	7	6	5	4	3	2	1
60%	10	9	8	7	6	5	4	3	2	1
70%	9	10	8	7	6	5	4	3	2	1
Ranking of SWF with Atkin. e=0.5										
30%	4	10	9	8	7	6	5	3	2	1
40%	4	10	9	8	7	6	5	3	2	1
50%	4	10	9	8	7	6	5	3	2	1
60%	3	10	9	8	7	6	5	4	2	1
70%	3	10	9	8	7	6	5	4	2	1
Ranking of SWF with Atkin. e=2.5										
30%	5	10	9	8	7	6	4	3	2	1
40%	5	10	9	8	7	6	4	3	2	1
50%	5	10	9	8	7	6	4	3	2	1
60%	5	10	9	8	7	6	4	3	2	1
70%	5	10	9	8	7	6	4	3	2	1

Source: Author's simulation