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The effects of a multi-pillar pension reform: The case of Peru

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Abstract

In this paper we study the consequences of a hypothetical multi-pillar pension system in Peru. We use unique administrative records of workers to estimate distributions of future pensions for the actual and multi-pillar system and assess the effects on pension inequality, pension liability and overall welfare for the insured population. Our results show that the large pension inequality and liability of the actual pension system can be substantially reduced with welfare preserving policies. As we consider different types of social welfare functions, our simulations illustrates, that when one considers welfare, it is important to define the implied value judgments, which are not universally agreed upon. Thus, the goal of this study is not to advice for a particular scenario of reform, but highlight the trade-offs that have to be made explicit in order to take the best possible option, which can be useful for policy-makers who intend to carry out a next generation of pension reforms in Latin America in the near future.

JEL Classification: H55, H63, I30, G23.

Keywords: Pension reform, pension inequality, social security, Latin America, Peru, economic policy.

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1. Introduction

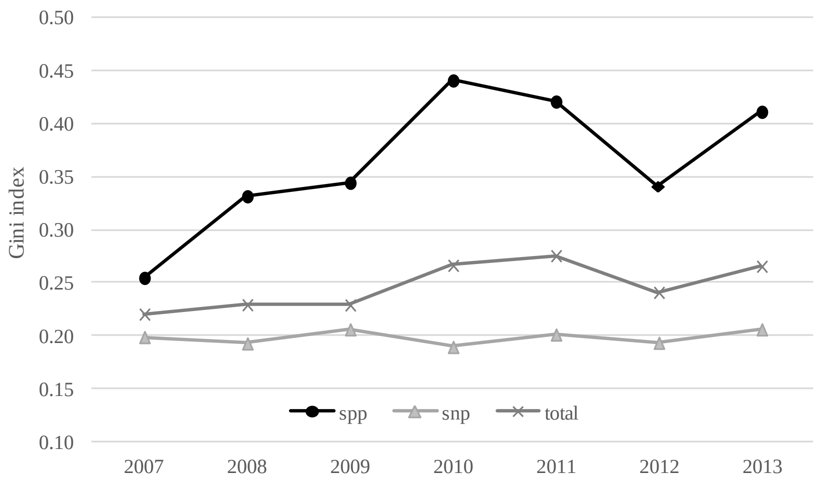
Inspired by the 1981 Chile reform, a number of Latin American countries have implemented Defined Contribution (DC) pension systems during the last two decades based on individual capitalization accounts and managed by the private sector. Some countries completely dismantled their public Defined Benefit (DB) systems (such as Bolivia, Chile, Dominican Republic, El Salvador and Mexico) whilst others kept these systems in order to complement the private scheme in an integrated system (Argentina, Costa Rica and Uruguay). Different from this practice, only Colombia and Peru maintained both public and private pension systems as two competing schemes. Arenas de Mesa and Mesa-Lago (2006) offer more details on these reforms. During recent years, Latin America has been experiencing a second wave of reforms, again under the influence of a major reform carried out in Chile in 2008. The idea behind these second generation reforms is to tackle the problems of low pension coverage, high administrative fees and old-age poverty. Kritzer et al. (2011) list some recent attempts in Colombia, Peru and Mexico and emphasizes on the major Chile's reform. The Chilean reform introduced a non-contributory pension based scheme on means-test and a top-up pension scheme with the aim of enhancing pension wealth. As a consequence, it is expected to result in a reduction in old-age poverty and pension inequality. This type of reform and the recent rise of non-contributory pension schemes in Latin America (see Bosch *et al.*, 2013) indicate, to some extent, that pension policy must also include measures to reduce old-age poverty and consequently pension inequality. This is an important shift with respect to the pension reforms 20 years ago, which were mostly focussed on financial sustainability. Recent evidence suggests that inequality and old-age poverty can be reduced in the mixed pension systems and, in particular, in the new reformed Chilean pension (Forteza, 2011 and Otero, 2013).

Peru started the process of a new pension reform in 2012[1], but the emphasis was merely on changing the scheme of administrative fees and certain administrative processes in order to reduce costs in the DC private pension system (SPP, for *Sistema Privado de Pensiones*). This reform overlooked distributive and fiscal problems caused by the competition between the private and public (a DB pension system called SNP) pension systems. The official actuarial liability of the public pension system is about 34% of GDP while the present value of contributions is about 14% of GDP, so the actuarial deficit is about 21% of GDP. This paper is motivated by the data presented in figures 1 and 2. The data used in Figure 1 comes from different cross-sections of the leading national household survey of Peru (ENAHO) and, with some limitations, show an increasing trend in the inequality measured with the Gini index of SPP pensions. In contrast, the Gini computed with public pensions is stable around 0.20. As a reference, the average Gini index of pensions is 0.158 in the OECD countries (see OECD, 2013). Currently, the measure of pension inequality in the whole system is not so high because the number of SNP pensioners (82%) is much larger than that of SPP pensioners (18%), although there is an increasing trend of the relative number of SPP pensioners. For instance, the share of SPP pensioners with respect to the sum of SPP and SNP pensioners has increased from 10% in 2007 to 18% in 2013. In general, public pensions are lower than private pensions because of the regulated minimum and maximum pensions, which in turn cause less inequality. In addition, private pensions have almost perfect correspondence with labour income, which explain the large inequality observed on these pensions. According to these trends, it is not difficult to foresee a continuing increase in the level of overall pension inequality as more SPP affiliates will enter into retirement during the coming years. Figure 2 shows the increasing evolution of official actuarial liabilities in the public system. Although the present value of contributions

[1] The pathway of this reform has not been free of controversy and political pressures. See Valladares (2012) for more details on the description and political analysis of this reform.

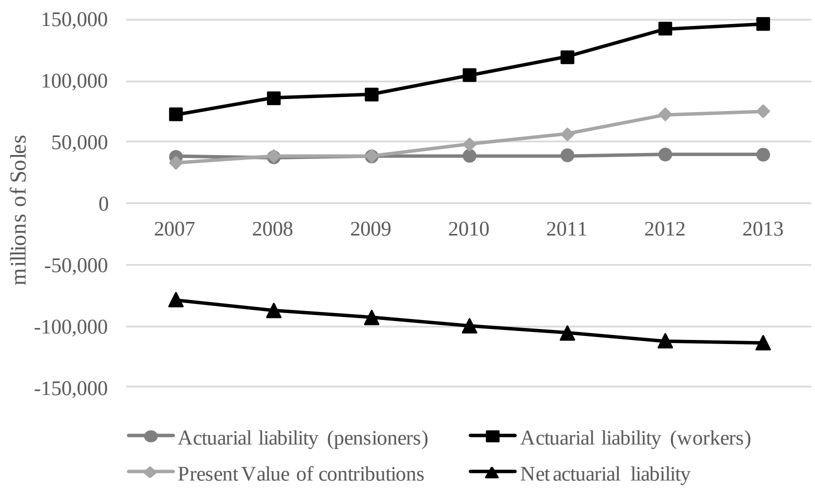
increases over time, this is largely surpassed by the sum of actuarial liability of present and future pensions.

Figure 1. Gini index of pensions (2007 – 2013)



Source: National Household Surveys (ENAHO) of Peru, years 2007 to 2013.
Author's elaboration.

Figure 2. Actuarial liability in the public pension system (2007 – 2013)



Source: National Pension Office (ONP). Author's elaboration.

The mentioned facts imply that the actual design of the Peruvian pension system is under the threat of facing larger inequality and liabilities. The existence of two competing pension systems does not appear to be reasonable in particular when one of those is a DB system where financial sustainability is precisely based on having an increasing number of contributors. In the end, the actual pension design encourages the middle and high income workers to choose the private system and the low income workers to opt for the public system. The aim of this paper is to study a policy response to this challenge and show the different effects on pension inequality, actuarial liability and overall welfare. In particular, we will study the effects of the implementation of a multi-pillar pension system that unifies the private and public pension systems of Peru. This is also a relevant exercise for other countries in Latin America (especially for Colombia) that are experiencing an increase in pension inequality caused by the implementation of capitalization accounts. Furthermore, we attempt to contribute with the analysis on distributional and welfare consequences of pension reform in Latin America. As pointed out by Arza (2008) and Barr and Diamond (2009) the study of distributional impacts of pension reforms is still limited in Latin America.

Our simulations are performed with unique data composed by administrative records of individuals affiliated to the private and public pension systems in December-2006. The strategy is to generate counterfactual distributions of future pensions under different scenarios of reform and compute actuarial liabilities, inequality and overall measures of welfare in order to compare it with the actual situation. The results of the exercises show that pension inequality and pension liability produced in the actual pension system can be substantially reduced without much overall welfare losses, but only under certain contribution rate values. Therefore, our set of different results are useful to highlight the trade-offs between inequality, efficiency and fiscal costs of a pension reform.

The rest of the paper is organized as follows. Section 2 outlines the Peruvian pension system. Section 3 presents the methodology of simulation. Section 4 presents and discusses the effects of the reform, and section 5 presents the conclusions.

2. The pension system in Peru

2.1 Actual characteristics

The private SPP was established in 1993 as a system based on individual capitalization without dismantling the public SNP, and hence individuals must choose one of them[2]. If the SNP is chosen, the insured is able to shift to the SPP, but the opposite is not permitted. If an insured moves from the SNP to SPP, the government can entitle a recognition bond (*Bono de Reconocimiento,* RB) to compensate for the contributions made to the SNP in the past. Public pensions are bounded with minimum and maximum values and the individual must contribute at least 20 years to obtain a minimum pension. There is no general scheme of minimum pensions in the SPP, but some old cohorts of workers caught in the reform transition can demand it. For this, the individual must be an ex-affiliate of the SNP and show at least a total of 20 contributed years to the SNP and/or SPP. The introduction of the SPP attracted a considerable number of insured from the SNP along with new workers who preferred to enrol in the new system, which weakened the financial sustainability of the pubic system. The net actuarial pension liability of the SNP at the time of the data collection (December 2006) was US$26 billion (about 23% of GDP). Note that this concept is defined as the present value of present and future pensions of the current insured and pensioners minus the present value of contributions of the current insured.

The 1993 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 a cost of US$2,137 million in actuarial terms due to the implementation of the Law 28891[3] (MEF, 2007; MEF, 2008). Only salaried employees of the formal sector are mandated to enrol

[2] The SPP is supervised by the Superintendence of Banking and Insurance (SBS) and the SNP is administrated by the Bureau of Pensions (ONP).
[3] Under restricted circumstances, the Law 28891 (*Ley de desafiliación*) allows some SPP insured to return to the SNP.

in the pension system, which means that self-employed, employers and informal sector employees can choose voluntarily to enrol or not. Since the informal sector in Peru is huge and incomes are low, pension enrolment may not be an optimal choice for informal workers[4]; hence the enrolment rate is small. Only about 25% of the population over 65 years old receive a pension.

2.2 The design of a multi-pillar pension system

The hypothetical multi-pillar pension system (MPP) can be implemented as the merger between the actual SNP and SPP, provided that the State recognizes the contributions made to any of these systems. In fact, the MPP will offer a minimum pension guarantee -similar to that of the SNP- to the individuals who are able to show 20 contributed years to any pension system, which is equal to the actual number of contributions required in the SNP. These contributions have to correspond to wages that are not lower than the official minimum wage. In addition, the insured previously enrolled in the SPP is allowed to keep her pension balance. Each insured will contribute a rate α of wages to her own individual capitalization account and a rate β of wages to a solidarity fund, which will help to finance the minimum pension guarantee. At retirement age, the pension is computed with the total pension balance and, if needed, topped up with additional resources from the solidarity fund to reach the value of a minimum pension.

As envisaged, the solidarity fund corresponds to the first pillar, while the individual capitalization accounts correspond to the second pillar. Note that the first pillar is financed by the contributions (rate α) paid by all the insured and, possibly, with public transfers if the solidarity fund is not enough. The second pillar is financed completely by the wages (rate β) of the insured. The MPP is a significant change with respect to the actual situation. The reform extends the minimum pension guarantee to the SPP affiliates and has the potential to reduce

[4] The informal sector was 55% of labour force in 2007 according to ILO (2009).

actuarial liabilities, which in turn may improve the allocation of public expenditures. The Government regularly transfer resources to pay the SNP pension payroll as the individual contributions are not enough. For example, the Government transferred about 0.73% of GDP to pay SNP pensions. This means that tax revenues (which are collected from all workers regardless of whether or not they are enrolled in pensions) are used to pay the pensions for a fraction of the population, which reinforces inequality. 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.

3. Data and methods

The effects of the reform are simulated by computing, first, the pensions of all individuals insured in the SNP, SPP and MPP; and then, the corresponding actuarial liabilities. The resulting distributions of pensions are used to compute pension inequality measures and pension averages and, therefore, welfare indexes. We estimate the effects of the proposed reform by comparing the actual and counter-factual distributions of pensions and pension liabilities. As mentioned before, α and β represent the percentage of individual's salary contributed to the solidarity fund and the individual capitalization account, respectively. We will use different values for these percentages in order to obtain different scenarios of reform. For comparability reasons we must choose values for α and β such as the contribution rate is $\alpha + \beta = 10\%$[5].

[5] 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 averages of the fee and insurance premium were 1.81% and 0.88%. Overall, the insured of the SPP and SNP pay a rather similar percentage of their salary.

3.1 Data

The data is composed of two representative samples of individuals registered in the administrative records of the SNP and SPP in December 2006. The database contains information on wage, age, sex, age of enrolment in the SPP, pension balance, BR value and its corresponding number of contributions. These samples are random and stratified by sex and age. Although this information dates from Dec-2006, our exercise is still relevant to analyse the Peruvian pension system as no structural reforms have been undertaken. After dropping records with inconsistent and missing information, the sample size in the SPP and SNP consist of 31,719 and 26,168 individuals, respectively. The simulation results use sample weights to account for the relative size of the SPP and SNP population.

3.2 Computation of pensions

The pensions of the SNP are computed following their specific pension rules, i.e. taking into account minimum and maximum pension values and particular replacement rates. The pensions of the SPP are computed with a simple capitalization process as the following:

$$P_{ik}^{spp} = \frac{0.10\sum_{j=k}^{z}\left(w_{ij}d_{ij}^{spp}\beta^{z-j}\right)+CIC_{ik}\beta^{z-k}+RB_{ik}}{A_{z,y}} \quad (1)$$

$$A_z = 12\left(\sum_{t=0}^{M-z}\frac{p_{z,z+t}}{\delta^t}\right) \quad (2)$$

$$A_{z,y} = A_z + 12\theta_{spp}\left(\sum_{t=0}^{M-y}\frac{q_{y,y+t}(1-p_{z,z+t})}{\delta^t}\right) \quad (3)$$

$$\delta = 1+\hat{r};\ \ \beta = 1+r \quad (4)$$

Where subscripts i, k and z indicate the individual, age at Dec-2006 and legal retirement age (equal to 65). P_{ik}^{spp} is the pension computed at retirement. w_{ik} is the annual wage, r is the yearly pension fund return rate and d_{ik}^{spp} is the density of contributions, which ranges from 0 to 1. The pension capital is composed by the contributions made between age k and z (first component of the right hand side of equation 1), the balance accrued up to Dec-2006 and their returns, and the Recognition Bond (RB_{ik}). The pension capital must be divided by the annuity price $A_{z,y}$ in order to obtain the pension amount. The annuity price is defined as the discounted capital needed to finance a monetary unit of life pension. Equations 2 and 3 denote the annuity price for a single and a married affiliate, respectively. To calculate the annuity price, we need $p_{z,z+t}$, which is the probability of survival from age 65 to 65+t according to the official mortality table; M is the maximum survival age; $\hat{r}$ is the annuity discount rate; $q_{y,y+t}$ represents the widow's probability of survival from age y to age $y+t$. Note that the fraction θ_{spp} indicates the percentage of pension that a spouse will receive upon the death of the pensioner[6].

The procedure to compute pensions in the MPP system (P_{ik}^{mpp}) is similar to the one employed in the SPP, though now the individual can receive a minimum pension (P_{min}^{mpp}) if she accrues a pension below this amount and simultaneously complies with the minimum required number of contribution years (see equation 5). Similar to the current SNP regulation, the minimum number of contribution years is 20.

$$P_{ik}^{mpp} = \begin{cases} Max\left[\frac{\alpha\sum_{j=k}^{z}\left(w_{ij}d_{ij}^{mpp}\beta^{z-j}\right)+CIC_{ik}\beta^{z-k}+RB_{ik}}{A_{z,y}}, P_{min}^{mpp}\right] & if\ comply\ with\ contribution\ period \\ \frac{\alpha\sum_{j=k}^{z}\left(w_{ij}d_{ij}^{mpp}\beta^{z-j}\right)+CIC_{ik}\beta^{z-k}+RB_{ik}}{A_{z,y}} & if\ not\ comply\ with\ contribution\ period \end{cases} \quad (5)$$

[6] This is 42% in the SPP, and 50% in the SNP.

3.3 Actuarial liabilities

Equipped with the previous pension formulas, we compute pensions for each individual of the sample at the age of retirement (65). Depending on the birth cohort of the individuals, we will obtain new flows of pensions in different years over the period 2007 to 2050. Thus, a particular year of the simulation includes the pensions of the new retirees of that year and the pensions of the retirees of previous years. This setting allows us to easily compute actuarial liabilities, which are defined as the capital needed to address the payment of current and future pensions. This payment is contingent on the life survival probability of current and future insured and pensioners. In a defined benefit system such as the SNP and a multi-pillar system as defined in this study, 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 and assumptions

Density of contributions:

Information regarding the number of individual past contributions are not available, so some assumptions have to be made. The goal is to obtain the estimated number of total contributions made by each individual between the date of pension enrolment and retirement. This will allow us to assess the individual's eligibility for a minimum pension in the MPP system and compute her pensions in the SPP and SNP. We will consider that all individuals retire at the legal retirement age, which is 65. The following expressions are used to compute the total number of contributions made by the individual:

For SNP: $$\tilde{a}_i^{snp} = t_0^{snp}\left(k_i - k_i^{snp}\right) + t_1^{snp}(65 - k_i) \quad (6)$$

For SPP: $$\tilde{a}_i^{spp} = a_i^{RB} + t_0^{spp}\left(k_i - k_i^{spp}\right) + t_1^{spp}(65 - k_i) \quad (7)$$

$$\text{For MPP:} \quad \tilde{a}_i^{mpp} = a_i^{RB} + t_0^j\left(k_i - k_i^j\right) + t_1^{mpp}(65 - k_i) \quad with\, j = snp, spp \tag{8}$$

$$a_i^j = \begin{cases} \tilde{a}_i^j & if \quad \tilde{a}_i^j \geq 20 \\ 20 & if \quad \tilde{a}_i^j < 20 \;\&\; 65 - k_i \geq 20 \\ \tilde{a}_i^j & if \quad \tilde{a}_i^j < 20 \;\&\; 65 - k_i < 20 \end{cases} \quad with\, j = snp, spp, mpp \tag{9}$$

$$d_i^{spp} = \frac{a_i^{spp} - a_i^{RB}}{65 - k_i^{spp}} \tag{10}$$

$$d_i^{mpp} = \frac{a_i^{mpp} - a_i^{RB}}{65 - k_i^j} \quad with\, j = snp, spp \tag{11}$$

Where k_i^j indicates the age at which the individual enrolled in the pension system j, a_i^j is the total number of contributed years between age k_i^j and retirement age, t_0^j is an assumed density of contributions between k_i^j and current age k_i, t_1^j is an assumed density of contributions between current age k_i and retirement age, and a_i^{RB} is the number of years contributed to the SNP recorded in the BR. Equation 9 computes the number of contribution years in each system and assumes that the individual contributes at least 20 years up to retirement (if age permits) in order to meet the eligibility criteria for minimum pensions. Equations 10 and 11 represent the density of contributions for each individual, which is the share of years contributed in a given period of years (between 0% and 100%). These densities are used in equation 1 and 5 to compute the value of pensions. In the case of the pension rules of the SNP, the computation of pensions requires the number of contributed years instead of the density of contributions (equation 9). We will assume that the parameters t_0^j and t_1^j are equal to 50% for each pension system, which is not far from the observed average of contribution density (51.1% in SPP in 1998-2008, and 47.1% in SNP in 2000-2007). Other more accurate estimated densities in Chile and Argentina are of a similar magnitude (Arenas de Mesa *et al.*, 2008; Bertranou and Sánchez, 2003).

Annuity price:

The annuity price is computed with the official mortality tables currently used in the SPP, and it is assumed that each insured has a spouse who is 4 years older/younger, being the male always older than the female. The annuity interest rate is 4.6%, which is the official interest rate to compute *Retiros Programados* (withdrawal pensions from the pension fund) in the SPP. Because of consistency, the discount interest rate for actuarial liabilities and present value of contributions must also be 4.6%. Other authors that estimate pensions in Latin American countries use similar rates. For example, 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%.

Pension fund return rate:

The assumed pension fund return rate is 6%, which is similar to other values used in pension projections for Peru (Moron and Carranza, 2003; Bernal *et al.*, 2008).

Pension rules:

The minimum monthly pension in the SPP and SNP is S/.484. In the SNP, the wife of a pensioner receives a survival benefit equal to 50% of the original pension (or at least S/.315 a month). We will assume all these values in the multi-pillar system.

Other assumptions:

We assume that prices, wages and pensions are held constant in the simulations, and there are no wage premiums based on seniority (due to data unavailability). The simulations do not consider the enrolment of new workers in the calculation of pensions and actuarial liability. In terms of micro-simulation techniques, our simulation exercise is similar to one of static simulation. The inclusion of new workers arriving into the pension system would demand the making of simulations and assumptions on fertility, labour supply and the decision of enrolment, which is beyond the scope of this study and, importantly, require data that is not available in the administrative records. However, the design of our simulation exercise is sufficient to highlight the trade-offs between inequality, pension debt and welfare.

We must clarify that we account for mortality differences (by sex and age) of the retirees when we add the pensions of different cohorts of retirees in a particular year. For example, the set of pensions in year *t* include the pensions of the new retirees of that year and the pensions of retirees of past periods *t-1*, *t-2*, and so on, which are accordingly multiplied by the probability of life survival. The survival probabilities are elicited from the official mortality tables of the SPP. As a result, we will have different sets of computed pensions for each year between 2007 and 2050, so that we will have a stream of computed distributions and indicators for each year.

3.5 Equity and welfare

The effect on the distribution of pensions is quantified by the Gini coefficient (*G*) and Atkinson Index (Atkinson, 1970). The Gini index is widely used to account for income inequality and measures the proportion of the area between the line of prefect income equality and the Lorenz curve. This index ranges from 0 to 1, with zero indicating perfect equality of incomes and one indicating extreme inequality (total income is owned by only one individual). The Atkinson index 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 A(*e*); where *e* is the parameter of inequality aversion of the social planner. In the context of pension systems, we argue that 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 the planner is not willing to sacrifice pension amounts in exchange for perfect equality. However, a planner that is more averse to inequality exhibits an index that tends to 1, and therefore tolerates large losses in pension values in exchange for greater equality. Similar to the Gini index, a lower value of the Atkinson index indicates lower inequality for a given value of e. For a population of n individuals (i=1,…,n) with pensions ranked in non-decreasing order $P_i \leq P_{i+1}$, and pension mean equal to μ, the Gini and Atkinson indexes are computed as follows:

$$G = 2\frac{\sum_{i=1}^{n-1} iP_i}{n\sum_{i=1}^{n-1} P_i} - \frac{n+1}{n} \tag{12}$$

$$A(e) = \begin{cases} 1 - \left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{P_i}{\mu}\right)^{1-e}\right]^{1/1-e} & if\ e \neq 1\ ; e \geq 0 \\ 1 - \frac{1}{\mu}\left(\prod_{i=1}^{n} P_i\right)^{1/n}\ if\ e = 1 \end{cases} \tag{13}$$

The estimated values of pension inequality indexes and pension means for the different scenarios of reform can be readily used to compute Social Welfare Functions (SWF). A key property of SWF is that these must be increasing income mean and decreasing in inequality (Lambert, 2001). This way, the SWF represents the tension between efficiency and equity. Two types of SWF are computed, one with the Gini index and the other with the Atkinson index as the following:

$$W_G = \mu(1 - G) \tag{14}$$

$$W_{A(e)} = \mu\big(1 - A(e)\big) \tag{15}$$

4. Effects of the reform

4.1 Actuarial liability

The actuarial liability of current SNP's pensioners is not estimated because the new multi-pillar pension system will not affect the pensions that are already entitled. Therefore, we abstract from the present pensioners in the computation of actuarial liabilities and define the *expected pension debt* as the difference between the actuarial liability of the actual affiliates and the present value of their contributions. Our estimation of expected pension debt in the actual SNP system is US$9,704 billion (10.4% of GDP) which is close enough to the equivalent official figure (US$9,958 billion). We must add to this amount the actuarial liability corresponding to minimum pensions that will be granted to few affiliates in the SPP in order to obtain the debt of the pension system as a whole. Thus, before any reform, the total expected pension debt amounts US$10,296 and represents 11% of GDP (see Table 1's top panel).

Table 1: Expected pension debt with and without reform (US$ millions)

No Reform	
a. Present value of contributions	4,550
b. Actuarial liability of SNP affiliates	14,255
c. Actuarial liability of SPP affiliates	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 contributions	20,763	18,456	16,149	13,842	11,535	9,228	6,921	4,614	2,307
f. Actuarial liability of affiliates	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

As defined before, the state must chose specific values for α and β to carry out the implementation of the MPP. Table 1 shows the effects of the MPP reform on pension debt under 9 different scenarios for these contribution rates subject to $\alpha + \beta = 10\%$. Each column reports the computed value of the expected pension debt for each contribution rate, which will be compared to the baseline of no reform. It is clear that each value of contribution rate will have different effects on pension debt, and as we will observe further, the effects on inequality and welfare will differ as well. For instance, in the first column only 1% of salary is contributed to the individual capitalization account and 9% to the solidarity fund, so that in this scenario the multi-pillar pension system will offer pretty similar pensions to everyone. In this scenario, the pension debt is sharply reduced to US$441 million, so the State may save up to US$9,855 million (about 10.5% of GDP). Of course, though instructive, this is an extreme scenario because equal benefits for everyone irrespective of salary differences will create large disincentives to contribute. However, if the contribution rate to the individual accounts is higher, as shown in the next columns of Table 1, the State may still obtain substantial reductions in expected pension debt. The other extreme case occurs when the contribution rate to the solidarity fund is only 1% and the contribution to the individual account is 9%. In this scenario the multi-pillar system would be more similar to the actual SPP although providing a general minimum pension. Instead of generating debt reductions, this scenario slightly raises the expected pension debt by US$245 million[7]. A social planner that is solely interested in reducing pension debt will chose the scenario with the lowest contribution rate to the individual capitalization account. This choice might also lead to less pension inequality, but it could also reduce the welfare of the pensioners and disincentive contribution.

4.2 Equity and welfare

Table 2 reports the indexes of pension inequality and pension means in the actual system disaggregated by SPP and SNP and in the proposed multi-pillar system. Given that in our simulation exercises we obtain the pension inequality indexes for each distribution of each year of the period 2007-2050, we must use a summary indicator or a reference period to compare the inequality arising from the reform and that from the actual system. We use the average of the Gini or Atkinson index obtained in the whole period. The same principle is applied to the case of pension means.

[7] This occurs because the multi-pillar system –different from the actual pension design- also guarantees a minimum pension to SPP affiliates.

Table 2: Pension inequality indexes and means

No Reform	Pensions			Wages		
	SNP	SPP	Total	SNP	SPP	Total
Pension 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
Atkinson (*e* =0.1)	0.004	0.062	0.050			
Atkinson (*e* =0.5)	0.018	0.270	0.215			
Atkinson (*e* =1.0)	0.010	0.313	0.204			
Atkinson (*e* =2.0)	0.057	0.696	0.634			
Atkinson (*e* =2.5)	0.067	0.770	0.725			

With Reform	Pensions								
	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	640.6	655.1	670.5	686.9	704	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
Atkinson (*e* =0.1)	0.036	0.037	0.038	0.039	0.040	0.041	0.042	0.042	0.043
Atkinson (*e* =0.5)	0.156	0.159	0.163	0.166	0.170	0.173	0.177	0.180	0.183
Atkinson (*e* =1.0)	0.199	0.190	0.184	0.179	0.175	0.171	0.168	0.165	0.162
Atkinson (*e* =2.0)	0.659	0.621	0.600	0.588	0.580	0.575	0.571	0.569	0.568
Atkinson (*e* =2.5)	0.814	0.764	0.736	0.717	0.704	0.695	0.688	0.683	0.679

A first look at the pension system before any reform evidences how different the SPP and SNP transmit inequality from labour to retirement. For instance, in the second row of Table 2's top panel one can observe that in the SNP the Gini of the affiliates' wages is 0.397 but the Gini of the retirees' pensions is only 0.117. In contrast, the Gini of wages in the SPP is 0.507 and the Gini of pensions is 0.563, so that the pensions granted in the SPP can exacerbate the inequality observed in wages. Overall, we observe that the actual pension system as a whole almost perfectly transmit the inequality from wages (Gini 0.496) to pensions (Gini 0.488). Evidently, the SNP reduces income inequality because of the minimum and maximum values of the pension. The SPP transmit income inequality to pensions because of the individual capitalization scheme. In particular, the greater inequality observed in pensions with respect to incomes in the SPP can be explained by the fact that younger cohorts of affiliates have more time to capitalize more funds and obtain better pensions than older cohorts with whom they will be compared to estimate the inequality index.

The second line of Table 2's bottom panel report the Gini indexes arising from the multi-pillar system implemented under different scenarios of contribution rates. The lowest value of the Gini corresponds to the lowest value considered for the contribution rate to the capitalization account, which is 1%. And the largest Gini corresponds to the highest value of contribution rate to the individual capitalization account. In any case, the pension inequality of the considered multi-pillar system scenarios (Gini 0.351 to 0.421) is always lower than that of the actual system (Gini 0.488). Similar results are observed for the Atkinson index until e = 0.5. However, higher values of the inequality aversion parameter lead to changes in the ranking of preferred pension distributions. For example, any planner who is very averse to inequality (e = 1.0, e = 2.0 or e = 2.5) prefers the scenario with a contribution rate of $\alpha = 9\%$, which is opposed to the case of a planner with e = 0.1 or e = 0.5 who prefers $\alpha = 1\%$ as this implies less inequality. However, this result is not entirely unexpected. As the aversion to inequality increases, more weight is given to the bottom part of the pension distribution; therefore, a distribution with more inequality at the end of the scale would be worst ranked (Atkinson, 1970). In our sample, we have detected that the variation of pensions at the bottom of the pension distribution decreases when α increases. The reason is that there are a large proportion of individuals receiving the minimum pension in the lowest deciles and some affiliates who cannot get this guarantee and obtain pensions below such level. This last group of individuals can accumulate more funds and have better pensions if α is larger, so that the differences between their pensions and the minimum pensions can shrink. So, increasing the level of pensions of the worst-off individuals is more important for a planner who is very adverse to inequality.

Table 3: Ranking of social welfare functions

Social Welfare Function	No reform	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%*
Gini	10	9	8	7	6	5	4	3	2	1
Atkinson (*e* =0.1)	2	10	9	8	7	6	5	4	3	1
Atkinson (*e* =0.5)	4	10	9	8	7	6	5	3	2	1
Atkinson (*e* =1.0)	3	10	9	8	7	6	5	4	2	1
Atkinson (*e* =2.0)	6	10	9	8	7	5	4	3	2	1
Atkinson (*e* =2.5)	5	10	9	8	7	6	4	3	2	1

Apart from the analysis of inequality of future pensions, Table 2 also provides information on pension means so that we can readily compute Social Welfare Functions (SWF) as denoted in equations 14 and 15. The total pension average is 775.9 Soles a month in the actual system which is larger than any pension average of the multi-pillar system with a contribution rate to individual capitalization below 9%. So, all the considered reform scenarios produce a lower pension average with respect to the actual system with the exception of $\alpha = 9\%$. However, the scenarios with higher α also produce larger inequality, and therefore we need to compute SWF to decide which policy is preferred in reference to the other. Table 3 reports the ranking of the SWF computed for each scenario and inequality index. As indicated in equations 12 and 13, the SWF takes a point of view that focuses on the overall welfare of the pensioners and not on any individual in particular. In any case, the inequality adverse parameter of the Atkinson index indicates the extent to which the social planner cares about the poorer.

The scenario with $\alpha = 9\%$ ranks as the most preferred with the Gini or the Atkinson criterion. The scenario of no reform is the worst ranked with the Gini criterion, but this can be better ranked with the Atkinson criterion. For example, if the planner does not care too much about inequality (e = 0.1), the actual system is ranked as the second most preferred, and hence only the scenario with $\alpha > 8\%$ will be advisable to implement from a SWF point of view. The reason is that a contribution rate larger than 8% will produce a welfare level that is at least as good as in the actual system with no reform. In contrast, if the planner largely dislikes inequality

(e = 2.5), the actual system is ranked fifth and hence only the scenario with $\alpha > 5\%$ will be advisable to implemented.

Figure 3: Pension debt and social welfare function (with Gini)

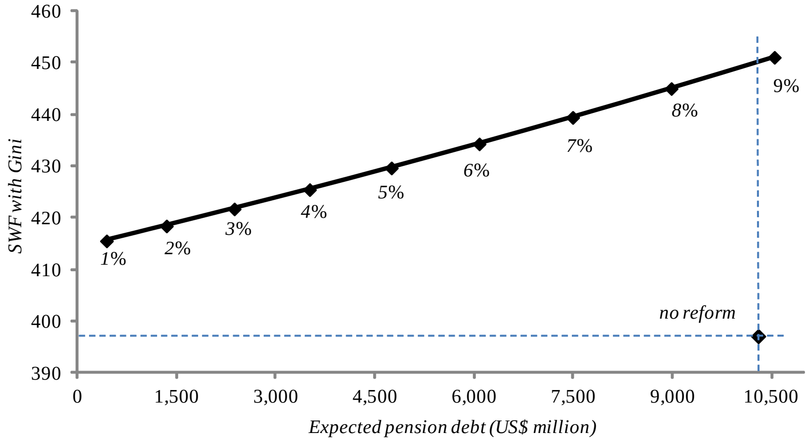


Figure 4: Pension debt and social welfare function (with Atkinson, e=0.5)

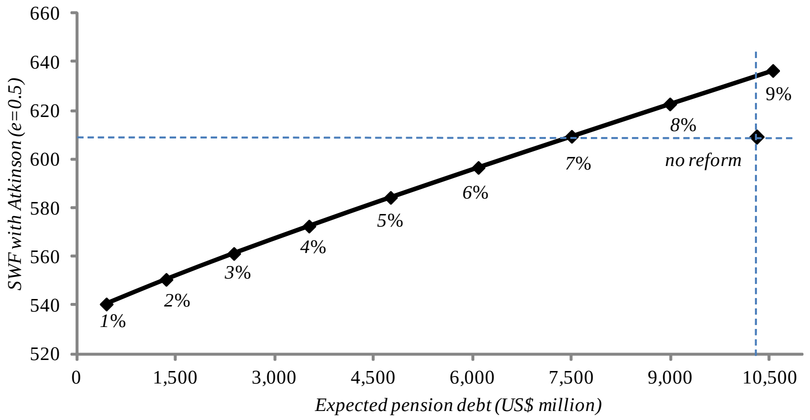
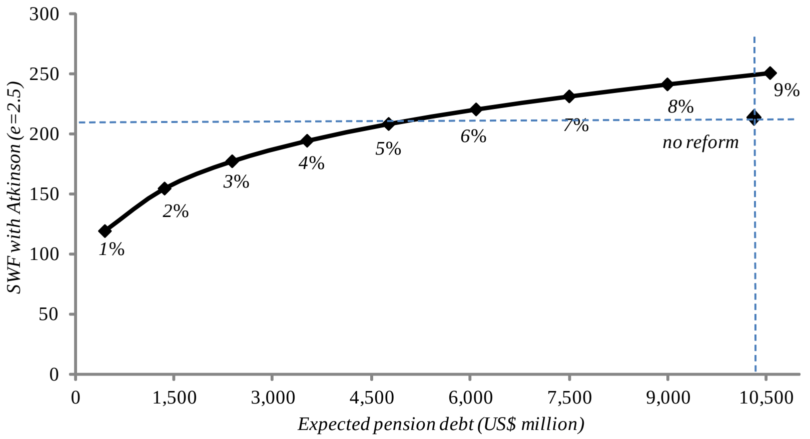


Figure 5: Pension debt and social welfare function (with Atkinson, e=2.5)



Note: The percentages next to each obervation indicate the contribution rate (α) for the individual capitalization account

Each scenario of reform implies a different level of expected pension debt. Recall that if no reform is implemented the present value of the pension debt will be US$10,296 million. The analysis of SWF seems to suggest that if any reform is undertaken, the scenario with $\alpha = 9\%$ should be the most preferred, but in that case the pension debt will increase to US$10,541 million. If one of the goals of the Government is to reduce the expected pension debt, then a contribution rate of 9% is unadvisable. To highlight these trade-offs, Figure 3 to 5 casts the relationship between different SWF and the expected pension debt for each reform scenario including the baseline case of no reform. In Figure 3 a social planner who favours the Gini criterion will find that a scenario of reform with a contribution rate somewhere just below 9% can improve the overall pensioners' welfare and keep the actual pension debt levels. But if the policy is intended to reduce the pension debt, then the planner must chose a lower contribution rate to individual accounts. As the graph shows, any contribution rate produces a superior value in the SWF with respect to the scenario of no reform.

Figure 4 depicts the relationship between the expected pension debt and the SWF of the Atkinson criterion with a low inequality aversion (e = 0.5). We observe that the contribution rate to individual accounts cannot be lower than 7% in order to maintain the pensioners as well off as in the case of no reform. If the chosen scenario is precisely $\alpha = 7\%$, then the Government can save about US$2,800 million, reduce the Atkinson index from 0.215 to 0.177 and maintain the pensioners with the same level of overall welfare. Therefore, for a planner with little concern for inequality and inclined to increase the welfare and reduce the pension debt from their actual levels, the preferred contribution rate will be between 7% and just under 9%. In contrast, Figure 5 illustrates the case of a planner with a high degree of aversion to inequality. In this case, the preferred contribution rate will be placed between 5% and just under 9%. Importantly, if $\alpha = 5\%$ is chosen, the pension debt can be significantly reduce by more than

50% (from US$10,296 million to US$4,749 million) while that the pensioners welfare is maintained at its actual levels.

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 sensitivity of the simulation 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. The results are much more sensitive to changes in the pension fund return rate than to density of contributions (see tables A1-A3 in the appendix). A multi-pillar pension 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%, any scenario of reform implies a debt reduction. In contrast, lower return rates limit the values of α under which there is a debt reduction (e.g. return rates of 4% and 5% in table A1). The same relationships 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.

As expected, higher pension fund returns lead to larger pensions but also wider pension inequality. However, the welfare position corresponding to the baseline scenario of no reform improves with the pension fund return. This in turn, imposes a limit for the value of α under which pensioners may be as well off as they would be with no reform. For instance, the baseline scenario is ranked in fourth place (under the Gini criterion) when the return is 8%; and hence the rate α must be larger than 6% in order to obtain a SWF with at least the same welfare level. Similar patterns are observed with the variation of the density of contributions.

5. Concluding remarks

In this paper we have shown that the actual design and conditions of the Peruvian pension system will lead to high levels of pension inequality and expected pension debt. According to our computations, the Gini index will be 0.488 and the present value of the pension debt will be US$10,296 million, which is about 11% of GDP. To address these problems, we have simulated a hypothetical multi-pillar pension system that unifies the public and private system of Peru and provides a minimum pension guarantee with a top-up scheme. In this proposed system, the affiliates will contribute a rate α of wages to individual capitalization accounts and a rate β of wages to a solidarity fund to finance out the top-ups for minimum pensions. Importantly, in terms of the transition for the new policy, the SPP affiliates will keep their actual pension balances. The results of the simulations are reported for different scenarios of contribution rates α which are compared with the baseline case of no reform.

Our results indicate that the pension debt can be significantly reduced if the contribution rate for the individual capitalization account is low, although at the same time, this represents lower values for the social welfare function (SWF). In addition, pension inequality also declines with α if the inequality is measured with the Gini index or with the Atkinson index when the planner is not too adverse to inequality. Looking only at the scenarios of reform that will maintain at least the same overall welfare as in the actual system and will not increase the expected pension debt, the simulations show that any α just under 9% is feasible for a SWF that uses the Gini criterion. But if the SWF uses the Atkinson criterion with low aversion for inequality, α should be between 7% and just under 9%. In contrast, if the SWF has a high degree of aversion to inequality, α should be placed between 5% and just under 9%. All these results illustrates, that when one considers welfare, it is important to define the implied value judgments, which are not universally agreed upon. Thus, the goal of this study is not to advice for a particular scenario of reform, but highlight the trade-offs that policy-makers have to make explicit in order to take the best possible option.

Of course, the government can be tempted to choose welfare preserving policies that achieve maximum reductions in the expected pension debt, so that the contribution rates (α, β) could be set in (1%, 9%), (7%, 3%) or (5%, 5%) under the Gini, Atkinson low inequality aversion and Atkinson high inequality aversion criterion, respectively. However, some possible behavioural responses can deter the government from choosing low contribution rates for the individual accounts. For example, the mandate to contribute to the solidarity fund can disincentive high-income earners to contribute, so that the solidarity fund will be smaller and the expected pension debt will be larger. In addition, moral hazard can be at work if the implementation of a general minimum pension scheme discourages workers from contributing beyond the minimum period to be eligible. All these factors are important to have a complete picture but we are unable to address them due to the limitations of our data[8].

The main lesson of the precedent analysis is that policy-makers must bear in mind that pension policies have different roles and effects to be considered. Making clear the trade-off of these policies will help to choose better and more appropriate reforms.

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[8] See for example the studies by Attanazio et al. (2011) and Joubert (2011) on the behavioural effects of the 2008's Chilean reform on labour participation and saving responses, which is possible thanks to an outstanding longitudinal survey matched with administrative records.

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Appendix

I. Computation of the actuarial liability

A. Actuarial liability for insured of the SNP

For insured ≤65 years old:

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

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

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

For insured >65 years old:

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

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

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

And the total actuarial liability in the 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 liability for all individuals of age *k*≤65.

d : 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:

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

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

$$RA_{\leq 65}^{spp} = \sum_{k=21}^{65} RA_{k}^{spp} (1+d)^{k-65} \quad \text{(A10)}$$

For insured >65 years old:

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

$$RA_{k}^{spp} = \sum_{i=1}^{N_k} RA_{ik}^{spp} \quad \text{(A12)}$$

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

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):

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

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

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 who is 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 do 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

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

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

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 contribution (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

Table A2: Sensitivity of inequality and welfare measures to pension fund return rate ($\tilde{r}$)

Outcome	*Interest rate*	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 index	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 Atkinson (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 Atkinson (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

Table A3: Sensitivity of inequality and welfare measures to density of contributions (t_1)

Outcome	*desnsity of contributions*	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 index	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 Atkinson (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 Atkinson (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