An Application of HERPOR Model: The Portuguese Social Security System Reform[1]

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Abstract: The paper analyses the impact of various types of reform options on Social Security system financial sustainability as well as on a range of macroeconomic variables. We use the HERPOR model to consider the effect of parametric reforms through changes in parameters of the existing pay-as-you-go system, namely the elimination of early retirement schemes, a positive shock in the effective contribution rate to social security, and the combination of those two reforms simultaneously, plus the effect of a systemic reform with the progressive abolition of the pay-as-you-go system and the implementation of a fully funded system. It is concluded that the former are sufficient to assure social security financial sustainability, although they should be accompanied of employment implementation measures. Therefore, a fully funded social security system does not seem to be a solution.

Key words: Social Security Systems Reforms; Macro econometric Model; Pay-as-You-Go System; Fully Funded System
JEL Classification: E13; E62; H55; H62; J14; J26

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1. Introduction

This paper adopts the HERPOR model to analyse alternative reform options to social security system. Demographic and economic factors are challenging social security system financial sustainability everywhere in the developed world provoking an intense debate all around European Union and worldwide (European Commission (2003); OECD (2001, 2003); World Bank (1994, 2001)). Considering that this is not a Portugal exception (Silva et al. (2004)), we observe some reforms that include the amendment of the formulae used in calculating pensions and the creation of a reserve fund. The role of private occupational pension plans and personal saving plans is also enhanced, although not without opponents (Mitchell and Utkus, 2003) and increasing awareness of risks (OECD, 2004).

The paper enlarges previous research in this field by considering additional reforms in the existing pay-as-you-go system and the adoption of a fully funded system, using a macro econometric model. In addition, we assume the complete convergence between public sector and private sector pension schemes, as far as eligibility requirements for old age pensions and benefit formulae is concerned, that is already taking place[2].

The paper is organised as follows: section 2 presents the institutional setting. Section 3 considers the literature review. Section 4 presents the model. Section 5 describes the methodology. Section 6 presents the results. Section 7 concludes.

2. Institutional Setting

The decrease of the proportion of the young combined with the increase in the proportion of aged 60 or more is a fact in Portugal. Two determinant factors contribute to this disequilibrium: the fertility rate and the life expectancy (Economic Policy Committee, 2003).

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[2]As can be seen in National Strategy Report (2005): adequate and sustainable pension systems available http://europa.eu.int/comm/employment_social/social_protection/pensions_en.htm#adequacy.

The implication of this on the financial sustainability and functioning of Social Security system is overwhelming. In the light of such evidence, what should be the best course of action to follow in order to maintain the contribution rate constant? In many countries, the raising of the standard age of retirement is being advised in order to minimise the effects of increased longevity. Additionally, the combination of pay-as-you-go with funded systems is enhanced as well as the responsibility of private occupational pension funds. On the other hand, governments have encouraged personal long-term saving by creating a stable economic and political environment, by establishing a legal framework for financial institutions, and by offering tax incentives to savers (World Bank, 1994, 2001).

In order to reduce the burden on future generations, the Portuguese Government introduced partial public capitalisation in 1989 with the creation of the Social Security Trust Fund (FEFSS). Funds not immediately used to pay out benefits are transferred into the fund for investment in the financial markets. The return on the investments will serve to reinforce the financial reserves sufficiently to help absorb the expected rising costs as more and more members of the active population go into retirement and long term unemployment remains high.

The simulation of the fund's assets was made by Silva et al. (2004) concluding that the fund's assets reach their peak of 12 032 501,7 million euros in 2012 and that the fund will be mobilised for the first time in 2011 and will run out in 2026. Similarly to other studies, particularly the Annual Report of the Board of Trustees of the Federal Old-Age and Survivors' Insurance and Disability Insurance Trust Funds (USA), they also analysed the actuarial and financial equilibrium of the system in the short term (the next 10 years) and in the long term (the next 50 years). The tests calculated helped to highlight the need for corrective action when actuarial and financial criteria were not met.

Considering that results obtained pointed to a weak financial condition on the part of the benefits subsystem, it is to be recommended that additional steps be taken to reform the system, namely the reinforcement of the fund[3]; the drive towards greater efficiency in the collection of contributions; the raising of the legal contribution rate; the

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[3] A supplementary contribution would have to be created to finance the costs of the life expectancy increases, since they correspond to additional pensions which have not been financed by the respective generations. This route has already been taken by several countries, in particular Sweden, which is an important reference model of the Welfare State (Scherman, 1999).

establishment of a ceiling for the pension benefit; and the introduction of an obligatory complementary pension, either in individual or group schemes.

The Portuguese social security system comprises three other systems[4]:

- The public social security system;
- The welfare provisions system; and
- The complementary system.

The public social security system comprises three sub-components: the benefits system[5]; the solidarity system and the family protection system. The welfare provisions system is developed by public institutions, namely autarchies, and by private institutions without profit purposes. Finally, the complementary system comprises legal regimes, contractual regimes and optional schemes. This system includes the second and the third pillars via the development of occupational and personal private pension schemes. In addition, civil servants scheme is regulated specifically and is not considered in the above structure.

The objective of the benefits system is to provide compensation for the loss or reduction of occupational earnings in the event of: sickness; maternity, paternity and adoption; unemployment; work accidents and occupational sickness; disability; old age; and death.

Those legally entitled to benefits under this sub-system are either employees or self-employed, constituting the general regime. In addition, the unemployed as well as non-working individuals have the option of subscribing to the sub-system, constituting the special regimes. The benefits system is based on the legal obligation to make contributions and covers the social insurance regimes applicable to employees and the self-employed. The complementary system is also regulated specifically, although it must obey to some criteria.

The financing of the system must obey the principles of diversification of the sources of income and of selective taxation criteria. More specifically, the financing of pecuniary benefits, which replace occupational earnings, is a twofold process, namely through the contributions of employees and through the contributions of employers. As already mentioned, and furthermore, the Law stipulates that there must be transference into the Social Security Trust Fund (FEFSS), created in 1989, of an amount between two and

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[4] In accordance with the terms of Law Nr. 32/2002, 20th December, that substitutes the Law Nr. 17 / 2000, 8th August.
[5] Or insurance-based system, which offers earnings-related pensions aiming to provide a standard of living similar to that obtained during working life, financed by earning-based contributions.

four percent of the contributions of employees, up to the point at which it the total expenditure on pensions for a minimum period of two years is ensured. In addition, any annual surplus in the benefits system, as well as profits on asset sales and the gains from financial investments, flow into the reserve fund, to be managed under principles of capitalization. In fact, the public social security system must consider the pay-as-you-go technique as well as the funded one to its financing.

At this point we should make a more detailed description of the pension system in its entirety in Portugal. Regarding first pillar pensions, Portugal offers a universal state pension regime, which is means-tested, and labour-market-based public pension schemes. All of them are mandatory for workers in the private sector, the public sector and the self employed. They represent pay-as-you-go schemes together with state budget financing in the case of the regime for civil servants. The second pillar is not mandatory, except for some workers of the private sector (namely banking and insurance sectors). The third pillar pension schemes are not mandatory[6].

The eligibility requirements for old age pensions are the following: the minimum age requirement for old age pensions for men and women is 65, exception made for the public sector which is 60 years of age or 36 years service whichever materialises first[7]; the requirements for contribution years is 15 years in the private sector and 5 in the public sector; the eligibility requirements for early retirement pensions is 60 years of age and 15 years of contribution in the private sector.

For the public sector, the indexation scheme is related to public employees' wages. Conversely, for the private sector the indexation scheme is ad hoc. Public pensions are taxed as wage income beyond a certain threshold and contributions to third pillar schemes receive a favourable tax treatment.

The pension formula is given by $P = x \frac{N}{D} w_{ref}$, where P is the pension benefit, x is the legal replacement rate, N is the number of years of the career, D is the maximum number of years of the career taken into account, and $w_{reft} = \sum_{i=0}^{T}(w_{t-i}/index_{t-i})$ is the reference salary, where index is the indexation rule for past earnings taken into consideration in the pension calculation . Thus, for the private sector scheme, the base period for the calculation of the reference salary (T) is the best 10 years' earnings over

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[6] See Garcia (2004) for the characteristics of private occupational and personal pension plans in Portugal.
[7] This requirement has changed since 2003. Accordingly, 60 years of age and 36 years of service must be fulfilled together.

the final 15 years[8] with x = 80% and D = 40 years. For civil servants is last wage for those who started working prior September 1993 with x = 100%[9] and D = 36 years, after that they are subject to the same rules as those of the private sector scheme. There is no ceiling and the indexation rule for past earnings is prices.

Finally, the statutory contribution rate is 34.75% for the private sector scheme (11% is the contribution of the employee and 23.75% is the contribution of the employer). Civil servants have a contribution rate of 10%.

3. Literature Survey

A major concern of policy-makers world wide, and especially in European Union, is that demographic shift will disrupt the social security systems. However, this increasing pressure must not put into question the importance of social security pension systems in terms of secure, durable and effective social protection, which should guarantee a decent standard of living in old age. Thus, social security pension systems should still be at the centre of the objective of strengthening the European Social Model[10]. The development of occupational retirement pension schemes as a complement in future is already underway (Directive 2003/41/EC of the European Parliament and of the Council).

Many European Councils have recognized the need to address the profound public policy implications of ageing populations at European level (Economic Policy Committee, 2001). The Economic Policy Committee (EPC) established a specific working group to examine the economic and budgetary implications of ageing, the Ageing Working Group, in 1999. The report that brought together the work carried out by the mentioned group included demographic projections, projections for the impact of

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[8] After the reform of 2002 this will become average lifetime earnings by 2035.
[9] Since 2004, x = 90%.
[10] Sapir (2005) argues that the notions of "European Model" or "Social Europe" are rather ambiguous, preferring to use the grouping of national systems into four different social policy models: Nordic countries, Anglo-Saxon countries, Continental countries, and Mediterranean countries. He presents the results of a typology exercise in terms of efficiency (high employment rate) and equity (high poverty rate) for the four country groupings: Nordic countries have a social model that delivers both efficiency and equity, whereas Mediterranean countries have a social system that delivers neither efficiency nor equity. He also emphasises the sustainability of social models noting that models that are not efficient are simply not sustainable in the face of growing strains on public finances coming from globalisation, technological change and population ageing. Therefore, there is a strong case for reforming European labour market and social polices, especially in Continental and Mediterranean countries.

ageing populations on public pension expenditures and on public expenditures on health and long-term care, and the analysis of how those projections could be used to examine the overall sustainability of public finances. The projections for spending before taxes on all public pensions and income transfers to the elderly (i.e. those schemes classified as general government expenditures in a national accounting framework and thus have a direct impact upon public finances, encompassing several schemes including old-age pensions, early retirement pensions, survivors and children's pensions, disability pensions and other transfers to the elderly) as a percentage of GDP reaches 13.3 in 2050, with a starting position in 2000 of 9.8.

Many changes were introduced to the functioning of social security systems in order to avoid some of the projected values, although unanimity on the forecasted results concerning financial sustainability has not been achieved.

Feldstein (2001) discusses a possible solution to the double problem of the rising cost of pensions and of assuring a European Union free labour market that combines an investment-based system of individual accounts with a "notional defined contribution" system financed by pay-as-you go taxes. Such a mixed system eliminates the risk of very low levels of retirement income but increases investment risk. Feldstein (2005a) describes the risks implied by a mixed system of social security pension benefits with different combinations of pay-as-you-go taxes and personal retirement account (PRA) saving, showing that those risks can be reduced by using private market guarantee strategies. Feldstein (2005b) discusses how such a mixed system could work in practice and how the transition to such a change could be achieved, analysing the economic gains and the problems that critics raise about any investment-based plan: administrative costs, risk, and income distribution.

European Commission (2001) makes an analysis of the policy options concerning reforms of pension systems in the EU. It discusses in broad terms the advantages and disadvantages of the various reform options making a distinction between parametric and systemic reforms, that is, whether the reforms are undertaken within the existing pension systems or whether they involve a switch from a current system to a new one. In addition, it presents some empirical simulations of selected reforms, which further illustrate the effects of reform options on some key economic variables, namely, economic growth, the sustainability of public finances and the income distribution between the working-age population and pensioners. Considering the parametric reforms, a number of individual and combined reform scenarios were assessed, namely

(1) a reduction in the generosity of the pay-as-you-go system brought about through changes in the systems replacement ratio[11], (2) an increase in the effective retirement age up to the statutory age of 65, and (3) a broad package of parametric reforms. On the other hand, two systemic simulations were undertaken: (1) an immediate 100 per cent switch to a fully funded pension system in 2000 + allowance for transition costs to a funded approach, and (2) a mixed pension system (25 per cent shift to funding + parametric reforms to bring the PAYG system back into equilibrium). The overall conclusion is that this last scenario may constitute an "optimal" policy path to be followed by the EU with strong gains for all the key policy variables which are targeted, namely a 28 per cent increase in the level of GDP compared with the baseline, a substantial reduction in the transition burden imposed on workers and overall gains in terms of the consumption of both the working age population and pensioners. An EU-15 aggregate version of DG ECFINs QUEST Model has been used for the scenarios, which can be characterized as a neo-classical growth model with short run Keynesian features arising from adjustment costs and nominal rigidities. It is considered a generalization to the Blanchard/Yaari life cycle framework or of a simple overlapping generations (OLP) model by allowing for realistic average lengths of life, work and retirement.

A good survey on different types of macroeconomic models used to analyze, to forecast or to simulate various economic situations can be found at Buscher et al. (2001), namely a computable general equilibrium model, a macroeconometric disequilibrium model, an overlapping generations model, and a small reduced form model for the German labor market. Beestmas et al. (2003) explore the consequences of aging for the Netherlands in a baseline scenario simulated with a dynamic general equilibrium model.

More recently, the Economic Policy Committee provides an overview of analyses on the impact of ageing populations on public finances and examines the merits and limitations of the approach used to assess the sustainability of public finances on the basis of the 2002 stability and convergence programs (Economic Policy Committee, 2003). Thus, public spending on pensions is projected to increase by between 3 and 5 percentage points of GDP in coming decades largely driven by the increase in the old-age dependency ratios (3,4 in the case of Portugal). One important conclusion is that parametric reforms such as the changing of indexing rules, a better actuarial match

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[11] This could be achieved in a large number of ways including cutting benefits directly, changes in the eligibility criteria, such as the number of years needed for full pension entitlement, or by changes to the rules applied with regard indexation.

between contributions and benefits, the linking of pension entitlements to life expectancy and measures to raise the effective age could have a major impact on expected pension expenditure, although on their own would only partially absorb the expected increase in pension expenditure. In addition, the assessment of the sustainability of public finances demonstrate a especially relevant risk of unsustainable public finances for the four euro area countries with highest underlying deficits in 2002, i.e. Germany, France, Italy and Portugal. Projections were made using the models of Member State authorities and applying a common population projection of Eurostat and broadly agreed assumptions on macroeconomic parameters.

In this context, our research aims to be an additional insight to the analysis of the impact of various types of reform options on social security system financial sustainability, following the concern that demographic changes have motivated.

4. The Model

The HERPOR model[12] is a macroeconometric model of the Portuguese economy that was inspired in the HERMIN Portugal[13]. The later is a four-sector macroeconometric model of the Portuguese economy and is part of a research project, involving teams from Greece, Ireland, Portugal and Spain, intended to build comparable macro models for these four countries of the European periphery to be used in the assessment of the effects of the Community Support Framework (CSF) on growth. The structure of HERMIN Portugal follows very closely the theoretical framework described in Bradley at al. (1995).

The HERPOR model considers four sectors: A (Agriculture, Forestry and Fishing), T (traded sector, mainly represented by Manufacturing), N (non-traded market sector, including Building and Construction, Utilities and other market services) and G (predominantly non-market services: Public Administration, Education, Health and Social services). It has the following features:

- in the short term, output is mostly determined by the demand oriented to all sectors;
- there is a short term trade-off between wage growth and unemployment;

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[12] The HERPOR model was developed at the Department of Prospective and Planning (DPP, Ministry of Environment, Territory Ordainment and Regional Development – Portugal). The working team included the DPP staff and two Professors at ISEG (Technical University of Lisbon). For a more detailed description of the model see Dias et al. (2003) and Dias (2006) available at http://www.dpp.pt/gestao/ficheiros/herpor.pdf.

[13] Modesto and Neves (1995).

- it admits long term (supply-side) effects of public policies promoting changes in physical and human capital stocks;
- the potential output, which determines the economy behaviour in the long-term, is a function of productive factors (stock of infrastructures, stock of productive capital, human capital and labour) with parameters estimated for the Portuguese economy.

The production functions considered in the model are Cobb-Douglas type with four productive factors: labour, given by the employment in volume; human capital, measured by the average number of years of training (either educational or professional) per person aged 25 years or more; infrastructure capital that corresponds approximately to the capital stock from sector G and a fraction of capital stock from sector N; and productive capital which corresponds to the remaining capital of the economy with the exception of dwellings. The production functions have constant returns to scale in labour, infrastructure capital, and productive capital. The model contains two production functions, one for the whole economy and other for the traded sector. The two production functions allow us to define measures of potential product which are used to determine output gaps. These output gaps interact with the remaining variables, namely, the demand for work in all sectors and in capital formation for the traded sector.

In the short term the traded sector assumes an important role in wage determination for the whole economy. The wage determination in the traded sector results from a specification where the change in the labour share depends negatively on the unemployment rate. This means that there is an implicit equilibrium unemployment rate associated with the stabilization of the labour share, in the long term.

The HERPOR Model was tested in two different ways. First, the analysis of the difference between the simulated and the historical values of the endogenous variables show that the model performs quite well since the within-sample errors were reasonably small. Second, some shocks were selected and implemented witch allowed us to perform a test of its theoretical coherence. Shocks in selected exogenous variables permit to estimate the partial derivatives or multipliers implied by our model.

The TSP 4.5 econometric software with the Gauss-Seidel solution method or the WINSOLVE econometric software with Newton's method were used to estimate the HERPOR showing a good behaviour and converging rather fast presenting a unique solution.

To perform the intended simulations considering social security system reforms, it was necessary to introduce some changes to the HERPOR model, namely to add equations and variables.

Firstly, to carry out the parametric changes in the existing pay-as-you-go system, the equations added or modified are (1) to (12) (see annexe 1).

On the other hand, to carry out the systemic reform concerning the progressive transition from the existing pay-as-you-go system to a fully funded system, the equations added or modified are (13) to (28) (see annexe 1).

Finally, and since the simulation period ends in 2050, we only took conclusions for the transition period between the two systems.

5. The Methodology

The new version of the HERPOR model was used to simulate the macroeconomic effects of social security system reforms as well as its impact on financial sustainability. The magnitude analysis of these reforms relies in the confrontation of two scenarios:

- The baseline scenario – representing the simulation of the social security system without reforms. This scenario corresponds to the trajectory observed in the Portuguese economy from 1977 until 2004, and to a projection of the economy from 2005 till 2050, with annual data; and

- Alternative scenarios - representing hypothetical trajectories of the economy given social security system reforms. These scenarios differ according to the specific reform implemented, that is, to a particular variable shock.

The baseline scenario, as well as the majority of the alternative scenarios, respects a political fiscal rule so that the public deficit is always around 3% of GDP from 2005 till 2050, with a decreasing trend. The introduction of this restriction intends to avoid the possibility that the deficit could reach values not acceptable from the point of view of European Union rules[14]. With this rule we make the fiscal burden over private income, in each year, dependent on the gap between public deficit with and without shock on the previous year.

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[14] Those rules are expressed in the Maastricht treaty.

In addition, we assumed a regulatory convergence between public sector social security scheme[15] and the general regime of social security system. This reflects a trend that is already taking place, namely considering the retirement age and the benefit formula, as mentioned in section 2. Hence, the effective contribution rate used in the model was constructed using the total revenues received by social security obtained from annual national accounts[16], that is, the effective contribution rate to social security is calculated as follows:

$$RGTYSOC = GTYSOC / YW ,$$ (29)

where $GTYSOC$ is the total contributions made by households and by employers to social security system and YW is total compensation. In fact, this is an estimate of the effective contribution rate in the sense that total compensation represents the sum of the gross wages with the contributions to social security made by the employers. Considering that the statutory contribution rate applies on gross wages, the effective contribution rate we obtained has a smaller value than the one that would be obtained if the contributions to social security made by the employers were removed from total compensations. Therefore, for 2004, the formula (29) gives us a contribution rate of 25.8% which corresponds to an effective contribution rate of 31.36% comparable with the statutory rate of 34.75%. The difference between 34.75% and 31.36% is due to some tax benefits and debts to the system. This issue must be considered in the conclusions.

We also assumed that the social security trust fund grows at a real rate of 3% per year in the simulation period. This assumption is based on the results presented in 2003 annual report of the FEFSS which presents an average real return of 2.8% for the period 1989 to 2003.

The results are presented in terms of percentage difference induced by the existence of a shock relatively to the baseline scenario under consideration. Formally, to a specific variable x, the percentage difference is given by

$$\frac{X^{with\ shock} - X^{without\ shock}}{X^{without\ shock}} * 100 .$$

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[15] Or civil servants scheme.
[16] National Statistical Institute.

5.1 The baseline scenario[17]

The construction of the baseline scenario, scenario 0, is of great importance, since a more optimistic projection for the exogenous variables will delay in time the imbalance of the current system, while a less optimistic projection will anticipate it. Therefore, we consider two baseline scenarios:

Baseline scenario 0 High: the growth rate of the real average pension is 1.5%[18]. Considering this scenario, social security system enters in imbalance in the year 2027 and survives until the year 2036 if the social security trust fund is mobilised, entering in imbalance in the year 2037.

Baseline scenario 0 Low: the growth rate of the average pension is equal to the growth rate of the gross average compensation, keeping the ratio between the average pension and the gross average compensation unchanged.

In this scenario, the imbalance of the system is in the year 2018. The mobilisation of the stabilization social security trust fund delays it to the year 2028[19]. Hence, this baseline scenario shows a worse evolution of social security financial sustainability.

The reforms impacts take into account these two baseline scenarios.

5.2 The alternative scenarios

Scenario 1

This scenario incorporates changes, or parametric reforms, to the existing pay-as-you-go system, namely:

Scenario 1A: the elimination of early retirement schemes;

Scenario 1B: a positive shock in the effective contribution rate to social security;

Scenario 1C: both changes simultaneously.

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[17] The data is with the authors.

[18] This hypothesis about this growth rate value constitutes a value between the 2.0% growth rate for the minimum pension and the 0.4% growth rate for the normal pension, projected by National Strategic Report (2002): adequate and sustainable pension systems.

[19] The results obtained in Garcia et al. (2004) are near to those of this scenario in which the social security trust fund runs out in 2026.

To obtain the scenario 1A we constructed an alternative series for the number of pension holders, where the early retirement schemes are eliminated considering that people will retire with 65 years (see annexe 2).

The scenario 1B considers a 1 percentage point increase in the effective contribution rate, reaching 26.8%.

Scenario 2

This scenario is related to the transition from the existing pay-as-you-go system to a funded system, representing a systemic reform. As mentioned, the base year for implementing the model is 2005. This year was chosen because is the last year for which all the data necessary to calibrate the model are available. The simulation period ends in 2050.

A set of hypotheses was established in order to perform this scenario:

- the new system has a unique fund and its management, whether private or public, it is not considered here;

- we considered a 3% real return rate for the new fund, similar to the one obtained by the social security trust fund;

- the introduction of a funded system occurs in 2005, meaning that the transition period ends when there is no pension claimers of the pay-as-you-go system;

- individuals with 15 years of contribution to the pay-as-you-go system, or less, at the inception of the funded system, automatically change systems contributing to the new funded system and making part of it. The individuals with more than 15 years of contributions remain in the pay-as-you-go system;

- in each moment in time there are individuals under the old system and individuals under the new system, but both the labour force and the pension claimers in the two systems must be equal to the value verified to those variables in the baseline scenario;

- after 2005 inclusive all entrees of new labour force go to the new system what means that the labour force in the pay-as-you-go system diminishes with time, running out in the moment at which the average age of individuals reaches 65 years old that, by hypothesis, we consider to be in year 2038;

- people under the new system may retire in the first two years of its existence, but the pension benefit calculation obeys to the old system rules;

- considering the gradual switch of systems, we assumed that the social security trust fund will run out with the disappearing of the pay-as-you-go system, alleviating the necessary additional financing of this old system;
- the scenario 2 is compared only with the baseline scenario 0 Low.

6. The Results

In this section we analyse the results of the mentioned reforms to the Portuguese social security system[20].

6.1 The baseline scenarios

To illustrate the main features of the model we present projections of the key variables under the two baseline scenarios. Naturally, these projections do not consider social security reforms. All parameters remain unchanged.

As can be seen, GDP has a better performance in the long term with scenario Lower, since this is a less generous one to pensioners (figure 1).

Figure 1: GDP - Baseline scenario (High and Low)

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[20] Data used to calibrate the model is collected by DPP, Ministry of Environment, Territory Ordainment and Regional Development – Portugal.
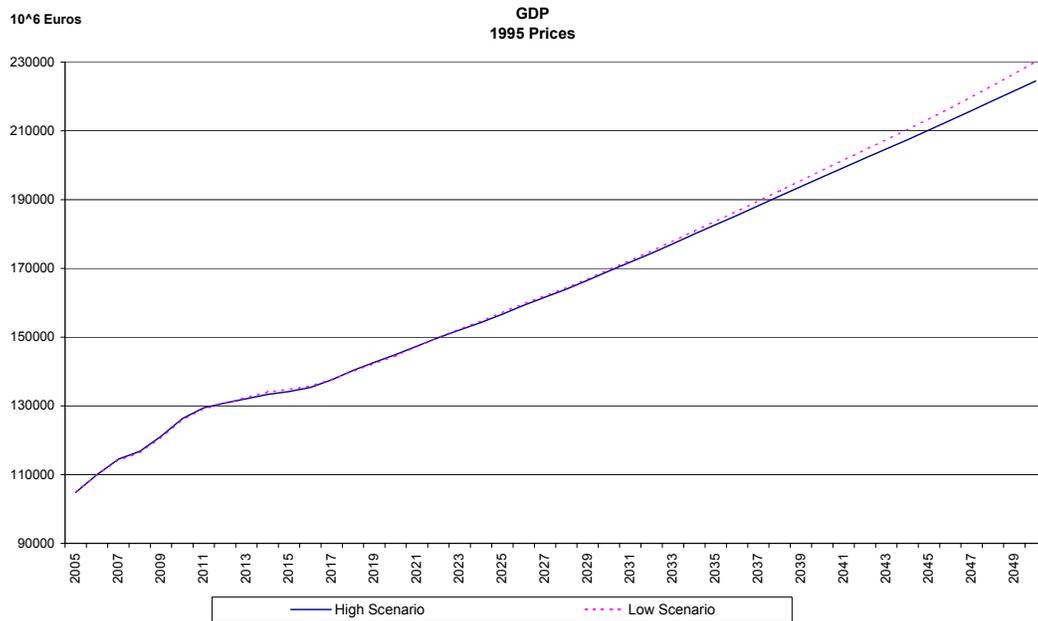
As mentioned in point 5.1, the financial situation of social security system is worse in scenario Low due to the hypothesis considered about the growth rate of the average pension that is assumed to be equal to the growth rate of the gross average compensation (figure 2).

Figure 2: Final Social Security Balance - Baseline scenario (High and Low)

10^6 Euros

**Final Social Security Balance
Current Prices**
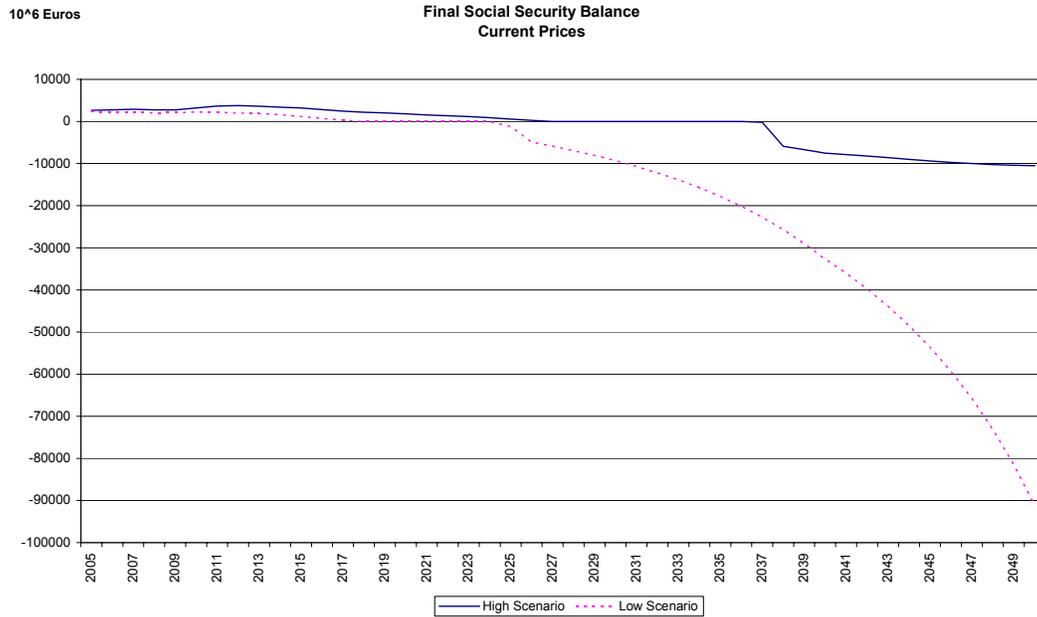
Figure 3 shows the evolution of the unemployment rate under the two scenarios. As expected, under the scenario Low, the unemployment rate is lower almost the entire simulation period.

Figure 3: Unemployment rate - Baseline scenario (High and Low)

Unemployment Rate
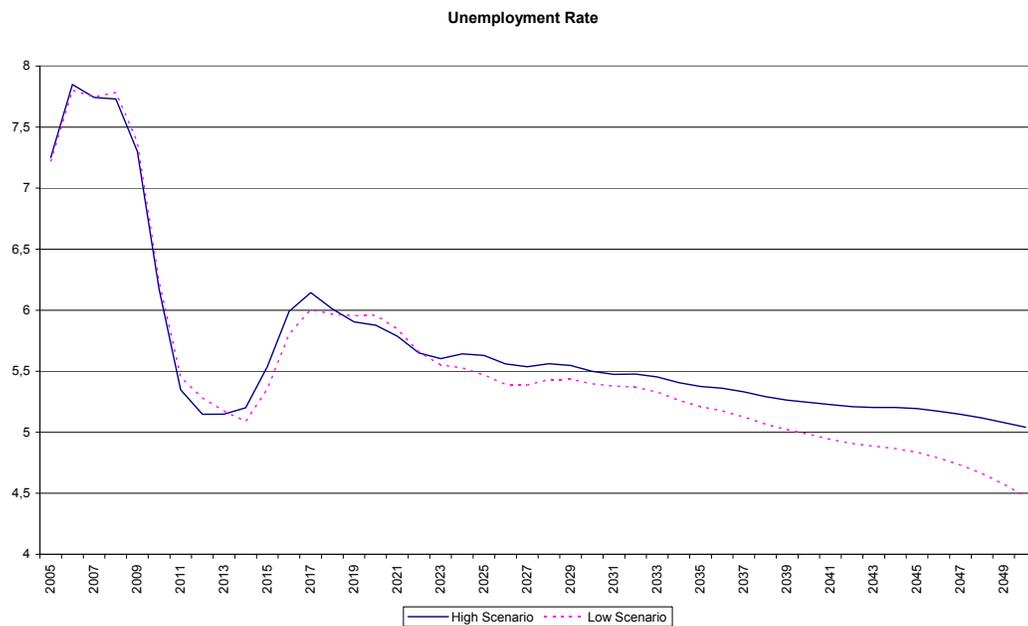
6.2 Scenario 1 - Parametric reforms to the pay-as-you-go system

6.2.1 Scenario 1A: the elimination of early retirement schemes

The results presented in Table 1 and Table 2 show that the effect of an increase in labour force is an increase in employment during all period and, simultaneously, an increase in the unemployment rate either in the beginning of the period under analysis (2005 to 2020) either at the end of the period (2031 to 2050), although, the decrease in the unemployment for the period 2021 to 2030 is not enough to eliminate a permanent increase in the unemployment rate for the period in analysis. The consequence of the increase in employment is a decrease in the wage and in the inflation rate, as well as an increase in the external competitiveness. Until 2010, the productivity increases but, as time goes by and the employment increases, the productivity decreases ending in 2050 with a negative effect. Despite the productivity decrease, the effect in GDP is positive, considering that the economy competitiveness increases due to a cost reduction. Synonymous of a better economic performance is an increase in real private consumption and in real gross capital formation. Private disposable income started to diminish with the shock, changing the trend after 2030 ending with a final positive effect. Private savings presents evidence to growth.

Public deficit improves with the shock and the social security balance presents improvements with both scenarios.

Table 1: Scenario 1A High: the elimination of early retirement schemes

Average percentage difference between values with and without shock					
Variables	2005-2010	2011-2020	2021-2030	2031-2050	2005-2050
GDP (1995 prices)	0,7	3,5	6,0	8,5	5,9
Potential GDP (1995 prices)	0,6	3,1	5,9	8,5	5,7
Private Consumption (1995 prices)	0,2	2,1	4,7	7,9	5,0
Gross Fixed Capital Formation (1995 prices)	0,4	2,6	4,5	6,3	4,3
Total Employment in volume	0,7	3,8	6,9	9,6	6,6
Unemployment rate	2,6	1,9	-0,5	1,5	1,3
Global Labour Force Productivity (1995 prices)	0,1	-0,1	-0,6	-0,9	-0,5
Global average wage (current prices)	-1,9	-5,8	-8,1	-10,3	-7,8
Private Savings (current prices)	3,6	8,8	6,9	10,5	8,4
Private Disposable Income (current	-0,6	-1,1	-0,2	1,8	0,4

prices)					
Labour Force	1,0	3,9	6,8	9,7	6,7
Number of Pensioners	-1,5	-4,8	-5,9	-4,9	-4,6
Average Pension (current prices)	-1,1	-3,7	-5,1	-6,2	-4,8
Average difference in percentage points of GDP					
Public Deficit (current prices)	0,0	-0,3	-0,5	-0,3	-0,3
Average values at current prices after the shock (millions of euros)					
Social Security Balance (current prices)	3057,2	4432,1	4024,0	1922,7	3073,0
Final Social Security Balance (current prices)	3057,2	4432,1	4024,0	1922,7	3073,0
Social Security Trust Fund (current prices)	6390,8	9274,8	15461,0	38259,0	22845,3

Table 2: Scenario 1A Low: the elimination of early retirement schemes

Average percent difference between values with and without shock					
Variables	2005-2010	2011-2020	2021-2030	2031-2050	2005-2050
GDP (1995 prices)	0,7	3,4	5,9	8,3	5,7
Potential GDP (1995 prices)	0,5	3,1	5,9	8,4	5,7
Private Consumption (1995 prices)	0,1	1,9	4,3	7,1	4,5
Gross Fixed Capital Formation (1995 prices)	0,3	2,5	4,5	6,2	4,2
Total Employment in volume	0,7	3,8	6,9	9,5	6,6
Unemployment rate	2,7	2,0	-0,4	2,5	1,8
Global Labour Force Productivity (1995 prices)	0,1	-0,1	-0,6	-1,0	-0,6
Global average wage (current prices)	-2,0	-6,1	-8,6	-11,6	-8,5
Private Savings (current prices)	3,2	7,3	5,4	5,7	5,7
Private Disposable Income (current prices)	-0,7	-1,6	-0,9	0,2	-0,6
Labour Force	1,0	3,9	6,8	9,7	6,7
Number of Pensioners	-1,5	-4,8	-5,9	-4,9	-4,6
Average Pension (current prices)	-1,9	-5,8	-8,1	-11,1	-8,1
Average difference in percentage points of GDP					
Public Deficit (current prices)	0,0	-0,4	-0,6	-0,4	-0,4
Average values at current prices after the shock (millions of euros)					
Social Security Balance (current prices)	2555,8	2990,4	569,8	-20857,1	-7961,0
Final Social Security Balance (current prices)	2555,8	2990,4	995,0	-19934,7	-7467,5
Social Security Trust Fund (current prices)	6491,1	9369,8	15049,7	1581,3	6842,8

We should note that, with the scenario High, the social security system imbalance is eliminated during the period in analysis, but, with the scenario Low, this shock is not

enough to eliminate the existing structural problems. In fact, social security system has a positive balance till 2027 and will become insolvent in 2034 when the social security trust fund runs out.

Clearly, the elimination of early retirement schemes induces a better economic performance and a better performance of social security accounts. However, a problem may arise with this kind of shock, that is, the increase in the unemployment level in the economy. This situation may not constitute a problem if some measures are taken at the same time.

6.2.2 Scenario 1B: a positive shock in the effective contribution rate to social security

Table 3 and Table 4 show the results of a 1 percentage point increase in the effective contribution rate to social security, changing from 25.8% to 26.8%, a percentage still lower than the statutory contribution rate of 34.75%.

Table 3: Scenario 1B High: a positive shock in the effective contribution rate to social security

Average percentage difference between values with and without shock					
Variables	2005-2010	2011-2020	2021-2030	2031-2050	2005-2050
GDP (1995 prices)	-0,1	0,0	0,0	0,0	0,0
Potential GDP (1995 prices)	0,0	0,0	0,0	0,0	0,0
Private Consumption (1995 prices)	-0,4	-0,3	-0,2	-0,2	-0,2
Gross Fixed Capital Formation (1995 prices)	-0,2	-0,1	0,0	0,0	-0,1
Total Employment in volume	0,0	0,0	0,0	0,0	0,0
Unemployment rate	0,5	-0,2	0,0	0,0	0,0
Global Labour Force Productivity (1995 prices)	0,0	0,0	0,0	0,0	0,0
Global average wage (current prices)	-0,5	-0,5	-0,3	-0,3	-0,4
Private Savings (current prices)	-1,9	-0,3	-0,1	-0,2	-0,4
Private Disposable Income (current prices)	-0,8	-0,7	-0,5	-0,3	-0,5
Labour Force	0,0	0,0	0,0	0,0	0,0
Number of Pensioners	0,0	0,0	0,0	0,0	0,0
Average Pension (current prices)	-0,3	-0,4	-0,2	-0,2	-0,2
Average difference in percentage points of GDP					
Public Deficit (current prices)	-0,2	-0,1	0,0	0,0	-0,1
Average values at current prices after the shock (millions of euros)					
Social Security Balance (current prices)	3530,2	3906,6	1840,0	-3606,5	141,7
Final Social Security Balance (current prices)	3530,2	3906,6	1840,0	-1812,4	921,7
Social Security	6447,9	9609,6	16252,0	11604,9	11508,8

Trust Fund (current prices)					

Table 4: Scenario 1B Low: a positive shock in the effective contribution rate to social security

Average percentage difference between values with and without shock					
Variables	2005-2010	2011-2020	2021-2030	2031-2050	2005-2050
GDP (1995 prices)	-0,1	0,0	0,0	0,0	0,0
Potential GDP (1995 prices)	0,0	0,0	0,0	0,0	0,0
Private Consumption (1995 prices)	-0,4	-0,3	-0,2	-0,1	-0,2
Gross Fixed Capital Formation (1995 prices)	-0,3	-0,1	0,0	0,0	-0,1
Total Employment in volume	0,0	0,0	0,0	0,0	0,0
Unemployment rate	0,5	-0,2	0,0	0,0	0,0
Global Labour Force Productivity (1995 prices)	0,0	0,0	0,0	0,0	0,0
Global average wage (current prices)	-0,5	-0,5	-0,3	-0,3	-0,4
Private Savings (current prices)	-1,9	-0,3	-0,1	-0,2	-0,4
Private Disposable Income (current prices)	-0,8	-0,7	-0,4	-0,3	-0,5
Labour Force	0,0	0,0	0,0	0,0	0,0
Number of Pensioners	0,0	0,0	0,0	0,0	0,0
Average Pension (current prices)	-0,5	-0,5	-0,3	-0,3	-0,3
Average difference in percentage points of GDP					
Public Deficit (current prices)	-0,2	-0,1	0,0	0,0	-0,1
Average values at current prices after the shock (millions of euros)					
Social Security Balance (current prices)	2927,7	1865,2	-3279,0	-35796,1	-15489,0
Final Social Security Balance (current prices)	2927,7	1865,2	-1631,6	-35796,1	-15130,9
Social Security Trust Fund (current prices)	6551,3	9727,7	6508,4	0,0	4384,1

We can conclude that this parametric change is not enough to resolve the financial problem of social security system, leading to a deterioration of the economic performance. Actually, the effects in the social security balance are rather modest: with the scenario High, social security system becomes insolvent in 2044 after the mobilisation of the social security trust fund; with the scenario Low the insolvency happens in 2028.

With respect to the economic performance it shows signals of deterioration. In fact, GDP shows a small decrease in the short run (-0.1 percentage points in the 2005 to 2010

period) entering in stagnation afterwards. Private consumption, disposable income and private savings show evidence of deterioration.

The increase in the effective contribution rate has a positive effect in public accounts till the year 2020, presenting stagnation after that year. Private savings and disposable income present signals of deterioration both in the short and in the long run.

6.2.3. Scenario 1C: both changes simultaneously

In this scenario, macroeconomic performance is similar to the one obtained in the scenario 1A, although it presents lower values to the economic growth, as can be seen in table 5 and table 6. This is due to the conjugation of a positive economic shock with a negative one as the second test revealed to be. Even with a worse economic result, it manages to get a better income in terms of the social security balance. Effectively, using scenario High, the social security balance presents a positive growing rate for the entire period, with the exception of the 2026 to 2040 period, where the growing rates were slightly negative. Using the scenario Low, social security becomes insolvent in 2038 after the total mobilisation of the social security trust fund.

This test enhances the importance of combined reforms in order to get better results either on the employment level either on the productivity level.

Table 5: Scenario 1C High: both changes simultaneously

Average percent difference between values with and without shock					
Variables	2005-2010	2011-2020	2021-2030	2031-2050	2005-2050
GDP (1995 prices)	0,6	3,4	6,0	8,5	5,8
Potential GDP (1995 prices)	0,5	3,1	5,9	8,5	5,7
Private Consumption (1995 prices)	-0,2	1,8	4,4	7,8	4,7
Gross Fixed Capital Formation (1995 prices)	0,1	2,5	4,5	6,3	4,3
Total Employment in volume	0,7	3,8	6,9	9,6	6,6
Unemployment rate	3,1	1,7	-0,6	1,5	1,3
Global Labour Force Productivity (1995 prices)	0,0	-0,1	-0,6	-0,9	-0,5
Global average wage (current prices)	-2,4	-6,3	-8,4	-10,6	-8,1
Private Savings (current prices)	1,7	8,4	6,7	10,2	7,9
Private Disposable Income (current prices)	-1,4	-1,8	-0,7	1,5	-0,1
Labour Force	1,0	3,9	6,8	9,7	6,7
Number of Pensioners	-1,5	-4,8	-5,9	-4,9	-4,6
Average Pension (current prices)	-1,4	-4,0	-5,3	-6,4	-5,0
Average difference in percentage points of GDP					
Public Deficit (current	-0,1	-0,3	-0,5	-0,3	-0,3

prices)					

Average values at current prices after the shock (millions of euros)					
Social Security Balance (current prices)	3747,0	5419,5	5518,0	5121,8	5093,3
Final Social Security Balance (current prices)	3747,0	5419,5	5518,0	5121,8	5093,3
Social Security Trust Fund (current prices)	6372,6	9243,0	15424,5	38187,8	22797,1

Table 6: Scenario 1C Low: both changes simultaneously

Average percent difference between values with and without shock					
Variables	2005-2010	2011-2020	2021-2030	2031-2050	2005-2050
GDP (1995 prices)	0,6	3,4	5,9	8,3	5,7
Potential GDP (1995 prices)	0,5	3,1	5,9	8,4	5,7
Private Consumption (1995 prices)	-0,3	1,5	4,1	6,9	4,2
Gross Fixed Capital Formation (1995 prices)	0,1	2,4	4,4	6,2	4,2
Total Employment in volume	0,7	3,8	6,9	9,5	6,6
Unemployment rate	3,2	1,8	-0,5	2,5	1,8
Global Labour Force Productivity (1995 prices)	0,0	-0,1	-0,6	-1,0	-0,6
Global average wage (current prices)	-2,5	-6,5	-8,9	-11,9	-8,8
Private Savings (current prices)	1,2	6,9	5,2	5,5	5,2
Private Disposable Income (current prices)	-1,5	-2,2	-1,3	-0,2	-1,1
Labour Force	1,0	3,9	6,8	9,7	6,7
Number of Pensioners	-1,5	-4,8	-5,9	-4,9	-4,6
Average Pension (current prices)	-2,3	-6,2	-8,4	-11,4	-8,4
Average difference in percentage points of GDP					
Public Deficit (current prices)	-0,2	-0,4	-0,6	-0,5	-0,5
Average values at current prices after the shock (millions of euros)					
Social Security Balance (current prices)	3273,6	4000,5	2117,9	-17132,9	-5692,0
Final Social Security Balance (current prices)	3273,6	4000,5	2147,6	-15809,0	-5110,0
Social Security Trust Fund (current prices)	6471,9	9337,6	15697,8	4690,6	8326,0

6.3 Scenario 2 - Systemic reform: transition from the existing pay-as-you-go system to a funded system

Confronting the three solutions for the pay-as-you-go system deficit described in section 4.2, we obtained the following results.

6.3.1 Scenario 2 with an increase in direct private income taxes

The adoption of a funded social security system has great and important macroeconomic implications. Yet, the transition period give rise to the necessity to finance the living pensioners of the pay-as-you-go system. Hence, this first simulation imposes a political

fiscal rule in such a way that the public deficit in percentage of GDP is close to the one simulated in the baseline scenario, avoiding that it could reach values not acceptable by European Union[21]. This rule makes the direct private income taxes dependent, in each year, of the gap between public deficit in percentage of the scenario with and without funded system from the previous year.

The introduction of a political fiscal rule makes the simulation more realistic, meaning that the inception of a tax to finance the old system has a direct impact on private disposable income by reducing it and an indirect effect on public deficit by increasing it, due to the slowdown in economic activity that could be not acceptable by European Union. Thus, the endogenous determination of the private income tax rate reflects the social security deficit and also the increase in taxes that would be necessary to avoid a public deficit not controlled.

The results presented in table 7 show that during the transition period the economy suffers a huge slowdown. GDP presents a percentage difference of minus 1.6% and to cover the increase in public deficit the private income tax rate should grow 78% on average for the period in analysis. Private savings decrease on average 25%. Private disposable income also decreases in the simulation period as well as private consumption.

On average, the total value of the fund is positive and the contribution rate to the funded system is 24% for the period in analysis on average. The contribution rate increases through the entire period due to both live expectancy increase and the average pension evolution.

Table 7: Scenario 2 with an increase in direct private income taxes

Average percent difference between values with and without shock					
Variables	2005-2010	2011-2020	2021-2030	2031-2050	2005-2050
GDP (1995 prices)	0,4	-0,8	-1,7	-2,5	-1,6
Potential GDP (1995 prices)	0,1	-0,3	-0,4	-0,5	-0,4
Private Consumption (1995 prices)	1,4	-2,6	-7,9	-12,6	-7,6
Gross Fixed Capital Formation (1995 prices)	1,0	-1,7	-2,7	-2,0	-1,7
Total Employment in volume	0,1	-0,3	-0,3	-0,2	-0,2
Unemployment rate	-1,8	5,0	4,8	4,7	3,9
Global Labour Force Productivity (1995 prices)	0,1	-0,3	-0,4	-0,6	-0,4

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[21] Namely the fulfilment of the relation between public deficit and GDP that should not be over 3% and of the relation between public debt and GDP that should not be over 60%.

Global average wage (current prices)	1,8	-3,4	-10,6	-21,5	-12,1
Private Savings (current prices)	7,8	-29,9	-30,4	-29,2	-24,8
Private Disposable Income (current prices)	3,0	-5,7	-15,4	-25,0	-15,1
Labour Force	0,0	0,0	0,0	0,0	0,0
Number of Pensioners	0,0	0,0	0,0	0,0	0,0
Average Pension (current prices)	1,7	-3,1	-9,9	-20,3	-11,4
Private Income Tax Rate	34,1	85,3	113,5	71,0	78,5
Average difference in percentage points of GDP					
Public Deficit (current prices)	5,3	3,3	0,6	-2,6	0,4
Average values at current prices after the shock (millions of euros)					
Social Security Balance (current prices)	-10142,0	-15024,8	-20232,5	-9284,7	-13024,3
Final Social Security Balance (current prices)	-9634,9	-14546,7	-20232,5	-9284,7	-12854,2
Social Security Trust Fund (current prices)	4825,3	1307,3	0,0	0,0	913,6
Pension Fund Value (current prices)	30090,6	126319,9	318715,4	860273,7	474703,7
Average values after the shock in %or in thousands of individuals					
Private Income Tax Rate	11,8	20,0	25,3	20,3	20,2
Pay-as-you-go Contribution Rate	25,8	25,8	25,8	25,8	25,8
Funded Contribution Rate	16,1	18,4	19,9	30,8	23,8
Additional Contribution Rate	-	-	-	-	-
Pay-as-you-go Labour Force	1835,7	1032,6	245,5	3,3	518,7
Funded Labour Force	3583,0	4368,2	5038,3	4996,2	4684,5
Pay-as-you-go Pensioners	3145,4	2853,8	2207,0	587,7	1766,0
Funded Pensioners	114,6	746,3	1865,0	4180,0	2400,0

6.3.2 Scenario 2 with an additional contribution rate

In this scenario we consider the creation of an additional tax to finance pay-as-you-go system pensioners. This additional tax will consider the total employment. In addition, the political fiscal rule is not imposed.

Table 8: Scenario 2 with an additional contribution rate

Average percent difference between values with and without shock					
Variables	2005-2010	2011-2020	2021-2030	2031-2050	2005-2050
GDP (1995 prices)	-0,4	-0,6	-0,6	-0,9	-0,7
Potential GDP (1995 prices)	-0,1	-0,1	-0,1	-0,2	-0,2
Private Consumption (1995 prices)	-1,8	-3,2	-3,1	-3,7	-3,2
Gross Fixed Capital Formation (1995 prices)	-0,9	-1,1	-0,8	-0,8	-0,9
Total Employment in volume	-0,1	0,0	0,0	-0,2	-0,1
Unemployment rate	1,6	0,9	0,4	3,1	1,8
Global Labour Force Productivity (1995 prices)	-0,1	-0,1	-0,1	-0,3	-0,2
Global average wage	-2,5	-4,4	-4,2	-7,1	-5,3

(current prices)					
Private Savings (current prices)	-5,0	-15,4	-3,3	-12,8	-10,3
Private Disposable Income (current prices)	-3,7	-6,7	-5,8	-8,0	-6,7
Labour Force	0,0	0,0	0,0	0,0	0,0
Number of Pensioners	0,0	0,0	0,0	0,0	0,0
Average Pension (current prices)	-2,3	-4,1	-3,9	-6,7	-5,0
Private Income Tax Rate	0,0	0,0	0,0	0,0	0,0
Average difference in percentage points of GDP					
Public Deficit (current prices)	3,1	4,6	3,9	-0,4	2,1
Average values at current prices after the shock (millions of euros)					
Social Security Balance (current prices)	-9751,2	-14906,2	-21597,1	-10717,6	-13867,2
Final Social Security Balance (current prices)	0,0	0,0	0,0	0,0	0,0
Social Security Trust Fund (current prices)	4733,4	1310,2	0,0	0,0	902,2
Pension Fund Value (current prices)	23324,0	125459,7	380509,8	1252035,2	657398,7
Average values after the shock in %or in thousands of individuals					
Private Income Tax Rate	8,7	10,7	11,9	11,9	11,2
Pay-as-you-go Contribution Rate	25,8	25,8	25,8	25,8	25,8
Funded Contribution Rate	13,6	20,9	23,3	32,2	25,4
Additional Contribution Rate	12,7	14,3	14,3	4,2	9,7
Pay-as-you-go Labour Force	1835,7	1032,6	245,5	3,3	518,7
Funded Labour Force	3583,0	4368,2	5038,3	4996,2	4684,5
Pay-as-you-go Pensioners	3145,4	2853,8	2207,0	587,7	1766,0
Funded Pensioners	114,6	746,3	1865,0	4180,0	2400,0

The results presented in table 8 illustrate a reduction in GDP of 0.7% on average for the period in analysis. Private disposable income also decreases (-6.7% on average for 2005 to 2050 period) and the public deficit would increase 2.1% on average for the period in analysis. The contribution rate to the pay-as-you-go system would be 25.8% (equal to the baseline scenario) and the contribution rate to the funded system would be 25.4% on average. The additional contribution rate that applies on all employed people would be 9.7% on average. Private savings decrease as well as the wages that show an average decrease of 5.3%. The unemployment rate rises 1.8% on average in relation to the baseline scenario.

6.3.3 Scenario 2 with an additional contribution rate and a political fiscal rule which leaves direct private income taxes endogenous

The simulation implemented by eliminating the social security imbalance through an additional contribution rate over the entire employed labour force and through the

imposition of a political fiscal rule that obliges the public deficit to be similar to the one obtained in the baseline scenario.

Table 9: Scenario 2 with an additional contribution rate and a political fiscal rule which leaves direct private income taxes endogenous

Average percent difference between values with and without shock					
Variables	2005-2010	2011-2020	2021-2030	2031-2050	2005-2050
GDP (1995 prices)	-0,6	-1,4	-2,1	-2,4	-1,9
Potential GDP (1995 prices)	-0,2	-0,3	-0,5	-0,5	-0,4
Private Consumption (1995 prices)	-2,3	-6,5	-10,8	-12,5	-9,5
Gross Fixed Capital Formation (1995 prices)	-1,4	-2,7	-3,2	-1,8	-2,2
Total Employment in volume	-0,2	-0,2	-0,2	-0,2	-0,2
Unemployment rate	2,5	3,9	3,9	3,1	3,4
Global Labour Force Productivity (1995 prices)	-0,2	-0,3	-0,5	-0,5	-0,4
Global average wage (current prices)	-3,0	-8,5	-14,0	-21,0	-14,4
Private Savings (current prices)	-11,0	-36,3	-29,3	-24,4	-26,3
Private Disposable Income (current prices)	-4,9	-13,1	-20,0	-24,5	-18,5
Labour Force	0,0	0,0	0,0	0,0	0,0
Number of Pensioners	0,0	0,0	0,0	0,0	0,0
Average Pension (current prices)	-2,8	-7,9	-13,0	-19,9	-13,5
Private Income Tax Rate	0,9	4,1	7,2	4,8	4,7
Average difference in percentage points of GDP					
Public Deficit (current prices)	2,6	2,5	0,6	-1,6	0,3
Average values at current prices after the shock (millions of euros)					
Social Security Balance (current prices)	-9705,7	-14293,0	-19543,5	-9227,6	-12633,7
Final Social Security Balance (current prices)	0,0	0,0	0,0	0,0	0,0
Social Security Trust Fund (current prices)	4725,9	1305,5	0,0	0,0	900,2
Pension Fund Value (current prices)	22825,6	109743,6	297927,1	912174,7	488199,0
Average values after the shock in %or in thousands of individuals					
Private Income Tax Rate	9,6	14,9	19,1	16,7	15,9
Pay-as-you-go Contribution Rate	25,8	25,8	25,8	25,8	25,8
Funded Contribution Rate	13,2	18,8	20,8	32,3	24,4
Additional Contribution Rate	12,7	14,3	14,4	4,3	9,7
Pay-as-you-go Labour Force	1835,7	1032,6	245,5	3,3	518,7
Funded Labour Force	3583,0	4368,2	5038,3	4996,2	4684,5
Pay-as-you-go Pensioners	3145,4	2853,8	2207,0	587,7	1766,0
Funded Pensioners	114,6	746,3	1865,0	4180,0	2400,0

The results in table 9 show that GDP presents a difference in relation to the baseline scenario of –1.9% on average for the period in analysis. Private disposable income decreases 18.5% on average and private consumption decreases 9.5%. Private savings

also decreases for the period in analysis. The additional contribution rate necessary to finance the pay-as-you-go system has a value of 9.7% on average and the direct private income tax necessary to impose a public deficit around 3% grows 4.7% on average for the period in analysis.

7. Conclusions

We can conclude that the implementation of a pure funded social security system of the benefit type brings an enormous burden to the economy, at least for the transition period. Unless there is an entire generation willing to support all the transition costs, the inception of a fully funded system does not seems to be a good solution. On the other hand, the existing social security system is not sustainable without a reform. The elimination of early retirement schemes is a possible path to go through with gains to all, although it provokes an increase in employment as well as an increase in the unemployment rate, which lead us to conclude that this policy should be adopted along with other measures in order to stimulate employment creation and productivity gains. Additionally, the increase in the effective contribution rate to social security system may constitute a strong improvement in its financial sustainability, although with economic performance deterioration. Finally, the combination of those two parametric reforms results in a consistent improvement of social security system financial sustainability as well as of economic growth. The mobilisation of the social security trust fund always delays social security system insolvency date, which reveals its importance in a mixed social security system[22].

Thus, we can conclude that reforms to the existing system suggest that the pay-as-you-go system with a trust fund (which makes it a mixed system) may have some advantages over a pure system. The results of the parametric shocks to the existing system show that it is possible to assure its financial sustainability.

On the other hand, the construction of a baseline scenario is very important to this kind of simulation.

One concluding remark has to do with the limitations of the model adopted. In fact, it does not consider a financial sector, which is very important if we consider the existence of a capitalization fund due to its impact on financial markets.

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[22] A mixed social security system is a solution defended by Feldstein (2001).

More than giving final solutions, this paper aims to present paths to future research. We can, however, reinforce the argument that any reform strategy needs to be as comprehensive as possible in order to increase economic growth, to contain future pension expenditure and to strength the financial basis of pension system (European Commission, 2001). In fact, current public pension system can be made more sustainable through undertaking parametric reforms with a view to improving incentives to work and to strengthening the actuarial link between contributions and benefits. A systemic reform involves questions other than funding, namely the objective of diversification in terms of retirement income provision, the risks involved in different systems and the difficult question of balancing the possible beneficial side effects on the economy with the inevitable costs of the transition process. Therefore, given the importance of the social security system to the well being of workers, retirees, the budget, and the economy, a serious and thoughtful debate on how best to reform social security system must continue. This also implies the examination of the possible myths of social security reform (Brown et al., 2005).

8. Annexes

8.1 Annexe 1 - The main variables and equations

To perform the intended simulations considering social security system reforms, it was necessary to introduce some changes to the HERPOR model, namely to add equations and variables.

Firstly, to carry out the parametric changes in the existing pay-as-you-go system, the equations added or modified are:

Labour force

$$LF = NPA(-1)*(N(-1) - NGE25(-1)) + (1 - LAMBDAW(-1))*LF(-1) \qquad (1)$$

where NPA is the proportion of population from 0 to 24 years that becomes labour force in each year, N is the total population, $NGE25$ is the population with 25 years and more, and $LAMBDAW$ is the proportion of people that were part of labour force and leaves becoming pensioners.

Employment in number of individuals

$$ND = ND(-1)*\left(\frac{L}{L(-1)}\right)*\left(1 + \frac{DNDN}{100}\right), \qquad (2)$$

where L is the total employment in volume, $DNDN$ is the difference between variation rates of total employment in number of individuals and in volume.

Total number of unemployed persons

$$U = LF - ND, \tag{3}$$

Current transfers balance between public administration sector and other institutional national sectors

$$GTR = GTRL + PENS, \tag{4}$$

where $GTRL$ is the current transfers balance between public administration sector and the others institutional national sectors.

Total contributions to social security

$$GTYSOC = RGTYSOC * ND * \frac{YWM}{1000}, \tag{5}$$

where YWM is the total average compensation.

Total number of pensioners

$$NR = LAMBDAW(-1) * LF(-1) + (1 - LAMBDAR(-1)) * NR(-1), \tag{6}$$

where $LAMBDAR$ corresponds to the pensioner's mortality rate.

Value of the average pension

$$PENSM = PENSM(-1) * \left(1 + \frac{TVPENSM}{100}\right), \tag{7}$$

where $TVPENSM$ is the nominal variation rate of the average pension.

Total value of pensions paid

$$PENS = PENSM * \frac{NR}{1000}, \tag{8}$$

Social security account balance

$$SSB = GTYSOC - PENS, \tag{9}$$

Social security trust fund value

$$SSF = \left(SSF(-1) * \left(1 + \frac{TVSSFR}{100}\right) * \left(\frac{PCONS}{PCONS(-1)}\right)\right) - SSFD, \tag{10}$$

where $TVSSFR$ is the real return rate of the social security trust fund and $PCONS$ is the private consumption deflator.

Social security trust fund mobilisation amount in each year to guarantee that the final social security account balance is null until the moment the trust fund runs out

$$SSFD = \begin{cases} 0, & \text{IF } SSB \geq 0 \\ PENS - GTYSOC, & \text{IF } SSB < 0 \end{cases} \qquad (11)$$

Final social security account balance

$$SSBF = GTYSOC - PENS + SSFD , \qquad (12)$$

To carry out the systemic reform concerning the progressive transition from the existing pay-as-you-go system to a fully funded system, the equations added or modified are:

Total contributions received by pay-as-you-go social security system

$$GTYSOC = RGTYSOC * LFY * \left(1 - \frac{UR}{100}\right) * \frac{YWM}{1000} , \qquad (13)$$

where $RGTYSOC$ is the contribution rate to the pay-as-you-go system, LFY is the labour force that remains in the pay-as-you-go system, and UR corresponds to the unemployment rate.

Current transfers from Public Administration sector to other institutional sectors

$$GTR = GTRL + PENSY , \qquad (14)$$

where $PENSY$ is the total amount of pensions paid to those who continue in the pay-as-you-go system.

Private disposable income

$$YPERD = YPER + GTYPER + PENSF - FYSOC , \qquad (15)$$

where $YPER$ is the private disposable income before taxes, $GTYPER$ is the amount of direct taxes collected from households, $PENSF$ is the amount of pensions paid to who belongs to the funded system, and $FYSOC$ is the families contributions to the funded system.

Amount of pensions paid to who belongs to the pay-as-you-go system

$$PENSY = PENSM * NRY / 1000 , \qquad (16)$$

where NRY is the number of pensioners who belong to the pay-as-you-go system.

Pay-as-you-go social security system balance

$$SSB = GTYSOC - PENSY , \qquad (17)$$

Pay-as-you-go social security system balance adjusted with the stabilization social security fund

$$SSBF = GTYSOC - PENSY - SSFD , \qquad (18)$$

Proportion of the stabilization social security fund that in each year contributes to soften the pay-as-you-go balance

$$SSFD = \frac{(PENSY - GTYSOC)}{20} \qquad (19)$$

Family contributions to the funded system

$$FYSOC = RFYSOC * LFF * \left(1 - \frac{RL}{100}\right) * \frac{YWM}{1000}, \qquad (20)$$

where LFF is the labour force that belongs to the funded system.

Amount of pensions paid to who belongs to the funded system

$$PENSF = PENSM * \frac{NRF}{1000}, \qquad (21)$$

where NRF is the number of pensioners that belongs to the funded system.

Funded system annual balance

$$SF = FYSOC - PENSF - SF, \qquad (22)$$

Funded system accumulated balance

$$SFB = SFB(-1) * \left(1 + \frac{TVSFBR}{100}\right) * \left(\frac{PCONS}{PCONS(-1)}\right) + SF, \qquad (23)$$

The contribution rate to the funded system is endogenous to the model and obeys to the constraint that the actual value of contributions maid during the working period must be equal to the actual value of future pensions, as follows:

$$\sum_{j=1}^{t} \frac{RFYSOC_j * YWMR_j - CRGF1_j}{(1+IRDR)^j} = \sum_{j=t+1}^{T} \frac{PENSMR_j - CRGF2_j}{(1+IRDR)^j}, \qquad (24)$$

where $RFYSOC$ is the contribution rate to the funded system, $YWMR$ is the average real compensation, $CRGF1$ is the fund management average real annual cost by person before retirement ($CRGF1 = Beta1 * RFYSOC * YWMR$), $IRDR$ is the real interest rate, $PENSMR$ is the average real pension, $CRGF2$ is the fund management average real annual cost by person after retirement ($CRGF2 = Beta2 * PENSMR$), t is the number of working years in which a contribution was made, and T is the number of lived years counted after the moment a person started working. In addition, and considering that in its 2003 report the social security fund presents a 0.77% total management cost, we assumed that Beta1 value is 1% and Beta2 value is 0.5%. In the year 2005 we assumed that t would be 36 years and T would be 51 years. In the end of the period in analysis, the year 2050, T will assume the value 55.3 years, meaning that T evolves with the

average live expectancy presented in the demographic projections of National Statistical Institute[23].

Contribution rate to the funded system

$$RFYSOC = ALFA * \frac{(1+Beta2)}{(1-Beta1)} * \frac{(1+IRDR)^{RE} - 1}{(1+IRDR)^{(36+RE)} - (1+IRDR)^{RE}} \,, \qquad (25)$$

where $IRDR$ is the real interest rate on long term deposits, RE is the average number of years that a pensioner will be in retirement which evolves with the average live expectancy, and $ALFA = PENSMR / YWMR$. We assumed that $ALFA$ is the ratio between real average pension verified in 2004 and the real average compensation verified in 1979. The difference between the two dates (25 years) corresponds to the difference between the average active live year and the average retirement year. For the period in which data is available, $ALFA$ assumes the value 0.5685, being this value considered in all simulation period.

Real interest rate on long term deposits

$$IRDR = \frac{\left(\dfrac{IRD}{100} - \left(\dfrac{PCONS}{PCONS(-1)} - 1 \right) \right)}{\left(1 + \left(\dfrac{PCONS}{PCONS(-1)} - 1 \right) \right)} \,, \qquad (26)$$

where IRD is the nominal interest rate and $PCONS$ is the private consumption deflator.

Since that, in the simulation period, the labour force under the pay-as-you-go system is lower than the pensioners number being financed by this system, and considering that after 2038 there will be no contributors to this system, we allowed for three alternative solutions for the deficit problem occurred meanwhile on the pay-as-you-go system:

a) the first solution considers an increase in direct private taxes, which corresponds to running the model guaranteeing that the public administration deficit is approximated to the one verified in baseline scenario;

b) the second alternative creates an additional contribution tax paid by the employed labour force; and

c) the third solution combines the last two.

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[23] Instituto Nacional de Estatística (www.ine.pt).

To simulate the second and the third solutions it was necessary to introduce two equations and reformulate other three:

Public revenue from direct taxes and social contributions

$GTY = GTYPER + GTYC + GTYSOC + GTYSOCF$

Amount of the new contribution paid by the employed labour force

$GTYSOCF = RGTYSOCF * YW$,   (27)

New contribution tax

$$RGTYSOCF = \left(\frac{(PENSY - GTYSOC - SSFD)}{YW} \right),$$ (28)

Private disposable income

$YPERD = YPER - GTYPER + PENSF - FYSOC - GTYSOCF$

Final pay-as-you-go system balance

$SSBF = GTYSOC - PENSY + SSFD + GTYSOCF$

8.2 Annexe 2 – Scenario 1A

Hence,

Number of statutory pension holders

NRE is equal to the sum of the invalid pension holders, the survivor pension holders and people with 65 and more years (period: 2005 to 2050).

In addition, we constructed a new series for $LAMBDAW$, called $LAMBDAWE$, a residual variable (period: 1977 to 2050). Accordingly, we have

Proportion of people that being in the labour force retires and becomes a statutory pension holder

$$LAMBDAWE_t = \frac{(NRE_{t+1} - (1 - LAMBDAW_t) * NRE_t)}{LF_t}.$$ The difference between

$LAMBDAWE$ and $LAMBDAW$ represents a shock given to the model in the variable $LAMBDAW$. In practice, this shock corresponds to diminishing the number of pension holders increasing the labour force.

9. References

Beetsma, R., Bettendorf, L. and Broer, P., 2003. The budgeting and economic consequences of ageing in the Netherlands. *Economic Modelling* 20, 987-1013.

Bradley, J., Modesto, L. and Sosvilla-Rivero, S., 1995. A macroeconometric modelling framework for the EU periphery. *Economic Modelling* 12, 3, 221-247.

Brown, J., Hasset, K. and Smetters, K., 2005. Top Ten Myths of Social Security Reform. CRR WP 1005-11, October.

Buscher, H. S., Buslei, H., Göggelmann, K., Koschel, H., Schmidt, T. F. N., Steiner, V. and Winker, P., 2001. Empirical macro models under test. A comparative simulation study of the employment effects of a revenue neutral cut in social security contributions. *Economic Modelling* 18, 455-474.

Dias, A., Ferreira, A., Lopes, E. G., Martins, N., Pina, Á., St. Aubyn, M., 2003. QCAIII – Impacto Macroeconómico – Avaliação Intercalar, *Departamento de Prospectiva e Planeamento*, Lisboa (available at www.dpp.pt).

Dias, A., 2005, HERPOR. A Macroeconometric Model for the Portuguese Economy, MIMEO, *Departamento de Prospectiva e Planeamento*, Lisboa (available at www.dpp.pt).

Economic Policy Committee, 2001. Budgetary challenges posed by ageing populations: the impact on public spending on pensions, health and long-term care for the elderly and possible indicators of the long-term sustainability of public finances. Brussels, 24 October, EPC/ECFIN/655/01-EN final.

Economic Policy Committee, 2002. Reform challenges facing public pension systems: the impact of certain parametric reforms on pension expenditure. Brussels, 5 July, EPC/ECFIN/237/02-final.

Economic Policy Committee, 2003. The impact of ageing populations on public finances: overview of analysis carried out at EU level and proposals for a future work programme. Brussels, 22 October, EPC/ECFIN/435/03 final.

European Commission, 2001. Reforms of Pension Systems in the EU – An Analysis of the Policy Options. *European Economy* No. 73, pp. 175-228.

European Commission, 2003. *Adequate and sustainable pensions – Joint report by the Commission and the Council*. Luxembourg: Publications Office.

Feldstein, M. S., 2001. The Future of Social Security Pensions in Europe. *National Bureau of Economic Research*. Working Paper 8487.

Feldstein. M. S., 2005a. Reducing the Risk of Investment-Based Social Security Reform. *National Bureau of Economic Research*. Working Paper 11084.

Feldstein. M. S., 2005b. Structural Reform of Social Security. *National Bureau of Economic Research*. Working Paper 11098.

Garcia, M. T. M., 2004. An analysis of pension funds in Portugal. *Pensions – An International Journal*. Vol. 9, Number 3, April, 227-245.

Instituto de Ciências Sociais da Universidade de Lisboa, 1999. *A situação Social em Portugal, 1960-1999*. http//www.ics.ul.pt/investiga/projectos/sitsoc/.

IGFCSS, 2003. *Relatório e Contas do Instituto de Gestão de Fundos de Capitalização da Segurança Social*.

Mitchell, O. and Utkus, S., 2003. Lessons from Behavioral Finance for Retirement Plan Design, *Pension Research Council Working Paper 2003-6*, The Wharton School, University of Pennsylvania.

Modesto, L. and Neves, P. D., 1995. HERMIN Portugal. *Economic Modelling* 12, 3, 275-294.

European Commission, 2002. National Strategy Report: adequate and sustainable pension systems, Available at

http://europa.eu.int/comm/employment_social/social_protection/pensions_en.htm#adeq uacy.

European Commission, 2005. National Strategy Report: adequate and sustainable pension systems, Available at

http://europa.eu.int/comm/employment_social/social_protection/pensions_en.htm#adeq uacy.

OECD, 2001. *Ageing and Income – Financial Resources and Retirement in 9 OECD Countries*.

OECD, 2003. *Strengthening Private Pensions – International Standards, Data and Analysis*. The OECD Working Party on Private Pensions.

OECD, 2004. Guidelines for the protection of rights of members and beneficiaries in occupational pension plans*, Financial Market Trends*, No. 87.

Official Journal of the European Union, 2003, Directive 2003/41/EC of the European Parliament and of the Council on the activities and supervision of institutions for occupational retirement provision, L235: 10-21.

Sapir, A., 2005. Globalisation and the Reform of European Social Models. Background document for the presentation at ECOFIN Informal Meeting in Manchester, 9 September 2005.

Scherman, K. G., 1999. The Swedish Pension Reform, Social Security Department, International Labour Office. *Issues on Social Protection,* Discussion Paper 7.

Séries Estatísticas da Segurança Social, 1990-1998, Instituto de Informática e Estatística da Solidariedade.

Segurança social. http//www.seg-social.pt

Silva, C. M. P., Garcia, M. T. M., and Calado, J. P. T., 2004. The Financial Sustainability of the Portuguese Social Security System. *The Geneva Papers on Risk and Insurance*. Vol. 29, No. 3, July, 417-439.

World Bank Policy Research Report, 1994. *Averting the Old Age Crisis, Policies to Protect the Old and Promote Growth*. Oxford University Press.

World Bank, 2001. N*ew Ideas about Old Age Security*. Holzmann, R. and Stiglitiz, J. E. (Editors).