The Actuarial Balance Sheet for Pay-As-You-Go Finance: Solvency Indicators for Spain and Sweden*

MARÍA DEL CARMEN BOADO-PENAS♣,
SALVADOR VALDÉS-PRIETO♦
CARLOS VIDAL-MELIÁ♠

ABSTRACT
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The solvency and sustainability of pension systems financed by the pay-as-you-go method can be measured with indicators derived from the actuarial balance sheet. Calculating the actuarial balance annually and making the outcome transparent to the public can provide incentives to improve the financial management of pay-as-you-go pensions and reduce the traditional divergence between the policymakers' planning horizon and that of the pension system itself. This paper provides the first estimate of the actuarial balance of the Spanish contributory pension system for the old age contingency, based on official data. The main accounting entries are developed from the principles of double-entry bookkeeping. The novel entry in the balance sheet, named "Contribution Asset" or "Hidden Asset", is explained in detail. A comparison between the official balance sheet for the Swedish notional account system and our balance sheet for the Spanish contributory pension system is also provided. The main finding is that the Spanish pension system has an insolvency rate of 36.2 %. The policy implication is that unless current legislation is reformed, Spanish taxpayers (the plan sponsor) should count on making transfers to the pension system with a present discounted value of 36.2 % of current liabilities, for all golden-rule steady states. Moreover, a comparison of the consecutive balance sheets for 2001-05 shows that the degree of insolvency is growing over time, even though the cash-flow outcome has improved over the same period. Taking steps to reverse this trend and restore solvency is in the Spanish taxpayers' interest, and possibly also in the interest of those in the European Union who recognise that there is a chance that they may have to support the Spanish budget in the future.
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Keywords: Retirement, Pay-as-you-go system, Accountancy, Pensions, Spain.

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♣University of the Basque Country, Department of Econometrics and Statistics, Faculty of Economics and Business Sciences, Avenida del Lehendakari Aguirre 83, 48015 Bilbao (Spain). Phone: +34-944386049.
e-mail:mcboado@hotmail.com

♦Catholic University of Chile, Institute of Economics, Avenida Vicuña Mackenna 4860, Macul, Santiago (Chile). Phone: +56-23544326.
e-mail:svaldes@faceapuc.cl

♠ University of Valencia, Department of Financial Economics and Actuarial Science, Faculty of Economics, Avenida de los Naranjos s/n, Valencia (Spain). Phone: +34-963828369, Fax: +34-963828370. e.mail:carlos.vidal@uv.es

1. Introduction.

Three important issues in pension finance are the social demand for transparency in the management of the finances of public or mandatory systems, the advantages of immunising the pay-as-you-go system against some of the political risk to which it is subject[1], and the desire to gain credibility among participants (contributors and pensioners) in the sense of harmonising their expectation with the economic realties of the pension plan[2]. All these issues point towards the value of new financial management instruments and indicators for old-age pensions[3].

The actuarial balance sheet is an instrument that can provide an attractive response to these three issues. Publishing the actuarial balance sheet may also supply a positive incentive to improve financial management, because it would allow opinion leaders to discuss the size and implications of fiscal risks originating in the pension system, acknowledging its long planning horizon. The relatively short-term vision of both politicians and voters is frequently at odds with the economic reality of a system with an indefinite time horizon. These indicators may help sidestep the difference between the planning horizons of the voters and politicians and of the system itself.

The actuarial balance sheet may also help neutralise and/or minimise populism with regard to pensions. Valdés-Prieto (2006) defines this type of populism as a form of competition between politicians in which voters are offered subsidies and higher pensions without the voters appreciating that it is they themselves that will pay through higher taxes, higher contributions or a higher rate of inflation. In the case of pensions, these negative effects are easy to conceal if the impact of a policy measure on current cash flow is nil or positive. This problem can be alleviated by comparing the balance sheets of the pension system under alternative policies, because the balance sheet shows how those policies may have a negative impact on net worth. This is the economic impact of the policy. It may be quite different from the impact on the annual cash flow over the electoral cycle horizon.

The actuarial balance sheet has been developed and applied by Sweden since 2001. Thanks to this leadership, Sweden has endowed its pay-as-you-go financed pensions with indicators and information which previously existed only for pensions financed by full funding. The result has been an extraordinary level of transparency. Political risk seems to have fallen (less populism in pensions) insofar as the budgetary tensions generated by the pension system can be forecasted and acted upon with longer lead times. In addition to this, Sweden is the only country that has legislated an automatic correction mechanism for financial imbalances in its pension system. This mechanism is based on the solvency indicator that emerges from the actuarial balance sheet, which is the solvency ratio.

These elements are also important because, as documented by Försäkringskassan (2002), there exists a strong connection between individuals' knowledge of the pension system and their confidence in it. Note also that insurance firms may have an incentive to enhance demand for products such as complementary private pensions by exaggerating and advertising the uncertainty and fears about the reliability of public pensions. Unfounded fears may be allayed by making the information on the balance sheet public.

Japan has also begun to use an actuarial balance sheet as the fundamental tool for analysing proposed reforms to the pension system (Takayama (2005). In the U.S., the Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance Trust Funds (2006) has been compiling the elements needed to build an actuarial balance sheet since 1965, and since 2002 it has added stochastic methodology. It is likely that the publication of this information contributed to the

[1] Definitions of political risk in pay-as-you-go finance are not uniform in the specialised literature. Political risk was defined by Diamond (1994), who considered it to be decisions made by politicians. Valdés-Prieto (2000) emphasised that the planning horizon of politicians (4-6 years) is much shorter than the horizon of the pension system. See also the concepts proposed by McHale (1999), Blake & Turner (2003) and Shoven & Slavov (2006).

[2] Besley & Prat (2005) have point out that one of the main problems in pension policy is to develop an institutional framework that guarantees that public (and private) pensions promises are kept. Pensions arrangements have been governed by highly incomplete contractual arrangements. According to Boeri *et al.* (2001) the European PAYG model faces serious problems from the point of view of credibility.

[3] Holzmann *et al.* (2004) argue that sound reporting of a government's pension promises would increase its financial credibility. Rating agencies would not necessarily reduce their grading of the outstanding explicit public debt when a government provides more financial information about fiscal risks.

decision taken by the U.S. in 1983 to create a reserve, the Trust Fund, despite its cost to current contributors. The pension reserves built up by the Canadian, Irish and New Zealand governments can be traced to similar actuarial exercises and their dissemination[4].

A stinging criticism of the Spanish contributory pension system is that it does not make periodic measurements of its benefit promises, let alone make them public. If companies in Spain, as in most countries, are required by law to report whatever commitments they have with their retirees and workers, and to fund them through an external pension fund or an insurance policy, it is inexplicable why the same government exempts an affiliate, the national pension system, from registering and making public its pension promises[5].

This paper has a double objective. On the one hand it shows the usefulness of the actuarial balance sheet as an indicator of the solvency, sustainability or financial solidity of any pay-as-you-go financed pension system. The examples developed here, jointly with transparency, confirm its potential to provide positive incentives to improve financial management by increasing the politicians' planning horizon. On the other hand, this paper offers the first estimate, based on official data, of the actuarial balance sheet of the Spanish contributory retirement pension system, which is financed by the pay-as-you-go method.

The structure of the paper is as follows: The second section explains the actuarial balance sheet for a pension system financed by the pay-as-you-go method and provides both fundamental and intuitive explanations of the entry entitled "Contribution Asset". The third section summarises the published balance sheets of the Swedish pension system and analyses how they have evolved over the period 2001-2005. In the fourth section balance sheets are compiled for the retirement contingency of the Spanish contributory pension system, based on official data supplied by the Ministry of Labour and Social Affairs (*Ministerio de Trabajo y Asuntos Sociales*, MTAS) for the period 2001-2005. The Spanish balance sheets are then compared with those of Sweden, focusing on solvency. Section 5 provides concluding comments. Four appendices show how the Contribution Asset emerges in discrete time, summarise the "Hidden Asset" literature, present a sensitivity analysis of the Spanish actuarial balance sheet with regard to changes in the projected growth rate of average real salaries, and provide information regarding the basic parameters of the Spanish contributory pension system.

II. The actuarial balance sheet of a pay-as-you-go pension system.

The actuarial balance sheet of the pay-as-you-go pension system is the financial statement showing the present discounted value of the pension system's benefit promises to contributors and pensioners at a particular date (liabilities), together with the amounts of the various assets (financial, real and contribution-based) that back up those promises. A major difference between full funding and pay-as-you-go finance is that in the former only financial and/or real assets protected by property rights appear on the assets side. With pure pay-as-you-go finance, however, only the "Contribution Asset" or the "Hidden Asset" appears. This economic asset is not protected by property rights in favour of the pension institution. If the amount of this asset is reduced by new legislation, the State does not have to compensate the pension institution for the losses inflicted, due to the absence of property rights.

The main entries on the actuarial balance sheet are those shown in Table 1. This structure is valid for any degree of funding: pure, partial and nil, the latter being equivalent to pure pay-as-you-go.

TABLE 1: MAIN ENTRIES ON THE BALANCE SHEET OF A PAY-AS-YOU-GO SYSTEM (in value terms)

ASSETS	LIABILITIES
Financial and Real Assets	Liability to Pensioners
Contribution Asset / Hidden Asset	Liability to Contributors
Accumulated Deficit	Accumulated Surplus
Total Assets	**Total Liabilities**

[4] New Zealand has begun to report an estimate of the fiscal risk originating in its old age pension system. See www.treasury.govt.nz/financialstatements/month/jan06/cfs7jan06.pdf

[5] On this subject see IFRS 19 issued by the International Accounting Standards Board (IASB).

In general terms it can be said that a pay-as-you-go pension system is reasonably *solvent,* and that therefore at the date of the balance sheet the participants should have a realistic expectation of receiving the benefits that have been promised, without the sponsor of the system (the State) having to make periodic contributions, as long as: (Financial and Real Assets + Contribution Asset or Hidden Asset) $\geq$ (Liability to Pensioners + Liability to Contributors)[6]. This condition implies that the accumulated deficit must be nil or negative (solvency ratio $\geq$ 1). If the accumulated deficit is positive, the pension system is *insolvent (partially solvent)* (solvency ratio < 1). It means that at some point in the future the sponsor will be forced to allocate extraordinary funds to cover the deficit, or that the promises made to some of the participants will be at least partially broken. Due to the fact that in a State-created pension system the sponsor is a sovereign power than can legislate to reduce the promised payments, the case of an accumulated deficit makes it likely that some promises will be partially broken.

The presence of the Contribution/Hidden Asset in the balance sheet counters those who discredit pure and partial pay-as-you-go finance by claiming that it is always "bankrupt" or insolvent. This claim is based on accepting the system's liabilities but ignoring the assets implicit in contributions, which exist under the pay-as-you-go financing method when aggregate flows of contribution and benefits are close to balance. As we recognise the contribution asset, it cannot be claimed that our proposal for calculating the balance sheet seeks to discredit pay-as-you-go finance. Still, if in spite of taking this asset into account the balance sheet revealed insolvency, concern would be justified.

1. Entries on the assets side.

The novel entry on the pay-as-you-go balance sheet is the one called the "Contribution Asset" by Settergren (2001, 2003) and Settergren & Mikula (2005), the "Hidden Asset" by Valdés-Prieto (2002), the "Hidden Tax" by others such as Lüdecke (1988), Sinn (1990, 2000) and Lindbeck & Persson (2003), and the "Implicit Tax on Pensions" by Cigno (2006).

The discrepancy in name between the "Contribution Asset" and the "Hidden Asset" is justified because these concepts are different, though complementary. On the one side is Settergren & Mikula's (2005) "Contribution Asset" and the literature spawned by the Swedish Social Insurance Agency. On the other side are the rest. For example, Cigno's (2006) definition of it being the difference between the present value of future contributions and the present value of future pensions with an infinite horizon is equivalent to the definition given by Valdés-Prieto (2002) and others, which is based on excess contribution, as will be explained below and in Appendix 2.

The Contribution Asset

The Contribution Asset is derived from linking the assets and liabilities of the pension system. For the case of pure pay-as-you-go (when the degree of funding is zero), consider a pension system in a steady-state scenario (not necessarily golden-rule) and in cash-flow equilibrium. The cash flow equilibrium repeats itself every period because of the steady-state assumption. Therefore, the ratio of assets to liabilities must be one, regardless of the level and sequence of discount rates. Because the assets and the liabilities are equal, calculating the closed-group liability based on the main characteristics of the pension system and the main features of the economy and demography, such as growth rate G of the contribution base, *also* produces an estimate of the Contribution Asset's size. This follows from the balance sheet identity. This method identifies the *size* of the Asset without delving into the origin or economic meaning of the cash flows that support it.

Consider representing the benefit formula with a *limited* set of parameters, such as pension age, replacement rate for the first pension, pension indexation rate, earnings base to which the replacement rate is applied; and representing the economy and the demography within which the pension system operates with another *limited* set of parameters, such as life expectancy, a fertility-driven population growth rate (γ), a growth rate of average covered earnings in real terms (g), and a discount rate (d) that are constant over time. In any steady state without periodic contributions

[6] According to the International Association of Insurance Supervisors (IAIS), an insurance company is solvent if it is able to fulfil its obligations under all contracts at any time (or at least under most circumstances). Due to the very nature of insurance business, it is impossible to guarantee solvency with certainty.

from the sponsor, the internal rate of return paid by a pure pay-as-you-go system to participants is g + γ = G, where G is the growth rate of the contribution base and also the growth rate of GDP. Under these assumptions and imposing the cash-flow equilibrium condition, the closed-group liability can be expressed as a simple product:

$$\overbrace{V_t}^{\text{Liabilities}} = \underbrace{f(\text{benefit parameters}, \gamma, g, d) \cdot C_t}_{\text{Assets}} \qquad [1.]$$

with V_t being the amount of accrued liabilities at date t (a stock), C_t being the amount of contribution revenue in year t (a flow), and f(·) being a function that does not depend on the parameters that determine the size of contribution revenues. This function is called "turnover duration" by Settergren and Mikula (2005).

Equation 1 can be reinterpreted in an intuitive way by noting that contribution revenue is proportional to the contribution rate θ. Given that the liability is also equal to the Contribution Asset in the assumed steady state, then *the maximum level of liabilities* that can be financed by *the existing contribution rate* θ, without periodic supplements from the sponsor, in a stationary state, is the product on the right hand side of Equation 1 (Settergren & Mikula, 2005):

$$CA_t = C_t \cdot f(\text{benefit parameters}, \gamma, g, d) \qquad [2.]$$

with CA_t being the value of the Contribution Asset. This result is inserted in the corresponding entry of the balance sheet. This method is valid for both defined-benefit and defined-contribution systems, because only steady states are being considered. Of course, the pay-as-you-go assumption implies that the DC system must be notional or points-based, as in Sweden, Poland, Latvia and Germany, and cannot be fully funded. Settergren (2003) interprets the Contribution Asset as the present value of the perpetual future flow of discounted contributions, where the discount rate is the inverse of the turnover duration.

The turnover duration (TD)[7]

It is considered the assumption that the economy within which the pension system operates is in a "golden-rule" stationary state, which is defined by the attribute that the real interest rate is equal to the real growth rate of the contribution base, which in turn is equal to the real growth rate of the economy. In a golden-rule stationary state, the interest or discount rate used to value both liabilities and assets is obtained *directly* from the growth rate of the economy G, avoiding any investigation of the financial market to identify the rate of interest applicable. Still, when comparing balance sheets across golden-rule steady states that differ by the rate G, a change in G may affect the value of the function f().

Appendix 1 determines the form of the function f(·) for the specific benefit formula for Spain and for a golden-rule steady state where γ =0 and thus d=g. In this case, the value of this function is the well-known concept of "average pay-in and pay-out durations".

$$d = g, \gamma = 0 \Rightarrow f(\text{benefit parameters}, \gamma, g, d) = (pt_r + pt_c) \qquad [3.]$$

with pt_c being the pay-in duration of one monetary unit for any g, and pt_r being the pay-out duration of one monetary unit for any g. Appendix 1 also proves that the turnover duration simplifies even more, becoming the difference between the weighted average age of pensioners and the weighted average age of contributors:

$$A_r - A_c = (A_r - \overline{\text{R}}) + (\overline{\text{R}} - A_c) = pt_r + pt_c \qquad [4.]$$

[7] Lee (1994) began the formal development of these formulae. See also the papers by Devesa *et al.* (2002) and Bravo (1996), who developed a concept in which a time average may, under certain conditions, represent the structure of salaries and pensions by age, like the difference between the average age of pensioners and contributors. Another pioneering paper which arrives at similar formulae is Arthur & McNicoll (1978).

with A_c being the average weighted age for the contributors (weighted by contribution sizes that take into account the age-earnings profile), A_r being the average weighted age for the pensioners (weighted by pension sizes that take into account the age-benefits profile) and $\overline{R}$, the average retirement age. TD remains valid for any constant γ because the averaging takes into account the rate of fertility-driven population growth (γ).

Appendix 1 also finds that the net effect of an increase in g is to decrease the turnover duration, when comparing across golden-rule steady states:

$$\left[(pt_r^{g>0} + pt_c^{g>0})\right] < \left[(pt_r^{g=0} + pt_c^{g=0})\right] \quad \textbf{[5.]}$$

According to Försäkringskassan (2006), the turnover duration reflects the difference in age between the average contributor and the average pensioner that would result if economic, demographic, and legal conditions were constant.

The Hidden Asset

The Hidden Asset[8] is the name of the contribution asset used by the literature which seeks to identify the origin of the cash flows that back up the contribution asset. Valdés-Prieto (2002) shows that the Hidden Asset is the present expected value of the hidden taxes that the system will apply to its participants in the future, whether in the form of excess contributions in relation to the pensions to be provided or in the form of insufficient pensions in relation to the contributions. In this literature there is no golden rule assumption, so the interest rate in the financial market and the discount rate (d) are expected to be different from the growth rate of GDP.

As the Hidden Asset is determined by projecting the future, it takes into account trends known with relative certainty, whether demographic or economic. It also takes into account the effect of known changes in benefit parameters in the pension system itself, such as gradual adjustments to retirement ages required by existing legislation.

The size of the Hidden Asset is inversely proportional to the system's degree of funding. When the system is fully funded (Financial plus Real Assets) = (Liability to Pensioners + Liability to Contributors), the hidden taxes that the system expects to apply to its participants in the future are zero. This explains why the Hidden Asset is nil in this case.

The amount of the Hidden Asset also depends inversely on the amount of the sponsor's periodic contributions to the pension system. Consider first a situation in which both the pension system and the economy are stationary. When the amount of the sponsor's periodic contributions increases, with no changes being made to the size of the pensions, it will be possible to reduce the contribution rate applied to the participant. This will reduce the amount of hidden tax and the size of the Hidden Asset. In the balance sheet, the present value of the sponsor's periodic contributions appears as "Accumulated Deficit". Therefore, for pension payments of a fixed size (and therefore for fixed liabilities), any increase in the Accumulated Deficit is compensated for by an equal reduction in the Hidden Asset. The identity of the balance sheet is preserved.

If the amount of the sponsor's periodic contributions were to increase sufficiently, the Hidden Asset would become nil or even negative. This last situation would indicate that instead of a hidden tax there is a "hidden subsidy" in favour of participants, in the form of contributions with a present discounted value lower than the present discounted value of the pension benefits to be obtained. In the situation with a negative Hidden Asset, the IRR obtained by each generation of participants in these stationary states is greater than the rate of interest offered by the financial market, if the extra taxes they may pay are ignored or inexistent because others bear the burden of the sponsor's contributions. This follows from the definition of the IRR and from the presence of a "hidden subsidy".

In Spain, the IRR of the pay-as-you-go system (the IRR for the participants implicit in current benefit formulae) far exceeds the past average growth rate of GDP and its estimated growth rate

[8] See Appendix 2.

for the next fifty years[9]. As the IRR also appears to exceed the rate of interest offered by the financial market (risk adjusted), the generations of current and near-future pensioners in Spain have received and will receive a "hidden subsidy" through their participation in the pension system. This subsidy will have to be paid by the sponsor (the State, which represents future Spanish and European contributors) and/or by the generations of participants who will live in an even more distant future.

A comparative summary of the main aspects of the Hidden Asset and the Contribution Asset can be seen in Table 2.

TABLE 2: CONCEPTS BEHIND THE CONTRIBUTION ASSET AND THE HIDDEN ASSET		
Entry	**Contribution Asset (CA)**	**Hidden Asset (HA)**
Definition	This is the product of the aggregate contribution flow and the turnover duration. It is equal to the pension system's liabilities in a steady state without supplements from the sponsor. It can also be interpreted as the maximum liability that can be supported in that steady state by the current contribution rate without supplements from the sponsor.	This is the present discounted value of the hidden taxes and hidden subsidies that will be applied by the pension system to its participants in the future, under legislated parameters. In turn, the hidden taxes are defined as the contributions over and above the contribution that a fully funded system would require to finance the payment of the same pensions.
Technical Basis	The turnover duration is the sum of the pay-in duration and the pay-out duration, in a triple stationary state for the economy, the demography and the pension system rules. These stationary states are assigned parameter values that attempt to represent the current situation. In this paper, all stationary states considered are of the "golden rule" type.	A pension system applies and collects the revenue from an implicit or "hidden" tax when it gives its participants a rate of return lower than the one given by the financial market, after adjusting for risk differences. The revenue from this implicit tax is a real flow of resources and its present value is an economic asset (the hidden asset) for the pension system.
Relation to the system's liabilities	For consistency, the actuarial liabilities of the system have to be calculated with the same discount rates and population parameters used to determine the Contribution Asset. This discount rate may be implicit in the steady state assumptions. In golden-rule steady states, the implicit discount rate is $g + \gamma = d$	For consistency, the actuarial liabilities of the system have to be calculated with the return of the financial market, r. The actuarial liabilities will coincide with the liabilities that there would be if the pension system were financed through full funding.
Application	Since 2001 it has been applied to compile the balance sheet for social security in Sweden. (See Försäkringskassan (2006))	Only theoretical, so far.
Details	See Appendices 1 and 2.	

2. Entries on the liabilities side.

This section examines the calculation of the liabilities contained in the balance sheet in more detail. In contrast to the previous section, this calculation takes into account real details of the benefit formula and current demographic and economic circumstances, both of which are usually much more complex than steady state assumptions. This, in turn, may be done with projections or using cross-section data. References and papers dealing with the calculation of actuarial liabilities are standard[10].

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[9] See Jimeno & Licandro (1999), Devesa-Carpio *et al.* (2002) and Devesa-Carpio & Vidal-Meliá (2004).

[10] Without being an exhaustive list, interested readers can consult the work of Van den Noord & Herd (1993), Franco (1995), Bravo & Uthoff (1999), Holzmann *et al.* (2004), Devesa & Devesa (2005) and Franco *et al.* (2005). In the economics literature the expression "implicit debt" is used frequently. Feldstein (1974) considered it to be the implicit promise that the next generation will tax itself in order to pay lifetime pension rights specified by current law. It is the pension system, not the government, which has the liability or

For commitments with pensioners, actuaries use the term "technical provisions for pensions in payment", the amount of which is labeled here as liabilities to pensioners. For contributors, actuaries use "technical provisions for rights being acquired", which will be reported as liabilities to contributors. Both have to be quantified following the standard procedures of actuarial mathematics.

For a balance sheet to make sense, the discount rate used for assets must be the same as the one used to determine liabilities, adjusting for risk. For this reason, the assumptions used to discount future pensions differ notably according to whether it is the Contribution Asset being calculated (under the assumption of a golden-rule stationary state with no periodic contributions from the sponsor), or if it is the Hidden Asset being calculated, or if it is a fully funded system being considered. In the first case the appropriate rate of discount is the growth rate of GDP (G), which coincides with the IRR of the pay-as-you-go system, under the assumptions mentioned. However, when the Hidden Asset is being calculated or in the case of a fully funded system, the discount rate used for liabilities must be the expected return of safe investments, or equivalently, the expected rate of return of the investments, minus the risk premium appropriate for those investments.

The technical provisions for pensions in payment are the present value of the amount of all the pensions accrued until the date of the balance sheet. Again, the life table and other population data must be consistent with those used on the assets side for the balance sheet to make sense. For this reason, the population data depend on whether it is the Contribution Asset being calculated, or if it is the Hidden Asset being calculated, or if it is a fully funded system being considered. As the Contribution Asset is calculated under the assumption of a golden-rule stationary state, the population data in the cross-section are identical to those applicable to longitudinal projections, so cross-section data are equally as valid as longitudinal data. Cross-section data are normally used in this case. As the Hidden Asset does not assume a steady state, and is therefore based on longitudinal projections, the population data used to provision for pensions in payment in that case must also be longitudinal projections. In fully funded systems, this provision is the capital that would be needed to purchase in the financial market a guarantee that pensioners will be paid their recognised pensions.

Calculating the technical provisions of rights in the process of being acquired (liabilities to contributors) also requires consistency with the method used to value assets. In the case of notional defined contribution (NDC) systems that value assets using Contribution Asset methodology, this provision would simply be the notional capital present at each moment in the virtual accounts (formed by the contributions made by participants, plus the return deriving from the notional rate of interest credited to those accounts), provided that the notional interest rate credited to the virtual accounts is equal to the discount rate used to calculate the Contribution Asset. In the case of a fully funded system that values assets with financial prices, this provision would simply be the value of the financial capital in the participants' accounts.

In other cases the calculation is less simple. With defined benefits, for example, these technical provisions can be obtained by applying the prospective method (the difference between the present value of the insurer's future commitments and those of the contributor), or the retrospective method (the difference between the present value of the contributor's past commitments and those of the insurer). In an actuarially fair system in which perfect information were available because the system operated within an economic and demographic steady state, both methods would provide the same result. In practice they differ. When acquired rights are fully respected, the prospective method is applied.

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commitment. If the sponsor of the pension system can redefine its support with new legislation, as in state-sponsored systems whose parameters are not protected by property rights, the sponsor only bears an “implicit” debt or a “fiscal risk”, not comparable to contractual obligations such as public debt.

III. The Swedish experience with the actuarial balance sheet.

The evolution of the actuarial balance sheet for the Swedish system during the period 2001-2005 is shown in Table 3. It is reviewed the construction of the different items, emphasising the solvency ratios rather than the size of items as compared to GDP.

The "Financial Asset" is the value of the financial assets owned by the Swedish pension system at the date of the balance sheet. Its valuation is made according to internationally accepted principles, i.e. based on the financial prices of the securities held.

TABLE 3: BALANCE SHEET OF THE SWEDISH PENSION SYSTEM AT DEC. 31 OF EACH YEAR AS % OF GDP.

Year	2005	2004	2003	2002	2001
ASSETS					
Financial Asset	28.8	25.1	23.5	20.6	24.7
Contribution Asset	214.0	217.9	222.2	223.2	222.2
Total Assets	242.8	243.0	245.7	243.7	246.9
LIABILITIES					
Liability to Contributors	172.6	174.3	175.4	175.3	172.3
Liability to Pensioners	69.2	68.3	67.9	66.3	65.1
Accumulated surplus	0.3	2.2	2.1	9.2	9.5
Change in Net Worth	0.7	-1.9	0.3	-7.0	
Total Liabilities	242.8	243.0	245.7	243.7	246.9
FUNDING AND SOLVENCY INDICATORS					
Solvency ratio[11] (Total Assets/Liabilities)	**1.0044**	**1.0014**	**1.0097**	**1.0090**	**1.0402**
Degree of funding (Financial Asset/Liabilities)	**11.90%**	**10.35%**	**9.64%**	**8.51%**	**10.40%**
Liabilities to Contributors/Liabilities	**71.4%**	**71.8%**	**72.1%**	**72.6%**	**72.6%**
Source: Försäkringskassan (2006), (2005), (2004), (2003), (2002) and authors					

The Contribution Asset is calculated in the way described in Försäkringskassan (2006), i.e. it is the annual contribution flow multiplied by turnover duration (TD). This turnover duration is based on population data obtained from a cross-section, not from a projection. Recall that this is valid on the assumption of a steady state for the economy, demography and the pension system. To limit fluctuation in the annual result of the pension system, the contribution flow used in the calculation of the contribution asset is smoothed. To achieve this smoothing, the average contribution of the past three years is calculated, then indexed by the annual percentage change in the contribution flow for the last three years, after eliminating the change in consumer prices during the same period, while the change in consumer prices over the last year is added. Moreover, the median turnover duration for the last three years is used in the calculation of the contribution asset.

The Liability to Contributors is calculated as the notional capital accumulated in the participants' accounts. Liabilities to contributors as a proportion of total liabilities amounted to 71.4% in 2005.

[11] For Auerbach and Lee (2006), the balance (solvency) ratio is not a perfect measure of the system's financial health, because the two components of the asset measure are based on inconsistent rate-of-return assumptions, the financial component being assumed to yield a market rate of return and the contribution asset being valued using the system's implicit rate of return.

The Liability to Pensioners is the "nominal" value of benefits expected to be paid, considering the current number of survivors and thus implicitly the life table and other population data that are taken from a cross-section of the data observed in the last year. This calculation also takes into account that benefits are indexed in a specific way by current law[12].

The Accumulated Surplus is the "accumulated profit" or net worth of the pension system, which is owned by the system's sponsor, in this case the State. The system's annual profit or loss is the difference between the increase in assets and the increase in liabilities during that period. The loss is also identical to the increase in the Accumulated Deficit or the reduction in the Accumulated Surplus, depending on the situation. It is important not to confuse this profit or loss with the annual cash deficit or surplus. The Swedish authorities present a detailed results account in their annual report, showing the sources of changes in net worth.

Both the assets and liabilities are valued on the basis of verifiable cross-section facts, i.e. no projections are made. For example, current longevity is used even though it is expected to increase. If and when that expectation materialises in new mortality tables, this will be incorporated into the information on the balance sheet on a year-to-year basis. Because of this assumption, the calculation of the Contribution Asset does not take into account that contributions will grow in line with real salaries due to expected economic growth. The Swedish authorities note that the system's solvency ratio does not depend on the amount of the assets and liabilities separately, but on the relation between them via the solvency ratio, and for this reason, valuing the assets and liabilities with cross-section data is adequate if applied consistently.

In Sweden, the valuation of the flow of the system's contributions and liabilities is based almost exclusively on ratios and data observed at the date of valuation. This should not be interpreted as a belief that all the basic parameters determining the items on the balance sheet will remain constant in time, but as a result of the policy of using cross-section data. Changes are not included until they happen and can be verified. Försäkringskassan (2002) argues that another advantage of using cross-section data is that it avoids the manipulations and biases that could affect any projections. Försäkringskassan (2002) also indicates that the economic and demographic forecasts that have to be made in order to predict the system's IRR and future variations in average salary are not very accurate. The authorities do not even consider themselves able to make this type of prediction in the short term with an acceptable degree of certainty or accuracy. According to their criteria, the ability to make this type of prediction for the long term with the degree of reliability required by the pension system is even more limited.

Projections of the system's possible future evolution are in fact carried out in the annual report of the Swedish pension system, with three basic scenarios being included –normal, pessimistic and optimistic- which provide valuable information. However, this information is not used in the preparation of the actuarial balance sheet, not even when making annual decisions that may affect contributors and pensioners[13].

It is useful to remember that, in contrast to most defined-benefit systems, the design of the Swedish pension has a built-in direct relation between the long-term evolution of the system's assets and liabilities due to the use of notional accounts, with a notional interest rate which has been similar to the internal rate of return of the system. In the shorter term, if the solvency ratio is greater than one, the Swedish system allows the assets and liabilities to evolve at slightly different

[12] In a comment to the model laid out by Settergren and Mikula (2005), Lee (2006, p. 146), pointed out that in that model liabilities to pensioners were calculated with an actuarial projection into the future, not with the cross-sectional alternative. That observation is correct for that model, but not for current Swedish practice, which relies on observed data only.

[13] This is one of the basic differences between the balance sheets in Sweden and the USA. Projections of demographic, economic and financial variables over a very long period of time are used in the USA, while the principle of valuing based on verifiable facts at the date of the balance sheet is applied in Sweden. According to BOT (2006), the actuarial balance is a measure of the program's financial status for the 75-year valuation period as a whole. It is essentially the difference between the income and cost of the program expressed as a percentage of taxable payrolls over the valuation period. This single number summarises the adequacy of program financing for the period. In addition, and unlike what happens in Sweden, the actuarial balance in the USA is not used for making annual decisions that may affect contributors and pensioners. All in all it could be said that the Swedish and American balance sheets are complementary indicators; the American method provides an idea of how the balance sheet may evolve in the future, whereas in Sweden decisions are made year after year according to the evolution of the annual balance sheet which incorporates real changes which may or may not coincide with those expected and which appear only gradually. There would be very little justification in a notional accounts system to argue that pensions have to decrease in real terms due to the fact that the expected projection for economic growth is negative or because longevity is expected to increase.

rates. On the other hand, if the solvency ratio is less than one, then the Swedish system imposes an "automatic balance mechanism", which is a legislated formula that modifies the notional interest rate credited and the indexation rate for pensions[14].

As can be seen in the lower panel of Table 3, the degree of funding of the Swedish system is clearly positive. This allows possible annual shortfalls in the system's income as compared to expenditure to be dealt with by selling financial assets. The high degree of solvency, on the other hand, implies that it is not likely that support from the sponsor (the State) will be sought.

The size of items in Table 3 as compared to GDP may depend on aspects of the design of the pension system, such as DB versus Notional DC and the type of pension indexation. To the extent that this is so, they are less relevant for international comparisons.

IV. The actuarial balance sheet for the Spanish pension system.

This section shows the first estimates of the actuarial balance sheet for the Spanish contributory retirement pension system, with the aim of producing a solvency indicator for the system. At present many observers mistakenly take the annual cash-flow deficit/surplus to be a solvency indicator, despite the fact that it is only a liquidity indicator. It is not difficult to imagine situations in a pay-as-you-go pension system in which a series of annual cash-flow surpluses may come about at the same time that the system's insolvency ratio is increasing. The opposite situation could also be true. To evaluate whether or not the system is solvent, it is essential to compile a balance sheet.

Our balance sheet for the Spanish pension system will include information relating to the commitments acquired with current workers and pensioners for the retirement contingency of the following social security regimes: general, agrarian workers (employed and self-employed), self-employed workers, coal mining, domestic employees, sea workers and the former Compulsory Old-Age and Permanent Disability Insurance (SOVI: *Seguro Obligatorio de Vejez e Invalidez*). Due to lack of information, we will not include the regime for civil servants and public sector workers.

A balance sheet always assumes that the system is closed: there can be no new members, and members can only exit through death or permanent disability. The system's commitments to all current pensioners and workers are taken into account, always assuming that current legislation holds. In the case of liabilities to workers, the prospective method is used, so their future contributions are subtracted from their expected pension benefits.

The philosophy used to compile the balance sheet in Sweden will be followed as far as possible when valuing the Spanish system's assets and liabilities, i.e. the calculations will be based on verifiable facts observed at the date of the balance sheet, with the lowest possible number of projections. However, there are differences in the design of the system (DB versus Notional DC) and in the type of pension indexation that will lead us to significant deviations.

To provide sensitivity analysis for the solvency ratio[15], we also calculate the balance sheet for the cases g=d=1.5% and g=d=3%. This is also useful to verify that the ratio of each balance sheet item to GDP falls as the discount rate and the projected growth rate of average real salaries rises. In all cases the turnover duration is calculated assuming a golden- rule steady state, so the discount rate is always set equal to the projected growth rate of average real salaries in that particular scenario.

The assets side will include the stock of financial assets (the reserve fund) and the Contribution Asset, which will be determined by the flow of contributions allocated to cover the retirement contingency for each regime, and the economic (amounts) and demographic characteristics of the groups of contributors and pensioners.

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[14] According to Auerbach and Lee (2006), the Swedish balance mechanism is an asymmetric "brake", because its effect is to prevent the excessive accumulation of debt, but not of assets; it applies only when the system is underfunded, as indicated by the balance (solvency) ratio, but not when it is overfunded.

[15] See Appendix 3.

1. Data.

Data on the number of pensioners and amounts by contingency, regime, sex and age were obtained from the Spanish Social Security website[16] and from information supplied by the Office of the Deputy Director of Economics at the National Institute of Social Security (Instituto Nacional de la Seguridad Social)[17].

The information on participants registered as working, by regime and sex, and on registered retirement pensions by age was obtained from the Annual Reports of Employment Statistics and Social Affairs for 2005, 2004, 2003, 2002 and 2001[18].

Data on the total amounts of contributions by regime are shown in the economic-financial report on Social Security budgets for 2007[19].

Data on the average contribution bases, by regime and age, have been estimated based on "Microdata from the Continuous Sample of Working Lives 2004" (*Microdatos de la Muestra Continua de Vidas Laborales*) supplied by the Ministry of Labour and Social Affairs (MTAS). For example, for the General Regime of Social Security, work was carried out using a sample of over 500,000 individuals for each of the years that estimates have been made for the balance sheet (2001-2005).

A summary of the data and the most relevant variables for calculating the balance sheet is provided in Appendix 4.

2. Other assumptions.

It is assumed that individuals join the labour market at age 25, except those who are already in the system at an earlier age, and contribute throughout their working lives with 100% density.

The mortality tables used are those from the National Institute of Statistics (Instituto Nacional de Estadística) 98-99. The permanent disability tables are those drawn up by Vicente *et al.* (2003) using data from Spanish Social Security. Although only the retirement contingency is evaluated, it should not be forgotten that current workers might not receive their retirement pension for two possible reasons: death or permanent disability. Therefore, to avoid overvaluing liabilities to contributors, multiple decrement life tables need to be used. These tables are compiled by combining those from the NIS 98-99 and the permanent disability tables drawn up by Vicente *et al.* (2003).

The real technical interest rate applied to discount future pensions and contributions is the IRR of the pay-as-you-go system. To be consistent with the estimate of the Contribution Asset (stationary state with population stability and salaries constant in real terms), this rate has to be 0%. It should be noted, see Appendices 1 and 3, that the system's financial position does not depend on the amount of assets and liabilities separately, but on the relation between them expressed by the solvency ratio.

In the Spanish social security system, the total contributions for common contingencies have no specific allocation to each contingency. The allocation of income from contributions applicable to the retirement contingency is calculated by taking into account the percentage represented by expenditure on pensions, for each contingency, out of the total expenditure for common contingencies. This method ensures that, in a stationary state, there is proportionality between expenditure and income for contingencies, and if there is a deficit or surplus it is distributed equally among all the common contingencies. This method may be inappropriate when the balance sheets give information which differs greatly from the cash flows estimated for the following year. However, as already mentioned above, this is the method used by the Swedish authorities, based on the principle of valuation based on verifiable facts at the effective date of the balance sheet, and we follow it here to maximise comparability of our results with those of the Swedish system.

The expenditure on pensions caused by the supplement to the minimum retirement benefits[20] is considered income from contributions.

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[16] http://www.seg-social.es/inicio/?MIval=cw_lanzadera&LANG=1&URL=82

[17] We are grateful for the information supplied by Don Antonio Millán.

[18] http://www.mtas.es/estadisticas/anuario.htm

[19] http://www.seg-social.es/inicio/?MIval=cw_usr_view_Folder&LANG=1&ID=49896

It is assumed that the pensions drawn by each beneficiary remain constant in real terms, as do the minimum and maximum pensions for each year of reference.

Salaries (contribution bases) are kept constant in real terms for each age group, which implies supposing that contributors will obtain wage rises only for increases in age.

It is considered that individuals can retire at age 60, 61, 62, 63, 64 and 65. The probability that they will retire at one of these ages is calculated from the pension applications by age for the year of reference. The retirement age for individuals of 62 is considered to be equal to 65, and for those of 67 equal to 70. Individuals of 67 do not pay contributions at 68 and 69, but, following Law 35/2002, for the calculation of their pension base it is as if they had contributed.

The pension base is calculated by taking into account the 15 years before retirement age, as required by the current benefit formula. The first pension to which pensioners will be entitled is equal to 100% of the pension base, with a 7% reduction being applied for each year that retirement is brought forward from age 65. On the other hand, the pension base for individuals of 67, who will retire at 70, will be multiplied by 1.1. (2% more for each year that retirement age is delayed beyond age 65).

3. Results for Spain[21].

The evolution of the balance sheet for the Spanish system for the period 2001-2005 is shown in Table 4.

TABLE 4: BALANCE SHEET AT DEC. 31 OF EACH YEAR FOR THE SPANISH PENSION SYSTEM AS % OF GDP. CONSOLIDATED FOR ALL REGIMES.

Year	2005	2004	2003	2002	2001
ASSETS					
Financial Asset	3.00	2.30	1.54	0.85	0.36
Contribution Asset	188.74	188.74	194.18	196.21	203.75
Accumulated Deficit	101.39	96.16	94.56	87.29	93.51
"Losses for the period"	7.32	13.12	8.67	14.19	0.00
Total Assets	300.45	300.32	298.95	298.53	297.62
LIABILITIES					
Liability to Pensioners	60.82	60.75	61.62	63.31	62.10
Liability to Contributors	239.63	239.57	237.33	235.22	235.52
Total Liabilities	300.45	300.32	298.95	298.53	297.62
FUNDING AND SOLVENCY INDICATORS					
Ratio of (in)solvency	**0.638**	**0.636**	**0.655**	**0.660**	**0.686**
Degree of funding	**1.00%**	**0.77%**	**0.51%**	**0.28%**	**0.12%**
Liabilities to Contrib./Liabilities	**79.8%**	**79.8%**	**79.4%**	**78.8%**	**79.1%**
Source: Authors					

Regarding the entries on the assets side, in the Spanish case (2001-2005):

1.-The value of the Financial Asset has grown steadily since 2001, rising from 0.36% to 3.00% of GDP. This is due to the fact that the contributory system showed a cash-flow surplus and it was decided to create a reserve fund[22]. However, the Spanish system's degree of funding is still very low, hardly reaching 1.00% of liabilities, as compared to Sweden, where the degree of funding is 11.90%.

[20] The necessary supplements for reaching the pension's minimum amount.

[21] This first estimate contains weaknesses which could be improved but which at present are unavoidable, basically regarding the estimate for the contribution liability and to a lesser extent for the liabilities for pensions in payment. We have calculated the liabilities using average values, whereas in an ideal situation there would be personalized details for each individual contributor (employment history) and pensioner. Mortality and disability tables also need to be updated in order to make the estimates more accurate. Finally, in the future the balance sheet could be completed by including the regime for civil servants and public workers, and increasing in all regimes the contingency for permanent disability pensions which end up becoming retirement pensions.

[22] As Blanco (2002) points out, the surplus would be greater and consequently so would the reserve fund if the supplement to the minimum benefits were financed wholly through taxation.

2.-The value of the Contribution Asset is smaller in Spain than in Sweden: about 189% of GDP, as compared to 214% for Sweden. The evolution of the Contribution Asset in Spain is rather worrying: it has fallen by 14 percentage points of GDP in barely 4 years, from 203.75% to 188.74% of GDP. In Sweden the fall has been 8.2 percentage points of GDP. Proportionally the worst falls in Spain have occurred in the coal mining and agrarian worker regimes, as can be seen in Appendix 4.

The results in Figure 1 and in the tables in Appendix 4 show that the fall in the Contribution Asset as a proportion of GDP is due to two basic reasons:

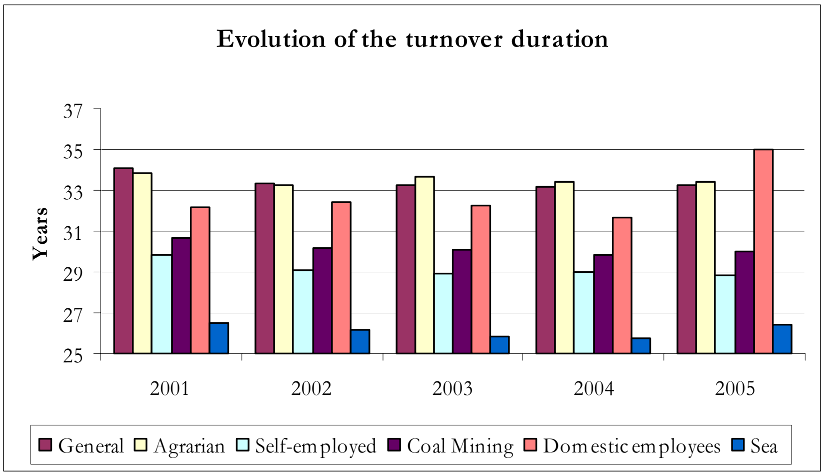


Figure 1: Evolution of the turnover duration for all regimes. Period 2001-2005.

a) The decrease in the difference between the weighted average age of the pensioners and the contributors. In the case of the general regime, the most important one, this decrease can be assessed at approximately 0.85 years (34.07-33.22). This is basically due to the ageing of the contributors as a whole. All the regimes, except the one for domestic employees, have undergone a similar process.

b) The rhythm of growth of contributions has either been less than the rhythm of growth of GDP, as in the two most important regimes (general and self-employed workers), or it has suffered a decrease or stagnation in the payment of contributions, as in the regimes for sea workers, coal mining and agrarian workers. The exception again is the regime for domestic workers. All this has come about in the context of a large increase in participants in the general, self-employed worker and, especially, domestic employee regimes in 2005. It should be pointed out that the average contribution in real terms per participant has decreased in the general and domestic employee regimes and grown in the others.

On the liabilities side, Table 4 shows that in Spain:

1.-The liability with retirement pensioners has decreased by 1.28% of GDP in absolute value in the period 2001-2005. This fall has not been uniform in relative terms. Indeed, some regimes have increased the value of their liability with retirement pensioners in relation to GDP: the general regime by 0.79% and the SOVI by more than 17%. The biggest decreases occurred in the self-employed agrarian worker regime (-16.66%), domestic employees (-17.24%) and coal mining (-11.43%).

2.-The share of commitments given by liabilities to contributors for retirement is 79.8%, which is 8.4 percentage points higher than in Sweden. These commitments have increased by 4.11% of GDP, with the biggest increases occurring in those regimes that have grown in number of contributors: general, self-employed workers and domestic employees. An important question is whether the solvency ratio is constant across different scenarios. The sensitivity analysis (Appendix 3) shows that the solvency ratio remains almost the same for the two alternative scenarios. This constancy does not extend to the other two ratios reported in Table 4. The funding ratio doubles as the discount rate and the growth of average salaries rise from 0% to 3%. The reason is that financial assets are reported at their current market value in all growth scenarios while total liabilities fall very significantly. The ratio of liability to contributors to total liabilities also falls, but not as strongly as the funding ratio, when the discount rate and the growth of average salaries rise from 0% to 3%. The reason is that because liabilities to contributors are farther away in the future, they fall faster than the liability to pensioners.

3.-The size of total liabilities is 300.45% of GDP in Spain, which is about 58.65 percentage points bigger than the comparable value for Sweden, which is 241.8% of GDP. This difference is due to a combination of factors, among which the following stand out: the different age structure, the difference in contribution density trajectories, the difference in retirement patterns and the difference in generosity. The latter includes differences in retirement ages, replacement rates and pension indexation rules, and can be identified by the excess of the IRR over the growth of the contribution base.

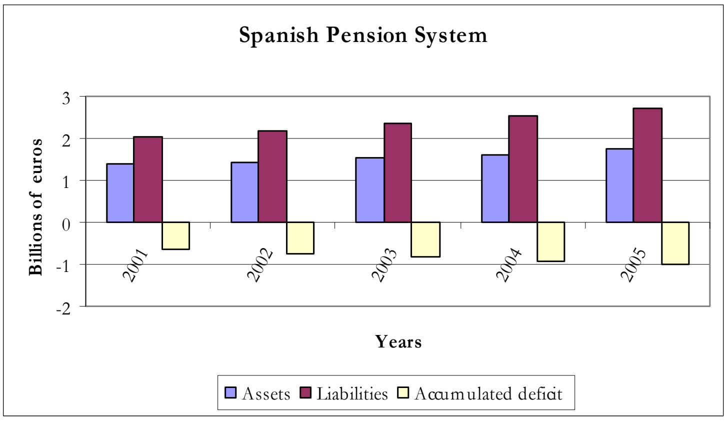
The liabilities reported by the balance sheets in Table 4 should not be confused with the cost of transferring the obligation to pay the commitments to a 100%-capitalised insurance company, or to a fully funded pension system. The cost of fully funding the liabilities would be less than that indicated by these balance sheets because, in order to carry out the calculations leading to Table 4, it was supposed that the real discount rate is 0%, while in a fully funded system the discount rate would have a positive value (1.5%-3%). However, as already indicated, the level of the discount rate does not affect the solvency ratio, i.e. the relation between the pension system's assets and liabilities, because both the liabilities and the Contribution Asset change in the same proportion in response to changes in the discount rate (this is due to the assumed cash flow equilibrium at every date).

The evolution of the total assets, liabilities and accumulated deficit

Figure 2 shows the evolution of the assets, liabilities and accumulated deficit (in billions of euros) along with the rates of variation for the same period.

It can be appreciated that the assets and liabilities have evolved at very different rhythms (rates of variation). For the period under analysis the liabilities grew at a higher cumulative rate than the assets. In other words the system is not only insolvent given that liabilities exceed assets by 36%, but it is also suffering a year-on-year increase in the degree of insolvency. Attaining solvency would only be possible if the liabilities grew at much lower rates than the assets, which is exactly the opposite of what has been happening over the last few years.

Although the solvency of the system as a whole improved very slightly in 2005, there is a deficit of 36% of liabilities. Contrary to some official signs of optimism as to the contributory pension system's financial health, the balance sheet shows an awkward position of solvency and a notable actuarial imbalance which calls for immediate reform.



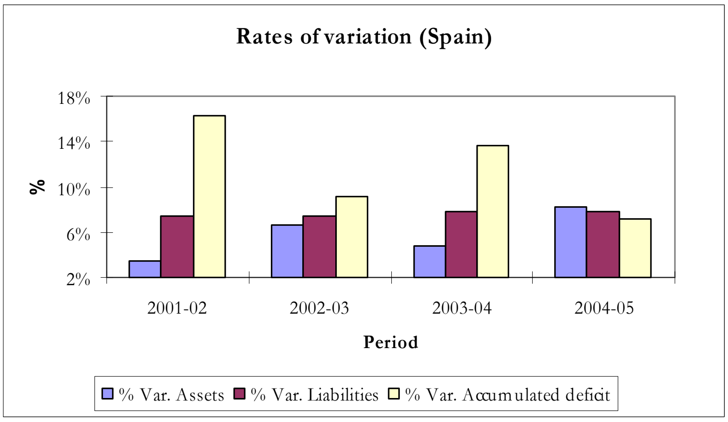


Figure 2: Evolution of the total assets, liabilities and accumulated deficit of the Spanish pension system and their rates of variation. Period 2001-2005.

Figure 3 shows the evolution of the (in)solvency ratio by regime.

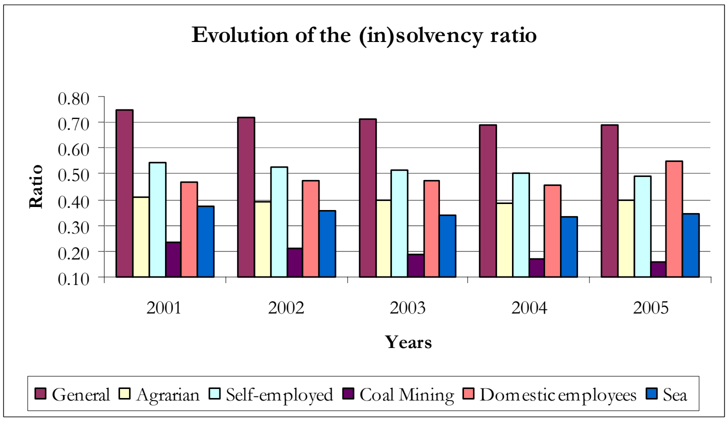


Figure 3: Evolution of the (in)solvency ratio by regime. Period 2001-2005.

On the other hand, by comparing Tables 3 (Sweden) and 4 (Spain) one can immediately see the difference between a solvent system (Sweden), which backs up all its liabilities, and an insolvent one (Spain), which backs up only 64% of its liabilities. There is also a clear difference between a balanced system (Sweden), in which the rates of variation of the assets and liabilities are similar due to the fact that new participants do not bring any additional deficit with them, and an imbalanced system (Spain), in which the new participants increase the pension system's deficit. Because of this, the level of insolvency in Spain increases as the number of contributors increases.

Balance sheets by pension regime

Tables 5A and 5B show the balance sheet by regime, under the assumption that existing financial assets are distributed in proportion to the Contribution Asset of each regime. It can be seen that the general regime is the one in the least serious situation of insolvency, although the accumulated deficit in terms of GDP has grown notably over the last five years, and quantitatively is the greatest.

TABLE 5A: BALANCE SHEET FOR THE SPANISH PENSION SYSTEM FOR THE PERIOD 2001-2005 AS % OF GDP AT 31-12 OF EACH YEAR. BY REGIME.					
Year	**2005**	**2004**	**2003**	**2002**	**2001**
ASSETS (General)					
Financial Asset	2.55	1.95	1.31	0.72	0.30
Contribution Asset	160.40	159.98	164.95	166.20	171.77
Accumulated deficit	72.55	72.63	67.56	65.65	57.56
Total Assets	235.50	234.56	233.82	232.57	229.63
LIABILITIES (General)					
Liability to Pensioners	43.14	43.10	43.32	44.16	42.80
Liability to Contributors	192.36	191.46	190.50	188.41	186.83
Total Liabilities	235.50	234.56	233.82	232.57	229.63
(In)solvency ratio	**0.692**	**0.690**	**0.711**	**0.718**	**0.749**
ASSETS (Agrarian workers)					
Financial Asset	0.10	0.08	0.06	0.03	0.01
Contribution Asset	6.25	6.57	7.18	7.55	8.34
Accumulated deficit	9.66	10.68	10.98	11.66	12.16
Total Assets	16.02	17.33	18.22	19.25	20.52
LIABILITIES (Agrarian workers)					
Liability to Pensioners	6.55	6.84	7.25	7.79	7.86
Liability to Contributors	9.47	10.49	10.97	11.46	12.66
Total Liabilities	16.02	17.33	18.22	19.25	20.52
(In)solvency ratio	**0.397**	**0.384**	**0.397**	**0.394**	**0.407**
ASSETS (Self-employed workers)					
Financial Asset	0.31	0.24	0.15	0.09	0.04
Contribution Asset	19.26	19.86	19.54	19.81	20.90
Accumulated deficit	20.36	19.96	18.58	17.97	17.61
Total Assets	39.92	40.07	38.27	37.86	38.55
LIABILITIES (Self-employed workers)					
Liability to Pensioners	5.39	5.28	5.29	5.35	5.48
Liability to Contributors	34.53	34.79	32.98	32.51	33.07
Total Liabilities	39.92	40.07	38.27	37.86	38.55
(In)solvency ratio	**0.490**	**0.502**	**0.515**	**0.525**	**0.543**
Source: Authors.					

The regime for self-employed workers is second to the general regime as regards its degree of solvency. It can cover only 55% of the commitments acquired with contributors and pensioners. Its situation has worsened over the last five years.

The third regime by size of accumulated deficit is the one for agrarian workers, although the absolute value of this deficit shows a downward trend over time due to the fact that the number of both contributors and pensioners is decreasing. The solvency ratio is very low, with barely 40% of acquired commitments covered.

Special mention should be made of the Regime for Domestic Employees, the only one that has improved in terms of solvency as a result of the extraordinary increase in contributors over the last year. Despite this, the solvency ratio barely reached 55% at the end of 2005.

The other special regimes (sea workers and coal mining) are of little quantitative importance but show a very high degree of insolvency.

TABLE 5B: BALANCE SHEET FOR THE SPANISH PENSION SYSTEM FOR THE PERIOD 2001-2005 AS % OF GDP AT 31-12 OF EACH YEAR. BY REGIME (CONTINUATION).

Date	2005	2004	2003	2002	2001
ASSETS (Coal Mining)					
Financial Asset	0.00	0.00	0.00	0.00	0.00
Contribution Asset	0.22	0.26	0.31	0.35	0.41
Accumulated deficit	1.19	1.27	1.31	1.34	1.35
Total Assets	1.42	1.53	1.62	1.70	1.76
LIABILITIES (Coal Mining)					
Liability to Pensioners	1.24	1.29	1.34	1.40	1.40
Liability to Contributors	0.18	0.24	0.28	0.30	0.36
Total Liabilities	1.42	1.53	1.62	1.70	1.76
(In)solvency ratio	**0.156**	**0.171**	**0.190**	**0.210**	**0.234**
ASSETS (Domestic employees)					
Financial Asset	0.03	0.02	0.01	0.01	0.00
Contribution Asset	1.90	1.34	1.47	1.47	1.46
Accumulated deficit	1.59	1.64	1.64	1.65	1.66
Total Assets	3.52	2.99	3.12	3.13	3.12
LIABILITIES (Domestic employees)					
Liability to Pensioners	1.20	1.26	1.33	1.43	1.45
Liability to Contributors	2.32	1.73	1.79	1.70	1.67
Total Liabilities	3.52	2.99	3.12	3.13	3.12
(In)solvency ratio	**0.549**	**0.453**	**0.474**	**0.473**	**0.468**
ASSETS (Sea workers)					
Financial Asset	0.01	0.01	0.01	0.00	0.00
Contribution Asset	0.71	0.72	0.74	0.82	0.87
Accumulated deficit	1.37	1.48	1.47	1.47	1.48
Total Assets	2.09	2.21	2.21	2.29	2.36
LIABILITIES (Sea workers)					
Liability to Pensioners	1.32	1.36	1.40	1.45	1.42
Liability to Contributors	0.77	0.85	0.81	0.84	0.94
Total Liabilities	2.09	2.21	2.21	2.29	2.36
(In)solvency ratio	**0.344**	**0.331**	**0.337**	**0.359**	**0.371**
Source: Authors.					

The causes of insolvency in the Spanish case

How has this situation come about? Why, in spite of an increase in contributors as a whole, does the Spanish system notch up “losses” every tax year? The answer that flows from these results and calculations is that the Spanish system suffers from a structural actuarial imbalance: the relation between the expected contributions and expected benefits “yields” too high an implicit IRR for the contributor. This is also true for new participants, suggesting that the implicit IRR is incompatible with the return that the system can pay out (which is the rate of contribution growth).

This problem has already been described in economics literature in the last few years[23]. Devesa-Carpio *et al.* (2002) show that the real IRR obtained by contributors in the general regime, under normal conditions, is 4.26%, which is way above the real historical growth of Spanish GDP (3%) for the period 1970-2000 which they took as a benchmark. This suggests that the system is financially unviable in the Samuelson-Aaron sense under the parameters currently in force. Of course it is possible to carry out a gradual adjustment of the parameters, but this adjustment would have to be very big to eliminate the insolvency.

Devesa-Carpio & Vidal-Meliá (2004) confirm this conclusion by a different method. These authors find that the value calculated for the IRR according to the rules for 2003 in Spain is far above the other values obtained by retrospectively applying the rules for different countries which have adopted notional account systems. The result that stands out with these rules is that it would not have been possible to obtain an IRR above 3.6%, the value of the average growth of GDP in Spain over the last 40 years (1963-2002).

Along the lines of the previous argument but focusing on immigration, Conde *et al.* (2006) state that if the pension system is not financially sustainable in its initial situation before admitting immigrants, it is because on average the right to receive a pension is too high in relation to the contributions paid. If measures are not taken to solve this problem, then in the long term, after the absorption of immigrants by the host country, the system will be in a worse situation than it was initially due to its increase in size.

The design of the pension system has important implications. In the Spanish defined-benefit design, the current evolution will continue until new legislation is adopted. In contrast, if the Swedish system had a balance sheet like the Spanish one, the automatic balance mechanism would be activated immediately. This would reduce the notional interest rate, cutting liabilities to contributors, and also reduce the rate of indexation of pensions, reducing the growth of pension liabilities. Specifically, the indexation rate of pensions and the notional interest rate received by contributors would be reduced by the percentage of insolvency, which is 36.2%. This harsh adjustment would be maintained until the balance sheet reached solvency.

Restoring solvency to the Spanish system would demand a package of far-reaching measures to reduce the speed of growth of the liabilities, a key aspect for the system to regain solvency over a period of time. The most immediate objective of public policy should be to stop the pension system accumulating "losses" year after year, i.e. it should recover actuarial equilibrium to prevent the insolvency from growing.

V. Concluding comments.

The existence of the Contribution Asset shows that there is no basis for the arguments put forward by those who discredit pure and partial pay-as-you-go finance systems by saying that they are always "bankrupt" or insolvent. These arguments are based on observing the liabilities of the system while ignoring the assets (contribution asset, hidden asset) associated with the pay-as-you-go financial method. A balance sheet that includes these assets cannot be accused of being compiled to discredit pay-as-you-go funding.

This paper has clarified the relation between the Contribution Asset and the Hidden Asset - concepts that are fundamental to enable the balance sheet for pay-as-you-go systems to be compiled with rigour- which establishes a correct indicator of the system's solvency. Nowadays politicians, many researchers and public opinion in general mistakenly consider the annual cash-flow deficit or surplus as an indicator of the pay-as-you-go system's solvency; i.e. they mistake a liquidity indicator for a solvency indicator. In order to assess whether or not a system is solvent, a balance sheet must be compiled.

The balance sheet for the Spanish pension system is a novelty since there is only one country - Sweden since 2001- which presents it periodically. The balance sheet for the Spanish contributory retirement pension system as of 2005 shows a weak position of solvency. It also shows falls in the

[23] See the papers by Durán (1995), Monasterio et *al.* (1996), Bandrés & Cuenca (1998), Jimeno & Licandro (1999), Devesa-Carpio *et al.* (2000, 2002), Devesa-Carpio & Vidal-Meliá (2004), Vidal-Meliá & Domínguez-Fabián (2006), Vidal-Meliá et al. (2006) and Boado-Penas *et al.* (2007) among others.

net worth of the system year after year. Although the solvency of the system as a whole improved very slightly in 2005, the assets deficit was 36% of liabilities.

The Spanish system shows signs of a structural actuarial imbalance: the relation between the expected contributions and pension benefits "yields" too high an implicit IRR for the average participant, to such an extent that this implicit IRR is incompatible with the sustainable return of the system (which is the growth rate of real contribution revenue). Put another way, the cost of selling (pensions and acquired commitments with contributors) is much higher than the selling price (contributions). However, as the cost of selling will create cash flow deficits far off in time and the selling price manifests itself through immediate income, the paradox comes about that the more sold, the more positive the net cash flow observed over the last five years, but the greater the degree of insolvency of the system as a whole.

The absence of a balance sheet in this specific case produces a "mirage effect"; by hiding the presence of a capital deficit, it relativises future cash deficits because there is still time before they occur and still time meanwhile for "something to save the system".

Contrary to official optimism regarding the financial health of the contributory pension system in Spain, the results presented here show how urgent it is that measures be adopted to restore solvency. The first measure should be to change the benefit formula to eliminate the "losses" or increases in the accumulated deficit, which accrue every year that goes by without reform.

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Appendix 1: The contribution asset

The contribution asset is the product of the turnover duration and the aggregate contribution flow. In this appendix it is determined an expression for the turnover duration for several steady states, making assumptions appropriate for the Spanish pension system.

Consider a steady state where participants' lives last ($w- x_e$) periods, where w is the highest age to which it is possible to survive (110 years or more according to recent mortality tables) and x_e is the age of entry into the system. In this case, A generations of contributors and ($w-x_e-A$) generations of pensioners coexist at each moment in time, and a period should be interpreted as one calendar year.

Nieto & Vegas (1993) consider a demographic and economic environment where the demographic structure is stable in time, i.e. the birth and death rates remain unchanged over time and there are no migratory exchanges. A stable population implies that the relative weight of any age group x remains or is kept constant, i.e. the relative size of the different cohorts does not change over time.

A simple case is supposed, where average covered salaries and the contribution base grow at an annual cumulative rate of g%. This growth is assumed to be due entirely to changes in average real salaries, in other words fertility-driven population growth is assumed to be zero ($\gamma = 0$). We assume this because the case for general γ has already been solved by Settergren and Mikula (2005, their equation. 7.7 and Annex C).

As too much generality would complicate our notation and reduce the transparency of our results, it is also assumed here that the age-earnings profile or wage pattern is flat, that the rate of pension indexation is zero in real terms and that the age-retirement pattern is cliff-shaped, meaning that all persons of each given generation are assumed to start full pensions and to retire fully at the same age. Average salaries increase in real terms over time if $g > 0$, and salaries fall in real terms over time if $g < 0$. Together with the previous assumptions, and assuming a fixed ratio of covered earnings to GDP, these assumptions imply that real GDP also grows (decreases) at rate g.

The parameters of the pension system are considered to be in a stationary state (fixed over time). Both the age giving entitlement to a retirement pension, "x_e+A", and the formula used for calculating the pension are constant, leading to a fixed replacement rate of size β.

In this triple stationary state, which has both demographic and economic aspects and fixed parameters for the pension system, the demographic-financial structure at any moment t since the start of the system is:

Age	Number of contributors	Average salary
x_e	N_{xe}	$y_{xe,t} = y_{xe,1}(1+g)^{t-1}$
x_e+1	N_{xe+1}	$y_{(xe+1),t} = y_{(xe+1),1}(1+g)^{t-1}$
.	.	.
.	.	.
.	.	.
x_e+A-1	N_{xe+A-1}	$y_{(xe+A-1),t} = y_{(xe+A-1),1}(1+g)^{t-1}$

The highest age for any member of the group, at which there are no longer any survivors, is defined as "w". Therefore, from date "w-x_e-A" counted from the start of the system, the probability that an individual of age "x_e+A" will reach age "w" is zero. In addition, all survival probabilities from that year onwards are also zero for that cohort.

${}_{w-xe-A}\,p_{xe+A}$: Probability that an individual of age "x_e+A" will reach the age limit w, verifies: $0 = {}_{w-x-A}\,p_{xe+A} = {}_{w-xe-A+1}\,p_{xe+A} = {}_{w-xe-A+2}\,p_{xe+A} = \ldots$

From this year onwards the population of participants is in a stationary state.

The annual retirement pension is $\beta \cdot Y_{C,t}$, which is calculated as a set percentage β of the average salaries by taking into account the 15 years before retirement, $Y_{C,t}$. This benefit formula represents the one used in the Spanish pension system. This pension is a constant real amount per year because the rate of pension indexation is zero in real terms. It is also assumed that all persons in a generation start full pensions and retire fully at the same age.

Given cash-flow equilibrium at all dates, the value of the liabilities of the pension system is equal to the value of the assets regardless of the level and sequence of discount rates[24]. If in addition we assume that the system does not have financial assets protected by property rights, the only possible remaining asset is the Contribution Asset. This makes it unnecessary to calculate the assets independently, starting from cash flows, as in the Hidden Asset approach. For a known liability, the size of the Contribution Asset follows directly, because under these conditions it must be equal to the liability.

The contribution rate that exactly achieves financial equilibrium is aggregate benefit expenditure divided by the aggregate contribution base:

$$\theta_{w-xe-A} = \frac{\beta\, Y_{C,1} \sum_{k=0}^{w-xe-A-1} N_{xe+A+k}\,(1+g)^{w-xe-A-1-k}}{(1+g)^{w-xe-A-1} \sum_{k=0}^{A-1} y_{(xe+k),1}\, N_{xe+k}} = \frac{\beta\, Y_{C,1} \sum_{k=0}^{w-xe-A-1} N_{xe+A+k}\,(1+g)^{-k}}{\sum_{k=0}^{A-1} y_{(xe+k),1}\, N_{xe+k}} = \theta_{w-xe-A+1} = \ldots = \theta \qquad \textbf{[6.]}$$

N_{xe+A} : Number of people who reach retirement at the normal age "$x_e + A$" in each year; under the stated hypotheses this number is constant in time.

The required contribution rate from year "w-x_e-A" onwards (counted from the start of the system) is constant from the actuarial point of view because, from that moment on, the number of deaths of people in receipt of retirement pensions (number of retirees leaving) during that year is equal to the number of people that retire during that year (number of retirees entering), and therefore the number of retirees remains constant.

Now it is calculated the system's liabilities starting from cash flows. They comprise those with current pensioners and those with current contributors.

Liabilities with current pensioners in the stationary state are equal to:

$$V^{r(g>o)}_{w-xe-A} = \beta\, Y_{C,1} \sum_{k=0}^{w-xe-A-1} N_{xe+A+k}\, \ddot{a}_{xe+A+k}\,(1+g)^{w-x_e-A-1-k} \qquad \textbf{[7.]}$$

$\ddot{a}_{xe+A+k}$ being the actuarial value of a lifetime pension payable in advance and valued at the age of "x_e+A+k" years with a technical interest rate equal to d=g.

The second component of liabilities are future pensions for current contributors, the payment of which has not yet begun, but which are commitments with working participants because of contributions already made. This second component is calculated by the prospective method and will be the *difference* between (i) the present value of the future pensions, and (ii) the present value of

[24] If the system is in a situation in which the inherited contribution rate does not allow financial equilibrium in the stationary state expected for the economy and demography from there onwards, then total assets do not coincide with total liabilities.

the future (remaining) contributions until retirement of current contributors. Part (i), i.e. the present value of the future pensions of the current working participants, is:

$$\beta\, Y_{C,1}\, N_{xe+A}\ \ddot{a}_{xe+A} \left[\begin{array}{l} (1+g)^{w-xe-A}(1+d)^{-1} + (1+g)^{w-xe-A+1}(1+d)^{-2} + \ldots\ldots \\ \ldots\ldots + (1+g)^{w-xe-A+A-1}(1+d)^{-A} \end{array} \right] =$$

$$= \beta\, Y_{(C,1)}\, N_{xe+A}\ \ddot{a}_{xe+A} \sum_{h=1}^{A} (1+g)^{w-xe-A+h-1}\ (1+d)^{-h} \qquad \textbf{[8.]}$$

Part (ii) is the present value of the future contributions:

$$\theta \left[\begin{array}{l} N_{xe+A-1}\ \ y_{(xe+A-1),1} \sum_{h=0}^{A-1} (1+g)^{w-xe-A+h-1}(1+d)^{-h} + N_{xe+A-2}\ \ y_{(xe+A-2),1} \sum_{h=0}^{A-2} (1+g)^{w-xe-A+h-1}(1+d)^{-h} + .. \\ \ldots + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + N_{xe}\ \ y_{xe,1}\ (1+g)^{w-xe-A-1} \end{array} \right] =$$

$$= \theta \sum_{k=0}^{A-1} \sum_{h=0}^{k} N_{xe+k}\, y_{(xe+k),1}\ (1+g)^{w-xe-A+h-1}(1+d)^{-h}$$

[9.]

The liabilities with contributors in this stationary state will be constant and equal to:

$$V^{c(g>0)}_{w-xe-A} = \overbrace{\beta\, Y_{C,1}\, N_{xe+A}\ \ddot{a}_{xe+A} \sum_{h=1}^{A} (1+g)^{w-xe-A+h-1}\ (1+d)^{-h}}^{\text{Future pensions}} - \underbrace{\theta \sum_{k=0}^{A-1} \sum_{h=0}^{k} N_{xe+k}\, y_{(xe+k),1}\ (1+g)^{w-xe-A+h-1}(1+d)^{-h}}_{\text{Future contributions}}$$

[10.]

According to Settergren and Mikula (2005), to obtain the turnover duration, total liabilities are divided by the annual contribution flow, leading to:

$$TD^{t(g>0)} = \frac{\beta\, Y_{C,1} \sum_{k=0}^{w-xe-A-1} N_{xe+A+k}\ \ddot{a}_{xe+A+k}\ (1+g)^{w-xe-A-1-k} + \beta\, Y_{C,1}\, N_{xe+A}\ \ddot{a}_{xe+A} \sum_{h=1}^{A} (1+g)^{w-xe-A+h-1}\ (1+d)^{-h}}{\theta\,(1+g)^{w-xe-A-1} \sum_{k=0}^{A-1} y_{(xe+k),1}\ N_{xe+k}}$$

$$- \frac{\theta \sum_{k=0}^{A-1} \sum_{h=0}^{k} N_{xe+k}\, y_{(xe+k),1}\ (1+g)^{w-xe-A+h-1}(1+d)^{-h}}{\theta\,(1+g)^{w-xe-A-1} \sum_{k=0}^{A-1} y_{(xe+k),1}\ N_{xe+k}}$$

[11.]

whereby:

$$TD^{t(g>0)} = \frac{\sum_{k=0}^{w\text{-}xe\text{-}A\text{-}1} N_{xe+A+k}\, \ddot{a}_{xe+A+k}\, (1+g)^{-k}}{\sum_{k=0}^{w\text{-}xe\text{-}A\text{-}1} N_{xe+A+k}\, (1+g)^{-k}} + \frac{N_{xe+A}\, \ddot{a}_{xe+A} \sum_{h=1}^{A} (1+g)^{h}\, (1+d)^{-h}}{\sum_{k=0}^{w-xe-A-1} N_{xe+A+k}\, (1+g)^{-k}} - \frac{\sum_{k=0}^{A-1} \sum_{h=0}^{k} N_{xe+k}\, y_{(xe+k),1}\, (1+g)^{h} (1+d)^{-h}}{\sum_{k=0}^{A-1} y_{(xe+k),1}\, N_{xe+k}} \qquad \textbf{[12.]}$$

In a "golden rule" steady state a further condition is met: the interest rate in the financial market, which is the discount rate d, is equal to the growth rate of GDP. Given the hypothesis $\gamma = 0$ adopted in this appendix, the growth rate of GDP is g, the real growth rate in average salaries. The value of the IRR for participants is also g in this steady state. Therefore, in any golden-rule steady state the discount rate is g. If it is substituted in the previous formula that g=d, then:

$$TD^{t(g>0)} = \underbrace{\overbrace{\frac{\sum_{k=0}^{w\text{-}xe\text{-}A\text{-}1} N_{xe+A+k}\, \ddot{a}_{xe+A+k}\, (1+g)^{-k}}{\sum_{k=0}^{w\text{-}xe\text{-}A\text{-}1} N_{xe+A+k}\, (1+g)^{-k}}}^{\text{Pay out duration}}}_{pt_r^{g>0}} + \underbrace{\overbrace{A - \frac{\sum_{k=0}^{A-1} N_{xe+k}\, y_{(xe+k),1}\, (k+1)}{\sum_{k=0}^{A-1} y_{(xe+k),1}\, N_{xe+k}}}^{pt_c^{g>0}}}_{\text{Pay in duration}} \qquad \textbf{[13.]}$$

Therefore, the turnover duration total is the sum of the weighted pay-in and pay-out durations of one monetary unit in the system for the year's contributions:

$$\frac{V_{w-xe-A}^{t\,(g>0)}}{C_{w-xe-A}} \equiv TD^{t(g>0)} = pt_r^{g>0} + pt_c^{g>0} \qquad \textbf{[14.]}$$

if "x_e+A-1" years are added to and subtracted from the previous expression, the turnover duration is the difference in average weighted ages of the pensioners and the contributors:

$$TD^{t(g>0)} = \overbrace{(x_e + A - 1) + pt_r}^{\text{Average weighted age for the pensioners}} - \underbrace{(x_e + A - 1 - pt_c)}_{\text{Average weighted age for the contributors}} =$$

$$= \overbrace{(x_e + A - 1) + \frac{\sum_{k=0}^{w-xe-A-1} N_{xe+A+k}\, \ddot{a}_{xe+A+k}\, (1+g)^{-k}}{\sum_{k=0}^{w-xe-A-1} N_{xe+A+k}\, (1+g)^{-k}}}^{\text{Average weighted age for the pensioners}} - \underbrace{\left(x_e - 1 + \frac{\sum_{k=0}^{A-1} N_{xe+k}\, y_{(xe+k),1}\, (k+1)}{\sum_{k=0}^{A-1} y_{(xe+k),1}\, N_{xe+k}} \right)}_{\text{Average weighted age for the contributors}} =$$

$$= \overbrace{\frac{\sum_{k=0}^{w-xe-A-1} \beta\, Y_{C,1} N_{xe+A+k}\, x_{e+A+k} (1+g)^{w-xe-A-1-k}}{\sum_{k=0}^{w-xe-A-1} \beta\, Y_{C,1} N_{xe+A+k} (1+g)^{w-xe-A-1-k}}}^{\text{Average weighted age for the pensioners}} - \underbrace{\frac{\sum_{k=0}^{A-1} y_{xe+k,1}\, N_{xe+k}\, x_{e+k} (1+g)^{w-xe-A-1}}{\sum_{k=0}^{A-1} y_{xe+k,1}\, N_{xe+k} (1+g)^{w-xe-A-1}}}_{\text{Average weighted age for the contributors}} =$$

$$= A_r^{g>0} - A_c^{g>0} \qquad \textbf{[15.]}$$

As higher discount rates reduce a present discounted value, for given cash flows, it is clear that:

$$\left[CA_{w-xe-A}^{g>0} = C_{w-xe-A}^{g>0} \cdot (pt_r^{g>0} + pt_c^{g>0}) = V_{w-xe-A}^{r+c(g>0)} \right] < \left[CA_{w-xe-A}^{g=0} = C_{w-xe-A}^{g=0} \cdot (pt_r^{g=0} + pt_c^{g=0}) = V_{w-xe-A}^{r+c(g=0)} \right]$$

[16.]

Appendix 2: The hidden asset

The development of the concept of the Hidden Asset is based on an initial approach by Valdés-Prieto (2002), with a population of overlapping generations in which each generation of members of the system lives for two periods of equal duration, surviving until the second with probability 1. In the first period the participant contributes fraction θ of his income from work or pensionable earnings and in the second receives the pension. It is supposed that aggregate covered earnings grow at the constant real annual rate of G%, where G = g + γ according to our previous notation. There is no assumption as to how G is formed by growth in average real salaries (g) and fertility-driven population growth (γ). It is also assumed that the real rate of interest in the financial markets is r% per period, where r > G. It is also supposed that the economy and the pension system are in a stationary state, and therefore all these parameters are constant in time. However, this steady state is not of the “golden rule” type, because r > G.

The tax or excess contributions paid by a participant in the pension system is the difference between the present value of the contributions made and the value of the pensions received. Therefore the aggregate “T” of the taxes or excess contributions charged to each generation of participants during their working period is:

$$T(t) = \left(\theta - \frac{\beta}{1+r}\right) y(t) \cdot N(t) \quad \textbf{[17.]}$$

Where:

$N(t)$: Number of working participants (“young people”) in period t.

$y(t)$: Pensionable earnings of the workers in t.

β : Replacement rate that the system gives in the second period of life.

In a stationary state where the degree of funding ϕ is constant in time, (ϕ can be positive, as in the case of Sweden, but less than 1 as long as funding is not full), the financial independence of the pension system from sponsor contributions demands that:

$$\theta = \beta \cdot \left[\frac{\phi}{1+r} + \frac{1-\phi}{1+G}\right] \quad \textbf{[18.]}$$

If the system is financed by pure pay-as-you-go, the degree of funding is zero ($\phi = 0$), and Equation (18) becomes:

$$\theta = \frac{\beta}{1+G} = \frac{\beta}{1+IRR} \quad \textbf{[19.]}$$

In the general case for intermediate degrees of funding, the aggregate tax or aggregate excess contribution is obtained by inserting (18) into (17). During period t the aggregate tax will reach the amount of:

$$T_{it} = y_{it} \cdot N_{it} \cdot \beta \cdot (1-\phi) \cdot \frac{(r-G)}{(1+r)(1+G)} \quad \textbf{[20.]}$$

These taxes (excess contributions) *are an economic asset* for the pension system, although not protected by property rights. As each generation of future participants has to contribute more than the present value of the pensions that will be awarded to them, the system obtains a profit from "serving" future generations.

The present value of the taxes that will be paid by all future generations of participants to the system, considering that aggregate pensionable earnings (y(t+j)·N(t+j)) grow at rate G, is defined as the Hidden Asset of the pension system:

$$HA \equiv \sum_{i=0}^{\infty} \frac{T(t+i)}{(1+r)^i} = \frac{\dfrac{(y(t)\cdot N(t))\beta\cdot(1-\phi)\cdot(r-G)}{(1+G)(1+r)}}{1-\dfrac{(1+G)}{(1+r)}} = \beta\cdot\frac{(1-\phi)}{1+G}\,y(t)\cdot N(t) \qquad \textbf{[21.]}$$

The important result is that the right hand-side expression, plus financial assets, whose value is by definition of ϕ equal to $\phi\dfrac{\beta\cdot y(t)\cdot N(t)}{1+G}$ at the end of period t, adds to the size of liabilities. This shows that the cash flows related to the hidden tax T back up the Contribution asset.

A different, possibly more intuitive way of reaching Equation 19 is as follows. The actuarially fair contribution rate, θ_f , defined on the basis of the return of the financial market, is defined as:

$$\theta_f = \frac{\beta}{1+r} \qquad \textbf{[22.]}$$

and therefore the aggregate "T" of the taxes or excess contributions charged to each generation of participants when they are young is:

$$T(t) = (\theta - \theta_f)\cdot y(t)\cdot N(t) \qquad \textbf{[23.]}$$

Now the Hidden Asset is calculated using (22) and (23):

$$HA \equiv \sum_{i=0}^{\infty} \frac{T(t+i)}{(1+r)^i} = \frac{(\theta - \theta_f)\cdot y(t)\cdot N(t)\cdot(1+r)}{r-G} \qquad \textbf{[24.]}$$

Now using Equation (18), it is found that:

$$(\theta - \theta_f) = \beta\cdot(1-\phi)\cdot\left[\frac{1}{(1+G)} - \frac{1}{(1+r)}\right] = \beta\cdot(1-\phi)\cdot\frac{(r-G)}{(1+G)\cdot(1+r)} \qquad \textbf{[25.]}$$

Whereby we obtain:

$$HA \equiv \underbrace{\frac{\beta\cdot y(t)\cdot N(t)}{1+G}}_{\text{Pensions paid to the first generation = Liabilities}} (1-\phi) \qquad \textbf{[26.]}$$

which is equal to Expression (21). That becomes clearer using Equation (18) again to eliminate β:

$$HA = \overbrace{\theta\cdot y(t)\cdot N(t)}^{\text{Contributions paid by the first generation}} \cdot \frac{1}{1+\left(\dfrac{\phi}{1-\phi}\cdot\dfrac{1+G}{1+r}\right)} \qquad \textbf{[27.]}$$

Expression (27) shows that in the specific case of pure pay-as-you-go ($\phi = 0$) the Hidden Asset is equal to the contributions paid by the first generation. However, if there is partial funding as in Sweden ($\phi > 0$), the Hidden Asset is necessarily less than the contributions paid by the first generation.

Appendix 3: sensitivity analysis of the Spanish actuarial balance sheet with regard to changes in the projected growth rate of average real salaries (g).

TABLE 6: BALANCE SHEET AT DEC. 31 OF EACH YEAR FOR THE SPANISH PENSION SYSTEM AS % OF GDP. CONSOLIDATED FOR ALL REGIMES.					
Year	**2005**	**2004**	**2003**	**2002**	**2001**
ASSETS					
Financial Asset	3.00	2.30	1.54	0.85	0.36
Contribution Asset	121.57	125.59	128.50	129.52	133.86
Accumulated Deficit	69.15	65.66	64.75	60.04	64.32
"Losses for the period"	2.90	8.87	5.74	9.45	0.00
Total Assets	196.62	202.42	200.52	199.86	198.54
LIABILITIES					
Liability to Pensioners	53.41	53.34	54.15	55.61	54.85
Liability to Contributors	143.21	149.08	146.37	144.24	143.69
Total Liabilities	196.62	202.42	200.52	199.86	198.54
FUNDING AND SOLVENCY INDICATORS					
Ratio of (in)solvency	**0.634**	**0.632**	**0.648**	**0.652**	**0.676**
Degree of funding	**1.53%**	**1.14%**	**0.77%**	**0.42%**	**0.18%**
Liabilities to Contrib./Liabilities	**72.8%**	**73.6%**	**73.0%**	**72.2%**	**72.4%**
IRR=g=d=1.5% **Source: Authors**					

TABLE 7: BALANCE SHEET AT DEC. 31 OF EACH YEAR FOR THE SPANISH PENSION SYSTEM AS % OF GDP. CONSOLIDATED FOR ALL REGIMES.					
Year	**2005**	**2004**	**2003**	**2002**	**2001**
ASSETS					
Financial Asset	3.00	2.30	1.54	0.85	0.36
Contribution Asset	77.70	80.77	81.85	82.10	84.10
Accumulated Deficit	46.21	43.95	43.53	40.59	43.49
"Losses for the period"	1.54	5.86	3.66	6.12	0.00
Total Assets	128.45	132.88	130.57	129.65	127.95
LIABILITIES					
Liability to Pensioners	47.84	47.77	48.49	49.79	49.23
Liability to Contributors	80.61	85.11	82.08	79.86	78.72
Total Liabilities	128.45	132.88	130.57	129.65	127.95
FUNDING AND SOLVENCY INDICATORS					
Ratio of (in)solvency	**0.628**	**0.625**	**0.639**	**0.640**	**0.660**
Degree of funding	**2.34%**	**1.73%**	**1.18%**	**0.65%**	**0.28%**
Liabilities to Contrib./Liabilities	**64.0%**	**62.9%**	**61.6%**	**61.5%**	**64.0%**
IRR=g=d=3% **Source: Authors**					

Working with the real data for a year, whatever the real system may be, the sensitivity analysis has one serious restriction in that the amount of the year's contributions cannot be changed. This implies that the TD for the various suppositions where d=g> 0 has to be obtained as a reference with respect to the supposition d=g=0 based on the new value of the liability. This restriction does not appear in the theory in Appendix 1, where the sensitivity analysis would be based on a pension system which is established at that moment and which for a particular replacement rate (β) the system would adjust the contribution rate (θ) until the stationary state of financial equilibrium was reached. This is the fundamental difference between the theoretical case of Appendix 1 and any real pension system.

In these tables (6, 7), financial assets are reported at their current market value in all growth scenarios, eschewing the likely impact of a change in the discount rate and average real salary growth on the value of those assets.

Appendix 4: Some data and calculation variables for the Spanish regimes considered

TABLE 8: MAIN DATA AND VARIABLES FOR THE GENERAL REGIME.					
Items	**2001**	**2002**	**2003**	**2004**	**2005**
Contributors (average)	11,656,769	12,079,280	12,472,605	12,888,000	13,488,868
Contributions (ret)[25] Millions of euros	33,269	35,295	37,717	39 463	42 609
Real contributions (ret) Millions of euros 2005	37,916	38,790	40,520	41,121	42,609
Average annual contribution Euros/year	2,854	2,922	3,024	3,062	3,159
Real average annual contribution Euros/year 2005	3,253	3,211	3,249	3,191	3,159
Retirement contribution rate %	19.37	19.26	19.10	18.84	18.85
Retirement pensioners	2,431,811	2,466,715	2,503,916	2,542,865	2,601,932
Average annual pension Euros/year	10,241	10,801	11,281	11,915	12,604
Real average annual pension Euros/year 2005	11,672	11,871	12,119	12,416	12,604
Ar (Age)[26]	72.69	72.09	72.25	72.36	72.45
Ac (Age)[27]	38.62	38.76	38.96	39.17	39.23
TD (years)[28]	34.07	33.32	33.29	33.19	33.22

TABLE 8A: MAIN DATA AND VARIABLES FOR THE GENERAL REGIME (ANNUAL VARIATIONS AND TOTAL FOR PERIOD)					
Items	**2002**	**2003**	**2004**	**2005**	**2001-2005**
Contributors (average)	3.62%	3.26%	3.33%	4.66%	15.72%
Contributions (ret) Millions of euros	6.09%	6.86%	4.63%	7.97%	28.07%
Real contributions (ret) Millions of euros 2005	2.30%	4.46%	1.48%	3.62%	12.38%
Average annual contribution Euros/year	2.38%	3.49%	1.26%	3.16%	10.68%
Real average annual contribution Euros/year 2005	-1.27%	1.17%	-1.79%	-1.00%	-2.89%
Retirement contribution rate %	-0.55%	-0.83%	-1.36%	0.06%	-2.65%
Retirement pensioners	1.44%	1.51%	1.56%	2.32%	7.00%
Average annual pension Euros/year	5.46%	4.44%	5.62%	5.78%	23.07%
Real average annual pension Euros/year 2005	1.70%	2.09%	2.45%	1.52%	7.98%
Ar (Age)	-0.83%	0.22%	0.16%	0.12%	-0.33%
Ac (Age)	0.37%	0.50%	0.54%	0.17%	1.59%
TD (years)	-2.18%	-0.11%	-0.28%	0.07%	-2.50%

[25] It is not considered the supplement to the minimum pensions.
[26] Ar: The average weighted age for the pensioners' pensions.
[27] Ac: The average weighted age for the contributors' pensions.
[28] TD: "Turnover duration".

TABLE 9: MAIN DATA AND VARIABLES FOR THE AGRARIAN WORKERS REGIME					
Items	**2001**	**2002**	**2003**	**2004**	**2005**
Contributors (average)	1,127,633	1,123,500	1,134,244	1,085,900	1,043,739
Contributions (ret) Millions of euros	909	874	897	894	864
Real contributions (ret) Millions of euros 2005	1,036	960	963	931	864
Average annual contribution Euros/year	806	778	791	823	828
Real average annual contribution Euros/year 2005	918	855	849	857	828
Retirement contribution rate %	10.61	10.04	9.95	9.89	9.87
Retirement pensioners	971,977	956,513	937,810	915,127	901,655
Average annual pension Euros/year	5,552	5,772	5,938	6,245	6,572
Real average annual pension Euros/year 2005	6,327	6,344	6,379	6,507	6,572
Ar (Age)	76.43	75.84	76.02	76.26	76.35
Ac (Age)	42.63	42.56	42.34	42.88	42.97
TD (years)	33.81	33.28	33.68	33.38	33.39

TABLE 9A: MAIN DATA AND VARIABLES FOR THE AGRARIAN WORKERS REGIME (ANNUAL VARIATIONS AND TOTAL FOR PERIOD)					
Items	**2002**	**2003**	**2004**	**2005**	**2001-2005**
Contributors (average)	-0.37%	0.96%	-4.26%	-3.88%	-7.44%
Contributions (ret) Millions of euros	-3.85%	2.62%	-0.34%	-3.29%	-4.90%
Real contributions (ret) Millions of euros 2005	-7.28%	0.31%	-3.34%	-7.19%	-16.56%
Average annual contribution Euros/year	-3.49%	1.65%	4.09%	0.62%	2.74%
Real average annual contribution Euros/year 2005	-6.94%	-0.64%	0.96%	-3.44%	-9.85%
Retirement contribution rate %	-5.39%	-0.85%	-0.64%	-0.22%	-7.00%
Retirement pensioners	-1.59%	-1.96%	-2.42%	-1.47%	-7.23%
Average annual pension Euros/year	3.97%	2.87%	5.17%	5.24%	18.38%
Real average annual pension Euros/year 2005	0.26%	0.56%	2.01%	1.00%	3.87%
Ar (Age)	-0.77%	0.23%	0.31%	0.13%	-0.10%
Ac (Age)	-0.15%	-0.53%	1.27%	0.20%	0.79%
TD (years)	-1.56%	1.20%	-0.89%	0.04%	-1.23%

TABLE 10: MAIN DATA AND VARIABLES FOR THE SELF-EMPLOYED WORKERS REGIME					
Items	**2001**	**2002**	**2003**	**2004**	**2005**
Contributors (average)	2,614,900	2,656,200	2,732,900	2,840,400	2,934,977
Contributions (ret) Millions of euros	4,399	4,591	4,901	5,378	5,631
Real contributions (ret) Millions of euros 2005	5,014	5,045	5,265	5,604	5,631
Average annual contribution Euros/year	1,682	1,728	1,793	1,893	1,919
Real average annual contribution Euros/year 2005	1,917	1,900	1,926	1,973	1,919
Retirement contribution rate %	20.61	20.59	20.54	20.40	20.45
Retirement pensioners	543,051	555,176	565,891	574,858	592,876
Average annual pension Euros/year	6,346	6,215	6,471	6,875	7,307
Real average annual pension Euros/year 2005	7,232	6,831	6,952	7,164	7,307
Ar (Age)	74.86	74.17	74.17	74.28	74.22
Ac (Age)	45.04	45.11	45.23	45.31	45.38
TD (years)	29.82	29.06	28.95	28.97	28.83

TABLE 10A: MAIN DATA AND VARIABLES FOR THE SELF-EMPLOYED WORKERS REGIME (ANNUAL VARIATIONS AND TOTAL FOR PERIOD)					
Items	**2002**	**2003**	**2004**	**2005**	**2001-2005**
Contributors (average)	1.58%	2.89%	3.93%	3.33%	12.24%
Contributions (ret) Millions of euros	4.36%	6.75%	9.74%	4.71%	28.00%
Real contributions (ret) Millions of euros 2005	0.63%	4.35%	6.44%	0.49%	12.31%
Average annual contribution Euros/year	2.73%	3.75%	5.59%	1.33%	14.04%
Real average annual contribution Euros/year 2005	-0.93%	1.42%	2.41%	-2.75%	0.06%
Retirement contribution rate %	-0.11%	-0.25%	-0.68%	0.25%	-0.78%
Retirement pensioners	2.23%	1.93%	1.58%	3.13%	9.18%
Average annual pension Euros/year	-2.06%	4.12%	6.24%	6.29%	15.15%
Real average annual pension Euros/year 2005	-5.55%	1.78%	3.04%	2.01%	1.04%
Ar (Age)	-0.92%	0.00%	0.14%	-0.08%	-0.86%
Ac (Age)	0.16%	0.26%	0.18%	0.17%	0.77%
TD (years)	-2.55%	-0.41%	0.09%	-0.47%	-3.32%

TABLE 11: MAIN DATA AND VARIABLES FOR THE COAL MINING REGIME					
Items	**2001**	**2002**	**2003**	**2004**	**2005**
Contributors (average)	16,561	14,884	13,387	11,900	10,370
Contributions (ret) Millions of euros	81	76	71	65	57
Real contributions (ret) Millions of euros 2005	92	84	76	67	57
Average annual contribution Euros/year	4,893	5,114	5,272	5,441	5,543
Real average annual contribution Euros/year 2005	5,577	5,620	5,663	5,670	5,543
Retirement contribution rate %	19.59	19.57	19.45	19.23	19.23
Retirement pensioners	41,940	41,298	40,762	40,209	39,731
Average annual pension Euros/year	17,011	17,983	18,872	19,930	20,999
Real average annual pension Euros/year 2005	19,387	19,763	20,274	20,767	20,999
Ar (Age)	69.82	69.20	69.37	69.54	69.72
Ac (Age)	39.16	39.05	39.31	39.69	39.75
TD (years)	30.66	30.15	30.06	29.85	29.96

TABLE 11A: MAIN DATA AND VARIABLES FOR THE COAL MINING REGIME (ANNUAL VARIATIONS AND TOTAL FOR PERIOD)					
Items	**2002**	**2003**	**2004**	**2005**	**2001-2005**
Contributors (average)	-10.13%	-10.06%	-11.11%	-12.86%	-37.38%
Contributions (ret) Millions of euros	-6.07%	-7.28%	-8.25%	-11.23%	-29.07%
Real contributions (ret) Millions of euros 2005	-9.42%	-9.37%	-11.01%	-14.81%	-37.76%
Average annual contribution Euros/year	4.51%	3.09%	3.22%	1.86%	13.28%
Real average annual contribution Euros/year 2005	0.78%	0.77%	0.11%	-2.24%	-0.61%
Retirement contribution rate %	-0.10%	-0.60%	-1.11%	-0.02%	-1.83%
Retirement pensioners	-1.53%	-1.30%	-1.36%	-1.19%	-5.27%
Average annual pension Euros/year	5.72%	4.94%	5.61%	5.37%	23.45%
Real average annual pension Euros/year 2005	1.94%	2.58%	2.43%	1.12%	8.32%
Ar (Age)	-0.89%	0.25%	0.24%	0.26%	-0.15%
Ac (Age)	-0.28%	0.67%	0.96%	0.16%	1.51%
TD (years)	-1.67%	-0.29%	-0.71%	0.39%	-2.27%

TABLE 12: MAIN DATA AND VARIABLES FOR THE DOMESTIC WORKERS REGIME					
Items	**2001**	**2002**	**2003**	**2004**	**2005**
Contributors (average)	155,915	176,000	184,561	181,000	284,660
Contributions (ret) Millions of euros	194	215	241	241	364
Real contributions (ret) Millions of euros 2005	221	236	258	252	364
Average annual contribution Euros/year	1,242	1,222	1,304	1,334	1,279
Real average annual contribution Euros/year 2005	1,415	1,344	1,401	1,390	1,279
Retirement contribution rate %	19.38	19.47	19.49	19.46	19.46
Retirement pensioners	175,729	174,679	172,687	170,175	168,233
Average annual pension Euros/year	4,983	5,165	5,294	5,566	5,857
Real average annual pension Euros/year 2005	5,680	5,676	5,688	5,800	5,857
Ar (Age)	76.47	75.99	76.26	76.58	76.79
Ac (Age)	44.31	43.59	43.97	44.96	41.77
TD (years)	32.16	32.40	32.29	31.63	35.03

TABLE 12A: MAIN DATA AND VARIABLES FOR THE DOMESTIC WORKERS REGIME (ANNUAL VARIATIONS AND TOTAL FOR PERIOD)					
Items	**2002**	**2003**	**2004**	**2005**	**2001-2005**
Contributors (average)	12.88%	4.86%	-1.93%	57.27%	82.57%
Contributions (ret) Millions of euros	11.12%	11.83%	0.35%	50.82%	88.06%
Real contributions (ret) Millions of euros 2005	7.15%	9.32%	-2.67%	44.74%	65.02%
Average annual contribution Euros/year	-1.56%	6.64%	2.32%	-4.10%	3.01%
Real average annual contribution Euros/year 2005	-5.08%	4.25%	-0.76%	-7.97%	-9.62%
Retirement contribution rate %	0.44%	0.14%	-0.20%	0.00%	0.39%
Retirement pensioners	-0.60%	-1.14%	-1.45%	-1.14%	-4.27%
Average annual pension Euros/year	3.63%	2.52%	5.13%	5.23%	17.53%
Real average annual pension Euros/year 2005	-0.06%	0.21%	1.97%	0.99%	3.13%
Ar (Age)	-0.63%	0.35%	0.43%	0.27%	0.43%
Ac (Age)	-1.61%	0.87%	2.24%	-7.09%	-5.73%
TD (years)	0.74%	-0.35%	-2.04%	10.75%	8.91%

TABLE 13: MAIN DATA AND VARIABLES FOR THE SEA WORKERS REGIME					
Items	**2001**	**2002**	**2003**	**2004**	**2005**
Contributors (average)	78,113	76,400	75,820	74,500	72,821
Contributions (ret) Millions of euros	186	190	187	199	205
Real contributions (ret) Millions of euros 2005	212	209	201	207	205
Average annual contribution Euros/year	2,385	2,485	2,465	2,669	2,809
Real average annual contribution Euros/year 2005	2,718	2,731	2,648	2,781	2,809
Retirement contribution rate %	21.50	21.35	21.16	20.89	20.83
Retirement pensioners	69,869	69,967	70,100	69,902	70,334
Average annual pension Euros/year	10,394	10,935	11,395	11,983	12,584
Real average annual pension Euros/year 2005	11,845	12,017	12,242	12,487	12,584
Ar (Age)	69.98	69.29	69.39	69.55	69.66
Ac (Age)	43.45	43.08	43.54	43.79	43.28
TD (years)	26.53	26.21	25.84	25.76	26.38

TABLE 13A: MAIN DATA AND VARIABLES FOR THE SEA WORKERS REGIME (ANNUAL VARIATIONS AND TOTAL FOR PERIOD)					
Items	**2002**	**2003**	**2004**	**2005**	**2001-2005**
Contributors (average)	-2.19%	-0.76%	-1.74%	-2.25%	-6.77%
Contributions (ret) Millions of euros	1.90%	-1.55%	6.39%	2.88%	9.80%
Real contributions (ret) Millions of euros 2005	-1.73%	-3.77%	3.19%	-1.27%	-3.66%
Average annual contribution Euros/year	4.19%	-0.80%	8.27%	5.25%	17.78%
Real average annual contribution Euros/year 2005	0.47%	-3.03%	5.02%	1.01%	3.34%
Retirement contribution rate %	-0.70%	-0.89%	-1.27%	-0.30%	-3.13%
Retirement pensioners	0.14%	0.19%	-0.28%	0.62%	0.67%
Average annual pension Euros/year	5.21%	4.21%	5.16%	5.01%	21.07%
Real average annual pension Euros/year 2005	1.45%	1.87%	2.00%	0.78%	6.24%
Ar (Age)	-0.99%	0.14%	0.23%	0.16%	-0.46%
Ac (Age)	-0.85%	1.07%	0.56%	-1.15%	-0.38%
TD (years)	-1.23%	-1.39%	-0.32%	2.39%	-0.59%