MISS: A MODEL FOR ASSESSING THE SUSTAINABILITY OF PUBLIC SOCIAL SECURITY IN PORTUGAL

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The analyses, opinions and findings of these papers represent the views of the authors, they are not necessarily those of the Banco de Portugal.

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EXECUTIVE SUMMARY

This paper presents the MISS model (Modelo Integrado da Segurança Social) and illustrates its use in two ways: firstly, through an analysis of the sustainability of the Portuguese public social security system in the light of the main reforms agreed in October 2006 between the government and social partners (the trade unions and employers federations); and secondly, through an assessment of the effects of these measures on the synthetic indicators of public finance sustainability used by the European Commission.

MISS is an accounting/actuarial model developed to generate projections of the accounts of the contributive components of the two public social security subsystems in Portugal (i.e. the contributive parts of the Segurança Social subsystem and the Caixa Geral de Aposentações – CGA – subsystem). Emphasis has been put on detail in the design of the model, with the aim of emulating the extremely complex rules underlying the country’s pension provisions. Due to its actuarial nature, the MISS model suffers from certain limitations, above all the fact that in many aspects the behaviour of economic agents is treated as exogenous. This would not be the case if it were a general equilibrium model. However, given the available modelling techniques, the treatment of the two subsystems using an overlapping generations general equilibrium model would not allow for the level of generational heterogeneity that would have been required to achieve a minimum degree of realism.

Since the aim of the model is to assess the financial sustainability of both subsystems, it is logical to restrict the analysis to their contributive components. It is reasonable for a benefit requiring a contributory history to be financed out of contributions and for other benefits to be financed out of taxes. The MISS model does not therefore take into account pensions and other payments of a non-contributive nature, such as the Rendimento Social de Inserção, granted to those on very low income irrespective of their contributive careers. Following the same logic, there is also no account made of pensions that are the direct responsibility of the State, such as those paid to military personnel and police officers injured on duty or to their families if they were killed (known as pensões de deficientes das Forças Armadas and pensões de preço de sangue, respectively).

Two sets of projections were generated over a 75-year horizon (i.e., up to 2080). They differ in terms of the inclusion (exclusion) of the main reforms in social security agreed in October 2006 between the government and social partners. The baseline scenario without reforms depicts a situation of serious financial imbalance and reveals a situation that is clearly unsustainable. If no measures were taken, the consolidated primary deficit
of the two subsystems would go beyond 10% of GDP by the early 2040s (it stood at 2.5% in 2005), even including in the revenue that part of VAT earmarked for social security as legally stipulated (around 1% of GDP). In the no-reform scenario, the implicit social security liabilities, evaluated as the present value at 2005 of the consolidated primary balances for the period 2005-2080, reach more than 500% of GDP.

For the baseline scenario including the effects of reforms, the accounts show a significant improvement. The most conservative assessment of these effects depicts a primary deficit on the rise until mid-century, reaching almost 5% of GDP (less than half the amount for the scenario without reform), before gradually declining to around 2% of GDP by end-horizon. A more optimistic assessment puts the primary deficit on a downward path over the horizon, reaching equilibrium in the later years. The present value of the stream of future primary balances stands between -190% and -90% of GDP. In both assessments, the implicit liabilities for the CGA contributive subsystem account for around 90% of GDP.

These conclusions depend on verifying a wide array of assumptions, both demographic and macroeconomic. A sensitivity analysis carried out on the projections shows that a bigger rise in fertility than supposed in the baseline scenarios results in an improvement in the financial situation of the Portuguese social security, albeit not very markedly. The effects of a smaller reduction in the mortality rate are somewhat more significant. If life expectancy were to rise only by half the figure set out in the baseline scenarios, a fall in liabilities of between 23 and 38 percentage points of GDP would be the outcome, depending on the scenario being considered. A different trend growth in productivity would also have a non-negligible impact on the consolidated social security accounts. The baseline scenarios assume a 2% annual growth in productivity but this, given the behaviour of this variable over the last ten years, could well be optimistic. If risks on the downside were to materialise, the imbalance in the Portuguese social security system would become larger. For example, if the productivity annual growth were 1% a year, implicit liabilities would rise by between 15 and 39 percentage points. As a last point, a fall in net immigration flows, as compared with the assumption that the figure to horizon will be as in recent years, would also impact negatively on the country’s social security accounts. It should be noted, however, that the MISS model, which is not a general equilibrium model, cannot accurately project the social and macroeconomic effects of immigration, particularly on the unemployment rate.

The analysis detailed in this paper also assesses the effects of the reforms in the European Commission’s sustainability gap indicators for Portugal. This reform cuts by around half the component pertaining to age-related public expenditure. If this reduction comes along with the continuation of the process of fiscal consolidation under way, this should allow for the country’s public finance sustainability assessment to be improved from high to average risk.
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1. INTRODUCTION

MISS is a model developed at the Banco de Portugal to generate long-term projections of the accounts for the two public social security subsystems. These are the subsystem run by the Ministry of Labour and Social Solidarity (Segurança Social) and the CGA (Caixa Geral de Aposentações) subsystem. The first is the predominant social security scheme, accounting for most private sector workers, while the latter (which was closed in 2005 to new registrations) covers most public employees contracted up to 2005, as well as some employees of public owned (or formerly public owned) enterprises. The model detailed in this paper was used for two purposes: firstly, to analyse the sustainability of the Portuguese public social security in the light of the main reform measures agreed in October 2006 between the government and social partners\(^\text{1}\); and secondly, to assess the effects of these measures on the synthetic indicators of public finance sustainability used by the European Commission.

In the literature, two types of models are typically considered for social security sustainability assessments:
- Models based on actuarial/accounting criteria;
- Dynamic general equilibrium models with overlapping generations.

In models of the first type, the macroeconomic scenario to horizon is set by the analyst, and it does not react endogenously either to reform or to possible changes in the perception of economic agents as to the financial sustainability of social security. Dynamic general equilibrium models, on the other hand, try to take account of the decisions of economic agents relating to inter-temporal optimization. In particular, the second type of model, unlike the first, permits the modelling of changes in the labour supply and demand as well as in consumption, investment and savings decisions resulting from the policies under review. Over the past twenty years, since publication of the seminal work by Auerbach and Kotlikoff (1987), there has been notable progress in the dynamic computable general equilibrium models with overlapping generations, but they still have serious limitations in terms of how realistically they can emulate the functioning of social security systems. For example, aspects related to modelling demography or the rules for pension accrual and access to other benefits are still unsatisfactory. In contrast, actuarial/accounting models can be rather more detailed and realistic in the treatment of demographic and labour market features and of the rules by which the social security system works. For these reasons, there is a clear trade-off between the two types of models, both in terms of advantages and of drawbacks.

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\(^1\) In terms of the general social security subsystem, this agreement is set down in the Social Security Framework Law (Law 4/2007 of 16 January) and in Decree Law 187/2007 of 10 May. The December 2006 update of the Portuguese Stability Programme (Ministry of Finance 2006) sets down the measures to be extended to the CGA subsystem (section I.3.2, clause A8). The corresponding legislation was approved in March 2007 and should be published soon.
MISS belongs to the first type of model, which was chosen because of the need for flexibility in dealing with the extremely varied and complex rules governing pension provision in Portugal. The objective was to carry out an integrated analysis of the two public subsystems, which currently operate with different rules. Only with such an analysis would it be possible to take into account the financial consequences of the 2005 decision not to allow any new registrations in the CGA and instead to register new public employees in the Segurança Social subsystem. Apart from this, there are various legal regimes in each of the subsystems, with relatively long transition periods, and a range of minimum pensions applicable in each of them. Moreover, there are two types of contributors in the Segurança Social subsystem, and although they are both basically subject to the same rules, they have features that are quite distinct: those who work for an employer (wage-earners, referred to in this paper as TCO, from the Portuguese trabalhadores por conta de outrem) and all the remainder (the self-employed, referred to in this paper as TI, trabalhadores independentes).

The concern for detail in the modelling cannot hide the fact that MISS suffers from limitations typical of models of its kind. The most important caveat has been mentioned above – it does not allow for endogenous analysis of the changes in supply and demand and in the consumption and investment decisions of economic agents stemming from their adjustment to the reforms in social security that are being assessed.

Another limitation is that the model was not set up to evaluate the effects of a possible transition from the present pay-as-you-go schemes to totally or partially funded schemes. The MISS model stemmed from the option to build an analytical tool to provide a detailed assessment of the effects of measures that change the parameters of the existing schemes. A capitalisation programme, if adopted (and, in particular, assuming that the capitalisation takes place outside the general government sector, as was the case in other countries where this has taken place), will have considerable implications for public finance indicators and lies beyond the scope of the present paper.

It is important to highlight that the model only takes into consideration the contributive components of the two subsystems, i.e., no account is taken of payments not conditioned by past or present contributions by the beneficiaries or their families. In terms of the Segurança Social subsystem (the Subsistema Previdencial da Segurança Social, designated in this paper by its Portuguese initials SPSS), the model treats expenditure on pensions related to contributions, as well as unemployment benefits, subsidies for temporary absence from work (sickness, maternity, paternity and adoption benefits and allowable household assistance), along with family benefits. Therefore, total expenditure does not include pensions and other payments of a non-contributive nature, such as the Rendimento Social de Inserção (granted to those on very low income irrespective of their contributive careers). In the CGA case (the subsistema previdencial da Caixa Geral de Aposentações, designated in this paper by its Portuguese initials, SPCGA), the same logic has been followed and only expenditure on pensions and on family benefits are included (since the CGA is responsible for the payments of the latter to its pensioners). Excluded from the model are the pensions paid by the CGA that are the direct responsibility of the State, such as those paid to military personnel or police

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2 Given the limitations in available information, projections of expenditure on family benefits in the SPSS also includes the non-contributive component, above all the expenditure on family allowance abono de família and funerals paid to beneficiaries who have no contributive career. This is, however, a very minor element.
officers injured on duty or to their families if they were killed (known as pensões de deficientes das Forças Armadas and pensões de preço de sangue, respectively).

The option to restrict the analysis to the contributive components of the two subsystems derives from the objective of MISS, which is to assess their financial sustainability. It is reasonable for a benefit requiring a contributory history to be financed out of the contributions of those who benefit or will in time benefit and for other benefits to be financed out of taxes. This principle chimes in with the spirit of the law-maker. Article 54 of the Social Security Framework Law stipulates: “The contributive subsystem should fundamentally be self-financing, based on a direct relationship between the legal duty to contribute and the right to receive.”

The model and the main assumptions are described in Chapter 2 and in the Annex. In Chapter 3, three scenarios projected up to 2080 are analysed, with a view to assessing the financial situation of the two subsystems. These are: “a baseline scenario without reforms”, “a baseline scenario with reforms – alternative I” and “a baseline scenario with reforms – alternative II”. The first scenario is different from the other two in that it does not include the effects of the measures agreed between the government and social partners in October 2006. The first scenario will be compared with the most recent official projections available, which also do not yet include the effects of the measures approved. The two scenarios with reforms include the four most representative measures of the social security reform:

- Earlier transition to the new formula for pension calculation set down in Decree Law 35/02, with a new transitional rule for SPSS beneficiaries, to be in force between 2007 and 2016;
- A new rule for updating pensions as a function of consumer inflation, the real growth of GDP, and the amount of the pension;
- A bigger financial penalty for early retirement, taking the figure up from 4.5% to 6% for every year prior to the legal retirement age (contributors must in any case have a minimum contributive career of 30 years and be at least 55 years old);
- The introduction from 2008 onwards of a “sustainability factor” that will relate the calculation of new pensions to life expectancy at age 65.

The introduction of a sustainability factor means multiplying the formula for calculating the statutory pension for old age by a penalty factor defined as the ratio between life expectancy at 65 in 2006 and life expectancy at the year before retirement. Contributors can opt for a combination of two extreme alternatives or “corner solutions”:

- They can put off retirement age until they completely offset the effect of the sustainability factor (alternative I); or
- They can retire at the statutory age and accept the financial penalty levied on the pension (alternative II).

It is straightforward to parameterise the MISS model to cater for each of the extreme alternatives, but it is harder to combine them in the model, above all because it is difficult to forecast how people will effectively react. And the choice of the combination will have a major impact on the numbers of active contributors and pensioners, as well as on the accounts of both subsystems. For these reasons, it was decided to consider a baseline scenario for each of the two extreme alternatives mentioned.

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3 Law 4/2007 of 16 January. In the previous version of this law (Law 32/2002 of 20 December), there was a passage with similar wording in article 30.

4 Ministry of Labour and Social Solidarity (2006a).
In Chapter 4, changes in various macroeconomic and demographic assumptions are introduced and the corresponding projections compared with those considered in the baseline scenarios. In this way the most critical assumptions for the projections can be identified. This sensitivity analysis is particularly important in actuarial/accounting models such as MISS: it helps to characterise the uncertainty of the results that stem from the inability of such models to generate endogenous responses from the demographic and macroeconomic variables to any changes in the system’s rules.

Chapter 5 contributes to the discussion on the effects of the recent reform of the Portuguese social security system on the synthetic indicators of public finance sustainability used by the European Commission. These indicators enable the Commission to classify Member States in terms of sustainability risk, and have been used in the discussions under way in European institutions preparing the approval of a methodology that will allow medium-term objectives (MTO) to be fixed for the structural budget balance\(^5\) of each Member State.

The aim is for the MTO to include an additional margin over and above the safety margin needed for the general government deficit not to exceed 3% of GDP at an unfavourable economic juncture. This extra margin is related to the assessment of the public finance sustainability of each Member State. The greater the risk of public finances in any one Member State becoming unsustainable, the more demanding will be its MTO and, as a consequence, a greater effort of budgetary consolidation will be required. This ties in with the increasing concern in the Stability and Growth Pact for the public finance sustainability and its connection to demographic trends\(^6\).

In October 2006, the European Commission published its report entitled “The Long-Term Sustainability of Public Finances in the European Union” (DGECFIN 2006a). The Commission’s services based their analysis on the structural indicators of sustainability, which had been coming into use since the assessments of the 2003 update of the stability and convergence programmes. For the first time, however, the indicators were calculated in a reasonably harmonised way for the Member States with the use of projections for age-related public expenditure. These projections were drawn up by the Ageing Working Group (AWG) within the EU’s Economic Policy Committee, which provides support to ECOFIN\(^7\).

The Commission’s services propose a classification of the Member States in three groups pertaining to the sustainability of public finances: high risk, medium risk and low risk. This grading stems fundamentally from the figures obtained for the synthetic sustainability indicators, although it also takes an array of “qualitative factors” into consideration\(^8\). Portugal was one of six countries graded as high risk. The others are

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\(^5\) Budget balance adjusted for cyclical effects and temporary measures.

\(^6\) The Stability and Growth Pact states the obligation of Member States to keep to the medium-term objective of reaching budgetary situations “close to balance or in surplus”. In the 2005 revision it was made explicit that “the medium-term budgetary objective should be differentiated for individual Member States, to take into account the diversity of economic and budgetary positions and developments as well as of fiscal risk to the sustainability of public finances, also in the face of prospective demographic changes”. This quotation is taken from paragraph 5 of the Preamble to Regulation CE 1055/2005 of the Council of 27 June, altering Regulation CE 1466/97. The same principle is stated in the Report approved by ECOFIN on 20 March 2005 and endorsed by the Council of Europe on 22-23 March of the same year (see especially section 2.1 of the Report).

\(^7\) These projections were published in the SGP and DGECFIN (2006).

\(^8\) See Chapter IV of the Report.
Greece, Slovenia, the Czech Republic, Cyprus and Hungary. Portugal stands out as presenting the worst figures for the indicators among the EU Member States, based on the 2005 scenario considered by the Commission. Two factors came into play in these results: the country’s large budget imbalance for 2005, in the framework of high sensitivity of the indicators to the initial budget position; and the projection of a steep rise in expenditure on pensions as a percentage of GDP (9.7 p.p. of GDP between 2004 and 2050, according to projections put forward by the AWG). It should be noted that the calculations for Portugal did not take into account the reforms decided in 2006, nor their adaptation to the SPCGA in 2007, as part of the harmonisation of the two subsystems.

The structural indicators computed by the Commission’s services require long-term projections for various types of age-related public expenditure, namely outlays on pensions, health-care, long-term care, education and unemployment. According to the AWG projections for Portugal, expenditure on pensions would seem to explain practically all the long-term age-related rise. As expenditure on health-care and education is beyond the scope of this paper, the choice fell therefore on an analysis of the reforms on pension expenditure and the consequent impact on the figures for the synthetic sustainability indicators. In Chapter 5, the assumptions underlying the AWG projections were adopted as far as possible, so as to avoid inconsistencies between the AWG assumptions for projecting the remaining items of expenditure and those used in MISS.

Finally, Chapter 6 sums up the main conclusions of the previous chapters.

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9 There are no comparable figures for Greece, since projections for pension expenditure are not available.
2. THE MODEL

2.1. Structure of the model

The structure of MISS is almost sequential. It can be broken down into 6 modules (detailed in schematic form in Figure 2.1.1):

- A demography module, which includes the dynamics of mortality, fertility, immigration and the resident population;
- A labour market module, which covers the dynamics of participation, employment and unemployment;
- A contributors and pensioners module, which projects the numbers of active contributors and pensioners from the various subsystems and types;
- A compensations, contributions and pensions module, which covers declared or stipulated compensations, new pensions and the pensions carried over from the past;
- A module for other benefits and allowances, which projects the numbers of beneficiaries and outgoings of unemployment benefits, of allowances for temporary absence from work and of family benefits;
- An SPSS and SPCGA accounts module, along with a summary of the consolidated accounts of the combined subsystems.

Each variable is decomposed into gender (masculine and feminine) and age for each of these (with 111 groups, covering 0 to 110 years). For the variables relative to participation in the labour market and contribution to social security (labour force, employment, unemployment, active contributors, declared or stipulated compensation, contributions due, unemployment benefits and allowances for temporary absence from work), the ages were confined to the range from 15 up to and including 80.

In the following sections there is a description of the modules in the model and an explanation of the assumptions used in the projections presented in Chapter 3. The main equations are detailed in the Annex.
### Demography:
- mortality
- fertility
- net immigration
- resident population

### Labour market:
- participation
- labour force
- unemployment
- total employment: wage earners (TCO)
- others, ie. self-employed (TI)
- non-active population

### Contributors and pensioners:
- Segurança Social contributive subsystem:
  - no. active contributors: TCO
  - T1
  - length of service: TCO
  - T1
  - no. of pensioners: old age
disability survivor

- CGA contributive subsystem:
  - no. active contributors
  - length of service
  - no. of pensioners: old age
disability survivor

### Compensations, contributions and pensions:
#### Segurança Social contributive subsystem:
- compensations: TCO
- contributions due: TCO
- T1
- amount of new pensions: old age: TCO
- disability: TCO
- T1
- survivor
- expenditure on pensions: old age
disability survivor

#### CGA contributive subsystem:
- compensations
- contributions due
- amount of new pensions: old age
disability survivor
- expenditure on pensions: old age
disability survivor

### Other benefits and allowances:
- no. of beneficiaries
- Unemployment:
  - temporary absence from work
  - sickness
  - maternity, paternity and adoption
  - children assistance
  - family
  - family allowance
  - other
- Expenditure:
  - temporary absence from work
  - sickness
  - maternity, paternity and adoption
  - children assistance
  - family
  - family allowance
  - other

### Accounts (contributive component):
- Segurança Social subsystem
- CGA subsystem
- Consolidation of the 2 subsystems
2.2 Demography module

At the heart of the MISS model are the equations relating to the projections for the resident population, by gender and age, for the end of each year to horizon. The initial figure is taken as the population at the end of the base years (2004 for the projections set out in the following chapters), with projections for fertility, mortality and net immigration. The procedure used is based on the factor analysis of the series available at the National Statistical Office and/or Eurostat for 1976-2004. The start of the period was chosen to leave 1974-75 out of the sample, avoiding the breaks in the series associated with the influx of returnees from the former colonies.

It was possible to put together a very reasonable description of the evolution of the variables, broken down by age, using either a model with just one factor (as in the case of male mortality rates, female mortality rates and the net numbers of immigrants, masculine and feminine) or a model with two factors (as in the case of fertility rates\(^1\)).

![Figure 2.2.1 Fertility factors](image)

Figure 2.2.1 shows the evolution of the two factors describing the fertility rates observed over the sample period, along with projections for the 2005-2080 horizon. The first factor is almost uniformly correlated with the fertility rates for all ages and indicates the general trend of fertility. It accounts for 90.8% of the variance in the sample. The second factor is strongly correlated with the fertility of older women. It accounts for 7.6% of the variance in the sample. The baseline scenarios described in Chapter 3 assume the first factor to level at -1.5 (-1.3 in 2004) and the second factor to increase to +4 (+1.77 in 2004).

\(^1\) When only one factor is used to project the variables for each age group (as with mortality and immigration), the analytical method used is equivalent to the method proposed by Lee and Carter (1992). However, where extrapolation of fertility by age group is concerned, a model with only one factor is too restrictive for an adequate description of the evolution in the sample period.
As far as male and female mortality are concerned, an upper bound of 84 years old was considered. This was because of limitations in the breakdown of available information on the resident population. One factor was identified for both men and women and this describes 93.2% of the variance in mortality rate for men and 95.8% for women. Figure 2.2.2 shows the evolution of the factors for male and female mortality over the period (overlapping almost totally), as well as the paths over the projection horizon assumed in the baseline scenarios described in Chapter 3. Both these paths converge to -4 along the horizon (from -1.61 for men and -1.68 for women in 2004). This implies that the strong declining trend in mortality will continue over the coming decades, though gradually slowing. No attempt was made (unlike other demographic projections) to bring male mortality closer to the (lower) levels of female mortality. To date there does not seem to be any empirical evidence to support such an assumption. For ages above 84, given the projections for mortality at that age for each year of the horizon, it was taken that the mortality rate would increase exponentially with age, reaching a unitary value at 110 years.

![Figure 2.2.2](image)

There are only a few statistics available for migration flows into and out of Portugal. The figures are, moreover, not always consistent with the population statistics and the natural balance. The decision was taken therefore, with regard to the period of the sample and for each age group, to use the net flow of immigration obtained as the difference between the variation in the stock of the resident population and the natural balance\(^2\). These figures are, however, not really credible for ages under 5, and least of all for children under 12 months, nor for the over 80s\(^3\). Given this, the factor analysis of net migration flows was limited to the ages of 5 to 80 (inclusive). Outside these age bounds, a nil figure was taken for the MISS projections.

\(^2\) This was the AWG approach.

\(^3\) The implicit flows indicate significant emigration of very young children and the elderly (especially female).
Figure 2.2.3 shows how the factors deriving from male and female net immigration evolved, along with extrapolation to horizon. Only one meaningful factor could be obtained for each gender and their explained variance percentages are well below what was obtained for fertility and mortality: 51.2% and 55.7% for male and female net immigration, respectively. It was assumed that both factors would converge to 1.25 along the horizon (1.15 and 1.23 in 2004). This implies the assumption, in terms of the baseline scenarios for the projections, that net annual immigration flows will hold relatively steady at the average of recent years.

### Figure 2.2.3
(Net) Immigration factors

![Figure 2.2.3](image)

#### 2.3 Labour market module

This module projects, for each gender and age cohort, the participation rates in the labour market, the unemployment rates and the percentage of wage earners in total employment. The model uses these rates to compute the annual averages of labour force, inactive population, employment and unemployment, by gender and age group.

As to definitions, it is worth highlighting that in the *MISS* model:
- participation and unemployment rates are to be understood in the widest sense, i.e., they take in all those who declare themselves as unemployed (and not just those who were actively looking for work during a short previous period);
- employment is decomposed into just two types, the wage earners who work for an employer (termed here by the Portuguese initials TCO – *trabalhadores por conta de outrem*) and all others, subsumed under the heading “self-employed”, taken in the widest sense (termed here as TI – *trabalhadores independentes*);
- all active contributors to the SPCGA are considered to be TCO.
The projections for this module are based on a series of regressions. For the years 1998 to 2005\(^4\) equations were estimated for the ratios between each of the variables (participation rate, unemployment rate and percentage of TCO in the total) and the related benchmarks. The regressors were the age and the percentages of individuals with secondary education and with university education.

The benchmark for each variable was defined as the average figure for the variable in question for males with elementary education, aged 26 up to and including 45. For the baseline scenarios shown in Chapter 3, it was assumed that the benchmarks would be constant to 2080 for the participation rate and the percentage of TCO in total employment. The figures were 94.9% and 80.5% respectively. For the unemployment rate, an increase was postulated (from 8.6% to 9.1% and then 9.6%), stabilising in 2008 and then falling until 2012 (from 9.1% to 8.6%, then to 8.1% and to 7.6%). The figure was then held steady. For the first two cases, the 1998 to 2005 period did not show any specific trend in the variables. In terms of the benchmark for the unemployment rate, it was assumed that the current figure is influenced by unfavourable cyclical factors, and this justifies the assumption that there will be a return to a natural or neutral figure from 2010 onwards.

Changes to the levels of schooling\(^5\) up to 2080 were built on the basis of available information relating to 2005 and then on the following assumptions:

- The percentage of individuals with complete secondary education and university education is nil up to and including age 16 and 20 respectively\(^6\);
- The percentage of individuals with complete secondary education and university education stabilises from ages 21 and 28 respectively and will remain constant as the age group gets older;
- For the intermediate ages, from 17 to 21 in the case of secondary education and 21 to 28 for university education, a gradual increase in the percentages was factored in over time, with annual increases defined exogenously, to cater for the increased availability of education for the young.

In the projections shown in Chapter 3, the annual increments considered for the intermediate ages were, in percentages:

- 0.4 for males and 0.2 for females in college education;
- 0.5 for males and 0.25 for females in secondary schooling.

It was decided to include higher increments for males than females to avoid an ever greater education differential over the period to horizon. Figures 2.3.1 and 2.3.2 show the resulting evolution of the structure of the resident population and the labour force by level of schooling.

\(^4\) 1998 is taken as the first year of the sample period for these regressions because it is the first year that the weights used to extrapolate the Labour Force Survey sample were updated in line with the 2001 census.

\(^5\) This level is defined as the maximum level of schooling achieved by the individual.

\(^6\) In 2005, there was hardly anybody aged 21 or less with a university degree. With the new organisation of higher education stemming from the Bologna agreement, the model factors in a gradual increase in university degrees for 21-year-olds for the period up to 2010, until it reaches the percentage now pertaining to age 22. Over and against this, the percentage of 21-year-olds with secondary schooling was correspondingly reduced.
Figure 2.3.1
Educational attainment:
structure of the resident population by highest level of education attained

Figure 2.3.2
Educational attainment:
structure of the labour force (aged 25 to 64) by highest level of education attained

For participation rate projections, the equations in the MISS model were multiplied by a parameter $0 \leq \hat{\theta} \leq 1$, to be defined by the model user. In the base year, 2005, the participation rate for ages above 50-55, depending on gender, present a decreasing profile. This is related with the rise in early retirement from age 55 observed in the past.
Where $\diamond = 0$, the evolution of the participation rate (by gender and age) to horizon will depend solely on the paths assumed for the participation rate benchmark and for the proportions of the resident population with secondary and university education. In this situation, the fall in the participation rates for older individuals will be fundamentally maintained to horizon. The evolution will be different for scenarios where social security reforms are introduced, changing the likelihood of early retirement through old age or increasing the legal age for retirement. It is reasonable to accept that measures of this type increase the participation rate for more advanced age groups.

The parameter $\diamond$ aims to make the model more flexible, leading to a smoother fall in the participation rate after age 55. At the other extreme, where $\diamond = 1$, the participation rate for gender $g$ and age $a$ (with $a$ between 55 and the legal retirement age) will be gradually corrected to horizon until it converges with the participation rate of the strata of same gender, age 55, although there may be a difference justified by a change in the levels of schooling. In other words, leaving out levels of schooling, the participation rate picture for the period between age 55 and the legal retirement age would be constant when $\diamond = 1$. Therefore, if reforms of the type already described are introduced, it is natural for the participation rate profile between age 55 and the legal retirement age to continue to decline, though by not as much as in 2005, meaning that the figure for $\diamond$ should be fixed somewhere between 0 and 1.

### 2.4 Module for contributors and pensioners

#### 2.4.1 Active contributors

The dynamics of the number of active contributors are modelled separately for the following three sub-sets of individuals:
- Active SPCGA contributors;
- Active SPSS contributors, who are wage earners (TCO);
- Active SPSS contributors, who are self-employed (TI)

There are substantial differences in the way the SPCGA and the SPSS work, both in terms of contribution and pension entitlement rules, motivating the consideration of separate dynamics for active contributors in the two subsystems. In addition, the basic information available meant that the SPSS contributors could be divided into TCO and TI. It was decided to include separate equations for each of these, given the very significant differences that exist between them – the stipulated minimum compensation for TI (which is the most common contributive base for TI) is on average considerably lower than the declared compensation of TCO. Typically, the self-employed also contribute for a shorter period than the employed and both factors lead to significant differences in pension accrual.

For the SPCGA, taking into account the initial figures for 2005, the number of active contributors is projected by adding the new contributors and subtracting the number of contributors who died, retired or severed from the subsystem for other reasons. The MISS model user can exogenously set severance rates (for all reasons but retirement and death) for SPCGA contributors by gender, age and year. For the projections set out in this paper, a severance rate of 0.25% will be considered for both genders, all ages and each year to horizon. This figure is the average rate observed in 2005.
It order to assess the financial effects of the 2005 decision to close the SPCGA to new registrations, a binary variable \( \rho \) was introduced. This takes the value of 1 or 0, depending on whether the aim is to build projections on the assumption that the SPCGA has been definitively closed to new registrations or to assume, in counterfactual terms, that the decision was not taken and new public employees are still being enrolled in the SPCGA. Closure implies that new public employees will be registered as TCO in the SPSS from 2006 onwards. For the next three or four decades, therefore, the SPSS will benefit from their contributions, without having to pay out pensions (given that the pensions of existing CGA contributors are reflected on the CGA accounts and not the SPSS).

The number of new public employees, broken down by gender and age over the period to horizon, is obtained from assumptions relating to the total number of new public employees each year, the male/female breakdown and the age distribution. For the projections in Chapter 3, for each year to horizon, 20 thousand new registrations were assumed, split evenly male/female. Distribution by age was kept as for 2005 (Figure 2.4.1).

![Distribution by age of new enrolments in the CGA, 2005](image)

For the SPSS, the equations for updating the number of employed and self-employed workers are simpler than for the SPCGA. The inconsistencies between the available sources of information (the National Statistical Office Labour Force Survey, the CGA and the Segurança Social databases) ruled out more detailed specifications.

For the self-employed, the model simply projects the number of contributors in line with the number of TI employment, for each gender and age group. The model allows the user to exogenously set the evolution of the coverage rate (defined as the ratio between the number of contributors and employment of the same type). This could, for example, be used to translate a fall in the importance of the informal sector in the economy. The projections in Chapter 3, however, do not reflect any exogenous intervention on coverage rates.

Where the dynamics of TCO in the SPSS are concerned, there are two additional complications, but the essence is the same as for the self-employed. The employment
relevant for calculation of the coverage rate is not TCO employment, but this figure less:

- the number of SPCGA active contributors (because these are already covered by a social security subsystem);
- in the case where $\rho = 1$, the number of public employee contributors to the SPSS who would have been enrolled in the CGA if this subsystem had not been closed to new registrations (because these have, by construction, a coverage rate of 100%).

So, when:

- $\rho = 1$,
- exogenous interventions on the coverage rates are taken out,
- public employees registered in the SPSS from 2006 are excluded,

then the rate of change in the number of remaining SPSS contributors equals the rate of change of TCO employment also net of SPCGA contributors and of the public employees hired from 2006 onwards.

### 2.4.2 Disabled and old age pensioners

In the MISS model, the numbers of disability or old age pensioners at the end of each year is obtained by taking the corresponding number for the end of the previous year, subtracting those who have died and adding new registrations.

To project the number of pensioners who die in a given year, the mortality rate is applied to the number of pensioners recorded at the end of the previous year. For those on a disability pension, the model allows for the user to apply a factor $\sigma \geq 1$ to the average mortality rate for individuals of that age and gender. This factor takes into account that the mortality rates for those on a disability pension are greater than the mortality rates for the gender and age group where they belong. On the basis of information available for 2004 and 2005, the estimate $\sigma = 3.75$ was obtained.

Due to data constraints, there are no separate equations in the MISS model for the dynamics of disability pensioners in the SPSS coming from the TCO and TI groups (the same type of aggregation occurs at year-end data for old age and survivor pensioners). The breakdown is, however, ensured when calculating the number of new pensioners (as well as when calculating average new pensions). Therefore, the most relevant detail for a realistic projection of pension expenditure is in fact maintained. It must be borne in mind that there are significant differences between TCO and TI contributors in the SPSS in terms of compensation and the average length of contributions.

It should also be highlighted here that an SPCGA disability pensioner receives a life-long pension. This does not happen in the SPSS, where all those on a disability pension are classified as old age pensioners when they reach the legal retirement age (currently 65). The MISS model allows the user to indicate, for each year, the legal retirement age in the subsystems. The equations where these legal ages come into play are automatically adjusted, simplifying the estimate of the effects caused by any change to these parameters of the model.

The evolution of the number of new disability pensioners is projected on the basis of the likelihood of an active contributor retiring because of a disability. The probabilities were estimated separately for each subsystem, using the information available on new
disability pensioners in 2004 and 2005. They grow in a non-linear way with the age of the contributor.

The numbers of new old age pensioners, by gender and age, are also projected by using functions which translate the “probability” of an active contributor retiring due to old age. In this case, however, it is not really a case of “probabilities,” because values above 1 could be reached, typically for ages on or above the legal retirement age. This happens when contributors exercise their right to a pension even if they are not active when they do so. The equations detailing projections of the number of new old age pensioners differ from the disability pensioners equations in two other ways:
- The legal retirement age is an additional argument for the “probability” functions;
- “Mitigation factors” come into play.

These mitigation factors will be equal to 1 unless the projection scenario takes into account policy measures that affect the “probabilities” of old age retirement. For example, the baseline scenarios with reforms analysed in Chapter 3 include a measure that implies a heavier financial penalty for early retirement, increasing the penalty from 4.5% to 6% per year below the legal retirement age. To parameterize this measure in the MISS model two actions were needed to complement the change in the specification of the formula by which the pension is calculated:
- Firstly, as pointed out in Section 2.3, it was necessary to adjust $\hat{\alpha}$ so as to ensure a smoother fall in the participation rates between 55 and the legal retirement age (the parameter was set at $\hat{\alpha} = 0.25$);
- Secondly, it was necessary to pin down the path for mitigating factors with values lower than 1, so as to express the expected fall in “probabilities” for old age retirement resulting from the higher penalty introduced for early retirement.

For this second effect, it was assumed that 50% of potential new old age pensioners in this age group who were financially affected by the measure would put off their retirement. Where the SPCGA is concerned, there is less likelihood of new old age pensioners appearing with a statutory pension that is less than the minimum pension applicable (because these contributors will not be financially affected by the measure). A mitigating factor of 0.6 (1-0.5x0.8) was assumed for the SPCGA for all years to horizon (on the assumption that the minimum pension is below statutory pension for 80% of new old age pensioners). For the SPSS, where only 44.5% of new old age pensioners in 2005 received above the minimum pensions, the mitigating factor for 2007 was fixed at 0.778 (1- 0.5x0.445). For subsequent years, bearing in mind that there will be a gradual fall in the numbers of pensioners receiving the minimum pension, a decrease of 0.002 per year was assumed, implying a mitigating factor of 0.632 in 2080, not far from what was considered for the SPCGA.

### 2.4.3 Survivor pensioners

The main differences between the dynamics of survivor pensioners in the two subsystems and the corresponding equations for old age and disability pensioners are related to the severance rates, as well as to the determination of the number of new pensioners.
As regards the first point, in terms of existing legislation\(^7\), there are a number of reasons for stopping a survivor’s pension, apart from the death of the beneficiary. Among these are:

- If the surviving spouse re-marries;
- When the descendant reaches adulthood or, being an adult, finishes his/her studies or drops out of school.

Rates of depreciation in life are one of the model’s inputs, and their calibration is based on the distribution profile of pensioners by gender and age. No distinction is made between the two subsystems. Figure 2.4.2 shows the rates considered for all years up to horizon.

**Figure 2.4.2**

*Rates of depreciation in life for survivor pensioners*

In terms of the dynamics relating to the number of new survivor pensioners, the *MISS* model takes as the basic factor to determine these flows the number of mortalities among active contributors and old age and disability pensioners. The beneficiaries of survivor pensions can be grouped into two main categories: descendants and surviving spouses (or equivalent). The modelling of new survivor pensioners takes as a simplifying assumption that:

- Up to and including age 25, they are all descendants of contributors or of pensioners who have deceased;
- From age 26 onwards, they are all surviving spouses or equivalent.

The proxies taken as an approximation to the number of deceased contributors and pensioners in each subsystem relevant to determine the number of new survival pensioners of gender \(g\) and age \(a\) were the following:

- For descendants of age \(a\) (at or below age 25) the number of mortalities of both genders with ages between \(a+25\) to \(a+40\) in that year;
- For spouses of age \(a\) (above age 25) the number of mortalities of the opposite gender with ages between \(a-5\) and \(a+5\).

\(^7\)For references and details, see [www.seg.social.pt](http://www.seg.social.pt) for the SPSS and [www.cga.pt](http://www.cga.pt) for the SPCGA.
The equations used to project new survivor pensioners (by gender and age) were estimated using these approximations.

2.4.4 Condition for coherence, by gender and age, between the total number of pensioners and the inactive population

The MISS model includes a condition for checking the coherence and for the possible truncation of the total number of (new) pensioners for each year. The model requires the ratio between the total number of pensioners – disability, old age and survivor – and the inactive population not to exceed, for both genders and all ages, a maximum between 1 and the value of the corresponding ratio at base year 2005 (year-end figures).

Given the differences between the demographic information available from INE and the administrative information from the IIES and CGA in 2005, the ratio in question is more than 1 for most ages above 65. Even if the existence of individuals in these age groups who receive more than one pension is taken into account, there is a “surplus” of over-65 pensioners which cannot be explained, when compared with the inactive population of the same age.

If the model did not put any restriction on the number of pensioners, the 2005 discrepancy would expand to horizon. The model therefore incorporates the restriction mentioned for the number of new pensioners. If the upper limit is breached in any given year, when the new pensioners are determined as described above, these numbers are truncated in proportion to the unrestricted figures so as to fulfil the condition.

2.5 Compensations, contributions and pensions module

2.5.1 Compensations declared/stipulated and contributions – SPSS

The MISS model includes separate equations for average compensation of active TCO and TI contributors of SPSS.

Average annual declared compensation by TCO contributors to the SPSS is calculated as a weighted average:
- Of the earnings of public employees registered in the SPSS in 2006;
- Of other employees’ compensation.

The separation of these two components is justified because the average earnings of public employees registered in the SPSS is higher than the average earnings of the other TCO contributors.

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8 For males, the ratio in 2005 is more than 1 for most ages above 48, and for females for most ages above 63.
9 According to Ministry of Labour and Social Solidarity data, there are around 200 thousand individuals who receive more than one pension.
10 Over and above those who receive more than one pension, there are also pensioners in the two subsystems who are not resident in Portugal. These total around 30 thousand in the SPSS. However, there is a larger number of residents who receive a pension from other social security systems (from other countries and from pension funds for bank employees, insurance and some large companies), to which have to be added the inactive individuals who receive no pension from any scheme.
The projection of the “private sector” TCO average compensation\textsuperscript{11} includes an annual up-date defined exogenously by the model user and it also takes into account the gender, age and gradual rise in schooling levels. The relationship between the latter variables and the private sector TCO compensation was estimated from 2002 “Quadros de Pessoal” registers, available from the Ministry of Labour and Social Solidarity. Education levels were projected with a similar procedure as the one described in section 2.3 for the projections of schooling levels among the resident population, the labour force and total employment.

The “pure” rate for updating TCO average compensation (that is without the effects of seniority and schooling) should be chosen for each year in line with the assumed rise in inflation and productivity in the economy and so as not to change in any significant way the share of labour in national income and the real unit cost of labour. From 2010 onwards, in order to obtain the projections described in Chapter 3, productivity, the GDP deflator and the consumer price index were all assumed to rise at 2% per annum. As regards the “pure” update rate for wages in the private sector, it was set at 3.75%\textsuperscript{12}.

In the \textit{MISS} model, the dynamics for the average declared compensation of TI is different from the one considered for TCO. This stems above all from the fact that in most cases what is at issue is the figure for minimum compensation stipulated by the SPSS for contributory purposes. This threshold is still quite low, though it was altered in mid-2005 from 1 to 1.5 minimum salaries. There is also the fact that micro data are not available for TI, as they are for TCO, which would make it possible to assess the relationship between declared compensation and the schooling levels of TI contributors. This being the case, the equation projecting the average compensation of self-employed contributors is an attempt to take into consideration the three main factors underlying the dynamics of this variable:

- The “pure” up-dating of salaries associated with inflation and productivity, leaving out composition effects (to generate the projections described in Chapter 3, the same rate was assumed for TI and TCO contributors);
- Possible changes to the minimum stipulated compensation for contributory purposes (this being defined in terms of the minimum wage);
- The up-dating of the national minimum wage.

To project more accurately the effects of a change in the minimum stipulated compensation for TI, the MISS model takes into consideration the distribution of TI compensation. For 2005, the initial year, 7 brackets were defined in relation to the average compensation for all self-employed (under 25%; between 25% and 50%; between 50% and 75%; between 75% and 100%; between 100% and 150%; between 150% and 200%; and above 200%). Seven “profiles” of compensation were correspondingly defined for TI contributors, such that it is assumed that each TI contributes according to a compensation defined as the mid point of the bracket to which he/she belongs\textsuperscript{13}. The change rate for the average compensation of the TI contributors is defined in the \textit{MISS} model, for each gender and age group, as the weighted average of the change rates of the seven profiles of TI. It should be noted that

\textsuperscript{11} Defined here as all TCO contributors except public employees registered in the SPSS from 2006.
\textsuperscript{12} Identical to the rate used for updating the minimum wage.
\textsuperscript{13} That is, 12.5%, 37.5%, 62.5%, 87.5%, 125%, 175%, and 300% of the average compensation for profiles 1 to 7 respectively.
changes to the stipulated minimum contribution affect the declared compensation of TI workers in the lower profiles, but not for those in the higher profiles, who are affected only by the pure up-dating factor.

The evolution of the stipulated minimum compensation to horizon is defined by the user of the model. This makes it easy to simulate the effects of any change. In the projections put forward in Chapter 3 it was assumed that the stipulated minimum compensation was 1.5 minimum wages, except for 2005, where the figure was set at 1.25 (it was raised from 1 to 1.5 in mid-2005).

Given the numbers of active SPSS contributors (TCO and TI) and their respective declared compensations, a preliminary approach to the total amount of contributions effectively paid to the SPSS consists in applying the standard rate of contribution to the total amount of declared compensations. The standard rate is currently 34.75%, with 23.75% paid by the employer and 11% by the employee.

In the case of public employees registered in the SPSS from 2006, the MISS model takes as a basis that the relevant overall rate of contribution is the basic rate set down in Decree Law 55/2006 of 15 March (23.08%). This rate does not cover the risks of unemployment and payments related to temporary absence from work (sickness, maternity and assistance to children). However, there is a group of public employees registered in the SPSS from 2006 that will be contributing at a rate above the basic rate, including coverage of certain risks excluded from the latter. Teachers’ contributions, for example, will include an additional amount associated with the coverage of risk relating to unemployment. Other public employees may come to be registered with coverage against the risk of sickness (instead of being registered for special health cover through what is known as the ADSE, as are all other public employees). It is impossible to predict the combinations that will involve additional coverage, so the MISS model takes the option that, by default, the contribution rate for all public employees registered in the SPSS will be the basic rate. This option has the additional advantage that it allows for a clearer comparison with the counterfactual situation where the CGA is not closed to new registrations, because the SPCGA is only responsible for payments of pensions and family benefits to its pensioners\textsuperscript{14}.

The above mentioned preliminary amount of contributions is then corrected using a factor defined exogenously by the model user, taking into consideration the level of efficiency in collecting contributions at the standard rate. In the projections in Chapter 3 it was assumed that this factor remains constant at around 92%, as observed in 2005 and estimated for 2006. There are two reasons why the degree of efficiency is lower than unity:

- A large number of subsidised special regimes were awarded to certain groups of workers, who therefore pay lower rates\textsuperscript{15};
- The SPSS is unable to collect all the contributions corresponding to declared or stipulated compensations.

\textsuperscript{14} Even so, the SPSS will be responsible for ensuring payment of family benefits to public employees registered in this subsystem from 2006. This situation would be different if they were registered in the CGA (which, as mentioned, only has responsibility for payment to pensioners).

\textsuperscript{15} For details, see www.seg-social.pt.
It should be noted that this degree of efficiency does not take tax evasion into consideration. Indeed, as regards social security contributions, tax evasion happens when earnings are not declared or are understated. These circumstances have a direct bearing on the underestimation of numbers of individuals in active employment and/or of average declared earnings.

2.5.2 Compensations and contributions – SPCGA

For the SPSS, micro data were available for 2005 for all contributors\(^\text{16}\). This was not the case with the SPCGA, where the data available related only to average earnings for contributors broken down by gender and age. As a result, this module of the MISS model – relating to earnings, contributions and new pensions – is more detailed for the SPSS than for the SPCGA. The latter subsystem does not take into account different profiles of earnings for each strata gender/age group. Based on the information available for 2005, the up-dating of the average compensation per strata is simply obtained by applying a variation rate defined by the model user to the earnings received the previous year for the same strata of gender and age (not the strata of the same gender and age less one year). Thus, as with the corresponding procedure for SPSS contributors, the up-dating rate defined by the user does not incorporate the effects of seniority in salary progression.

In the projections in Chapter 3, an updating rate of 3% is assumed for active SPCGA contributors. This is equivalent to a real gain of 1% per year (that is, half the assumed increase in productivity). The decision was taken not to index the compensation of public employees to the earnings of private sector workers. This way, the existing compensation gap in favour of the former is assumed to narrow gradually over time.

In the SPSS, the 34.75% overall rate of contribution in the standard regime (“Regime Geral”) includes both the employees’ and the employers’ contributions. For the SPCGA, it was necessary to deal separately with these two components and the latter was in turn broken down into two components:

- The employers’ part duly paid to CGA by a number of entities (such as central government autonomous funds, local and regional government and some bodies outside the scope of general government but with employees registered with the CGA)\(^\text{17}\);
- The State’s contribution as employer for the remaining public employees.

The second of the above is not explicitly taken as a State outlay and appears in the State Budget as part of what is termed “the State subsidy to the CGA.” This is an amount transferred annually to the CGA to balance their accounts.

In terms of employers’ contributions duly paid to the CGA, it is assumed that this corresponds to a proportion of the contributions paid by employees. The path of this proportion is defined exogenously, meaning that it is possible to simulate the effects of measures that may be introduced, increasing the rate of employer contributions that is projected over the horizon.

\(^\text{16}\) Anonymous data.

\(^\text{17}\) In 2005, the rate for employers’ contributions was changed from 10 to 13% (Law 60-A/2005 of 30 December).
As far as the State is concerned, and the contributors on whose behalf there are no explicit employer contributions, the decision was taken to take a “reference figure for employer contribution” so as to separate for each year the State’s responsibility as employer and the financing of the CGA’s annual deficit. For this, the MISS model calculates the reference amount for employer contributions that would be due to the CGA if all bodies made employer contributions at a rate equivalent to what the private sector employer pays to the SPSS, after taking into consideration the different coverage of risks in the SPSS and the SPCGA. In 2005, this rate was around 13.1%. The MISS user can change this figure for any period along the horizon. It should be noted that the sum of this rate with the rate for the CGA contributor (10%) brings us very close to the basic overall rate (23.08%) set for public employees registered in the SPSS.

2.5.3 Pensions for old age and disability – SPSS

In the MISS model, the average amount of old age and disability pensions is determined for each strata of age and gender as a weighted average of the pensions carried over from the previous year and of the average figure for new pensions started during the year. Pensions carried forward are up-dated by an exogenous factor whereas new pensions are generated in accordance with relevant regulations and bearing in mind the varying profiles of beneficiaries’ contributions over the years.

The SPSS rules for calculating pensions of new retirees for old age and disability are extremely complex, a fact stemming from the coexistence of more than one legal scheme. These schemes are set down in the Decree Law 329/93 of 25 September, Decree Law 35/02 of 19 February and Decree Law 187/07 of 10 May. The complexity is clearly visible in Figure 2.5.1, which was taken from the Ministry of Labour and Social Solidarity site in 2006 (on www.seg-social.pt). And this does not reflect yet the added complexity of the 2006 reform measures (Decree Law 187/07), when a new transitional scheme was inserted for the calculation of the statutory value of the pension, which is to be applied between 2007 and 2016, overriding the provisions for this period set down in Decree Law 35/02.

In all the schemes, a “statutory” pension is calculated for each new pensioner. This depends on a number of factors:
- The period during which contributions are made (“contributory period” or career);
- The compensation which is taken as the basis for the pension (“reference compensation”), which depends on the salary declared for part or all of the period of contributions, depending on the applicable legal scheme;

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18 As mentioned above, the SPCGA (unlike the SPSS) provides no cover for unemployment, nor subsidies related to temporary absence from work (sickness benefit, maternity, paternity, adoption and other family benefits).
19 Decree Law 200/99 of 8 June states that coverage for possible unemployment corresponds to 5.22 percentage points (p.p.), while coverage for a number of circumstances related to temporary absence (sickness, maternity, paternity, adoption and other family benefits) corresponds to 6.43 p.p. For this reason, when adjusting for the narrower coverage provided by the SPCGA, the social security standard contribution rate falls from 34.75% to 23.1%, of which 10% is paid by public employees. The “equivalent” employer’s rate is 13.1%, very close to the one in force since 2005 for public services with financial autonomy and for regional and local government.
Figure 2.5.1

### Table I - Statutory Pension Amount

<table>
<thead>
<tr>
<th>Registration</th>
<th>Qualifying Period</th>
<th>Pension Beginning</th>
<th>Amount Payable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Until 31/12/2001</td>
<td>The required qualifying period is fulfilled on 31/12/2001</td>
<td>From 1/1/2001 to 31/12/2016</td>
<td>Highest amount - calculation rules as shown in Table II, nos. 1, 2 and 3.</td>
</tr>
<tr>
<td></td>
<td>The required qualifying period is not fulfilled on 31/12/2001</td>
<td>From 1/1/2001 to 31/12/2016</td>
<td></td>
</tr>
<tr>
<td>From 1/1/2002</td>
<td></td>
<td>From 1/1/2001 to 31/12/2016</td>
<td>From 1/1/2017 - Amount resulting from the calculation rules shown in Table II, no. 1.</td>
</tr>
</tbody>
</table>

### Table II - Calculation of the Invalidity and Old Age Pensions

**Calculation Rules**

1. **Decree-Law no 329/93, of 25/99**
   - Correspond to \( R / 140 \), whereby:
   
   \( R = \text{Sum of all earnings of the 10 calendar years with the highest earnings within the last 15 years, after they have been adjusted} (1) \)
   
   \( 140 = 10 \times 14 \text{ months of earnings} (2) \)

   - **Annual Rate**
     - It corresponds to 2% for each calendar year with earnings registration.
   
   - **Global Rate**
     - It corresponds to the product of 2% and the number of calendar years with earnings registration. It can neither be lower than 30% nor higher than 80%.

   - Correspond to \( TE / (n \times 14) \), whereby:
     - \( TE = \text{sum of all annual earnings after they have been adjusted} (3) \)
     - \( n = \text{number of calendar years with earnings registration up to the limit of 48} (4) \)
   
   - **Annual Rate**
     - Insured persons who have 28 calendar years or less with earnings registration:
       - It corresponds to 2% for each calendar year with earnings registration.
       - Insured persons who have 21 calendar years or more with earnings registration:
       - It varies between 2.3% and 4.9% depending on the Reference Earnings (RE) amount indexed to the Minimum Legal Earnings in force when the pension begins, as follows:

   \[
   \begin{align*}
   \text{Reference earnings (RE) portions indexed to the Minimum Legal Earnings (MLE)} & \quad \text{Annual rate} \\
   \text{1st portion} & \quad \text{Up to 1.1 x MLE} \\
   & \quad 2.30 \\
   \text{2nd portion} & \quad \text{Higher than 1.1 x MLE up to 2 x MLE} \\
   & \quad 2.25 \\
   \text{3rd portion} & \quad \text{Higher than 2 x MLE up to 4 x MLE} \\
   & \quad 2.20 \\
   \text{4th portion} & \quad \text{Higher than 4 x MLE up to 8 x MLE} \\
   & \quad 2.10 \\
   \text{5th portion} & \quad \text{Higher than 8 x MLE} \\
   & \quad 2.00
   \end{align*}
   \]

   - **Global Rate**
     - Insured persons who have 28 calendar years or less with earnings registration:
       - It corresponds to the product of 2% and the number of calendar years with earnings registration; its lower limit is 30%.
     - Insured persons who have 21 calendar years or more with earnings registration:
       - It corresponds to the product of the annual rate and the number of calendar years with earnings registration, as set limits. It is determined by the individual concerned.

   In what concerns the reference amounts, they correspond to the Reference Earnings.

### Proportional Application of the Calculation Rules

The Statutory Pension amount results from the application of the following formula:

\[
P_{P1} = C \times (P_{P1} \times CPI)
\]

Whereby:

- \( P_{P1} \): Pension calculated by applying the calculation rules of the Decree-Law no. 329/93, of 25/99
- \( C \): Number of calendar years with earnings registration of the whole insurance career
- \( CPI \): Consumer Price Index

\[
P_{P1} = C1 \times (P_{P1} \times CPI)
\]

Whereby:

- \( P_{P1} \): Pension calculated by applying the calculation rules of the Decree-Law no. 35/2002, of 19/92
- \( C1 \): Number of calendar years with earnings registration completed until 31/12/2001

---

(1) The registered annual earnings are adjusted according to the Consumer Price Index (CPI) without considering the home factor.
(2) Whenever the number of years with earnings registration is lower than 10, the Reference Earnings are obtained by dividing the total existing earnings by 14 times the corresponding number of calendar years.
(3) The registered annual earnings are adjusted as follows: until 31 December 2001, according to the Consumer Price Index (CPI), without considering the home factor; from 1 January 2002, according to an Index which results from the weighting both of the CPI and of the average evolution of the earnings which underlie the contributions stated to the Social Security.
(4) Where there are more than 40 years, it will be taken into account the sum of the 40 highest annual earnings, after they have been adjusted.
- The annual accrual rate for the pension, which depends on the contributory period and the reference compensation (except for those covered by Decree Law 329/93);
- Any penalty for early retirement in the case of old age pensions;
- Also for old age pensioners, the so-called “sustainability factor,” to be applied from 2008 onwards.

The actual amount of the new pension is the highest value when comparing the figures for the statutory pension and for the minimum pension due, the latter depending on the number of years of contributions.

The *MISS* model attempts, as far as possible, to replicate these rules regarding how the pension amount is arrived at. In terms of the contributory period, one of the inputs required for the projection over the horizon is the percentage of contributors in the first year (broken down by age and gender) with a length of contributions in various brackets – 15 or more years, 21 or more, 31 or more and 40 or more.

For 2005, it was possible to reach an approximation to these percentages, calculated on the basis of the information available relating to registration in the SPSS. The duration recorded can however seriously overestimate the length of the contributory period, given that:
- SPSS beneficiaries may be registered for many years before they start contributing;
- there are periods of unemployment or inactivity which are not taken into consideration when the record is analysed.

In the light of this, the durations since first registration in the SPSS as observed in 2005 were calibrated to reflect more accurately the actual contributory periods (for both TCO and TI workers). This was done in two ways:
- Through an age restriction, since a worker cannot contribute more than the difference between his age and 15 years;
- Through a coverage restriction, which ensures that a proportion of workers contributing over a period equal to the difference between his/her age and any reference age $\overline{a}$ ($\leq a$) is not larger than the proportion of workers of the same type (TCO or TI) of age $\overline{a}$ who pay contributions to the SPSS (whatever the contributory period of the latter)\(^{20}\).

As a further point in relation to 2005, the average lengths of the contributory period for new pensioners of each type as calculated from the percentages obtained were also calibrated to replicate the figures for contributory periods observed in that year. The model projects the length of contributions for employees (TCO) and self-employed (TI) on the basis that:

\(^{20}\) For example, it is taken that the levels of coverage for 2005, computed as the time span since registration in the SPSS, are x% for those aged 30 and with at least 5 years of contributions and y% for those aged 25, however long the contributory period of the latter. The restriction guarantees that x cannot be greater than y, because if it was, it could indicate that the level of coverage for those aged 25 in 2000 would be greater than for those aged 25 in 2005. Indeed, $x > y$ means implicitly that the coverage in 2000 was larger than in 2005 for individuals of the same age, a result that is not likely given the maturing of the system.
- For ages below the legal retirement age, the percentage of contributors is non increasing with the career length (for example, the percentage of contributors of a certain type of gender $g$ and age $a$ with 21 or more years of contributions cannot be higher than the percentage corresponding to 15 or more years of contributions);
- For ages above the legal retirement age, the relationship is kept between the percentages of contributory duration for contributors of age $a$ and of age $a-1$ in the previous year $^{21}$;
- As time passes, there is a gradual pass-through from the percentages of groups with small contributory duration to those with longer contributory duration.

In terms of the reference compensation used for the purposes of calculating the statutory pension, and as detailed in Figure 2.5.1, two different procedures are used to determine the amount. The first is connected with the rule set down in Decree Law 329/93. Here, the reference compensation corresponds to the average of the 10 best out of the last 15 years of declared or stipulated compensation (after revaluation using the CPI excluding housing). The MISS model takes the last ten years as the best of the last 15. The second procedure for calculating the reference wage for a new old age or disability pensioner is set down in Decree Law 35/02. This takes the whole period of contributions into consideration. In addition, from January 2002, the revaluation index for past wages comes from weighting the CPI excluding housing and the average evolution of earnings underlying contributions to the SPSS (with weights 75% and 25%, respectively).

The MISS model takes different equations for the amounts of pensions related to the various legal regimes:
- Decree Law 329/93 is applied (being the most favourable) to active contributors who had completed 15 years of contributions at the end of 2001;
- Decree Law 35/02 “pure” is the least favourable and is therefore only applied to those registered in SPSS from January 2002;
- Decree Law 35/02 “mixed”, less favourable than the first but more than the second, consists of a weighted average made up of the amount of the new pension calculated according to previous systems and will be applied to all new pensioners registered in social security in or before 2001 but not yet reaching 15 years of contributions in that year $^{22}$;
- The “mixed” regime agreed in 2006 between the government and social partners for the period 2007-2016 $^{23}$.

For the regime defined in Decree Law 329/93, the annual accrual rate of pension for old age and disability is 2% $^{24}$. In terms of the regimes defined in Decree Law 35/02, the accrual rate depends on the reference compensation (as shown in Figure 2.5.1). In this

$^{21}$ It should be noted that the percentage will fall (or at least hold steady) for ages above the legal retirement age. This is because those who have been contributing for a longer period tend to take a pension first, while those with a shorter period stay longer in active employment.
$^{22}$ This transitional regime takes a weighted average of the amounts calculated according to the rules of each of the two previous regimes, straight, with 2001 as the point of reference for weighting.
$^{23}$ The difference between this mixed transitional regime and the previous one is the reference year for calculating the weights: end-2006 instead of end-2001.
$^{24}$ By annual accrual rate of pension is meant the percentage applied to the reference wage for each year of contributions in the formula used to calculate the statutory pension.
last case, it would be over-simplistic to use the average obtained for each strata (employed/self-employed, gender, age) so the MISS model attempts to approximate to the rule by applying different salary profiles relative to the reference compensation, following the logic detailed in section 2.5.1 in relation to the calculation of average earnings of self-employed.

For ages below the legal retirement age, the statutory pension is multiplied by a factor that includes an attempt to cover the penalties for early retirement. The MISS model also takes into consideration the possibility that the statutory pension, from 2008 onwards, will be affected by the “sustainability factor.” This corresponds to the ratio between the 2006 level of average life expectancy at age 65 and the same indicator in the year before retirement.

Once the statutory pension is obtained for each of the 7 income profiles and by gender and age group, type of worker and legal regime, the figure is compared with the minimum pension for the specific profile (bearing in mind the average length of contributions for the strata), and the higher of the two figures is used. In this way, the MISS model attempts to take the contribution profile into consideration and come to a more realistic simulation of those situations where the set of minimum pensions is an active lower bound for the new pension.

Once the amounts for new old age and disability pensions have been calculated for the four regimes that are legally stipulated (these amounts decomposed for each strata of gender and age and for each year along the horizon), the MISS model then proceeds with a weighting of these figures, using the relative importance of the regimes assumed for each year. The projections thus obtained are then calibrated to replicate in 2005 the figures for new average pensions observed in that year.

2.5.4 Old age and disability pensions – SPCGA

The dynamics of average old age and disability pensions for the SPCGA follow a logic similar to what was described for the SPSS at the start of the previous section. The only exception is the way new pensions are calculated. In the SPCGA, the statutory pension is calculated on the basis of the “Retirement Statute” (Estatuto de Aposentação) reviewed in 2005 (CGA 2006a). This also includes a number of regimes and transition periods replicated in the MISS model, bearing in mind the main components:
- The contributory period;
- The reference compensation, which differs according to the date of registration in the CGA and the year of retirement;

25 The MISS model allows for the activation or deactivation of the “sustainability factor” depending on whether the scenario under review refers to projections with or without this measure.
26 Let \( \phi^{329/93}(t) \), \( \phi^{35/02}(t) \), \( \phi^{mc2001}(t) \) and \( \phi^{mc2006}(t) \) denote the weights of the rules for computing the statutory pensions, according to Decree Laws 329/93, 35/02 and 187/07. They must add up to 1 for each year. The 2006 reform agreed between the government and social partners implied cancelling \( \phi^{329/93}(t) \) to horizon, and set \( \phi^{mc2006}(t) = 1 \) for \( 2007 \leq t \leq 2016 \); (ii) \( \phi^{mc2001}(t) = 1 \) from 2017, with a gradual fall in this last weight, substituting the gradual rise in the \( \phi^{35/02}(t) \) weight (in the baseline scenarios presented in Chapter 3, this rise occurs gradually between 2033 and 2041, after which \( \phi^{35/02}(t) = 1 \)).
27 See also CGA (2006b) where the rules of pension accrual for CGA contributors is set out.
- The annual accrual rate of pension, which varies according to the year of registration in the CGA, the retirement year and the reference compensation;
- In the case of old age pensions, any possible future financial penalties for early retirement or the “sustainability factor” (applicable from 2008 onwards).

The information available for the SPCGA, as opposed to the SPSS, included the average length of the contributory periods of active contributors by gender and age for the initial year of 2005. These average contributory periods are projected by the MISS model, assuming that they will not exceed an upper bound of 40 years of contributions and with the following considerations in mind:
- For ages above the retirement age, the length of the contributory period is updated by adding one year to the time of service recorded in the previous year for contributors of the same gender and one year younger;
- For ages below the retirement age, the updating takes into consideration the fact that new pensioners of each strata generally have a contributory period longer than the average contributory period in the same strata.

The typical picture, in fact, is that those contributors retiring at an age less or equal to the legal retirement age are those with longer contributory periods. Curiously, the information available for 2005 shows a similar phenomenon for contributory periods of new disability pensioners. In 2005, new CGA pensioners have on average contributed for a period 30% higher than the average contributory period in the same strata. For CGA contributors registered before 1993, the statutory pension is the result of a weighted average of two components, where the weights are defined by the number of contributing years up to and beyond 2005. The first component corresponds to the rule existing in 2005 for those registered before 1993 (basically, 90% of the last gross compensation), while the second component is related to the rules set down in Decree Law 35/02, but these are only applied to post-2005 contributions. For SPCGA contributors registered after 1993, the rule used for calculating the statutory pension is as set down in Decree Law 35/02.

After the statutory pensions have been calculated according to the two legal schemes for each type of pension, each gender and age group and each year to horizon, the MISS model then chooses which legal scheme is applicable for each strata as a function of the year of start-up (on average) for the contributions of that strata. This figure is compared with the minimum pension which is applicable (taking into consideration the average contributory period for that strata), and the higher of the two figures is the one used. The projections obtained for the new pensions were then calibrated (as they were for the SPSS) to replicate in 2005 the observed figures.

2.5.5 Survivor pensions

The way survivor pensions are calculated is very complex. It depends on factors such as the nature of the beneficiaries (typically the spouse or child/children of the deceased, the number and age of the beneficiaries, along with the contributory period of the deceased). It is impossible to model adequately all the add-on factors that influence the amount of these pensions, so the MISS model uses the simplest solution available: it

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28 To simplify, the MISS model does not take into account the case of the contributor with enough years of service to warrant a complete pension in 2005, on the assumption that he/she opted for retirement in that year.
starts with the average survivor pensions paid out in 2005 and updates them using the change in the average old age pension for the subsystem in question.

2.6 Module for remaining benefits and allowances

As mentioned in Chapter 1, the MISS model projects, in addition to pensions, other outlays related to previous or current contributions by the beneficiary or his/her family. In the Segurança Social subsystem there are three types of benefits or allowances that fulfil this definition:

- Unemployment benefits;
- Benefits to compensate for loss of income during absences from work with leave, covering sickness, maternity, paternity and adoption benefits and subsidies for assistance to children;
- Family benefits, including the family allowance for children, teenagers and young adults (abono de família), along with a number of other family-related benefits involving relatively small payments.

For each of these types of outlays, there were micro-data available for 2005, making it possible to calculate by gender and age the numbers of beneficiaries (and the family members in the case of family allowances), as well as the average amount paid.

In the CGA, apart from pensions, the only other payouts are the family benefits and only for pensioners, since contributors in active employment receive these payments directly from the services where they work. It should also be remembered, as mentioned in section 2.5.1, that the MISS model uses the basic rate set out in Decree Law 55/06 of 15 March as the rate of contribution for all public employees registered in the SPSS from 2006 on. This does not cover unemployment and being temporarily off work but includes coverage for family benefits.

2.6.1 Unemployment benefit

For any given strata of gender and age, the MISS model takes into consideration three factors when projecting the change in the number of individuals receiving unemployment benefit:

- The change in the number of unemployed individuals with that gender and age;
- Any change in the SPSS coverage for that strata (i.e. in the ratio between the number of TCO active contributors and the number of TCO in the strata);
- Any alterations to legal eligibility for the unemployment benefit.

An “eligibility index” is defined exogenously for the unemployment benefit so that the figure for 2005 was set to one and an increase (decrease) in the index to horizon means that there has been legislative change giving less (greater) restriction on access to this benefit.

As regards the average annual amount processed per beneficiary, it is updated from 2005 for all strata of gender and age, taking two factors into account: the change rate of the average declared or stipulated earnings for SPSS contributors in active employment (after excluding an amount as close as possible to the earnings paid to public employees
registered in the system from 2006); and the variation in a “unemployment benefit generosity index”, which is set exogenously by the model user.

In the projections presented in Chapter 3, the indices for eligibility and generosity are kept constant and equal to 1 along the horizon.

2.6.2 Sickness benefit

The number of SPSS contributors on sickness leave is updated for each strata of gender and age by reference to the figure for the initial year (2005) in accordance with the evolution of the number of active contributors in the strata (employees and self-employed), after excluding the approximate number of public employees registered in the SPSS as and from 2006.

As for the average amount paid out for this benefit, the rule for updating, applied to each strata, considers only the variation in average earnings, as declared or stipulated.

2.6.3 Maternity, paternity and adoption allowance

These allowances, as their name suggests, are for contributors or their spouses (or the equivalent) on occasion of childbirth or child adoption. Given that the number of adoptions is relatively small when compared with the number of births, the updating rule included in the MISS model considers the number of beneficiaries involved for each strata of gender $g$ and age $a$ as follows:

- For females, the number of births per woman at age $a$;
- For males, the number of births per woman with age between $a - 4$ and $a^{29}$.

To update the average subsidy for beneficiaries in each strata, a process similar to the one described for sickness benefit is used.

2.6.4 Subsidy for children assistance

The MISS model updates the number of contributors for each strata who benefit from this subsidy by taking as a point of reference the numbers for the resident population below age $10^{30}$, and the numbers of active contributors belonging to the same strata.

The rule for updating the average subsidy is exactly the same as the rule considered for other types of subsidy relating to temporary absence with leave from work.

2.6.5 Family allowance abono de familia - SPSS

Due to limitations of the information available, the calculation of the number of abono de familia beneficiaries and the expenditure on this allowance includes payments to contributors and non-contributors (welfare benefits). This is an exception to the MISS model rule of only considering the contributive social security scheme. However, for the base year, the non-contributive component is unlikely to account for more than 10% of the number of beneficiaries of this allowance, so the SPSS accounts are not significantly affected by its inclusion.

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29 It is assumed, ad-hoc, that the spouse (or equivalent) giving birth is of the same age as or somewhat younger than the beneficiary of the allowance.
30 Those requiring assistance are most likely to be found below this age.
The MISS model extrapolates the total number of those entitled to family allowance for the two subsystems, based on the number in 2005 and the variation in the active resident population under 25 years old, the group which may be eligible for the subsidy.

To reach the number of those entitled to the allowance through the Segurança Social subsystem, the MISS model subtracts from the total number those for whom the CGA has responsibility to grant this allowance (i.e. children, teenagers and young adults under the legal custody of beneficiaries who are CGA pensioners).

The SPSS expenditure on abono de família per holder (in euros) is a simple projection based on the figure observed in the initial year and updated using a change rate of payments relating to family benefits, defined exogenously by the model user.

For the projections in Chapter 3, the variation rate set for family benefits was identical to the one for pensions carried on from the previous year.

2.6.6 Other family benefits – SPSS

Abono de família represents the major part of SPSS expenditure on families (excluding outlays on non-contributory items such as the Rendimento Social de Inserção, a family support programme). Other outlays include funeral allowance, an allowance if a third-party has to be employed for assistance, an extra payment granted to the handicapped, a subsidy for special education purposes, a monthly life-long allowance (subsídio mensal vitalício) and a “home allowance” (subsídio de lar). Among all these household benefits, only the payment of funeral costs, like abono de família, is not fully contributive-based.

Due to lack of more detailed information, the non-contributive component of the funeral allowance is also considered by the MISS model, although the amounts involved are very small and have a negligible effect on the SPSS accounts.

The number of beneficiaries for these payments (excepting abono de família), broken down by gender and age group, was projected on the basis of the figure for 2005 and the projected variation rates of the number of active contributors and pensioners. It should be noted that this variation includes public employees registered in the SPSS as and from 2006. Article 2 of Decree Law 55/2006 of 15 March stipulates that the basic contribution rate of 23.08% covers the payment for all the above household benefits.

The procedure for projecting the average amount under this heading is similar to the one used to project abono de família, and it is based on the variation rate fixed exogenously for the average payment relating to family benefits.

2.6.7 Other family benefits – SPCGA

Data on family benefits paid by the SPCGA by type of benefit, gender and age group were not available, so the MISS model treats all payments from the CGA to its beneficiaries as a whole. It should be mentioned, however, that the amount involved is

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31 The entitlement holder is the child, teenager or young adult entitled to the benefit.
32 This is only for beneficiaries of the insurance sector employees’ social security fund.
quite small in all the criteria and does not justify a more detailed analysis. It is assumed that the CGA expenditure on family benefits evolves as per the number of pensioners in the subsystem and with the above-mentioned variation rate of average family benefits (defined exogenously).

2.7 SPSS and SPCGA accounts module

This is the last of the MISS modules and brings together the financial information calculated from the equations of the two previous modules (described in sections 2.5 and 2.6). It aggregates this information for each of the subsystems, consolidates the accounts and calculates some relevant financial indicators.

2.7.1 Non-consolidated accounts of the SPSS and the SPCGA

The (non-consolidated) accounts of the SPSS and the SPCGA are obtained directly from the aggregation of revenue and expenditure items described above, with a few exceptions:

i. “Administration costs”

The ratio between the total administration costs (also including those related to the management of welfare benefits) and the sum of a set of items relating to income and expenditure, considered the most relevant for generating the administration costs, was first computed for 2005.

For the SPSS, there is an item for administrative costs in the published accounts and this was taken as the numerator for the ratio. The denominator includes revenue from contributions and quotas and expenditure on pensions along with a number of other payments (including the welfare benefits, such as acção social, abono de família and Rendimento Social de Inserção and outlays on professional training).

For the SPCGA, administration costs were taken as the items relating to staff costs, purchases of goods and services and operational costs and losses. For this subsystem, the denominator includes receipts from contributions (quotas) and receipts earmarked from other bodies which are responsible for pension payments (except the so-called “State subsidy”) along with expenses on pensions and other benefits.

In 2005, these ratios were 0.0141 and 0.0024, respectively, for the Segurança Social subsystem and for the CGA. For each year to horizon, the administrative costs were obtained by applying these ratios to the relevant revenue and expenditure items. The MISS model allows for changes in the administrative costs ratios along the horizon, but in the simulations presented in Chapter 3 they were kept constant at 2005 values.

33 In 2005, payments of family benefits made by the CGA to its pensioners only accounted for 0.6% of outlays on pensions and other items. Moreover, these outlays only represent 1.3% of total social security payments and 6.3% of family benefits.
ii. “Receipts earmarked for pensions payments” – SPCGA

These are the amounts received by the CGA from other entities (among them the SPSS National Pensions Centre and former public companies whose employees were initially registered in the CGA) to reimburse the SPCGA for pension outlays for which it is not responsible. It would have been best to exclude these amounts from the SPCGA revenue, cancelling out the pensions paid out from this source. Unfortunately, the information available did not allow to do this with decomposition into gender and age groups.

This being so, the decision was taken to consider expenditure on pensions, including the amounts paid on behalf of other bodies and to offset these with the payments made by these entities to the CGA. In this way, the balance of the SPCGA is not affected. The projections presented in Chapter 3 assume that the ratio of liabilities from other entities to expenditure on pensions is unchanged from 2005.

iii. “State responsibility for pension payments” - SPCGA

In the baseline year (2005), a sum was deducted from the CGA pension expenditure corresponding to the payment of pensions of a non-contributive nature which are the direct responsibility of the State. These are the pensions for disabled members of the armed forces and the survivor pensions related to those killed while on military or police service.

iv. “Use of reserves from former pension funds” – SPCGA

Over recent years, the CGA has been absorbing liabilities for payments of pensions for employees or retirees of several public enterprises and former public enterprises. These extra liabilities were offset (only partially in some cases), by transfers of pension funds from these enterprises to the CGA. At year-end 2005, the CGA special reserve made up of these amounts totalled 4028.2 million euros. When carrying out the projections of CGA accounts, these special reserves had to be filtered in gradually. For these purposes, the audit report published by the State Audit Board (Tribunal de Contas, 2005) was taken into consideration so as to come up with a simple procedure. The report covered the years 2006-2015, and it was assumed that these reserves transferred from CGD, NAV, ANA, INCM, RDP and DRAGAPOR would not be used during this period. Subsequently, it was assumed that there would be a linear usage until the funds were exhausted by 2050 (all except CGD) or 2065 (CGD). These dates correspond approximately to the point where pension liabilities cease, according to the State Audit Board’s report. There is a second group of special reserves made up of funds from the BNU, Macao, INDEP and the CTT. For these, the recent usage pattern was maintained, implying that they will be exhausted between 2014 and 2020.

v. VAT receipts earmarked to the SPSS and the SPCGA

The logic underlying these accounts of the two subsystems is to include only revenue and expenditure items related to the contributive social security
components, but the MISS model also includes as revenue the amount transferred from the State Budget corresponding to the VAT receipts legally assigned to each of the subsystems. For 2005, the amount actually transferred was taken as input of the model. For 2006 and 2007, the source was the State Budget for 2007. From 2008 onwards, it was assumed that the transfer amount would grow in line with nominal GDP. The split of the VAT transfer between the SPSS and the SPCGA was kept proportional to the split budgeted for 2007, though with the restriction that no surplus should be projected in the SPCGA owing to the VAT transfer, in the last years along the horizon, when other receipts and outlays will tend to zero at the final stage of the system being closed down. During those last years of the projection period when this restriction is active, the amount not allocated to the SPCGA reverts to the SPSS. The sum of the funds assigned to the two subsystems, as a percentage of GDP, remain unchanged.

2.7.2 Consolidated accounts of the two subsystems

A final point in the description of the main features of the MISS model relates to the consolidated accounts of the SPSS and the SPCGA. The consolidation process is very simple, and can be expressed as the sum of the financial flows in the two subsystems, after adjustments in two items:

- On the revenue side, the transfer from the SPSS National Pensions Centre to the SPCGA was withdrawn;
- To offset this, the corresponding amount was withdrawn from the sum of expenditures on old age, disability and survivor pensions in the two subsystems. This was to avoid duplication of expenditure (given that the outlay on pensions in the SPSS includes the amounts transferred to the CGA corresponding to that part of the pensions paid through it).

For 2005 there is information available on pensions paid by the CGA which were the responsibility of the SPSS. It was therefore possible to break down by type of pension and to compute the proportions of these liabilities of the National Pension Centre for the payment of CGA pensions. In the projections presented in Chapter 3, these proportions are maintained unchanged along the horizon.

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34 In 2005, the National Pension Centre was responsible for 3.6% of CGA pensions paid through the CGA subsystem.
3. BASELINE SCENARIOS WITH AND WITHOUT REFORM MEASURES

Three projection scenarios over the horizon 2006-2080 are presented and analyzed in this chapter: “the baseline scenario without reforms,” “the baseline scenario with reforms – alternative I” and “the baseline scenario with reforms – alternative II.” The first scenario differs from the other two in that it does not include the effects of the main reform measures agreed between the government and social partners in October 2006. The other two scenarios include the most representative measures, being distinct in the sense that each refers to an extreme alternative of modelling the reaction of economic agents to one of the measures.

The baseline scenario of official projections released in May 2006 did not yet include the effects of the measures agreed between the government and social partners. The only information available related to the anticipated effects of several measures on the overall balance of the Segurança Social subsystem\(^1\). For this reason, the baseline scenario without reforms will be used for comparisons with official projections throughout this chapter.

3.1 The main reforms

The four most representative measures of the 2006 social security reform are:

- Earlier transition to the pension formula set down in Decree Law 35/02, which considers the whole contributive career and increases the accrual rate for lower wages;
- A new rule for updating pensions as a function of consumer inflation, the real growth of GDP and the pension amount;
- A bigger financial penalty for early retirement, i.e. retirement prior to the legal retirement age;
- The introduction of a “sustainability factor” that will relate the calculation of new pensions to the evolution of life expectancy at age 65.

The first measure applies only to the SPSS and the other three apply to both the SPSS and the SPCGA.

3.1.1 The regime set down in Decree Law 35/2002 brought forward to 2007

Decree Law 35/2002 set out a formula for calculating the amount of new pensions which differs from the one set out in Decree Law 329/1993 in two fundamental points:

\(^1\) Ministry of Labour and Social Solidarity (2006a and 2006c).
it takes the compensation over the whole contributive career (instead of the best ten out of the last fifteen years) and sets out different accrual rates, depending on the workers compensation (the lower the compensation, the higher the rate, varying between 2 and 2.3 per cent). Decree Law 35/2002 set out a transitional period, during which the pension to be applied will be whichever is the higher, either the new regime one or as calculated as a weighted average of the pension from the last regime and from the new regime, where the weights correspond to the number of years of service before and after 2001. Decree Law 35/2002 set down 2017 as the start of the transitional period but in 2006 the decision was taken to bring forward the transition to the new formula to 2007. The intervening period, up to 2016, will be covered proportionately depending on the number of contributive years up to 2006 and after.

3.1.2 The new rule for updating pensions and family benefits

In the baseline scenarios with reforms, it was considered that pensions and family benefits would be updated from 2007 in accordance with consumer prices, plus 0.25 percentage points. This means a change from recent years, where there have been increases significantly higher than inflation, above all as a result of the rise in minimum pensions\(^2\). More specifically, the measure is to be applied as from 2008 and brings future pension up-dates within a regulatory framework. This removes the discretionary element, and indexes the up-date to consumer inflation in the previous year. The indexation takes into account the real growth of GDP (annual average of the two previous years) and the value of the pension, as follows:

<table>
<thead>
<tr>
<th>Pensions under 1.5 IAS(^3)</th>
<th>GDP real variation rate less than 2%</th>
<th>GDP real variation rate from 2% to 3%</th>
<th>GDP real variation rate equal or greater than 3%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CPI change rate</td>
<td>CPI change rate + 20% GDP real variation rate (minimum: CPI change rate + 0.5 percentage points)</td>
<td>CPI change rate + 20% GDP real variation rate</td>
</tr>
<tr>
<td>Pensions 1.5 to 6 IAS</td>
<td>CPI change rate – 0.5 percentage points</td>
<td>CPI change rate</td>
<td>CPI change rate + 12.5% GDP real variation rate</td>
</tr>
<tr>
<td>Pensions 6 to 12 IAS</td>
<td>CPI change rate – 0.75 percentage points</td>
<td>CPI change rate – 0.25 percentage points</td>
<td>CPI change rate</td>
</tr>
</tbody>
</table>

It is assumed that economic growth will be around 2% per year. In such a case, the new rule for pension updating corresponds fundamentally to indexation to the consumer price index plus a relatively small differential, besides some pro-cyclical changes and some discrimination in favor of lower pensions.

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2 The main reason for this was the convergence of minimum old age and disability pensions to the mandatory minimum wage as set down in the Social Security Framework Law of 2002 (Law 32/2002).

3 The “IAS” is the social support index (Indexante de Apoios Sociais). For 2007, it was defined as the 2006 mandatory minimum wage updated by the consumer inflation of that year (Law 53-B/2006). This Law provides that the rule for IAS updating in the future is to be identical with the rule for updating lower pensions (lower bracket).
3.1.3 Additional penalty for early retirement

One of the measures approved – within the scope of the so-called “promotion of active ageing” – consists in introducing a disincentive to early retirement, with the penalty factor rising from 4.5% to 6% per year. Early retirement can still be taken, as long as the worker is at least age 55 and has a contributive career of at least 30 years. The baseline scenarios with reforms include the additional financial penalty to be applied to new pensions and consider a multiplicative factor to reduce the probability of those eligible actually retiring. The latter factor implies an increase in the participation rates for the age groups between 55 and 65 years old.

3.1.4 Sustainability factor

The so-called “sustainability factor” will be applied from 2008 onwards. It consists in multiplying the formula for calculating the statutory pension (obtained by applying the other existing regulations) by the ratio between average life expectancy at 65 in 2006 and life expectancy in the year prior to retirement. Contributors can opt for a combination of two extreme alternatives or “corner solutions”⁴:

- They can put off retirement age until they completely offset the effect of the sustainability factor (Alternative I); or
- They can retire at the statutory age and accept the financial penalty levied on the pension (Alternative II).

It is relatively easy to parameterise the MISS model to cater for each of the extreme alternatives⁵, but it is more complicated to combine them in the model, above all because it is difficult to forecast how people will react. For this reason the decision was taken to present two alternatives scenarios with reform measures, corresponding to the two extreme alternatives for modelling the sustainability factor.

3.2 Demography projections

Table 3.2.1 summarizes the projections of the main demographic variables. These are the same for the three scenarios being analyzed. In the light of these projections, the population will continue to rise until mid-century, although the annual variation will be less and less significant. Beyond that there is likely to be a slight reduction in population figures. The population will age markedly over the whole period, with a major increase in the relative proportion of the elderly.

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⁴ A third possibility is also available. This involves additional voluntary contributions to public or private capitalization schemes. In its essence, this alternative is already available through pension savings funds (known as PPRs).

⁵ It should be noted that alternative I means indexing the legal retirement age to average life expectancy at 65. One of the limiting factors in MISS is that the legal retirement age is an integer number, so in alternative I changes in that age are only considered when average life expectancy at 65 rises by one year (as an average for males and females). The demography projections presented below assume that indexation of average life expectancy at 65 is equivalent to increases in the legal retirement age in 2013, 2020, 2029 and 2043.
### Table 3.2.1
Demographic projections – baseline scenarios with or without reforms

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident population</td>
<td>10561</td>
<td>10891</td>
<td>11806</td>
<td>12224</td>
<td>12041</td>
</tr>
<tr>
<td>(annual average in thousands)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>annual variation rate</td>
<td>0.6</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Dependency ratios</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pop. 65 years or more / pop. 15 years to 64 years</td>
<td>0.25</td>
<td>0.27</td>
<td>0.40</td>
<td>0.56</td>
<td>0.52</td>
</tr>
<tr>
<td>pop. under 15 years / pop. 15 years to 64 years</td>
<td>0.23</td>
<td>0.24</td>
<td>0.22</td>
<td>0.26</td>
<td>0.26</td>
</tr>
<tr>
<td>pop. under 15 or more than 64 years / pop. 15 to 64 years</td>
<td>0.49</td>
<td>0.51</td>
<td>0.62</td>
<td>0.82</td>
<td>0.78</td>
</tr>
<tr>
<td>Net immigration (thousands)</td>
<td>48</td>
<td>48</td>
<td>49</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Total fertility rate (15 years to 49 years) (1)</td>
<td>1.45</td>
<td>1.48</td>
<td>1.55</td>
<td>1.58</td>
<td>1.59</td>
</tr>
<tr>
<td>15 years to 29 years (1)</td>
<td>0.75</td>
<td>0.74</td>
<td>0.73</td>
<td>0.72</td>
<td>0.72</td>
</tr>
<tr>
<td>30 years to 49 years (1)</td>
<td>0.70</td>
<td>0.74</td>
<td>0.83</td>
<td>0.86</td>
<td>0.87</td>
</tr>
<tr>
<td>Mortality rate x 1000 (total)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>under 15 years</td>
<td>7.2</td>
<td>7.1</td>
<td>8.0</td>
<td>10.0</td>
<td>10.5</td>
</tr>
<tr>
<td>15 years to 29 years</td>
<td>0.3</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>30 years to 49 years</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>50 years to 64 years</td>
<td>1.1</td>
<td>1.0</td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>65 years to 80 years</td>
<td>3.7</td>
<td>3.3</td>
<td>2.3</td>
<td>1.9</td>
<td>1.8</td>
</tr>
<tr>
<td>81 years or more</td>
<td>18.4</td>
<td>16.1</td>
<td>9.8</td>
<td>8.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Life expectancy (in years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at birth</td>
<td>75.4</td>
<td>76.7</td>
<td>79.8</td>
<td>81.1</td>
<td>81.8</td>
</tr>
<tr>
<td>at 65 years</td>
<td>16.5</td>
<td>17.4</td>
<td>19.8</td>
<td>20.9</td>
<td>21.4</td>
</tr>
<tr>
<td>female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>at birth</td>
<td>82.2</td>
<td>83.6</td>
<td>86.9</td>
<td>88.4</td>
<td>89.1</td>
</tr>
<tr>
<td>at 65 years</td>
<td>20.3</td>
<td>21.2</td>
<td>24.0</td>
<td>25.3</td>
<td>25.9</td>
</tr>
</tbody>
</table>

Note: (1) Sum of fertility rates for the ages indicated.

The population pyramids in Figure 3.2.1 show this ageing very clearly. Other interesting indicators are the dependency ratios (Table 3.2.1). The ratio between the number of people of 65 or more years of age and the number of people between 15 and 64 more than doubles between 2005 and 2080, while the ratio of children under 15 to the number of individuals between 15 and 64 years old remains stable. At the same time, life expectancy at birth and at age 65 is likely to rise significantly with increases of around 5 years up to 2050 and one more year to end-horizon. The rise in life expectancy is a direct reflection of the assumptions taken for mortality rates, which continue to show a sharp fall up to mid-century, as observed in these indicators during the last century for each of the age groups

6 However, the average mortality rate for the population as a whole increases consistently along the horizon, from 7.2 per thousand in 2005 to 10.5 per thousand in 2080. This result would appear to go against the conclusion that there is a fall in the mortality rate, but it is simply the result of the composition effect associated with the progressive ageing of the population. In spite of the significant fall in the mortality rate for each age group, the rise in the overall mortality rate is due to the considerably higher rates for the older age groups and the increase in the proportion of the elderly in the population structure. The same phenomenon also explains the rise in the mortality rate in the oldest strata in the last two decades to horizon (see Table 3.2.1).
Figure 3.2.1
Population pyramids – baseline scenarios with or without reforms
The pace at which the population is ageing would be even more pronounced if two assumptions had not been made: a recovery in the fertility rate when compared with recent decades and a stabilization of the net immigration flows seen in recent years.

As mentioned in the last chapter, it is assumed that fertility among younger women (under 30) will continue to fall to horizon, though at a slower rate than recorded in recent decades, but the fall will be more than offset by a rise in the fertility rate among women aged 30 or more.

In terms of migration flows, it was also considered reasonable (and maybe even conservative, in the context of growing globalization in the world economy), to accept that there would be the same net migratory flows to horizon (with around 50 thousand net inflow per year).

<table>
<thead>
<tr>
<th>Table 3.2.2</th>
<th>Comparison of results - demography</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Official projections (May 2006) (1)</td>
</tr>
<tr>
<td>Resident population (10⁶, end-year)</td>
<td>10.5</td>
</tr>
<tr>
<td>0 years to 14 years</td>
<td>1.7</td>
</tr>
<tr>
<td>15 years to 64 years</td>
<td>7.1</td>
</tr>
<tr>
<td>65 years or more</td>
<td>1.6</td>
</tr>
<tr>
<td>Dependency ratios (%)</td>
<td></td>
</tr>
<tr>
<td>pop. 0 years to 14 years / pop. 15 years to 64 years</td>
<td>23.3</td>
</tr>
<tr>
<td>pop. 65 years to 110 years / pop. 15 years to 64 years</td>
<td>25.2</td>
</tr>
<tr>
<td>Total fertility rate (2)</td>
<td>1.45</td>
</tr>
<tr>
<td>Life expectancy (years)</td>
<td></td>
</tr>
<tr>
<td>at birth</td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>74.2</td>
</tr>
<tr>
<td>female</td>
<td>81.0</td>
</tr>
<tr>
<td>at 65 years</td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>15.6</td>
</tr>
<tr>
<td>female</td>
<td>19.0</td>
</tr>
<tr>
<td>Net immigration (annual flow, 10³)</td>
<td>42</td>
</tr>
</tbody>
</table>

Notes: (1) Identical to AWG projections.
(2) Sum of fertility rates from 15 years to 49 years.

When comparing the MISS model and official projections⁷, it should be highlighted that, according to the latter, the resident population shows a downward trend as and from the 2020s. It is clear from Table 3.2.2 that this difference is related to a smaller fall in the population of active age (ages 15 to 64) and also to a bigger increase in the elderly population in the MISS projections. The explanation for these differences relates above all to the assumptions on migratory flows. The fertility and life expectancy indicators follow similar paths⁸, but official projections, unlike those obtained with the

⁷ The official projections include demography projections identical to those published for Portugal by the European Commission in early 2006. These were the results of the study undertaken by the AWG (EPC and DGECFIN 2006).
⁸ The figures for life expectancy for 2004/2005 calculated in the MISS model are around 1 year higher than in the official scenario. This stems from the different assumptions for the distribution of the resident over-85s. Demographic statistics put the over-85s in one group, but this had to be decomposed into
MISS model, point to a significant fall in migrations flows, to around a third of the current figures.

3.3 Labour market projections

Table 3.3.1 is based on demographic projections and illustrates the baseline scenario without reforms for some of the main variables related to the labour market. The overall participation rate for ages between 15 and 64 rises slightly to horizon in this scenario. This is explained by the maturation of the female participation rate and by the assumption of a gradual rise in schooling (sections 2.2 and 2.3), in the context of a positive correlation between schooling and participation in the labour market. These factors more than offset the double effect of negative composition related to the increasing relative weight of older strata and the later entry of young people into the labour market.

Table 3.3.1
Labour market projections – baseline scenario without reforms

<table>
<thead>
<tr>
<th>Participation rate</th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 years to 80 years</td>
<td>63.5</td>
<td>63.5</td>
<td>59.5</td>
<td>57.5</td>
<td>59.1</td>
</tr>
<tr>
<td>male</td>
<td>70.3</td>
<td>70.3</td>
<td>65.7</td>
<td>62.1</td>
<td>63.4</td>
</tr>
<tr>
<td>female</td>
<td>57.0</td>
<td>57.1</td>
<td>53.4</td>
<td>53.1</td>
<td>55.0</td>
</tr>
<tr>
<td>15 years to 64 years</td>
<td>73.8</td>
<td>74.2</td>
<td>72.7</td>
<td>74.3</td>
<td>74.5</td>
</tr>
<tr>
<td>male</td>
<td>79.8</td>
<td>80.1</td>
<td>78.4</td>
<td>78.8</td>
<td>79.1</td>
</tr>
<tr>
<td>female</td>
<td>68.0</td>
<td>68.3</td>
<td>67.0</td>
<td>69.9</td>
<td>70.1</td>
</tr>
<tr>
<td>Employment (annual average in thousands)</td>
<td>4851</td>
<td>4980</td>
<td>5103</td>
<td>4873</td>
<td>4906</td>
</tr>
<tr>
<td>15 years to 80 years</td>
<td>4668</td>
<td>4790</td>
<td>4832</td>
<td>4561</td>
<td>4630</td>
</tr>
<tr>
<td>15 years to 64 years</td>
<td>4668</td>
<td>4790</td>
<td>4832</td>
<td>4561</td>
<td>4630</td>
</tr>
<tr>
<td>Productivity (annual variation rate)</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Annual average compensation (as % of minimum wage)</td>
<td>176.5</td>
<td>186.6</td>
<td>217.2</td>
<td>234.8</td>
<td>250.5</td>
</tr>
<tr>
<td>SPSS - Declared or stipulated</td>
<td>380.5</td>
<td>386.5</td>
<td>391.8</td>
<td>347.9</td>
<td>-</td>
</tr>
<tr>
<td>SPCGA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real unit labour cost (2005=1)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.98</td>
<td>0.96</td>
</tr>
</tbody>
</table>

The first of these negative composition effects justifies the fall in the participation rate when the age bracket is increased to 15-80. In this case, the negative composition effect dominates the projection, given that participation rates are lower for older age groups and these groups become proportionately bigger.

distinct groups up to 105 (the upper limit was chosen because it corresponds to the top age found in the INE Labour Force Survey and in the SPSS and SPCGA databases for pensioners). Distribution by ages, as used in MISS inputs, was estimated from information supplied by INE and from data on pensioners provided by the two social security subsystems. Everything points to a greater proportion of older people, unlike the age distribution implicit in the official figures for life expectancy.
As highlighted in the previous chapter, productivity (defined as the gross domestic product per worker, at constant prices) was fixed exogenously for the period after 2010 on a trend growth of 2% per year. In the first years of the period, more specifically up to 2009, lower figures were assumed, albeit on an increasing path, reflecting the assumption that Portuguese economic growth will gradually recover in the coming years.

The assumptions on wages and other earnings, when taken in conjunction with the effects of longer schooling and seniority, imply that the average compensation declared to the SPSS will grow in line with productivity. For SPCGA contributors, the projections point to a more modest growth of average compensation. This results from the assumption that real wages of public employees will not grow as fast as in the private sector. A negative drift of around 1 percentage point per year was postulated when compared to private sector employees, based on the assumption that there would be a gradual convergence and that the advantage of the public sector would be gradually whittled away (although part will persist because of the much higher level of schooling in general government than in the private sector\(^9\)).

The combination of the projected path for productivity and for real wages results in a very slight fall to horizon in the real unit cost of labour.

### Table 3.3.2
**Comparison of results: scenarios without reforms – labour market**

<table>
<thead>
<tr>
<th></th>
<th>Official projections (May 2006)</th>
<th>MISS without reforms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
<td>2030</td>
</tr>
<tr>
<td><strong>Participation rates (15 years to 64 years)</strong></td>
<td>75.6</td>
<td>76.1</td>
</tr>
<tr>
<td><strong>Employment (annual variation rate)</strong></td>
<td>1.3</td>
<td>-0.1</td>
</tr>
<tr>
<td><strong>Productivity (annual variation rate)</strong></td>
<td>1.5</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Table 3.3.2 shows the main labour market indicators for which it is possible to compare the baseline scenario without reforms with official projections (which do not incorporate the measures agreed in 2006). Two differences stand out, the first being the path assumed for productivity, where official figures are based on a more gradual recovery in productivity, but to a trend growth higher than the one considered in the projections obtained from using the MISS model. The second difference has to do with the fact that official projections point to an increase in the participation rate (ages 15 to 64) greater than the rise projected in baseline scenario without reforms obtained from the MISS model. This difference is more marked if the different projections for the population are also factored in, above all the sharp fall in active old people in official

---

\(^9\) The large initial wage gap visible in Table 3.3.1 is also bigger because contributors to the SPSS subsystem include the self-employed. For most of these, the compensation declared to the social security is the minimum compensation stipulated as reference to the minimum contribution, which is very low (1.5 mandatory minimum wages, since mid 2005).
figures. Indeed, increasing ageing, *ceteris paribus*, should imply a fall in the participation rate due to a composition effect\(^\text{10}\).

Table 3.3.3 shows projections of the labour market variables for the two alternatives of the baseline scenario with reforms. If compared with Table 3.3.1, the most salient difference is the behaviour of participation rates, which are higher than in the scenario without reforms, in particular for alternative I (which is postulated on retirement being put off until the sustainability factor is completely offset).

### Table 3.3.3

Labour market projections – baseline scenario with reforms

<table>
<thead>
<tr>
<th></th>
<th>Alternative I</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Alternative II</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
<td>2010</td>
<td>2030</td>
<td>2050</td>
<td>2080</td>
<td>2005</td>
<td>2010</td>
<td>2030</td>
<td>2050</td>
<td>2080</td>
</tr>
<tr>
<td>Participation rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 years to 80 years</td>
<td>63.5</td>
<td>63.9</td>
<td>61.9</td>
<td>60.8</td>
<td>62.7</td>
<td>63.5</td>
<td>63.7</td>
<td>60.2</td>
<td>58.3</td>
<td>60.0</td>
</tr>
<tr>
<td>male</td>
<td>70.3</td>
<td>70.7</td>
<td>68.3</td>
<td>65.9</td>
<td>67.4</td>
<td>70.3</td>
<td>70.5</td>
<td>66.5</td>
<td>63.1</td>
<td>64.5</td>
</tr>
<tr>
<td>female</td>
<td>57.0</td>
<td>57.4</td>
<td>55.6</td>
<td>56.0</td>
<td>58.3</td>
<td>57.0</td>
<td>57.3</td>
<td>54.1</td>
<td>53.8</td>
<td>55.8</td>
</tr>
<tr>
<td>15 years to 64 years</td>
<td>73.8</td>
<td>74.6</td>
<td>74.4</td>
<td>76.4</td>
<td>76.7</td>
<td>73.8</td>
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<td>73.6</td>
<td>75.3</td>
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<tr>
<td>male</td>
<td>79.8</td>
<td>80.6</td>
<td>80.3</td>
<td>81.2</td>
<td>81.6</td>
<td>79.8</td>
<td>80.3</td>
<td>79.4</td>
<td>80.0</td>
<td>80.3</td>
</tr>
<tr>
<td>female</td>
<td>68.0</td>
<td>68.7</td>
<td>68.6</td>
<td>71.7</td>
<td>72.1</td>
<td>68.0</td>
<td>68.5</td>
<td>67.8</td>
<td>70.8</td>
<td>71.1</td>
</tr>
<tr>
<td>Employment (annual average in thousands)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 years to 80 years</td>
<td>4851</td>
<td>5009</td>
<td>5314</td>
<td>5166</td>
<td>5215</td>
<td>4851</td>
<td>4995</td>
<td>5165</td>
<td>4943</td>
<td>4983</td>
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<tr>
<td>15 years to 64 years</td>
<td>4668</td>
<td>4816</td>
<td>4943</td>
<td>4684</td>
<td>4765</td>
<td>4668</td>
<td>4803</td>
<td>4888</td>
<td>4622</td>
<td>4696</td>
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<tr>
<td>Productivity (annual variation rate)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
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<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Annual average compensation (as % of minimum wage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPSS - Declared or stipulated</td>
<td>176.5</td>
<td>186.6</td>
<td>216.8</td>
<td>235.5</td>
<td>251.1</td>
<td>176.5</td>
<td>186.6</td>
<td>217.0</td>
<td>234.9</td>
<td>250.6</td>
</tr>
<tr>
<td>SPCGA</td>
<td>380.5</td>
<td>387.4</td>
<td>393.1</td>
<td>347.9</td>
<td></td>
<td>380.5</td>
<td>387.3</td>
<td>392.3</td>
<td>347.9</td>
<td></td>
</tr>
<tr>
<td>Real unit labour cost (2005=1)</td>
<td>1.00</td>
<td>1.01</td>
<td>1.00</td>
<td>0.99</td>
<td>0.97</td>
<td>1.00</td>
<td>1.01</td>
<td>1.00</td>
<td>0.98</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Both the additional penalty for early retirement and the introduction of the sustainability factor will lead to a fall in the probability of old age retirement among workers over 55 years old. As a result, there will be a rise in the participation rate for these age groups. In 2005, the participation rates for ages over 55 (i.e., those ages less than 10 years below the legal retirement age) take a downward profile when age increases. To take the effects of these two measures of reform into account, the parameterization of the model implied an attenuated decreasing profile of participation rates over age 55, which in turn caused a rise in the overall participation rate when comparing the baseline scenarios with and without reforms.

### 3.4 Projection of the numbers of contributors and beneficiaries and of average pensions

Table 3.4.1 shows an array of synthetic indicators for the baseline scenario without reforms, relating to the dynamics of the numbers of contributors and pensioners and of average pensions, the latter as a percentage of the mandatory minimum wage. What stands out is the big rise projected for dependency ratios in the social security system. There is a reasonable increase in the number of active SPSS contributors to horizon (in

\(^{10}\) The participation rates are higher for the so-called prime ages, between 25 and 50. As the labour force ages, this age group loses some of its importance in relation to the 51–64 group, which has considerably lower participation rates.
net terms almost 1 million individuals between 2005 and 2080). But when looking at the SPSS and the SPCGA together, the relationship between the number of pensioners (of different types) and the number of active contributors rises by almost 70% from the early years of the century to a figure above 110% from mid-century. This ratio goes beyond unity at the start of the 2040s. At this point, following the logic of a pay-as-you-go system, the contributions made by each worker would have to cover more than one pensioner (as well as the payment of other contribution-based benefits such as unemployment benefits). The increase stems exclusively from the component linked to old age pensioners, given that the indicators referring to the remaining components (disability and survivor pensioners) hold steady or even decrease.

Table 3.4.1
Contributors and beneficiaries – baseline scenario without measures

<table>
<thead>
<tr>
<th>Dependency ratios (SPSS+SPCGA)</th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>total pensioners / active contributors</td>
<td>69.0</td>
<td>70.0</td>
<td>85.1</td>
<td>113.6</td>
<td>113.3</td>
</tr>
<tr>
<td>old age pensioners / active contributors</td>
<td>44.1</td>
<td>46.5</td>
<td>60.0</td>
<td>87.4</td>
<td>90.5</td>
</tr>
<tr>
<td>disability pensioners / active contributors</td>
<td>7.9</td>
<td>6.7</td>
<td>7.7</td>
<td>7.6</td>
<td>6.4</td>
</tr>
<tr>
<td>survivor pensioners / active contributors</td>
<td>17.1</td>
<td>16.7</td>
<td>17.3</td>
<td>18.6</td>
<td>16.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Numbers of contributors (annual average in thousands)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SPSS subsystem</td>
<td>3696</td>
<td>3947</td>
<td>4439</td>
<td>4498</td>
<td>4613</td>
</tr>
<tr>
<td>TCO</td>
<td>3330</td>
<td>3593</td>
<td>4095</td>
<td>4200</td>
<td>4336</td>
</tr>
<tr>
<td>TI</td>
<td>366</td>
<td>354</td>
<td>344</td>
<td>298</td>
<td>277</td>
</tr>
<tr>
<td>SPCGA subsystem</td>
<td>741</td>
<td>650</td>
<td>244</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of pensioners (annual average in thousands)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Old age</td>
<td>1955</td>
<td>2138</td>
<td>2812</td>
<td>3935</td>
<td>4174</td>
</tr>
<tr>
<td>SPSS</td>
<td>1650</td>
<td>1812</td>
<td>2450</td>
<td>3687</td>
<td>4170</td>
</tr>
<tr>
<td>SPCGA</td>
<td>305</td>
<td>326</td>
<td>362</td>
<td>247</td>
<td>4</td>
</tr>
<tr>
<td>Disability</td>
<td>349</td>
<td>309</td>
<td>362</td>
<td>343</td>
<td>294</td>
</tr>
<tr>
<td>SPSS</td>
<td>278</td>
<td>246</td>
<td>284</td>
<td>303</td>
<td>294</td>
</tr>
<tr>
<td>SPCGA</td>
<td>71</td>
<td>62</td>
<td>77</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>Survivor</td>
<td>759</td>
<td>770</td>
<td>810</td>
<td>839</td>
<td>756</td>
</tr>
<tr>
<td>SPSS</td>
<td>634</td>
<td>635</td>
<td>676</td>
<td>748</td>
<td>751</td>
</tr>
<tr>
<td>SPCGA</td>
<td>125</td>
<td>135</td>
<td>135</td>
<td>91</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Average pension (as a percentage of minimum wage)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Old age</td>
<td>118.8</td>
<td>124.2</td>
<td>144.0</td>
<td>137.8</td>
<td>140.2</td>
</tr>
<tr>
<td>SPSS</td>
<td>85.0</td>
<td>92.4</td>
<td>117.8</td>
<td>129.1</td>
<td>140.2</td>
</tr>
<tr>
<td>SPCGA</td>
<td>301.6</td>
<td>301.3</td>
<td>321.2</td>
<td>267.7</td>
<td>-</td>
</tr>
<tr>
<td>Disability</td>
<td>96.8</td>
<td>108.2</td>
<td>143.5</td>
<td>121.7</td>
<td>106.3</td>
</tr>
<tr>
<td>SPSS</td>
<td>73.5</td>
<td>80.0</td>
<td>94.6</td>
<td>104.6</td>
<td>106.2</td>
</tr>
<tr>
<td>SPCGA</td>
<td>188.6</td>
<td>219.3</td>
<td>324.0</td>
<td>251.3</td>
<td>-</td>
</tr>
<tr>
<td>Survivor</td>
<td>52.1</td>
<td>54.6</td>
<td>68.1</td>
<td>75.8</td>
<td>84.4</td>
</tr>
<tr>
<td>SPSS</td>
<td>45.0</td>
<td>47.4</td>
<td>62.4</td>
<td>75.5</td>
<td>84.7</td>
</tr>
<tr>
<td>SPCGA</td>
<td>88.1</td>
<td>88.5</td>
<td>96.9</td>
<td>77.6</td>
<td>-</td>
</tr>
</tbody>
</table>

In the technical report containing the official projections for the Segurança Social subsystem, there are no indicators comparable to those in Table 3.4.1. The only information that allows for some comparison is what was published in December 2005 in the fiche on Portugal prepared by the Portuguese representatives in the Ageing
Working Group of the European Union Economic Policy Committee\(^\text{11}\). Table 3.4.2 summarizes the information available on the number of pensioners in the Segurança Social subsystem (scenario without reforms) and puts it side by side with the projections from the baseline scenario without reforms obtained from the MISS model. The AWG information may be to some extent out of date, but it was prepared on the basis of the model used to obtain the official projections of May 2006 (the ModPensPor model) and probably with very similar assumptions. It should also be noted that the AWG projections relating to the numbers of pensioners include those with a non-contributive welfare pension (the so-called pensões sociais), omitted from the MISS model\(^\text{12}\). With this caveat, the figures in Table 3.4.2 show that the MISS model projects a bigger increase in old age pensioners, which more than offsets the smaller rise in the number of survivor pensioners.

### Table 3.4.2
Comparison of results: scenarios without reforms
number of pensioners in the Segurança Social subsystem

<table>
<thead>
<tr>
<th></th>
<th>Ageing Working Group (Dec 2005)</th>
<th>MISS without reforms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
<td>2010</td>
</tr>
<tr>
<td>Segurança Social pensioners (10(^6))</td>
<td>2.64</td>
<td>2.79</td>
</tr>
<tr>
<td>Old age</td>
<td>1.69</td>
<td>1.80</td>
</tr>
<tr>
<td>Disability</td>
<td>0.30</td>
<td>0.31</td>
</tr>
<tr>
<td>Survivor</td>
<td>0.65</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Note: (1) AWG includes pensioners from the contributive and non-contributive regimes; MISS only includes pensioners from the contributive regime.

Table 3.4.3 includes the same indicators as Table 3.4.1, but for the alternatives I and II of the baseline scenarios with reforms. A comparison of the two tables shows that there are important differences in alternative I relating to the projections of most variables, while alternative II shows smaller changes, apart from the relative average pensions.

In the scenario without reforms, the ratio of old age pensioners practically doubles and goes beyond 90% at end-horizon. In alternative II, where workers do not change their retirement age and accept the financial penalty associated with the sustainability factor, the ratio for old age pensioners moves in a less pronounced way (due to the higher penalty imposed on early retirement), but still practically doubles to horizon. By contrast, in alternative I (putting off the retirement age until the financial penalty is completely offset) the same ratio only moves up slightly, from 44.1% in 2005 to 51.1% in 2080. It must, of course, be borne in mind that putting off retirement age logically causes an increase in the number of disability pensioners, but the overall effect is still notable: in alternative I, the ratio for pensioners as a whole increases by 4.8 percentage points to horizon, compared with 44.3 percentage points if there are no reforms and 39.4 percentage points for alternative II. The significance of these differences is even greater because it occurs in a context where there are more active contributors, given the rise in participation rates for older age groups, a point already highlighted.

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\(^{11}\) Appended to EPC and DGECFIN (2006) and available on http://ec.europa.eu/economy_finance/epc/epc_sustainability_ageing_en.htm

\(^{12}\) There were around 80 thousand non-contributive welfare pensions in 2005.
Table 3.4.3
Contributors and beneficiaries – baseline scenario with measures

<table>
<thead>
<tr>
<th>Dependency ratios (SPSS+SPCGA)</th>
<th>Alternative I</th>
<th>Alternative II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
<td>2010</td>
</tr>
<tr>
<td>total pensioners / active contributors</td>
<td>69.0</td>
<td>68.9</td>
</tr>
<tr>
<td>old age pensioners / active contributors</td>
<td>44.1</td>
<td>45.5</td>
</tr>
<tr>
<td>disability pensioners / active contributors</td>
<td>7.9</td>
<td>6.7</td>
</tr>
<tr>
<td>survivor pensioners / active contributors</td>
<td>17.1</td>
<td>16.7</td>
</tr>
<tr>
<td>Numbers of contributors (annual average in thousands)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPSS subsystem</td>
<td>3696</td>
<td>3953</td>
</tr>
<tr>
<td>TCG</td>
<td>3330</td>
<td>3596</td>
</tr>
<tr>
<td>TI</td>
<td>366</td>
<td>359</td>
</tr>
<tr>
<td>SPCGA subsystem</td>
<td>741</td>
<td>661</td>
</tr>
<tr>
<td>Number of pensioners (annual average in thousands)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old age</td>
<td>1955</td>
<td>2099</td>
</tr>
<tr>
<td>SPSS</td>
<td>1650</td>
<td>1764</td>
</tr>
<tr>
<td>SPCGA</td>
<td>305</td>
<td>315</td>
</tr>
<tr>
<td>Disability</td>
<td>349</td>
<td>309</td>
</tr>
<tr>
<td>SPSS</td>
<td>278</td>
<td>247</td>
</tr>
<tr>
<td>SPCGA</td>
<td>71</td>
<td>62</td>
</tr>
<tr>
<td>Survivor</td>
<td>759</td>
<td>769</td>
</tr>
<tr>
<td>SPSS</td>
<td>634</td>
<td>635</td>
</tr>
<tr>
<td>SPCGA</td>
<td>125</td>
<td>134</td>
</tr>
<tr>
<td>Average pension (as a percentage of minimum wage)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old age</td>
<td>118.8</td>
<td>120.3</td>
</tr>
<tr>
<td>SPSS</td>
<td>85.0</td>
<td>88.8</td>
</tr>
<tr>
<td>SPCGA</td>
<td>301.6</td>
<td>298.9</td>
</tr>
<tr>
<td>Disability</td>
<td>96.8</td>
<td>106.8</td>
</tr>
<tr>
<td>SPSS</td>
<td>73.5</td>
<td>77.3</td>
</tr>
<tr>
<td>SPCGA</td>
<td>188.6</td>
<td>222.2</td>
</tr>
<tr>
<td>Survivor</td>
<td>52.1</td>
<td>53.3</td>
</tr>
<tr>
<td>SPSS</td>
<td>45.0</td>
<td>45.9</td>
</tr>
<tr>
<td>SPCGA</td>
<td>88.1</td>
<td>87.8</td>
</tr>
</tbody>
</table>

Another notable difference between the projections in Tables 3.4.3 and 3.4.1 refers to the way average pensions overall evolve as a percentage of the minimum wage. To illustrate the difference in the most relevant group (old age pensions) the social security system matures to the point where, if there are no reforms, the average pension in the SPSS will rise between 2005 and 2080 from 85% of the minimum wage to close 140%. In alternative I, this increase is smaller and the average old age pension rises to 101% of the minimum wage at the end of horizon. In alternative II there is even a slight decrease in the average pension as a percentage of the minimum wage (from 85% in 2005 to 82.7% in 2080). In the SPCGA, the indicators fall in all three cases, but more steeply when taking into consideration the reforms, the figures being 33.9, 63.9 and 79.6 percentage points, respectively in the scenarios without reforms and with reforms, alternatives I and II.14

These distinct paths for the average pension as a percentage of the minimum wage can be justified above all by the reference to pension updates made for each scenario. With no reforms, updating is indexed to the change in wages (without accounting for the effects of increasing seniority and longer schooling) and this is a “natural” rule for pay-

14 With the CGA closed to new registrations, the number of SPCGA pensioners will be relatively small after 2050 and the average figure will be insignificant. Because of this, no figures are given for 2080.
-as-you-go systems\textsuperscript{15}. With both alternatives of the baseline scenarios with reforms, the indexation for pension update is taken as consumer inflation plus 0.25 percentage points. As mentioned in section 3.1.2, this was the simplification adopted in the scenarios with reforms to approximate the new complex updating rule for pensions.

3.5 Projections of the financial synopsis of SPSS and SPCGA

3.5.1 The contributive \textit{Segurança Social} subsystem

Tables 3.5.1 and 3.5.2 provide projections of the SPSS accounts for all three baseline scenarios. If the logic to be followed was to consider only contribution-based revenue items, calculation of the balance should in fact include on the revenue side only the revenue related to the contributions of workers and employers. However, Portuguese legislation assigns part of the country’s VAT receipts for social security financing, so this income was also included\textsuperscript{16}.

Table 3.5.1

<table>
<thead>
<tr>
<th>SPSS account – baseline scenario without reforms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Actual contributions (employees and employers)</th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAT assigned</td>
<td>0.4</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Primary expenditure</td>
<td>9.1</td>
<td>9.9</td>
<td>13.8</td>
<td>20.3</td>
<td>22.0</td>
</tr>
<tr>
<td>Pensions</td>
<td>6.7</td>
<td>7.4</td>
<td>11.3</td>
<td>17.7</td>
<td>19.4</td>
</tr>
<tr>
<td>Old age</td>
<td>5.0</td>
<td>5.7</td>
<td>9.1</td>
<td>14.9</td>
<td>16.7</td>
</tr>
<tr>
<td>Disability</td>
<td>0.7</td>
<td>0.7</td>
<td>0.9</td>
<td>1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Survivor</td>
<td>1.0</td>
<td>1.0</td>
<td>1.3</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Other benefits and allowances</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Administrative costs</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>SPSS primary balance</td>
<td>-1.2</td>
<td>-1.2</td>
<td>-3.7</td>
<td>-9.5</td>
<td>-10.9</td>
</tr>
<tr>
<td>Present value (2005) of primary balances (1)</td>
<td>-399.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: (1) Discount rate taken as the implicit public debt interest rate.

The primary balance\textsuperscript{17} is one of the basic indicators that can help gauge the financial sustainability of the social security contributive regimes. If no reforms were made (see Table 3.5.1) the primary balance would have been negative to horizon and getting progressively worse, reaching beyond 10% of GDP from mid-century. This path changes substantially with alternatives I and II of the scenarios with reforms (Table 3.5.2). Alternative I leads to better results, with an improvement in the primary balance during the first thirty years, reaching a surplus of 0.6% of GDP in 2030, followed by a

\textsuperscript{15} For the SPCGA, the update of compensations is assumed to be smaller than for the private sector and the minimum wage. This is the reason why the ratio between average pension and minimum wage falls gradually to horizon, even in the scenario without reforms.

\textsuperscript{16} The way the \textit{MISS} model projects the VAT assigned to social security is explained at the end of subsection 2.7.1.

\textsuperscript{17} Excluding financial income and costs.
slight decrease, with the primary balance staying practically even. The results for alternative II show a smaller improvement when compared with the picture if there are no reforms, but still remain substantial. The primary balance reaches near equilibrium around 2030 and then falls to deficits of around 2% - 3% of GDP in the second half of horizon.

Table 3.5.2
SPSS account – baseline scenario with reforms

<table>
<thead>
<tr>
<th>As a percentage of GDP</th>
<th>Alternative I</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Alternative II</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2005</td>
<td>2010</td>
<td>2030</td>
<td>2050</td>
<td>2080</td>
<td>2005</td>
<td>2010</td>
<td>2030</td>
<td>2050</td>
</tr>
<tr>
<td>Actual contributions (employees and employers)</td>
<td>7.5</td>
<td>7.9</td>
<td>9.1</td>
<td>9.8</td>
<td>9.9</td>
<td>7.5</td>
<td>7.9</td>
<td>9.3</td>
<td>10.0</td>
</tr>
<tr>
<td>VAT assigned</td>
<td>0.4</td>
<td>0.7</td>
<td>0.7</td>
<td>1.0</td>
<td>1.0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Primary expenditure</td>
<td>9.1</td>
<td>9.5</td>
<td>9.2</td>
<td>10.3</td>
<td>10.9</td>
<td>9.1</td>
<td>9.6</td>
<td>10.2</td>
<td>13.4</td>
</tr>
<tr>
<td>Pensions</td>
<td>6.7</td>
<td>7.0</td>
<td>6.5</td>
<td>8.0</td>
<td>8.6</td>
<td>6.7</td>
<td>7.1</td>
<td>7.8</td>
<td>11.0</td>
</tr>
<tr>
<td>Old age</td>
<td>5.0</td>
<td>5.4</td>
<td>5.9</td>
<td>8.8</td>
<td>6.6</td>
<td>5.0</td>
<td>5.4</td>
<td>6.1</td>
<td>8.1</td>
</tr>
<tr>
<td>Disability</td>
<td>0.7</td>
<td>0.6</td>
<td>0.9</td>
<td>1.2</td>
<td>1.0</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Survivor</td>
<td>1.0</td>
<td>1.0</td>
<td>0.9</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Other benefits and allowances</td>
<td>2.1</td>
<td>2.1</td>
<td>2.0</td>
<td>1.9</td>
<td>1.8</td>
<td>2.1</td>
<td>2.1</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Administrative costs</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>SPSS primary balance</td>
<td>-1.2</td>
<td>-0.9</td>
<td>0.6</td>
<td>0.2</td>
<td>0.1</td>
<td>-1.2</td>
<td>-0.9</td>
<td>-0.2</td>
<td>-2.7</td>
</tr>
<tr>
<td>Present value (2005) of primary balances (1)</td>
<td>0.7</td>
<td>-97.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: (1) Discount rate taken as the implicit public debt interest rate.

The cumulative value of the primary balances for 2005-2080 in terms of present value (referred to 2005)\(^{18}\) as a percentage of the 2005 GDP can be taken as a synthetic indicator of financial sustainability. The present value (truncated at 2080) corroborates earlier conclusions: serious financial imbalance in the SPSS before reforms and a major improvement if measures are put in place, although the imbalance is still significant in alternative II, where it reaches almost 100% of GDP.

Table 3.5.3 allows for a comparison between official projections (before any reforms) up to 2050 and the baseline scenario without reforms obtained from using the *MISS* model for the same horizon. The latter shows a bigger growth in revenue from contributions, related to the different demographic path projected: higher numbers of resident population, labour force and contributors to the system. The larger revenue is, however, more than offset by an exponential growth in expenditure on old age pensions, which is much less apparent in the official scenario. Part of the difference in the behaviour of expenditure on old age pensions stems from a stronger dynamic in the numbers of this group of pensioners in the scenario put forward in *MISS*. But the fundamental explanation would seem to be in the indexation rule of pensions adopted for each scenario. In the scenario without reforms generated by *MISS* the rule was an indexation of the SPSS pensions to the updating of wages in the private sector (excluding the effects of increasing seniority and longer schooling). The way pensions are indexed is not clear in the official scenario but it is undoubtedly based on a much more moderate criterion\(^{19}\).

---

18 The discount rate taken was the (nominal) implicit public debt interest rate, which was set at 4.5% from 2010.

19 The *fiche* on Portugal appended to the AWG (EPC and DGECFIN 2006) refers to pension updating in real terms of 0.1% per year.
### Table 3.5.3
Comparison of results: scenarios without reforms - SPSS account

<table>
<thead>
<tr>
<th></th>
<th>Official projections (May 2006)</th>
<th>MISS without reforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributions and dues</td>
<td>7.4</td>
<td>7.6</td>
</tr>
<tr>
<td>Expenditure on pensions (1)</td>
<td>5.3</td>
<td>6.0</td>
</tr>
<tr>
<td>Old age</td>
<td>3.8</td>
<td>4.4</td>
</tr>
<tr>
<td>Disability</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Survivor</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Expenditure on other benefits and allowances</td>
<td>1.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Balance (1),(2)</td>
<td>0.1</td>
<td>-0.2</td>
</tr>
</tbody>
</table>

Unit: percentage of GDP for each scenario.
Notes: (1) Official projections only include pensions from the Segurança Social general regime while pensions in the MISS model also include other regimes, only non-contributive being excluded.
(2) In MISS, the primary balance is calculated with assigned VAT included. In official projections, the balance is called the effective balance of the contributive system. This is the best concept for comparison with the MISS primary balance, although it includes expenditure on active employment policies.

Primary balances in all three scenarios – i.e. with and without reforms – develop in a non-linear pattern. This is due to demographic factors, to the maturing of the system, to the dynamics of reform effects and, in addition, to registrations of public employees after 2006 (following the closure of CGA to new entrants). In the first half of the horizon, the effect of these new registrations in the SPSS is reflected above all in a rise in revenue, to the extent that expenditure on pensions for this group will still be negligible. Later on, the positive effect on the balance is reversed, as expenditure on pensions for this group will catch up. In the box at the end of this chapter, there is a discussion of the consequences on SPSS accounts of closing CGA to new registrations as and from 2006.

### 3.5.2 The CGA contributive subsystem

Because of the special way the SPCGA is financed, a concept of imputed contribution is presented in Tables 3.5.4 and 3.5.5. Only some entities pay employer contributions to the SPCGA (fundamentally those in general government with financial autonomy). Given the fact that actual employer contributions are not paid for the remaining public employees, the State transfers what is commonly known as the “State subsidy” to the CGA, the amount depending on what is needed to keep the system financially in balance (besides the transfer of the VAT assigned to CGA). The MISS model does not take this State subsidy into consideration. If it did, it would not be possible to clarify the CGA’s financial situation or consolidate the accounts of the two subsystems. Instead, it factors in the same rate of contribution for each public employee as the employer rate in the private sector adjusted for the different coverage of risks in the two subsystems. That part of the employer contribution considered as SPCGA revenue that is not in fact paid is called the “imputed employer contribution”.
### Table 3.5.4

**SPCGA account – baseline scenario without reforms**

As a percentage of GDP

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributions (employees and employers) (actual and imputed)</td>
<td>2.4</td>
<td>2.1</td>
<td>0.7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Income from entities in charge of pensions and other payments</td>
<td>0.5</td>
<td>0.5</td>
<td>0.6</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Use of other reserves (former pension funds)</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>VAT assigned</td>
<td>0.0</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Primary expenditure</td>
<td>4.2</td>
<td>4.3</td>
<td>4.9</td>
<td>2.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Pensions</td>
<td>4.2</td>
<td>4.3</td>
<td>4.9</td>
<td>2.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Old age</td>
<td>3.4</td>
<td>3.5</td>
<td>3.8</td>
<td>2.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Disability</td>
<td>0.4</td>
<td>0.4</td>
<td>0.7</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Survivor</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Other benefits and allowances</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Administrative costs</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>SPCGA primary balance (1)</td>
<td>-1.2</td>
<td>-1.4</td>
<td>-3.3</td>
<td>-2.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Present value (2005) of primary balances (1),(2)</td>
<td>-113.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Memorandum item: balance of special reserves (former pension funds)

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPCGA primary balance (1)</td>
<td>2.7</td>
<td>2.0</td>
<td>0.5</td>
<td>0.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Notes: (1) Including employer contributions imputed to the State.
(2) Discount rate taken as the implicit public debt interest rate.

### Table 3.5.5

**SPCGA account – baseline scenario with reforms**

As a percentage of GDP

<table>
<thead>
<tr>
<th></th>
<th>Alternative I</th>
<th>Alternative II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributions (employees and employers) (actual and imputed)</td>
<td>2.4 2.1 0.8 0.0 0.0</td>
<td>2.4 2.1 0.8 0.0 0.0</td>
</tr>
<tr>
<td>Income from entities in charge of pensions and other payments</td>
<td>0.5 0.5 0.5 0.3 0.0</td>
<td>0.5 0.5 0.5 0.3 0.0</td>
</tr>
<tr>
<td>Use of other reserves (former pension funds)</td>
<td>0.1 0.1 0.0 0.0 0.0</td>
<td>0.1 0.1 0.0 0.0 0.0</td>
</tr>
<tr>
<td>VAT assigned</td>
<td>0.0 0.3 0.3 0.3 0.0</td>
<td>0.0 0.3 0.3 0.3 0.0</td>
</tr>
<tr>
<td>Primary expenditure</td>
<td>4.2 4.2 4.0 2.3 0.0</td>
<td>4.2 4.2 4.2 2.2 0.0</td>
</tr>
<tr>
<td>Pensions</td>
<td>4.2 4.1 3.9 2.2 0.0</td>
<td>4.2 4.1 4.1 2.2 0.0</td>
</tr>
<tr>
<td>Old age</td>
<td>3.4 3.3 2.8 1.7 0.0</td>
<td>3.4 3.3 3.1 1.7 0.0</td>
</tr>
<tr>
<td>Disability</td>
<td>0.4 0.4 0.7 0.3 0.0</td>
<td>0.4 0.4 0.7 0.3 0.0</td>
</tr>
<tr>
<td>Survivor</td>
<td>0.4 0.4 0.4 0.2 0.0</td>
<td>0.4 0.4 0.4 0.2 0.0</td>
</tr>
<tr>
<td>Other benefits and allowances</td>
<td>0.0 0.0 0.0 0.0 0.0</td>
<td>0.0 0.0 0.0 0.0 0.0</td>
</tr>
<tr>
<td>Administrative costs</td>
<td>0.0 0.0 0.0 0.0 0.0</td>
<td>0.0 0.0 0.0 0.0 0.0</td>
</tr>
<tr>
<td>SPCGA primary balance (1)</td>
<td>-1.2 -1.2 -2.4 -1.7 0.0</td>
<td>-1.2 -1.3 -2.6 -1.6 0.0</td>
</tr>
<tr>
<td>Present value (2005) of primary balances (1),(2)</td>
<td>-89.1</td>
<td>-90.3</td>
</tr>
<tr>
<td>Memorandum item: balance of special reserves (former pension funds)</td>
<td>2.7 2.0 0.5 0.1 0.0</td>
<td>2.7 2.0 0.5 0.1 0.0</td>
</tr>
</tbody>
</table>

Notes: (1) Including employer contributions imputed to the State.
(2) Discount rate taken as the implicit public debt interest rate.

The aim was to reach equivalence between the imputed State contribution rate and the contribution rate paid by private sector employers to the SPSS. After adjustments for different coverage of risks, that rate was found to be 13.1% of the employee’s compensation, which is very close to the 13% rate paid by general government entities.
with financial autonomy for their employees registered in the SPCGA. This “imputed employer contribution” of the State amounted to around 2.5% of GDP in 2005 and was included as part of the overall contribution revenue of the SPCGA for the purposes of Tables 3.5.4 and 3.5.5.

With this revenue included, the primary balance of the SPCGA reached -1.2% of GDP in 2005. All three baseline scenarios then point to a worsening of the primary balances until the 2030s, after which the deficits gradually tail off and become insignificant at end-horizon.

The initial worsening stems from the fact that the SPCGA no longer receives contributions from new registrations. In the baseline scenario without reforms, the maximum deficit, above 3% of GDP, is reached in the 2030s. And even in the two alternatives with reforms the primary deficit is likely to be more than 2% of GDP for a large part of the second quartile of the century.

Using the cumulative present value of the 2005-2080 primary balances of the SPCGA, one comes to around 114% of GDP for the baseline scenario without reforms and 89% of GDP for the two alternatives of the baseline scenario with reforms, both considerably high figures. The conclusion, therefore, is that there is a deep financial imbalance in the SPCGA and that the measures agreed do not substantially change the situation, as they do for the SPSS. This finding is understandable in the light of a number of unfavourable factors that have accumulated over the past and also because revenue will gradually dry up owing to the closure of the subsystem to new registrations.

### 3.4.3 Consolidated accounts of the two subsystems

The indicators set out in Tables 3.5.6 and 3.5.7 were obtained after consolidation of the SPSS and SPCGA accounts, as described at the end of Chapter 2. These Tables make it possible to have an integrated view of the accounts of the contributive regimes of both subsystems.

The projections for the baseline scenarios after inclusion of the reforms follow a path that is not so stark but even so shows significant imbalance, which is fundamentally because of the SPCGA accounts, as shown in the previous subsections. Contrary to the scenario without reforms, the primary deficits do not get sharply worse in the initial phase of projections. In alternative I, there is even a gradual decrease of deficits to a virtually balanced situation in 2080. In alternative II, the projection shows a worsening of the primary deficit until mid-century, then a gradual fall, with a deficit in 2080 similar to 2005 deficit. In these scenarios with reforms, the implicit liabilities as measured by the present value of primary balances for 2005-2080 is estimated at 88.4% and 187.6% of GDP for first and the second alternatives, respectively.

---

20 This is also almost identical to the 13.08% the State pays as employer contributions for public service employees registered in the SPSS after 2006. These still have coverage of risks similar to the ones registered in the CGA.

21 It should be remembered that the last three of the four measures detailed in section 3.1 apply both to SPSS and SPCGA contributors.
Table 3.5.6
SPSS+SPCGA consolidated accounts – baseline scenario without reforms

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual and imputed contributions</td>
<td>9.9</td>
<td>10.0</td>
<td>10.1</td>
<td>10.1</td>
<td>10.2</td>
</tr>
<tr>
<td>Income from entities in charge of pensions and other payments</td>
<td>0.3</td>
<td>0.4</td>
<td>0.4</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Use of other reserves (former pension funds)</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>VAT assigned</td>
<td>0.4</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Primary expenditure</td>
<td>13.1</td>
<td>14.1</td>
<td>18.6</td>
<td>22.9</td>
<td>22.0</td>
</tr>
<tr>
<td>Pensions</td>
<td>10.8</td>
<td>11.6</td>
<td>16.0</td>
<td>20.3</td>
<td>19.4</td>
</tr>
<tr>
<td>Old age</td>
<td>8.2</td>
<td>9.1</td>
<td>12.8</td>
<td>17.0</td>
<td>16.7</td>
</tr>
<tr>
<td>Disability</td>
<td>1.1</td>
<td>1.0</td>
<td>1.5</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Survivor</td>
<td>1.4</td>
<td>1.4</td>
<td>1.7</td>
<td>2.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Other benefits and allowances</td>
<td>2.1</td>
<td>2.2</td>
<td>2.1</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Administrative costs</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>SPSS+SPCGA subsystems primary balance(1)</td>
<td>-2.4</td>
<td>-2.6</td>
<td>-7.0</td>
<td>-11.6</td>
<td>-10.9</td>
</tr>
<tr>
<td>Present value (2005) of primary balances (1),(2)</td>
<td>-512.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memorandum item: balance of special reserves (former pension funds)</td>
<td>2.7</td>
<td>2.0</td>
<td>0.5</td>
<td>0.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Notes: (1) Including employer contributions imputed to the State.
(2) Discount rate taken as the implicit public debt interest rate.

Table 3.5.7
SPSS+SPCGA consolidated accounts – baseline scenario with reforms

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual and imputed contributions</td>
<td>9.9</td>
<td>10.0</td>
<td>9.9</td>
<td>9.8</td>
<td>9.9</td>
</tr>
<tr>
<td>Income from entities in charge of pensions and other payments</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Use of other reserves (former pension funds)</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>VAT assigned</td>
<td>0.4</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Primary expenditure</td>
<td>13.1</td>
<td>13.5</td>
<td>13.0</td>
<td>12.5</td>
<td>10.9</td>
</tr>
<tr>
<td>Pensions</td>
<td>10.8</td>
<td>11.0</td>
<td>10.6</td>
<td>10.2</td>
<td>8.6</td>
</tr>
<tr>
<td>Old age</td>
<td>8.2</td>
<td>8.6</td>
<td>7.7</td>
<td>7.4</td>
<td>6.6</td>
</tr>
<tr>
<td>Disability</td>
<td>1.1</td>
<td>1.0</td>
<td>1.6</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Survivor</td>
<td>1.4</td>
<td>1.4</td>
<td>1.3</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Other benefits and allowances</td>
<td>2.1</td>
<td>2.2</td>
<td>2.0</td>
<td>1.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Administrative costs</td>
<td>0.2</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>SPSS+SPCGA subsystems primary balance(1)</td>
<td>-2.4</td>
<td>-2.1</td>
<td>-1.7</td>
<td>-1.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Present value (2005) of primary balances (1),(2)</td>
<td>-88.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memorandum item: balance of special reserves (former pension funds)</td>
<td>2.7</td>
<td>2.0</td>
<td>0.5</td>
<td>0.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Notes: (1) Including employer contributions imputed to the State.
(2) Discount rate taken as the implicit public debt interest rate.

Consequences of the closure of the CGA on the SPSS accounts

One of the MISS model’s features which is not found in other models simulating the financial situation of the Portuguese social security is that it was conceived in such a way as to provide a straightforward method for assessing the consequences of the decision to close the CGA to new registrations as and from 2006. This simulation meant introducing two relatively simple changes in the parameterization of the MISS model: i) changing the value of \( \rho \) from 1 to 0; ii) taking the revenue received by the CGA from other entities in charge of pension payments and then fixing them at the levels projected when the CGA was closed.
In terms of this latter point, it was assumed that, even in a counter factual situation of non-closure, there would be no enrollment of employees (on a contributive basis) with liability for future pension payments in the hands of outside entities. In the past, such situations were normally associated with employees in public-owned, or formerly public-owned enterprises, who were traditionally registered in the CGA up to a certain date. In other words, it was assumed that, irrespective of whether the CGA was closed at the end of 2005, these situations would not lead to new registrations in the CGA.

### Table 3.C.1

**Consequences of non-closure of CGA to new registrations on the SPSS accounts: differences from the respective baseline scenario with reforms**

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
<th>2060</th>
<th>2070</th>
<th>2080</th>
<th>2090</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-1.0</td>
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<td>-0.2</td>
<td>-0.9</td>
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<td>-1.0</td>
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<td>-1.7</td>
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<td>-0.2</td>
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<td>0.0</td>
<td>0.0</td>
<td>-0.1</td>
<td>-0.3</td>
<td>0.0</td>
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<tr>
<td>Administrative costs</td>
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<tr>
<td>SPSS primary balance</td>
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<td>1.4</td>
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<td>-0.2</td>
<td>-0.7</td>
<td>-0.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Present value (2005) of primary balances (1)</td>
<td>-2.8</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.7</td>
</tr>
</tbody>
</table>

Note: (1) Discount rate taken as the implicit public debt interest rate.

Taking the two alternatives of the baseline scenario with reforms as terms of comparison, Table 3.C.1 shows the estimated difference in the SPSS accounts in the hypothetical situation of the CGA continuing to receive registrations from new public employees as and from 2006. It can be seen that this would imply a fall in SPSS revenue from contributions (reaching a maximum of 1.3% of GDP by mid-century) stemming from the fact that there were no new public employees coming in. Over and against this, expenditure on pensions would be lower. However, as mentioned in the main text, reductions in revenue and expenditure would not occur at the same time: revenue would fall first and expenditure only later because, in the first decades, the new public employees would be contributing and there would be no major expenditure on their pensions, given that they would be in the early stages of their contributive careers.

In terms of the primary balance of the SPSS, non-closure of the CGA would imply a worsening until mid-century. It would reach a maximum of around 0.75 percentage points of GDP around 2030. After 2050, there would be a significant reduction of expenditure due to the SPSS not having to pay pensions to public employees and the primary balance of the subsystem would improve. This could reach between 1 and 1.5 percentage points of GDP in the last decade to horizon.

There is not a great difference in the present value of primary balances in the period up to 2080, in spite of the very specific intertemporal distribution of the effects. This is understandable because the alternatives (baseline scenario with reforms) used for comparison do not show any great imbalance, and also because any new registrations in the CGA would basically come under the rules pertaining to public employees registered in the SPSS.
4. SENSITIVITY TO CHANGES IN DEMOGRAPHIC AND MACROECONOMIC ASSUMPTIONS

This chapter looks at the sensitivity of projections to changes in some of the main demographic and macroeconomic assumptions, specifically:
- Fertility rates;
- Mortality rates;
- Net immigration flows;
- Trend growth of productivity.

The analysis was carried out through a comparison with the two alternative baseline scenarios with reforms, changing only one of the dimensions in each exercise.

In the following sections, the effects obtained with the MISS model will, wherever possible, be compared with similar sensitivity analyses published in other papers and reports, such as those by the Ministry of Labour and Social Solidarity (2006c) and EPC and DGECFIN (2006).

4.1. A higher fertility rate

The baseline scenarios described in the previous chapter assume a small recovery in the fertility rate along the horizon. The first sensitivity analysis carried out was an assessment of the effect of a higher fertility rate on the projections of the baseline scenarios. In terms of model parameterization, it should be recalled that the projection of fertility rates (see Chapter 2) is based on the extrapolation of two factors: the first indicates the overall trend in fertility rates, while the second indicates the evolution of fertility in women over 30, compared with younger women. For the purposes of this sensitivity analysis, the limit towards which the first factor converges in 2080 was raised (from -1.5 to -0.5), while the recovery path of the second factor was left unchanged. This meant gradually pushing up the total fertility rate from 1.45% in 2005 to nearly 1.9% from mid-century (instead of nearly 1.6%).

As can be seen in Table 4.1.1, the different assumption regarding the fertility rate has moderate long-term repercussions on the size of the population and in its structure by age groups. However, it leads to only a slight improvement in the primary balances of the SPSS and the SPCGA. In terms of the cumulative present value of the primary balances 2005-2080, the effect is favourable, though not markedly.
Table 4.1.1
Sensitivity to a rise in fertility:
differences from the respective baseline scenario with reforms

<table>
<thead>
<tr>
<th></th>
<th>Alternative I</th>
<th></th>
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<th>Alternative II</th>
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<td></td>
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<tr>
<td>Total fertility rate</td>
<td>- 0.09 0.24 0.30 0.33</td>
<td>- 0.09 0.24 0.30 0.33</td>
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<tr>
<td>Population (10^6)</td>
<td>- 0.0 0.2 0.4 0.9</td>
<td>- 0.0 0.2 0.4 0.9</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ratio of over 65s to 15-64 years</td>
<td>- 0.0 0.0 -0.02 -0.04</td>
<td>- 0.0 0.0 -0.02 -0.04</td>
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</tr>
<tr>
<td>Expenditure on pensions - consolidated total (% GDP)</td>
<td>- 0.0 0.0 -0.4 -0.8</td>
<td>- 0.0 0.0 -0.3 -0.7</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Social Security</td>
<td>- 0.0 0.0 -0.3 -0.8</td>
<td>- 0.0 0.0 -0.3 -0.7</td>
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<td></td>
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</tr>
<tr>
<td>CGA</td>
<td>- 0.0 0.0 -0.1 0.0</td>
<td>- 0.0 0.0 -0.1 0.0</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Primary balance SPSS+SPCGA (% GDP)</td>
<td>- 0.0 0.0 0.4 0.9</td>
<td>- 0.0 0.0 0.3 0.8</td>
<td></td>
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<tr>
<td>Social Security</td>
<td>- 0.0 0.0 0.3 0.8</td>
<td>- 0.0 0.0 0.2 0.8</td>
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<tr>
<td>CGA(1)</td>
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<td>- 0.0 0.0 0.0 0.0</td>
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<tr>
<td>Present value of primary balances (% GDP) (2)</td>
<td>17.7 11.2</td>
<td>17.5 10.8</td>
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<td></td>
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</tr>
<tr>
<td>Social Security</td>
<td>17.5 10.8</td>
<td>17.5 10.8</td>
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<tr>
<td>CGA(1)</td>
<td>0.2 0.4</td>
<td>0.2 0.4</td>
<td></td>
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</tr>
</tbody>
</table>

Notes: (1) Includes the imputed State contribution (CGA).
(2) Calculation made on the basis of the discount rate implicit in public debt and truncated for the period 2005-2080.

4.2 A higher mortality rate

The evolution of mortality rates projected in the baseline scenarios leads to gradual rises in average life expectancy at birth to horizon, reaching nearly 6 years more at 2080. As might be expected, this result depends critically on the assumptions for the mortality rate. To assess the sensitivity to changes in these rates, the factors used in MISS for the extrapolation of mortality were pushed up (from -4 to -3). In terms of the baseline scenarios, this implied reducing by almost a half the increase of the average life expectancy at end-horizon (Table 4.2.1).

Table 4.2.1
Sensitivity to a rise in mortality:
Differences from the respective baseline scenario with reforms

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<tr>
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<th>Alternative I</th>
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<th></th>
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<th>Alternative II</th>
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<td>2005 2010 2030 2050 2080</td>
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<td>Mortality rate (x1000)</td>
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<td>- 0.5 1.1 1.2 0.5</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (10^6)</td>
<td>- 0.0 -0.2 -0.4 -0.5</td>
<td>- 0.0 -0.2 -0.4 -0.5</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ratio of over 65s to 15-64 years</td>
<td>- 0.0 0.0 -0.02 -0.06 -0.07</td>
<td>- 0.0 0.0 -0.02 -0.06 -0.07</td>
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<td>Life expectancy at birth</td>
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<td>-0.6 -2.1 -2.7 -3.1</td>
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<td></td>
<td>Female</td>
<td>-0.7 -2.3 -3.2 -3.6</td>
<td>-0.7 -2.3 -3.2 -3.6</td>
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<tr>
<td>Expenditure on pensions - consolidated total (% GDP)</td>
<td>- 0.0 -0.5 -0.8 -0.8</td>
<td>- 0.0 -0.5 -0.4 -0.5</td>
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<td>- 0.0 -0.2 -0.2 -0.5</td>
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<td></td>
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<td></td>
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<tr>
<td>CGA</td>
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<td>- 0.0 -0.1 -0.3 0.0</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Primary balance SPSS+SPCGA (% GDP)</td>
<td>- 0.0 0.5 0.8 0.8</td>
<td>- 0.0 0.3 0.5 0.5</td>
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</tr>
<tr>
<td>Social security</td>
<td>- 0.0 0.3 0.5 0.8</td>
<td>- 0.0 0.2 0.2 0.5</td>
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<tr>
<td>CGA(1)</td>
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<td>- 0.0 0.1 0.2 0.0</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Present value of primary balances (% GDP) (2)</td>
<td>37.7 22.6</td>
<td>28.2 15.1</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Social Security</td>
<td>28.2 15.1</td>
<td>9.5 7.5</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

Notes: (1) Includes the imputed State contribution (CGA).
(2) Calculation made on the basis of the discount rate implicit in public debt and truncated for the period 2005-2080.

The response of expenditure on pensions to the rise in mortality is in the region of 0.3 to 0.5 percentage points of GDP for the 2020s and between 0.5 and 0.8 percentage points.
of GDP at end-horizon, depending on the alternative considered. Given that the reduction occurs throughout the period, the present value of primary balances rises between 22.6 and 37.7 percentage points of GDP (2005 figures), evidence of the fact that the evolution of life expectancy is the cause of some pressure on the financial situation of the Portuguese social security.

Looking at a sensitivity analysis carried out by the AWG on the same issue of mortality, the findings are to a large extent consistent, although the AWG only analysed the SPSS. Their assessment of a 15% increase in mortality rates by 2050 implies an additional pensions expenditure of 0.6 percentage points of GDP also for 2050. This compares with 0.5 to 0.8 percentage points as projected by MISS for the same period (as a result of a 12% increase in the overall mortality rate).

### 4.3 Less immigration

In the baseline scenarios, it was assumed that net immigration flows would remain relatively stable, in contrast with AWG and official assumptions, which point to a drop to around a third of current figures. To assess the sensitivity of projections to these different assumptions, the limits towards which the two factors used for the extrapolation of net immigration flows were brought down as compared with the baseline scenarios (from 1.25 to 0).

The results (Table 4.3.1) show a significant change in the long-term financial situation of social security. The fall in population stems not only from the lower flow of immigrants, but also from the lower birth rate that it implies. Another long-term effect is the increase in the older population dependency ratio.

#### Table 4.3.1

| Sensitivity to less immigration: differences from the respective baseline scenario with reforms |
|---------------------------------|--------|--------|--------|--------|
| Net immigration (10^3)          | 2005   | 2010   | 2030   | 2050   |
| Net immigration (10^3)          | -      | -8     | -23    | -28    |
| Population (10^6)              | -      | 0.0    | -0.4   | -1.2   |
| Ratio of over 65s to 15-64 years| -      | 0.00   | 0.02   | 0.09   |
| Number of old age pensioners (annual average, 10^3) | - 0 | 1 | -12 | -241 |
| Expenditure on pensions - consolidated total (% GDP) | - 0.5 | 1.4 | 1.9 | - 0.6 |
| Social security                | - 0.0  | 0.4    | 1.1    | 1.9    |
| CGA                            | - 0.0  | 0.2    | 0.3    | 0.0    |
| Primary balance SPSS+SPCGA (% GDP) | - 0.0 | -0.5 | -1.4 | -2.0 |
| Social security                | - 0.0  | -0.4  | -1.1   | -2.0   |
| CGA                            | - 0.0  | -0.1  | -0.3   | 0.0    |
| Present value of primary balances (% GDP) | 47.5 | -42.8 | -46.1 | -40.8 |
| Social security                | -1.4   | -1.4  | -2.0   | -2.0   |

Notes: (1) Includes the imputed State contribution (CGA).
(2) Calculation made on the basis of the discount rate implicit in public debt and truncated for the period 2005-2080.

In terms of the social security accounts, it is again the expenditure on pensions as a percentage of GDP that records the biggest rise, fundamentally as a result of lower economic growth brought on by the fall in employment. In the longer term, that is from the 2040s, there is a decrease in the number of pensioners, but the effect of lower output growth continues to dominate, leading to a fall in the consolidated primary balance.
(SPSS+SPCGA) of 2.0 and 2.5 percentage points of GDP at end-horizon, respectively in alternatives I and II of the scenarios with reforms. The present value of primary balances falls by 47.5 and 42.8 percentage points of GDP.

In the official projections, the sensitivity analysis presupposed a 10,000 increase in immigration flows (net annual amounts) and the improvement in the Social Security account\(^1\) was 0.3 percentage points of GDP in 2050. In the MISS simulation, the impact of a reduction of around 20 thousand individuals per year until 2050 in the primary balance of the Segurança Social system is 1.1 to 1.6 percentage points of GDP. This means that, even factoring in the differences in the concepts, the MISS model is more sensitive to assumptions on immigration.

### 4.4 Lower productivity growth

In the baseline scenario, productivity growth was set at 2% per year from 2010 and for the sensitivity exercise this rate was cut by half (1% per year from 2008). As a result, the GDP growth trend also fell by around 1 percentage point. This implied revising the approximation to the indexation rule of pensions and other payments considered in both alternatives of the scenario with reforms: consumer inflation less 0.25 percentage points in the sensitivity scenarios rather than consumer inflation plus 0.25 percentage points as in the baseline scenarios.

#### Table 4.4.1

**Sensitivity to lower productivity growth:**
Differences from the respective baseline scenario with reforms

<table>
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<tr>
<th></th>
<th>Alternative I</th>
<th></th>
<th></th>
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<th>Alternative II</th>
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<td></td>
<td>2005 2010 2030 2050 2080</td>
<td>2005 2010 2030 2050 2080</td>
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<tr>
<td>Productivity (t.v.a.)</td>
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<td>-1.0 -1.0 -1.0 -1.0</td>
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<tr>
<td>Contributions from employees and employers - consolidated total (% GDP)</td>
<td>-0.0 0.2 0.4 0.6</td>
<td>-0.0 0.2 0.4 0.6</td>
<td></td>
<td></td>
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<tr>
<td>Social Security</td>
<td>-0.0 0.2 0.4 0.6</td>
<td>-0.0 0.2 0.4 0.6</td>
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<td>CGA(^1)</td>
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<td>-0.0 0.1 0.0 0.0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Expenditure on pensions - consolidated total (% GDP)</td>
<td>-0.1 1.3 2.3 2.4</td>
<td>-0.1 1.5 2.8 3.0</td>
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</tr>
<tr>
<td>Social security</td>
<td>-0.0 0.8 1.7 2.3</td>
<td>-0.0 0.9 2.2 3.0</td>
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<tr>
<td>CGA</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary balance SPSS+SPCGA (% GDP)</td>
<td>-0.0 -1.1 -2.0 -1.9</td>
<td>-0.0 -1.2 -2.5 -2.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social security</td>
<td>-0.0 -0.7 -1.4 -1.9</td>
<td>-0.0 -0.8 -2.0 -2.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CGA(^1)</td>
<td>-0.0 -0.4 -0.6 0.0</td>
<td>-0.0 -0.4 -0.6 0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present value (2005) for cumulative primary balances (% GDP)(^2)</td>
<td>-38.9</td>
<td>-15.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social security</td>
<td>-44.9</td>
<td>-20.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CGA(^1)</td>
<td>5.9</td>
<td>5.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: (1) Includes the imputed State contribution (CGA).
(2) Calculation made on the basis of the discount rate implicit in public debt and truncated for the period 2005-2080.

In the MISS model, a lower pace in productivity growth is reflected firstly in a lower growth rate of compensation (including the minimum wage and other related payments). In tandem, the revenue from contributions for the two subsystems fell but the slower growth of the economy meant a slight rise in the importance of this item in terms of GDP (Table 4.4.1). On the expenditure side, there is a lower rate of pensions growth (-0.5 percentage points per year compared with the baseline alternatives) but there is a considerable increase in expenditure on pensions as a percentage of GDP (due

\(^1\) This concept is not comparable to what is used in the MISS model.
to a denominator effect) and this leads to a fall in the consolidated SPSS+SPCGA primary balance. This amounts to around 2 percentage points of GDP by the end of the horizon for alternative I and around 2.5 percentage points for alternative II. The corresponding present values of the primary balances go down by almost 40 percentage points of GDP in alternative I and around 15 percentage points in alternative II\(^2\). Therefore, if the somewhat optimistic assumption of 2% per year productivity growth does not materialize, this can lead to a worsening of the social security financial situation relative to the baseline scenarios, even under the new rule for pension updating.

Over a longer horizon than projected, there is likely to be less effect from the changes to productivity growth on the social security accounts. If the horizon was extended, say, to 120 years, it is very likely that the effects generated for the last period would show a less significant sensitivity to the trend productivity growth\(^3\). The effects estimated for the next decades, above all up to 2050, can be understood as a result of the natural inertia in any social security system. In fact, the change in the way productivity grows has a relatively rapid impact on wages and contributions to social security, while the impact on new pensions will only be felt in the long term. The longer the contributive career considered to determine the reference wage, the slower the impact of wage moderation on the value of new pensions. It should be added that the knock-on effect on pensions expenditure in the wake of a slowdown in productivity growth is more difficult in countries like Portugal where a relatively generous range of minimum pensions helps to isolate the evolution of expenditure on pensions from contributive careers.

If we compare the effect of this change on the evolution of contributions and pensions, using a similar analysis to the AWG, there is some similarity in the responses, though they are less marked with the MISS model. According to the AWG, a reduction of 0.25 percentage points in productivity growth will imply, for 2050, an increase in contributions revenue of 0.14 percentage points of GDP and an increase in expenditure on pensions of 0.93 percentage points of GDP. If these effects are multiplied by 4, to provide a comparison with the figures in Table 4.4.1, there would be, in general terms, a 1.1 percentage points fall in the trend growth of productivity, implying rises of 0.6 percentage points of GDP in SPSS revenue and 3.7 percentage points of GDP in SPSS expenditure. These figures compare with increases of 0.4, 2.3 and 2.8 percentage points estimated by the MISS model for the same subsystem.

---

\(^2\) By subsectors, the SPSS balance worsens but the CGA balance improves. The latter change is in apparent contradiction with the deterioration of SPCGA annual primary balances, but it stems from two points: on one hand, there is a lower rate of pension update \((\textit{ceteris paribus})\) and this pushes up the present value of the primary balances as a percentage of GDP; and on the other hand, lower productivity growth implies lower primary balances as a percentage of GDP in each year to horizon.

\(^3\) There will be no full neutrality since payments to public employees, in the assumptions used for the baseline scenarios, are only partially indexed to productivity growth (i.e. a 1 percentage point increase in overall productivity translates into a 0.5 percentage points growth in the compensation of public employees). Moreover, in the baseline scenarios with reforms (taken as reference case), the updating of pensions is not indexed to the updating of wages of active workers.
5. THE EFFECT OF REFORMS ON THE EUROPEAN COMMISSION SUSTAINABILITY GAP INDICATORS FOR PORTUGAL

A number of estimates are presented in this chapter relating to the impact of the Portugal’s social security reforms on the synthetic sustainability indicators used by the European Commission to assess long-term public finance sustainability.

The Commission calculates these indicators taking into consideration the AWG long-term projections of those items of public expenditure that are most age-sensitive. According to the AWG projections, in the case of Portugal, pensions expenditure explains practically all the long-term rise in overall age-related expenditure. The present analysis was restricted, for this reason, to the effects of the reforms on pensions expenditure and its impact on the sustainability indicators. The response to the reform measures of other kinds of age-related expenditure, such as education or health was therefore ignored.

It would not make sense to assess the reform package by using projections for expenditure on pensions based on different assumptions than those the AWG used for generating projections of the remaining types of expenditure included in the calculation of the indicators. For this reason the assumptions underlying the 2006 AWG projections have been used in this chapter as much as possible. They differ in some ways from the assumptions underlying projections presented in previous chapters. The most significant differences will be highlighted and discussed.

5.1 The S1 and S2 indicators

The European Commission services calculate two main synthetic sustainability indicators known as the sustainability gaps S1 and S2\(^1\). Their purpose is to measure the size of the permanent budgetary adjustment (translated as a variation of the primary public revenue and/or expenditure ratios on GDP) as required:

\(^1\) The logic is similar to the tax-gap indicator proposed by Blanchard et al (1990).

\(^2\) There is a third indicator, deriving from S2 and called Required Primary Balance (RPB). This is simply the sum of S2 and the average value of the primary structural balance (that is, corrected for the cycle and temporary measures) in the five years after end-horizon of the last stability/convergence programme update. Whereas the S1 and S2 indicators show the departure from sustainability (conditional on the available projections), the RPB indicates the objective for the primary structural balance at the end of the current stability/convergence programme required to achieve sustainability (S2=0) without any further policy changes. Given the low value added of the RPB indicator compared with S2, the decision was taken to limit the analysis of this chapter to S1 and S2.
i. In the case of S1, for the public debt ratio to reach 60% of GDP at the end of an extended horizon (2050 in the European Commission calculations);

ii. In the case of S2, for the present value of public debt to tend to zero when the horizon widens to infinity (so as to respect the intertemporal budgetary restriction over an infinite horizon).

The public finances of any economy are subject to an intertemporal constraint, meaning that at any moment the present value of all future public revenue must cover public debt at that moment and also the present value of future public expenditure. In a framework of unchanged policies (in particular, unchanged tax rates), a situation of non-sustainability of public finances is considered to exist when there is an excessive accumulation of public debt in the long term (translated into an explosive path for the ratio of public debt to GDP). Conditional to a set of long-term projections, if the sustainability gaps S1 and S2 are significantly positive and large, then this can be taken as evidence that the current budgetary policy is not consistent with the intertemporal budgetary constraint, and cannot accommodate the projected evolution of public expenditure most sensitive to the ageing of the population.

The sustainability gaps for S1 and S2 can be decomposed in the following way:\(^3\):

\[
S1 = IBP_1 + LTC_1 + DR
\]

\[
S2 = IBP_2 + LTC_2
\]

where:

- \(IBP_i\) (i=1,2) – (Initial Budgetary Position) – This is the change required in the initial budgetary position, defined as the difference between the initial value of the primary structural balance (as a % of GDP) and the constant value of that balance (also as a % of GDP), so as to guarantee that, in the case of S1, the ratio of public debt at end-horizon (2050) is identical to the initial value of that ratio and, in the case of S2, the present value of public debt at current prices tends to zero (over an infinite horizon);\(^4\);

- \(LTC_i\) (i=1,2) – (Long-Term Change in the budgetary position) – The effect on the indicator of the projected increase in age-related public expenditure;

- \(DR\) – (Debt Requirement) – The additional variation in the public debt ratio needed to reach 60% of GDP in 2050.

This breakdown of S1 and S2 shows that it is possible to identify whether the main factors underlying the high value of an indicator stem from an insufficient initial primary balance and/or from an unfavourable projection of age-related public expenditure.

For the baseline scenario of the sustainability gaps in 2005, and over and beyond the projection of expenditure most sensitive to the ageing of population produced by the AWG (EPC and DGECFIN 2006), the Commission accepts a number of assumptions to simplify the calculation. The most salient of these are:

- The implicit real rate of interest on public debt is taken as 3% per year, for all Member States for the period 2010-2050;

- The annual variation in the GDP deflator is taken as 2% for all Member States for the period 2010-2050;

---

\(^3\) See Annex 1 of DGECFIN (2006a) for a derivation of the S1 and S2 algebraic expressions.

\(^4\) It should be noted that this does not imply that the ratio of debt to GDP (not its present value) should also tend to zero.
- Total revenue and primary expenditure not directly influenced by the ageing of the population is taken as constant at 2005 figures as a ratio of GDP, after correction for cyclical effects and one-off and other temporary measures;
- (Only for S2) the primary balance is taken as constant after 2050 (as a % of GDP), since the AWG projections for age-related expenditure are only available up to that year.

As for the initial public debt ratios, the Commission subtracted from the “Maastricht debt” the estimated stock of financial assets held by public pension funds. In the case of Portugal, the financial assets to be deducted from public debt were taken as those held by the Segurança Social subsystem and the CGA reserves (reaching 2.1% of GDP). The European Commission also assumed that the average rate of real GDP variation for Portugal would be 1.5% per year for the period 2010 to 2050.

Table 5.1.1 gives the values of S1 and S2 for the 2005 baseline scenario, as reported by the European Commission in the DGECFIN (2006a). Portugal has the highest figures of all Member States, with only Hungary on a par for S1. The figures are 3 times greater than the average for the EU12 and 4 times greater than the average for the EU25. This is due to both the initial budgetary position (IBP) and the long-term change in age-related expenditure (LTC). This combination of two unfavourable elements is shared by only two Member States – Hungary and Portugal.

<table>
<thead>
<tr>
<th>Table 5.1.1 Sustainability gaps calculated by the European Commission services</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005 baseline scenario</td>
</tr>
<tr>
<td>Change (2005-2010) in age-related expenditure (p.p.)</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>Greece (5)</td>
</tr>
<tr>
<td>Spain</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>Ireland</td>
</tr>
<tr>
<td>Italy</td>
</tr>
<tr>
<td>Luxembourg</td>
</tr>
<tr>
<td>Netherlands</td>
</tr>
<tr>
<td>Austria</td>
</tr>
<tr>
<td>Portugal</td>
</tr>
<tr>
<td>Finland</td>
</tr>
<tr>
<td>EU12 (b)</td>
</tr>
<tr>
<td>Czech Republic</td>
</tr>
<tr>
<td>Denmark</td>
</tr>
<tr>
<td>Estonia</td>
</tr>
<tr>
<td>Cyprus</td>
</tr>
<tr>
<td>Latvia</td>
</tr>
<tr>
<td>Lithuania</td>
</tr>
<tr>
<td>Hungary</td>
</tr>
<tr>
<td>Malta</td>
</tr>
<tr>
<td>Poland</td>
</tr>
<tr>
<td>Slovenia</td>
</tr>
<tr>
<td>Slovakia</td>
</tr>
<tr>
<td>Sweden</td>
</tr>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>EU25 (b)</td>
</tr>
</tbody>
</table>

Source: DG ECFIN (2006), Table II.1 (p.28) and Chapter VI (pp.91-167).

Notes:
(a) Not comparable since there are no projections available for expenditure on pensions.
(b) Excluding Greece.

The large IBP figure for Portugal stems directly from the high negative primary structural balance in 2005, the initial year for this baseline scenario, when it stood at -
2.5% of GDP. In this scenario, as mentioned above, total revenue and primary expenditure excluding age-related items remain constant as a percentage of GDP along the horizon at 2005 levels (after correction for cyclical effects and temporary measures). In other words, in the 2005 baseline scenario, no consideration is given to the projection of budgetary consolidation set down in the country’s stability programme.

The European Commission services also report calculations of the sustainability gaps in an alternative scenario called “MTO scenario”. The difference between this and the 2005 baseline scenario is that the path towards the medium-term objective (MTO) is factored in for all Member States. This brings convergence of the structural balance in 2010 to the MTO as defined by each government when it updated its stability programme in December 2005\(^7\) (the AWG projections on age-related public expenditure were used for both scenarios, baseline and MTO). In the case of Portugal, the second scenario makes all the difference, because the MTO for the overall structural balance is -0.5% of GDP, which corresponds to a primary structural surplus of 2.5% of GDP, instead of the 2.5% deficit incorporated in the 2005 baseline scenario.

Table 5.1.2
Sustainability gaps

<table>
<thead>
<tr>
<th>MTO Scenario</th>
<th>Difference from 2005 baseline scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S1</td>
</tr>
<tr>
<td>Belgium</td>
<td>1.3</td>
</tr>
<tr>
<td>Germany</td>
<td>0.1</td>
</tr>
<tr>
<td>Greece (a)</td>
<td>-1.9</td>
</tr>
<tr>
<td>Spain</td>
<td>2.2</td>
</tr>
<tr>
<td>France</td>
<td>0.0</td>
</tr>
<tr>
<td>Ireland</td>
<td>1.7</td>
</tr>
<tr>
<td>Italy</td>
<td>-1.0</td>
</tr>
<tr>
<td>Luxemburg</td>
<td>3.9</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2.2</td>
</tr>
<tr>
<td>Austria</td>
<td>-0.7</td>
</tr>
<tr>
<td>Portugal</td>
<td>2.5</td>
</tr>
<tr>
<td>Finland</td>
<td>-0.7</td>
</tr>
<tr>
<td><strong>EU12</strong> (b)</td>
<td><strong>0.3</strong></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>2.2</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.7</td>
</tr>
<tr>
<td>Estonia</td>
<td>-2.6</td>
</tr>
<tr>
<td>Cyprus</td>
<td>2.3</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.6</td>
</tr>
<tr>
<td>Lithuania</td>
<td>0.3</td>
</tr>
<tr>
<td>Hungary</td>
<td>1.7</td>
</tr>
<tr>
<td>Malta</td>
<td>-2.5</td>
</tr>
<tr>
<td>Poland</td>
<td>-4.0</td>
</tr>
<tr>
<td>Slovenia</td>
<td>3.8</td>
</tr>
<tr>
<td>Slovakia</td>
<td>0.1</td>
</tr>
<tr>
<td>Sweden</td>
<td>-1.9</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>EU25</strong> (b)</td>
<td><strong>0.2</strong></td>
</tr>
</tbody>
</table>

Source: DG ECFIN (2006), Table III.6 (p.50) and Table II.1 (p.28)

Notes:
(a) Not comparable since there are no projections available for expenditure on pensions.
(b) Excluding Greece.

\(^7\) A compilation of the MTOs defined by the national governments involved can be found in Fig 7.1 of the DGECFIN report (2006b).
The S1 and S2 figures for the MTO scenario are detailed in Table 5.1.2. Given that the LTC is unchanged (and given that the DR for S1 is also similar), the sustainability gap differences from the baseline scenario are due above all to a change in the IBP. In absolute terms, what is particularly noticeable is the improvement in both gaps, coming in at over 5 percentage points of GDP. However, in relative terms Portugal’s position is still quite unfavourable, given that most Member States with large budget imbalances are also aiming at major budgetary consolidations.

Therefore, according to European Commission figures, the risk of long-term public finance unsustainability remained high for Portugal, even if the process of consolidation were successful, because of the contribution of the increase in age-related public expenditure (LTC). It can be seen from Table 5.1.1 that the LTC element in S1 and S2 is high for Portugal – nearly twice the EU12 or EU25 averages, as a result of an increase of 9.7 percentage points of GDP from 2010 to 2050 in age-related public expenditure as projected by the AWG, with 8.9 percentage points relating to the increase in expenditure on pensions. These figures compare with an EU12 average of 4.4 and 2.8 percentage points, respectively.

It is important, however, to highlight the fact that these figures for Portugal do not take the 2006 social security reforms into account.

5.2 The effects of social security reforms on S1 and S2

The European Commission’s long-term projections of expenditure on pensions for Portugal were prepared during 2005 by the Portuguese representatives in the AWG. They were based on a series of assumptions agreed by the Group, and the projection models were the same as those used to produce the official Portuguese projections. The logic underlying these models is described very succinctly in the fiche on Portugal appended to the AWG report (EPC and DGECFIN 2006). Without access to those models, it is impossible to accurately replicate the projections and test the effects of the reforms. It is, however, possible to use the MISS model to generate alternative projections on pensions, based on a set of demographic and macroeconomic assumptions similar to those used by the AWG.

There are fundamentally four main differences between the AWG assumptions and those underlying the baseline scenario without reforms described in Chapter 3:

- Smaller net immigration flows (in the AWG projections there are positive flows but they are around one-third of those considered in Chapter 3);
- Updating of pensions and other benefits and allowances by inflation plus 0.1 percentage points instead of the indexation to salary updates;
- Higher real interest rate implicit in public debt (3% instead of 2.5%);
- Lower mortality tables for the CGA contributors than for the population as a whole, where MISS assumes that mortality rates are the same for both subsystems and only considers an amplifying factor for the mortality of disability pensioners.

In Table 5.2.1 the AWG projections for expenditure are compared with their equivalents obtained with the MISS model, after adjusting the assumptions as indicated, except for the information that refers to the CGA mortality tables, since this seems to be unrealistic in terms of the projection horizon. As far as the SPSS is concerned, the initial difference
in the figures relates above all to non-contributive pensions, which are not covered by the MISS model.

Table 5.2.1  
Pensions expenditure projections – scenario without reforms

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>Difference 2050-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(1) AWG</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total of the two subsystems</td>
<td>11.5</td>
<td>11.9</td>
<td>16.0</td>
<td>20.8</td>
<td>9.3</td>
</tr>
<tr>
<td>Segurança Social</td>
<td>7.5</td>
<td>8.0</td>
<td>11.2</td>
<td>16.6</td>
<td>9.1</td>
</tr>
<tr>
<td>CGA</td>
<td>3.9</td>
<td>3.6</td>
<td>4.5</td>
<td>3.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Residual difference</td>
<td>0.1</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>(2) MISS (excluding non-contributive pensions) with AWG assumptions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total of the two subsystems</td>
<td>10.8</td>
<td>11.4</td>
<td>14.7</td>
<td>19.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Segurança Social</td>
<td>6.7</td>
<td>7.3</td>
<td>9.7</td>
<td>16.0</td>
<td>9.2</td>
</tr>
<tr>
<td>CGA</td>
<td>4.2</td>
<td>4.3</td>
<td>5.3</td>
<td>3.4</td>
<td>-0.8</td>
</tr>
<tr>
<td>Difference (consolidation effect)</td>
<td>-0.1</td>
<td>-0.2</td>
<td>-0.2</td>
<td>-0.1</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Difference (1) - (2)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total of the two subsystems</td>
<td>0.7</td>
<td>0.5</td>
<td>1.3</td>
<td>1.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Segurança Social</td>
<td>0.8</td>
<td>0.7</td>
<td>1.5</td>
<td>0.6</td>
<td>-0.1</td>
</tr>
<tr>
<td>CGA</td>
<td>-0.3</td>
<td>-0.7</td>
<td>-0.8</td>
<td>0.5</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Sources: Fiche on Portugal appended to the AWG report, Revised Long-Term Projections for the Public Pension Schemes, December 2005 and MISS model.

In terms of the SPSS, it is worth noting that the increase in pensions expenditure between 2005 and 2050 is practically the same in the AWG and the MISS model projections (9.1 and 9.2 percentage points, respectively). The differences in the SPCGA are, however, more significant. As regards 2005, the reason for the difference probably lies in the fact that the AWG information was more provisional. Their projections were available at the end of 2005, whereas the MISS model uses information provided to the Banco de Portugal by the CGA in mid-2006. Apart from the difference in initial figures, the AWG projections show the same figure (as a percentage of GDP) for the initial year and for end-horizon, while the projections generated by the MISS model show a 0.8 percentage points fall. With the CGA subsystem closed to new registrations from 2006 onwards, it is reasonable to expect considerably less expenditure on pensions in 2050, 45 years after the last registrations. The reason why the AWG projections are more resilient is possibly because lower mortality rates were used for public employees than for the population in general.

Apart from the differences, it is clear that the MISS model allows for the projection of an increase in public expenditure on pensions similar to the figure produced by the AWG and used by the European Commission. It seems reasonable, therefore, to use the MISS model to assess the effects of the reforms on this expenditure and then analyse its impact on the sustainability gaps.

The reforms considered in the alternative scenarios are those analysed in Chapter 3:

i) The new rule to update pensions as a function of consumer inflation, the real GDP growth and the size of the pension;

ii) The additional financial penalty on the statutory pension for those taking early retirement;
iii) Early adoption of the new formula for calculating the statutory pension, taking the whole contributive career into consideration and increasing the accrual rate for lower compensations;

iv) Inclusion of the “sustainability factor” in the formula used to calculate the statutory pension.

As mentioned in section 3.1, the new rule for updating pensions is rather complex and takes into account whether real GDP growth is less than 2%, above 3% or within these figures. In Chapter 3, an average GDP growth of 2% per year was projected, and an approximation to the rule consisted in assuming an update equal to inflation plus 0.25 percentage points. When the AWG assumptions are emulated, it would be excessive to use this average update, because the trend growth in the economy is lower. A new approximation to the rule was taken as an indexation of pensions to the inflation rate less 0.1 percentage points.

As considered in Chapter 3, the option was to project the two extreme alternatives of the sustainability factor in tandem, in terms of the reactions of those concerned: alternative I was based on workers preferring to put off their retirement until they were able to offset the financial penalty; and alternative II was based on workers not changing their retirement age and accepting the financial penalty in full.

According to the projections presented in Table 5.2.2, the four measures reduce the rise in pensions expenditure up to the 2050 horizon by between 4.1 and 7.4 percentage points of GDP. The figures provide a comparison between the no-reform and the post-reform situations, with the AWG assumptions being used in both cases. Therefore, the estimate of 4 percentage points of GDP put forward in the Commission’s assessment of the December 2006 update of the Portuguese stability programme corresponds to the lower limit of the interval (which is defined by the effect of the sustainability factor in alternative II of the scenario).

### Table 5.2.2

Pensions expenditure projections – including the effect of reforms

<table>
<thead>
<tr>
<th>MISS projections (excluding non-contributive pensions) based on AWG assumptions</th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>Difference 2050-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total of the two subsystems in alternative I (a)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Segurança Social</td>
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<td>10.9</td>
<td>10.9</td>
<td>11.8</td>
<td>1.0</td>
</tr>
<tr>
<td>CGA</td>
<td>6.7</td>
<td>7.0</td>
<td>7.0</td>
<td>9.2</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Total of the two subsystems in alternative II (b)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>11.0</td>
<td>12.1</td>
<td>15.2</td>
<td>4.4</td>
</tr>
<tr>
<td>CGA</td>
<td>6.7</td>
<td>7.0</td>
<td>8.0</td>
<td>12.7</td>
<td>5.9</td>
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</table>

<table>
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<tr>
<th>Effect of the reforms</th>
<th>2005</th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
<th>Difference 2050-2005</th>
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<tbody>
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<td><strong>Total of the two subsystems in alternative I (a)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segurança Social</td>
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<td>-0.5</td>
<td>-3.8</td>
<td>-7.4</td>
<td>-7.4</td>
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<tr>
<td>CGA</td>
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<td>-0.3</td>
<td>-2.7</td>
<td>-6.7</td>
<td>-6.7</td>
</tr>
<tr>
<td><strong>Total of the two subsystems in alternative II (b)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segurança Social</td>
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<td>-0.4</td>
<td>-2.6</td>
<td>-4.1</td>
<td>-4.1</td>
</tr>
<tr>
<td>CGA</td>
<td>0.0</td>
<td>-0.2</td>
<td>-1.0</td>
<td>-0.8</td>
<td>-0.8</td>
</tr>
</tbody>
</table>

Notes: (a) Assuming that everyone opts to put off retirement and cancel out the sustainability factor penalty.

(b) Assuming that everyone retires at legal retirement age, preferring to accept the financial penalty of the factor.

With the exception of the sensitivity analysis to lower productivity growth.
In spite of the reduction, there is still a considerable increase in pensions expenditure up to 2050, even though this is around half what the increase would have been without reforms. In the MTO scenario, which factors in the on-going budgetary consolidation process until the MTO is reached by 2010, the sustainability gaps S1 and S2 are now close to the average value for the euro area (Table 5.2.3).

Table 5.2.3  
Effect of the reforms on the sustainability gaps for Portugal

<table>
<thead>
<tr>
<th></th>
<th>S1</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>IBP</td>
</tr>
<tr>
<td>2005 baseline scenario 2005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) European Commission figures (no reforms)</td>
<td>7.9</td>
<td>3.6</td>
</tr>
<tr>
<td>(2) Effect of the reforms (MISS estimates)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2.I) Alternative I</td>
<td>-3.2</td>
<td>-</td>
</tr>
<tr>
<td>(2.II) Alternative II</td>
<td>-2.0</td>
<td>-</td>
</tr>
<tr>
<td>(3) Figures after inclusion of the reforms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3.I) = (1)+(2.I) Alternative I</td>
<td>4.7</td>
<td>3.6</td>
</tr>
<tr>
<td>(3.II) = (1)+(2.II) Alternative II</td>
<td>6.0</td>
<td>3.6</td>
</tr>
<tr>
<td>Memorandum item: EU12 average excluding Greece</td>
<td>2.3</td>
<td>0.1</td>
</tr>
<tr>
<td>MTO scenario</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) European Commission figures (no reforms)</td>
<td>2.5</td>
<td>-1.7</td>
</tr>
<tr>
<td>(2) Effect of the reforms (MISS estimates)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2.I) Alternative I</td>
<td>-3.2</td>
<td>-</td>
</tr>
<tr>
<td>(2.II) Alternative II</td>
<td>-2.0</td>
<td>-</td>
</tr>
<tr>
<td>(3) Figures after inclusion of the reforms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3.I) = (1)+(2.I) Alternative I</td>
<td>-0.8</td>
<td>-1.7</td>
</tr>
<tr>
<td>(3.II) = (1)+(2.II) Alternative II</td>
<td>0.5</td>
<td>-1.7</td>
</tr>
<tr>
<td>Memorandum item: EU12 average excluding Greece</td>
<td>0.3</td>
<td>-1.8</td>
</tr>
</tbody>
</table>

Sources: European Commission (Sustainability report 2006) and MISS.
Notes: (a) Assuming that everyone opts to put off retirement and cancel out the sustainability factor penalty.
(b) Assuming that everyone retires at legal retirement age, preferring to accept the financial penalty of the factor.

In relative terms and for the MTO scenario, comparing the revised S1 and S2 gaps (taking into account the reform measures) with the figures for other euro area countries (see Table 5.1.2) Portugal has more favourable values than Belgium, Spain, Ireland, Luxemburg and the Netherlands (and Slovenia, which adopted the euro in 2007). It is important, however, to underline that for Portugal to move into an average risk group, it will have to proceed with the ambitious but necessary budgetary consolidation process set out in the country’s stability programme.
6. CONCLUSIONS

The idea underlying the MISS model was to create an instrument allowing for an integrated analysis of the long-term financial situation of the two contributive subsystems of Portuguese public social security. A detailed design was needed so as to emulate the extremely complex rules governing pension determination. The aim was to be able to make a reasonably realistic assessment of any future changes to these rules. Due to its actuarial nature, the MISS model suffers from certain limitations, above all the fact that in many aspects the behaviour of economic agents is treated as exogenous. This would not be the case if it were a general equilibrium model. However, given the available modelling techniques, the treatment of the two subsystems using an overlapping generations general equilibrium model would not allow for the level of generational heterogeneity that would have been required to achieve a minimum degree of realism.

A first set of projections generated by the model did not include the social security reform measures agreed in October 2006 between the government and social partners. This baseline scenario without reforms depicts a situation of serious financial imbalance and reveals a situation that is clearly unsustainable. If no measures were taken, the consolidated primary deficit of the two subsystems would go beyond 10% of GDP by the early 2040s (it stood at 2.5% in 2005), even including in the revenue that part of VAT earmarked for social security as legally stipulated (around 1% of GDP). In the no-reform scenario, the implicit social security liabilities, evaluated as the present value at 2005 of the consolidated primary balances for the period 2005-2080, reach more than 500% of GDP.

A second set of projections generated by the MISS model takes into account the four most representative measures of the social security reform:

- Earlier transition to the new formula for pension calculation set down in Decree Law 35/02, with a new transitional rule for calculating SPSS beneficiaries, to be in force between 2007 and 2016;
- A new rule for updating pensions as a function of consumer inflation, the real growth of GDP, and the amount of the pension;
- A bigger financial penalty for early retirement, taking the figure up from 4.5% to 6% for every year prior to the legal retirement age (contributors must in any case have a minimum contributive career of 30 years and be at least 55 years old);
- The introduction from 2008 onwards of a “sustainability factor” that will relate the calculation of new pensions to life expectancy at age 65.
The introduction of a sustainability factor means multiplying the formula for calculating the statutory pension for old age by a penalty factor defined as the ratio between life expectancy at 65 in 2006 and life expectancy at 65 in the year before retirement. Contributors can opt for a combination of two extreme alternatives or “corner solutions”:

- They can put off retirement age until they completely offset the effect of the sustainability factor (alternative I); or
- They can retire at the legal retirement age and accept the financial penalty levied on the pension (alternative II).

It is straightforward to parameterise the MISS model to cater for each of the extreme alternatives, but it is harder to combine them in the model, above all because it is difficult to forecast how people will effectively react. For these reasons, it was decided to consider a baseline scenario for each of the two extreme alternatives mentioned.

When comparing the two alternatives with the no-reform situation, the accounts show considerable improvement. In the case of alternative II, which provides the most conservative assessment of the reform effects, the consolidated primary deficit rises until mid-century, reaching almost 5% of GDP (less than half the amount for the scenario without reform), before gradually declining to around 2% of GDP by end-horizon. In alternative I, the consolidated primary deficit evolves along a downward path over the horizon, reaching equilibrium in the later years. The present value of the stream of future primary balances stands at -190% and -90% of GDP, respectively in alternatives II and I. In both assessments, the implicit liabilities for the SPCGA account for around 90% of GDP.

These conclusions depend on verifying a wide array of assumptions, both demographic and macroeconomic. A sensitivity analysis carried out on the projections shows that a bigger rise in fertility than supposed in the baseline scenarios results in an improvement in the financial situation of Portuguese social security, albeit not very markedly. The effects of a smaller reduction in the mortality rate are somewhat more significant. If life expectancy were to rise only by half the figure set out in the baseline scenarios, a fall in liabilities of between 23 and 38 percentage points of GDP would be the outcome, depending on the scenario being considered. A different trend growth in productivity would also have a non-negligible impact on the consolidated social security accounts. The baseline scenarios assume a 2% annual growth in productivity but this, in the light of the behaviour of this variable over the last ten years, could well be optimistic. If risks on the downside were to materialise, the imbalance in the Portuguese social security system would become larger. For example, if the annual growth were 1% a year, implicit liabilities would rise by between 15 and 39 percentage points. In turn, a fall in net immigration flows, as compared with the assumption that the figure to horizon will be as in recent years, would also impact negatively on the country’s social security accounts. It should be noted, however, that the MISS model by its nature cannot accurately project the social and macroeconomic effects of immigration, particularly on the unemployment rate.

The analysis detailed in this paper also assesses the effects of the reforms in the European Commission’s sustainability gap indicators for Portugal. This reform cuts by around half the component pertaining to age-related public expenditure. If this reduction comes along with continuation of the process of fiscal consolidation under way, it
should allow for the country’s public finance sustainability assessment to be improved from high to average risk.
REFERENCES


ANNEX: THE MAIN EQUATIONS OF THE MODEL

A.1 Basic notation

In the equations presented in this Annex, each variable is designated by a letter, associated in principle with two subscripts and one or two superscripts. The subscripts refer to the gender \((g = 1, 2)\) and age \((a)\). For gender, 1 is masculine and 2 is feminine. The age subscript \((a)\) takes values between 0 and 110 years, except for the variables associated with the labour market, where age \(a\) is restricted to the range from 15 to 80. As far as the superscripts are concerned, the most common use is to designate decomposition of a given universe or typology. Superscripts, for example, can assume the variants \(i = SS, TCO, TI, CGA\). The superscript \(SS\) designates the SPSS as a whole, encompassing employees (TCO) and self-employed workers (TI). The \(\oplus\) symbol is used to represent the aggregate value for a set of values in either script.

The year \(t\) to which a variable refers will always be given in brackets after the letter designating the variable in question. In the projections discussed in these notes, \(t\) varies between the base year, that is 2004 or 2005 (depending on the variables), and 2080, the last year of a 75-year horizon. So, for example, \(x_{g,a}^{CGA}(t)\) refers to the value of a given variable \(x\) in year \(t\) for those in the SPCGA of gender \(g\), with age \(a\). In turn, \(x_{g,a}^{CGA}(t)\) represents the aggregate of the values of variable \(x\) for the two genders and for all the relevant ages, i.e.:

- If the variable assumes values for the whole interval 0-110 years,

\[
x_{g,a}^{CGA}(t) = \sum_{g=1}^{2} \left( \sum_{a=0}^{110} x_{g,a}^{CGA}(t) \right) \quad (A.1.1)
\]

- If the variable only assumes values for ages 15 up to and including 80 (the ages of participation in the labour market),

\[
x_{g,a}^{CGA}(t) = \sum_{g=1}^{2} \left( \sum_{a=15}^{80} x_{g,a}^{CGA}(t) \right) \quad (A.1.1')
\]

Another convention in the notation consists of representing flow-variables by small case Latin letters, stock-variables by upper case Latin letters and ratios or probabilities (rates of fertility or mortality, for example) by Greek letters or other symbols.
For stock-variables, an upper case letter with a circumflex means stock at year-end, while an upper case letter with a horizontal accent means annual average stock. For example, for a given stock-variable \( X \), the notations \( \hat{X}_{g,a}^{TCO}(t) \) and \( \overline{X}_{g,a}^{TCO}(t) \) are, respectively, the year-end value at year \( t \) and the average of variable \( X \) in year \( t \) relative to TCO of gender \( g \) and age \( a \).

It would be useful here to clarify the precise meaning of the age subscript. For a flow – variable and a stock-variable at year-end, the \( x_{g,a}^i(t) \) and \( \hat{X}_{g,a}^i(t) \) notations refer to values for individuals in subsystem \( i \) of age \( a \) completed during the year \( t \) (which is equivalent to considering individuals who would be age \( a \) at the end of the year in question). However, for an annual average stock-variable, \( \overline{X}_{g,a}^i(t) \) refers to the average value for individuals in subsystem \( i \) aged \( a \) during part of year \( t \), with each individual weighted in the calculation of that average according to the part of the year he/she was age \( a \).

For many of the stock-variables, data are available for the end of the base year and the projections for each of the years during horizon are based on dynamic equations defined for year-end variables. After the values for year-end are projected, the corresponding annual average stocks are obtained from the following equation, which gives the approximate weighted average mentioned above:

\[
\overline{X}_{g,a}^i(t) = \frac{1}{4} \left( \hat{X}_{g,a}^i(t) + \hat{X}_{g,a+1}^i(t) + \hat{X}_{g,a}^i(t-1) + \hat{X}_{g,a-1}^i(t-1) \right) \tag{A.1.2}
\]

For some stock-variables, such as those referring to the labour market, there is no reliable information for year-end, only for annual averages. In these cases, the projections are carried out using the annual averages and the year-end values, when necessary, are obtained from the equations:

\[
\hat{X}_{g,a}^i(t) = \begin{cases} 
\frac{4}{3} \overline{X}_{g,15}^i(t) & (a = 15) \\
\overline{X}_{g,a-1}^i(t) + \overline{X}_{g,a}^i(t+1) - \hat{X}_{g,a}^i(t) & (15 < a \leq 80)
\end{cases} \tag{A.1.3}
\]

These equations give a simple approximation to solving equation (A.1.2) in order to \( \hat{X}_{g,a}^i(t) \).

\[1 \text{ In fact, considering (A.1.2), one obtains:}
\]

\[
\begin{align*}
\hat{X}_{g,a}^i(t) + \hat{X}_{g,a}^i(t+1) &= \frac{1}{2} \hat{X}_{g,a}^i(t) + \frac{1}{2} \hat{X}_{g,a}^i(t+1) + \frac{1}{2} \hat{X}_{g,a}^i(t+1) + \frac{1}{2} \hat{X}_{g,a}^i(t-1) + \frac{1}{2} \hat{X}_{g,a}^i(t-1) \\
\end{align*}
\]

Using the proxies

\[
\hat{X}_{g,a}^i(t) = \frac{1}{2} \left[ \hat{X}_{g,a}^i(t+1) + \hat{X}_{g,a}^i(t-1) \right] \quad \text{and} \quad \hat{X}_{g,a}^i(t) = \frac{1}{2} \left[ \hat{X}_{g,a}^i(t+1) + \hat{X}_{g,a}^i(t-1) \right],
\]

solving in order to \( \hat{X}_{g,a}^i(t+1) \) and taking one year off the age, the equation (A.A.3) is obtained for \( 15 < a \leq 80 \). For \( a = 15 \), the equation must be adapted because (A.A.2) would lead to a non-null annual average for 14 year-olds.
Finally, the notation of many variables relating to contributors and pensioners in the SPSS and SPCGA subsystems also include the binary variable $\rho$ as an additional argument, and this assumes:

- the value of 1 when representing the situation resulting from closure of the CGA to new registrations from the start of 2006 (decision taken in 2005);
- the value of 0 when analysing the counterfactual situation, in which there is no closure and the CGA continues to take new registrations.

For example:

$$\hat{X}_{g,a}^{CGA}(t | 1) \quad \text{and} \quad \hat{X}_{g,a}^{CGA}(t | 0) \quad (A.1.4)$$

denote the value of the stock-variable $X$ at the end of year $t$, for individuals of gender $g$ and age $a$, for the situation where the CGA is closed and for the (counterfactual) situation where it is not, respectively.

The binary variable $\rho$ was introduced into the model to allow for modelling the effects on the accounts of the two subsystems deriving from CGA closure to new registrations from the start of 2006.

### A.2 Demography module

Let $\hat{p}_{g,a}^{res}(t)$ be the stock (in thousands) of individuals of gender $g$ and age $a$ resident in the country at the end of year $t$. This can be written:

$$\hat{p}_{g,a}^{res}(t) = \begin{cases} \psi(t)(g = 1) + (1 - \psi(t))\iota(g = 2)n(t)(1 - \mu_{g,0}(t)) + m_{g,0}(t) & (a = 0) \\ (1 - \mu_{g,a}(t))\hat{p}_{g,a-1}^{res}(t - 1) + m_{g,a}(t) & (a > 0) \end{cases} \quad (A.2.1)$$

where:

- $\psi(t)$ is the proportion of individuals of masculine gender among newborn in year $t$;
- $\iota(\cdot)$ is the indicator function, which assumes value 1 if the condition between brackets is true and value 0 otherwise;

Hypothetically, for variables restricted to the 15 to 80 age bracket, all year-end stocks for 14 year-olds or less are null. This being so, the annual average $\hat{X}_{g,14}^i(t)$ has to be zero, contrary to what was obtained in (*) from (A.1.2). However, for the purposes of approximation for age 15, (*) is preferable to $\hat{X}_{g,14}^i(t) = 0$ in the expression

$$\hat{X}_{g,15}^i(t) = \frac{1}{4}(\hat{X}_{g,14}^i(t) + \hat{X}_{g,15}^i(t) + \hat{X}_{g,14}^i(t - 1) + \hat{X}_{g,15}^i(t - 1)) = \frac{1}{4}\hat{X}_{g,15}^i(t) \quad (*)$$

Solving in order to $\hat{X}_{g,15}^i(t)$, one obtains $\hat{X}_{g,15}^i(t) = \frac{4}{3}\hat{X}_{g,15}^i(t)$.
- \( n(t) = \sum_{a=15}^{49} \phi_a(t) \bar{n}_{t,a} \) is the number of live births occurring during year \( t \) (in thousands);
- \( \phi_a(t) \) is the fertility rate of women of age \( a \) in year \( t \), defined as the ratio between the number of live births in year \( t \) for women of age \( a \) and the resident female population (annual average) of age \( a \) in year \( t \);
- \( \mu_{g,a}(t) \) is the mortality rate in year \( t \) for individuals of gender \( g \) that completed or would complete of age \( a \) during year \( t \) (that is, that were aged \( a - 1 \) at the end of the year \( t - 1 \));
- \( m_{g,a}(t) \) is the net flow of immigrants (that is, the number of immigrants minus the number of emigrants) in thousands, of gender \( g \) and age \( a \).

The data on the resident population are only available age by age until age 84. The number of individuals of age 85 or above is presented in aggregate form for each gender, and for this reason it was necessary to break down the two aggregates for the base year of 2004:

\[
\hat{P}_{g,a}^{res}(2004) = \hat{P}_{g,85-110}^{res}(2004) \frac{1 - \exp[-\sigma \cdot (a - 84)]}{\sum_{i=85}^{110} \{1 - \exp[-\sigma \cdot (i - 84)]\}}
\]

\[(84 < a \leq 110) \quad (A.2.2)\]

where \( \sigma \) is a parameter that was chosen so that \( \sum_{a=85}^{110} \hat{P}_{g,a}^{res}(2004) \), for \( g = 1 \) and for \( g = 2 \), were identical to the corresponding aggregate provided by INE and Eurostat. The values obtained presented age profiles similar to those observed for the number of pensioners per age.

The available values for fertility rates cover women of ages 15 to 48 year by year and then those aged 49 or more as a single group. In the MISS model, and by simplification, it was assumed that this last class corresponds totally to the fertility of women aged 49.

The projections of fertility rates, mortality rates (masculine and feminine) and net immigration flows (masculine and feminine), for each age, were based on the historical linear relationship with the relevant factors and the projection of these factors over the horizon, as described in section 2.2. More specifically:

\[
\phi_a(t) = \phi_a(t-1) + \text{coef}_{a}^{fert(I)} (f_{(t)}^{fert} - f_{(t-1)}^{fert}) + \text{coef}_{a}^{fert(II)} (f_{(t)}^{fert} - f_{(t-1)}^{fert})
\]

\[(15 \leq a \leq 49) \quad (A.2.3)\]

\[
\mu_{g,a}(t) = \begin{cases} 
\mu_{g,a}(t-1) + \text{coef}_{g,a}^{morr(I)} (f_{g,a}^{morr} - f_{g,a}^{morr}) & (a \leq 84) \\
\left[ \mu_{g,84}(t) \right]^{1 - \frac{a - 84}{26}} & (a > 84)
\end{cases}
\]

\[(A.2.4)\]
\[ m_{g,a}(t) = \begin{cases} 
 0 & (a < 5) \\
 m_{g,a}(t-1) + \text{coef}_{g,a}^{\text{imig}} (t) \left( f^{\text{imig}}_{g,a}(t) - f^{\text{imig}}_{g,a}(t-1) \right) & (5 \leq a \leq 80) \\
 0 & (a > 80) 
\end{cases} \]  
(A.2.5)

where:

- \( f^{\text{fert}}_{(I)}(t) \), \( f^{\text{fert}}_{(II)}(t) \), \( f^{\text{mort}}_{g,a}(t) \) and \( f^{\text{imig}}_{g,a}(t) \) represent, respectively, the projection of the fertility first factor, the fertility second factor, the mortality first factor and the net immigration first factor for gender \( g \); 
- \( \text{coef}_{a}^{\text{fert}(I)}, \text{coef}_{a}^{\text{fert}(II)}, \text{coef}_{g,a}^{\text{mort}(II)} \) and \( \text{coef}_{g,a}^{\text{imig}(I)} \) are the coefficients estimated for each age \( a \).

Among the demographic indicators made available in MISS, there are the "life expectancy at birth" and the "life expectancy at 65". The corresponding values are calculated from the following expression:

\[ V_{g,A}(t) = \frac{1}{2} + \sum_{a=A-1}^{10} \prod_{a'=A+1}^{A} \left( 1 - \frac{\mu_{g,a}(t) + \mu_{g,A-1}(t)}{2} \right) \]  
(A.2.6)

where \( A = 0 \) or \( A = 65 \). It should be noticed that the term between straight brackets translates the probability of an individual of gender \( g \) who reaches the reference age \( A \), to complete age \( a^* (A > A) \) before dying.

### A.3 Labour market module

The evolution of schooling levels up to 2080 reflects the following premises:

- if \( a \leq 16 \), \( \varepsilon_{g,a}^{\text{res,sec}}(t) = \varepsilon_{g,a}^{\text{act,sec}}(t) = \varepsilon_{g,a}^{\text{emp,sec}}(t) = 0 \)  
(A.3.1)

- if \( a \leq 20 \), \( \varepsilon_{g,a}^{\text{res,sup}}(t) = \varepsilon_{g,a}^{\text{act,sup}}(t) = \varepsilon_{g,a}^{\text{emp,sup}}(t) = 0 \)  
(A.3.2)

- if \( a \geq 22 \), 
\[ \varepsilon_{g,a+1}^{\text{res,sec}}(t) = \varepsilon_{g,a}^{\text{res,sec}}(t-1), \quad \varepsilon_{g,a+1}^{\text{act,sec}}(t) = \varepsilon_{g,a}^{\text{act,sec}}(t-1), \quad \varepsilon_{g,a+1}^{\text{emp,sec}}(t) = \varepsilon_{g,a}^{\text{emp,sec}}(t-1), \]  
(A.3.3)

- if \( a \geq 28 \), 
\[ \varepsilon_{g,a+1}^{\text{res,sup}}(t) = \varepsilon_{g,a}^{\text{res,sup}}(t-1), \quad \varepsilon_{g,a+1}^{\text{act,sup}}(t) = \varepsilon_{g,a}^{\text{act,sup}}(t-1), \quad \varepsilon_{g,a+1}^{\text{emp,sup}}(t) = \varepsilon_{g,a}^{\text{emp,sup}}(t-1) \]  
(A.3.4)

- if \( 17 \leq a \leq 21 \),

---

\( ^2 \) In the cases of immigration and mortality, different factors were calculated and projected for the two genders, masculine ( \( g = 1 \) ) and feminine ( \( g = 2 \) ).
The projection equation for activity rates used in MISS is as follows:

$$
\tau_{g,a}(t) = \tau_{g,a}(t-1) + \left[ \beta_{act}(t) \hat{\phi}_{act}(g,a,\varepsilon_{g,a}^{res,sec}(t),\varepsilon_{g,a}^{res,sec}(t)) + 
- \beta_{act}(t-1) \hat{\phi}_{act}(g,a,\varepsilon_{g,a}^{res,sec}(t-1),\varepsilon_{g,a}^{res,sec}(t-1)) \right] + 
+ \delta(t55 < a \leq \bar{a}^{SS}(t))[\tau_{g,a}(2005) - \tau_{g,55}(2005)][1 - \exp(-0.05(t-2005))]$$

(A.3.6)
The projection equations for the unemployment rates and the percentages of TCO employment are similar to the projection equation for the participation rates, with the exception of the parameter \( \phi \):

\[
\delta_{g,a}(t) = \delta_{g,a}(t-1) + \beta_{\text{des}}(t) \hat{\phi}_{\text{des}} \left( g, a, e_{g,a}^{\text{act,sec}}(t), e_{g,a}^{\text{act,sup}}(t) \right) + \\
- \beta_{\text{des}}(t-1) \hat{\phi}_{\text{des}} \left( g, a, e_{g,a}^{\text{act,sec}}(t-1), e_{g,a}^{\text{act,sup}}(t-1) \right) \quad (A.3.7)
\]

\[
\kappa_{g,a}(t) = \kappa_{g,a}(t-1) + \beta_{\text{emp}}(t) \hat{\phi}_{\text{emp}} \left( g, a, e_{g,a}^{\text{emp,sec}}(t), e_{g,a}^{\text{emp,sup}}(t) \right) + \\
- \beta_{\text{emp}}(t-1) \hat{\phi}_{\text{emp}} \left( g, a, e_{g,a}^{\text{emp,sec}}(t-1), e_{g,a}^{\text{emp,sup}}(t-1) \right) \quad (A.3.8)
\]

where:

- \( \delta_{g,a}(t) \) is the rate of annual average unemployment rate for individuals of gender \( g \) and age \( a \) in year \( t \);
- \( \kappa_{g,a}(t) \) is the annual average percentage of TCO in total employment for individuals of gender \( g \) and age \( a \) in year \( t \);
- \( \beta_{\text{des}}(t) \) and \( \beta_{\text{emp}}(t) \) are, respectively, benchmarks for the unemployment rates and the share of TCO employment in total employment;
- \( \hat{\phi}_{\text{des}}(\cdot) \) and \( \hat{\phi}_{\text{emp}}(\cdot) \) are the regression equations that have as a dependent variable, respectively, the ratio between the unemployment rate and its benchmark and the ratio between the percentage of TCO employment and the corresponding benchmark.

When the rates \( \tau_{g,a}(t) \), \( \delta_{g,a}(t) \) and \( \kappa_{g,a}(t) \) are projected, then for each strata \((g, a)\) the annual averages of labour force, inactive population, unemployment, total employment, TCO employment and TI employment are obtained:

\[
\bar{P}_{g,a}^{\text{act}}(t) = \tau_{g,a}(t) \bar{P}_{g,a}^{\text{act}}(t) \quad (A.3.9)
\]

\[
\bar{P}_{g,a}^{\text{inact}}(t) = \bar{P}_{g,a}^{\text{act}}(t) - \bar{P}_{g,a}^{\text{act}}(t) \quad (A.3.10)
\]

\[
\bar{D}_{g,a}(t) = \delta_{g,a}(t) \bar{P}_{g,a}^{\text{act}}(t) \quad (A.3.11)
\]

\[
\bar{E}_{g,a}^{\text{TOT}}(t) = \bar{P}_{g,a}^{\text{act}}(t) - \bar{D}_{g,a}(t) \quad (A.3.12)
\]

\[
\bar{E}_{g,a}^{\text{TCO}}(t) = \kappa_{g,a}(t) \bar{E}_{g,a}^{\text{TOT}}(t) \quad (A.3.13)
\]

\[
\bar{E}_{g,a}^{\text{TI}}(t) = \bar{E}_{g,a}^{\text{TOT}}(t) - \bar{E}_{g,a}^{\text{TCO}}(t) \quad (A.3.14)
\]

where:

- \( \bar{P}_{g,a}^{\text{act}}(t) \) is the labour force, in annual average, for the strata \((g, a)\) in year \( t \);
- \( \bar{P}_{g,a}^{\text{inact}}(t) \) is the inactive population, in annual average, for the strata \((g, a)\) in year \( t \);
- \( \bar{D}_{g,a}(t) \) is the unemployment, in annual average, for the strata \((g, a)\) in year \( t \);
- \( \bar{E}_{g,a}^{\text{TOT}}(t) \) is the total employment, in annual average, for the strata \((g, a)\) in year \( t \);
- $\overline{E}_{g,a}^{TCO}(t)$ is the number of employees (TCO), in annual average, for the strata $(g, a)$ in year $t$; $\overline{E}_{g,a}^{TI}(t)$ is the number of individuals with other forms of employment (TI), in annual average, for the strata $(g, a)$ in year $t$.

### A.4 Module of contributors and pensioners: number of contributors

The MISS model takes the following equation for the dynamics of contributors to the CGA:

$$\hat{C}^{CGA}_{g,a}(t \mid \rho) = \hat{C}^{CGA}_{g,a-1}(t-1 \mid \rho) \left(1 - \mu_{g,a}(t) - \xi_{g,a}(t) - \nu^{CGA}_{g,a}(t \mid \rho) - \iota^{CGA}_{g,a}(t \mid \rho) + (1 - \rho)c_{g,a}(t)\right) \tag{A.4.1}$$

where, over and beyond the binary variable $\rho$ (closure or not of the CGA to new registrations) and the mortality rates $\mu_{g,a}(t)$ previously defined:

- $\hat{C}^{CGA}_{g,a}(t \mid \rho)$ is the number of active contributors to the CGA of gender $g$ and age $a$ at the end of the year $t$, conditional on $\rho$;
- $\xi_{g,a}(t)$ is the severance rate of SPCGA contributors (for other motives but retirement and death) of gender $g$ and of age $a$ during year $t$;
- $\nu^{CGA}_{g,a}(t \mid \rho)$ is the number of new old age pensioners in the SPCGA in year $t$, of gender $g$ and age $a$, conditional on $\rho$;
- $\iota^{CGA}_{g,a}(t \mid \rho)$ is the number of new disability pensioners in the SPCGA in year $t$, of gender $g$ and age $a$, conditional on $\rho$;
- $c_{g,a}(t)$ is the number of new contributors (essentially new public employees) of gender $g$ and of age $a$ that would have be registered in the CGA in year $t$ if this subsystem had not been closed to new registrations, that is, if $\rho = 0$.

It was taken that $\hat{C}^{CGA}_{g,a}(2005 \mid 1) = \hat{C}^{CGA}_{g,a}(2005 \mid 0)$, given that the decision to close the CGA to new registrations was not in force in 2005.

The number of new public employees of each gender and age along the horizon, $c_{g,a}(t)$, is obtained in the MISS model in accordance with the following equation:

$$c_{g,a}(t) = \left[\mathcal{G}(t)\omega(g = 1) + (1 - \mathcal{G}(t))\omega(g = 2)\right]p(t)\omega_{g,a}(t) \tag{A.4.2}$$

where:

- $p(t)$ is the total number of new public employees admitted in year $t$, in thousands;
- $\mathcal{G}(t)$ is the percentage of these employees that are male;
- $\omega_{g,a}(t)$ is the percentage, in year $t$, of new public employees of gender $g$ with age $a$.

Note that, by construction, for each year $t$:

$$\sum_{a=15}^{80} \omega_{g,a}(t) = 1 \quad (g = 1, 2) \tag{A.4.3}$$
The transition equations for the number of TCO and TI contributors of the SPSS are:

\[
\hat{C}_{g,a}^{TCO}(t \mid \rho) = \hat{C}_{g,a}^{TCO}(t-1 \mid \rho) + \hat{\lambda}_{g,a}^{TCO}(t)(\hat{E}_{g,a}^{TCO}(t) - \hat{C}_{g,a}^{TCO}(t \mid \rho)) - \left[\hat{C}_{g,a}^{TCO}(t \mid 0) - \hat{C}_{g,a}^{TCO}(t \mid \rho)\right] - \left[\hat{C}_{g,a}^{TCO}(t-1) - \hat{C}_{g,a}^{TCO}(t-1 \mid \rho)\right] + (1 - \hat{\lambda}_{g,a}^{TCO}(t \mid \rho))\left[\hat{C}_{g,a}^{TCO}(t \mid 0) - \hat{C}_{g,a}^{TCO}(t \mid \rho)\right] - \left[\hat{C}_{g,a}^{TCO}(t-1 \mid 0) - \hat{C}_{g,a}^{TCO}(t-1 \mid \rho)\right] \]  
(A.4.4)

\[
\hat{C}_{g,a}^{TI}(t) = \hat{C}_{g,a}^{TI}(t-1) + \hat{\lambda}_{g,a}^{TI}(t)\left(\hat{E}_{g,a}^{TI}(t) - \hat{C}_{g,a}^{TI}(t-1)\right) \]  
(A.4.5)

\[
\hat{\lambda}_{g,a}^{TCO}(t \mid \rho) = \min \left\{ \frac{\hat{C}_{g,a}^{TCO}(t-1) - \left(\hat{C}_{g,a}^{TCO}(t-1 \mid 0) - \hat{C}_{g,a}^{TCO}(t-1 \mid \rho)\right)}{\hat{E}_{g,a}^{TCO}(t-1) - \hat{C}_{g,a}^{TCO}(t-1 \mid 0) - \hat{C}_{g,a}^{TCO}(t-1 \mid \rho)} + \eta_{g,a}^{TCO}(t) ; 1 \right\} \]  
(A.4.6)

\[
\hat{\lambda}_{g,a}^{TI}(t \mid \rho) = \min \left\{ \frac{\hat{C}_{g,a}^{TI}(t-1)}{\hat{E}_{g,a}^{TI}(t-1)} + \eta_{g,a}^{TCO}(t) ; 1 \right\} \]  
(A.4.7)

where:
- \( \hat{C}_{g,a}^{TCO}(t \mid \rho) \) and \( \hat{C}_{g,a}^{TI}(t) \) are, respectively, the number of active TCO contributors and the number of active TI contributors in the SPSS, of gender \( g \) and age \( a \) at the end of year \( t \) (in the case of the first variable, conditional on \( \rho \));
- \( \hat{E}_{g,a}^{TCO}(t) \) and \( \hat{E}_{g,a}^{TI}(t) \) are the stocks of TCO and TI employment, respectively, at the end of year \( t \), of gender \( g \) and age \( a \);
- \( \hat{\lambda}_{g,a}^{TCO}(t \mid \rho) \) and \( \hat{\lambda}_{g,a}^{TI}(t \mid \rho) \) are the "coverage rates" of the SPSS, respectively for TCO and TI workers (in the first case, conditional on \( \rho \)), of gender \( g \) and age \( a \) at the end of year \( t \), defined as ratios between the number of active contributors and the relevant employment of each type, evaluated in the previous year and possibly modified by the "coverage variations" \( \eta_{g,a}^{TCO}(t) \) and \( \eta_{g,a}^{TI}(t) \) supplied by the user of the model at his/her discretion.

In equations (A.4.6) and (A.4.7), a maximum value 1 for coverage rates is imposed, resulting from the inconsistencies in the information of the Labour Force Survey. Indeed, in 2005, for older age groups, the latter gives lower numbers of TCO employees than the sum of TCO contributors registered in the SPSS and the SPCGA.

Equations (A.4.4) and (A.4.5) can be written as:

\[
\frac{\hat{C}_{g,a}^{TCO}(t \mid \rho) - \left(\hat{C}_{g,a}^{TCO}(t \mid 0) - \hat{C}_{g,a}^{TCO}(t \mid \rho)\right)}{\hat{E}_{g,a}^{TCO}(t) - \hat{C}_{g,a}^{TCO}(t \mid \rho) - \left(\hat{C}_{g,a}^{TCO}(t \mid 0) - \hat{C}_{g,a}^{TCO}(t \mid \rho)\right)} - \left[\hat{C}_{g,a}^{TCO}(t-1 \mid 0) - \hat{C}_{g,a}^{TCO}(t-1 \mid \rho)\right] - \left[\hat{C}_{g,a}^{TCO}(t-1) - \hat{C}_{g,a}^{TCO}(t-1 \mid \rho)\right] = \hat{\lambda}_{g,a}^{TCO}(t \mid \rho) \]  
(A.4.4)
\[
\frac{\hat{C}_{g,a}^{TI}(t) - \hat{C}_{g,a}^{TI}(t-1)}{\hat{E}_{g,a}^{TI}(t) - \hat{E}_{g,a}^{TI}(t-1)} = \lambda_{g,a}^{TI}(t) \quad (A.4.5')
\]

When \( \eta_{g,a}^{TI}(t) = 0 \), the equation (A.4.5') imposes simply that the number of TI contributors (\( \hat{C}_{g,a}^{TI}(t) \)) changes in line with the TI employment variation rate (i.e. the variation rate of \( \hat{E}_{g,a}^{TI}(t) \)). It is possible for the model user to set non zero values \( \eta_{g,a}^{TI}(t) \), in order to control over the evolution of the coverage rate along the horizon (for example, to represent situations where the informal sector of the economy becomes less important). However, in the projections presented in Chapter 3, \( \eta_{g,a}^{TI}(t) = 0 \) and \( \eta_{g,a}^{TCO}(t) = 0 \) were assumed for every year \( t \), gender \( g \) and age \( a \).

In comparison to equation (A.4.5'), equation (A.4.4') is less straightforward but its logic is similar, the difference being that the reference employment taken for calculation of the coverage rate is not TCO employment. Instead, the option was made to take TCO employment and subtract from this:

- that part of TCO employment that corresponds to SPCGA contributors (because these TCO are already covered by a social security subsystem);
- in the case of \( \rho = 1 \), the number of TCO contributors of the SPSS that would have been registered in the SPCGA if this new subsystem had not been closed to new registrations (because these have, by construction, a coverage rate of 100%).

Note that, when \( \rho = 1 \), the difference \( \left( \hat{C}_{g,a}^{CGA}(t | 0) - \hat{C}_{g,a}^{CGA}(t | \rho) \right) \) is an approximation to the number of public employees registered in the SPSS from 2006 and who remained active in year \( t \).

The equations (A.4.4) or (A.4.4') make it possible to take into account any endogenous changes to the coverage rate implied by the decision to close the SPCGA. In other words, if \( \eta_{g,a}^{TCO}(t) = 0 \), the variation rate in the number of TCO contributors in the SPSS, when the public employees registered in the subsystem from 2006 are excluded from the calculation, is identical to the variation rate of TCO employment net of CGA contributors and also excluding the public employees registered from 2006 onwards.

A.5 Equations for the number of pensioners in the contributors and pensioners module

A.5.1 Disability pensioners

For the year-end number of disability pensioners in the SPCGA and SPSS subsystems, the dynamic equations are as follows:

\footnote{The approximation error stems from the fact that the retirement probabilities defined by the model user may not be identical for the two sub-systems. If this were to happen (as in the projections in Chapter 3 and following), the number of public servants registered in the SPSS from 2006 on and still active in year \( t \) would not exactly match to the difference between the number of active contributors in the SPCGA in the counterfactual situation of non-closure and the real situation of closure to new registrations as and from 2006.}
\[ \hat{I}_{g,a}^{CGA}(t \mid \rho) = \hat{I}_{g,a-1}^{CGA}(t \mid \rho) \left(1 - \sigma \mu_{g,a}(t)\right) + i_{g,a}^{CGA}(t \mid \rho) \quad (A.5.1) \]

\[ \hat{I}_{g,a}^{SS}(t \mid \rho) = \hat{I}_{g,a-1}^{SS}(t \mid \rho) \left(1 - \sigma \mu_{g,a}(t)\right) + i_{g,a}^{TCO}(t \mid \rho) + i_{g,a}^{TI}(t) \quad (a < \hat{a}^{SS}(t)) \quad (A.5.2) \]

where:
- \( \hat{I}_{g,a}^{CGA}(t \mid \rho) \) is the number of disability pensioners in the SPCGA at the end of year \( t \) of gender \( g \) and age \( a \), conditional on \( \rho \);
- \( \hat{I}_{g,a}^{SS}(t \mid \rho) \) is the number of disability pensioners in the SPSS at the end of year \( t \) of gender \( g \) and age, conditional on \( \rho \);
- \( i_{g,a}^{CGA}(t \mid \rho) \), \( i_{g,a}^{TCO}(t \mid \rho) \) and \( i_{g,a}^{TI}(t) \) are the numbers (in the two first cases conditional on \( \rho \) ) of new disability pensioners during year \( t \), respectively of the SPCGA, TCO and TI of the SPSS, of gender \( g \) and of age \( a \) completed in the year;
- \( \sigma \mu_{g,a}(t) \) is the mortality rate in year \( t \) for disability pensioners of gender \( g \) and age \( a \) completed in the year.

The parameter \( \sigma \ (\geq 1) \), which multiplies the mortality rates, can be chosen by the model user, to make the mortality rates for disability pensioners larger than the mortality rates for the total number of individuals of the specific strata \((g, a)\) where they are found.

The evolution of the number of new disability pensioners \( \hat{I}_{g,a}^{CGA}(t \mid \rho) \), \( \hat{I}_{g,a}^{TCO}(t \mid \rho) \) and \( i_{g,a}^{TI}(t) \) is projected on the basis of the probabilities of an active contributor retiring through disability during year \( t \):

\[ i_{g,a}^{CGA}(t \mid \rho) = i_{g,a}^{CGA}(t-1 \mid \rho) \frac{\pi^{inv,CGA}_{g} \left( \hat{C}_{g,a-1}^{CGA}(t-1 \mid \rho) \right)}{\pi^{inv,CGA}_{g} \left( \hat{C}_{g,a-1}^{CGA}(t \mid \rho) \right)} \quad (A.5.3) \]

\[ i_{g,a}^{TCO}(t \mid \rho) = i_{g,a}^{TCO}(t-1 \mid \rho) \frac{\pi^{inv,SS}_{g} \left( \hat{C}_{g,a-1}^{TCO}(t-1 \mid \rho) \right)}{\pi^{inv,SS}_{g} \left( \hat{C}_{g,a-1}^{TCO}(t \mid \rho) \right)} \quad (A.5.4) \]

\[ i_{g,a}^{TI}(t) = i_{g,a}^{TI}(t-1) \frac{\pi^{inv,SS}_{g} \left( \hat{C}_{g,a-1}^{TI}(t-1) \right)}{\pi^{inv,SS}_{g} \left( \hat{C}_{g,a-1}^{TI}(t \mid \rho) \right)} \quad (A.5.5) \]

where \( \pi^{inv,CGA}_{g} \) and \( \pi^{inv,SS}_{g} \) are functions that represent the probability of an active contributor, respectively in the SPCGA and in the SPSS, of gender \( g \) and age \( a-1 \) at the end of the year \( t-1 \), retiring through disability during year \( t \) (the year when age \( a \) is completed).

**A.5.2 Old age pensioners**

The logic of the equations for the stocks of old age pensioners at the end of the year is similar to the one described for pensioners retiring through disability:
\[
\hat{V}^\text{CGA}_{g,a}(t | \rho) = \hat{V}^\text{CGA}_{g,a-1}(t-1 | \rho)(1-\mu_{g,a}(t)) + \nu^\text{CGA}_{g,a}(t | \rho) \quad (A.5.6)
\]

\[
\hat{V}^\text{SS}_{g,a}(t | \rho) = \hat{V}^\text{SS}_{g,a-1}(t-1 | \rho)(1-\mu_{g,a}(t)) + \nu^\text{TCO}_{g,a}(t | \rho) + \nu^\text{TI}_{g,a}(t) +
+t(\alpha = \hat{\alpha}^\text{SS}(t))\hat{i}^\text{SS}_{g,a-1}(t-1 | \rho)(1-\sigma\mu_{g,a}(t)) \quad (A.5.7)
\]

where:

- \( \hat{V}^\text{CGA}_{g,a}(t | \rho) \) is the number of old age pensioners in the SPCGA at the end of year \( t \) of gender \( g \) and age \( a \), conditional on \( \rho \);
- \( \hat{V}^\text{SS}_{g,a}(t | \rho) \) is the number of old age pensioners in the SPSS at the end of year \( t \) of gender \( g \) and age \( a \), conditional on \( \rho \);
- \( \nu^\text{CGA}_{g,a}(t) \), \( \nu^\text{TCO}_{g,a}(t) \) and \( \nu^\text{TI}_{g,a}(t) \) are the numbers of new old age pensioners during year \( t \), the first for the SPCGA, the second and third for the SPSS, TCO and TI respectively (in the two first cases, conditional on \( \rho \)), of gender \( g \) and completing age \( a \) during the year (this excludes former disability pensioners who were reclassified as old age pensioners at the legal age of retirement).

The numbers of new old age pensioners are projected in the MISS model in a similar way to the numbers of disability pensioners, on the basis of functions that represent the "probability" of an active contributor of gender \( g \) and age \( a-1 \) at the end of the year \( t-1 \) to retire through old age in year \( t \) when he/she completes age \( a \):

\[
\nu^\text{CGA}_{g,a}(t | \rho) = \nu^\text{CGA}_{g,a}(t-1 | \rho)\frac{\pi^\text{velh,CGA}_g(a,\hat{\alpha}^\text{CGA}(t))\nu^\text{CGA}(t)\hat{C}^\text{CGA}_{g,a-1}(t-1 | \rho)}{\pi^\text{velh,CGA}_g(a,\hat{\alpha}^\text{CGA}(t-1))\nu^\text{CGA}(t-1)\hat{C}^\text{CGA}_{g,a-1}(t-2 | \rho)} \quad (A.5.8)
\]

\[
\nu^\text{TCO}_{g,a}(t | \rho) = \nu^\text{TCO}_{g,a}(t-1 | \rho)\frac{\pi^\text{velh,SS}_g(a,\hat{\alpha}^\text{SS}(t))\nu^\text{SS}(t)\hat{C}^\text{TCO}_{g,a-1}(t-1 | \rho)}{\pi^\text{velh,SS}_g(a,\hat{\alpha}^\text{SS}(t-1))\nu^\text{SS}(t-1)\hat{C}^\text{TCO}_{g,a-1}(t-2 | \rho)} \quad (A.5.9)
\]

\[
\nu^\text{TI}_{g,a}(t) = \nu^\text{TI}_{g,a}(t-1)\frac{\pi^\text{velh,SS}_g(a,\hat{\alpha}^\text{SS}(t))\nu^\text{SS}(t)\hat{C}^\text{TI}_{g,a-1}(t-1)}{\pi^\text{velh,SS}_g(a,\hat{\alpha}^\text{SS}(t-1))\nu^\text{SS}(t-1)\hat{C}^\text{TI}_{g,a-1}(t-2)} \quad (A.5.10)
\]

where:

- \( \hat{\alpha}^\text{CGA}(t) \) is the legal retirement age applicable to the SPCGA in year \( t \);
- \( \pi^\text{velh,CGA}_g(a,\hat{\alpha}^\text{CGA}(t)) \) and \( \pi^\text{velh,SS}_g(a,\hat{\alpha}^\text{SS}(t)) \) are functions that represent the "probability" of an active contributor, from the SPCGA and the SPSS, respectively, of gender \( g \) and age \( a-1 \) at the end of the year \( t-1 \), to retire through old age during year \( t \) (the year in which he/she completes age \( a \));
- \( \nu^\text{CGA}(t) \) and \( \nu^\text{SS}(t) \) are "mitigating factors" of the "probabilities" of retirement through old age, defined by the user of the model, as described in section 2.4.2.
A.5.3 Survivor pensioners

The MISS model uses the following equations to project stocks of survivor pensioners at year-end:

\[
\hat{S}_{g,0}^{\text{CGA}}(t \mid \rho) = s_{g,0}^{\text{CGA}}(t \mid \rho) \quad (A.5.11)
\]

\[
\hat{S}_{g,0}^{\text{SS}}(t \mid \rho) = s_{g,0}^{\text{SS}}(t \mid \rho) \quad (A.5.12)
\]

\[
\hat{S}_{g,a}^{\text{CGA}}(t \mid \rho) = \hat{S}_{g,a-1}^{\text{CGA}}(t-1 \mid \rho) \left(1 - \mu_{g,a}(t) - \chi_{g,a}(t)\right) + s_{g,a}^{\text{CGA}}(t \mid \rho) \quad (a > 0) \quad (A.5.13)
\]

\[
\hat{S}_{g,a}^{\text{SS}}(t \mid \rho) = \hat{S}_{g,a-1}^{\text{SS}}(t-1 \mid \rho) \left(1 - \mu_{g,a}(t) - \chi_{g,a}(t)\right) + s_{g,a}^{\text{SS}}(t \mid \rho) \quad (a > 0) \quad (A.5.14)
\]

where:
- \( \hat{S}_{g,a}^{\text{CGA}}(t \mid \rho) \) and \( \hat{S}_{g,a}^{\text{SS}}(t \mid \rho) \) are the stocks of survivor pensioners at the end of year \( t \), in the SPCGA and the SPSS respectively, of gender \( g \) and age \( a \), conditional on \( \rho \);
- \( s_{g,a}^{\text{CGA}}(t \mid \rho) \) and \( s_{g,a}^{\text{SS}}(t \mid \rho) \) are the numbers of new survivor pensioners during year \( t \), in the SPCGA and the SPSS respectively, of gender \( g \) and age \( a \), conditional on \( \rho \);
- \( \chi_{g,a}(t) \) is the depreciation rate of the stock of survivor pensioners, of gender \( g \) and age \( a \), for reasons other than the death of the beneficiary (“depreciation in life”).

The rates of depreciation in life \( \chi_{g,a}(t) \) are one input of the MISS model, and its measurement is based on the profile of the distribution of pensioners by gender and age. No distinction was made between the rates of depreciation in life rates considered for the two subsystems.

Let \( b_{g,a}^{\text{CGA}}(t \mid \rho) \) and \( b_{g,a}^{\text{SS}}(t \mid \rho) \) be the numbers of contributors and pensioners in the SPCGA and the SPSS, respectively, deceased in year \( t \) and relevant to determine the number of new survivor pensioners of gender \( g \) and age \( a \) in the specific subsystem (conditional on \( \rho \)). The following approximations were considered:

\[
b_{g,a}^{\text{CGA}}(t \mid \rho) = \begin{cases} 
\sum_{g=1}^{2} \left( \sum_{j=a+25}^{a+40} \left( \hat{C}_{g,j}^{\text{CGA}}(t-1 \mid \rho) + \sigma \hat{C}_{g,j}^{\text{CGA}}(t-1 \mid \rho) + \sigma \hat{V}_{g,j}^{\text{CGA}}(t-1 \mid \rho) \right) \mu_{g,j}(t) \right) 
& \text{if } a \leq 25 \\
\sum_{j=a-5}^{a+5} \left( \hat{C}_{g,j}^{\text{CGA}}(t-1 \mid \rho) + \sigma \hat{C}_{g,j}^{\text{CGA}}(t-1 \mid \rho) + \sigma \hat{V}_{g,j}^{\text{CGA}}(t-1 \mid \rho) \right) \mu_{g,j}(t) 
& \text{if } a > 25
\end{cases}
\]

(A.5.15)
where \( \tilde{g} \) represents the complementary gender of \( g \) (that is, if \( g = 1 \), \( \tilde{g} = 2 \) and vice versa).

To project the number of new survivor pensioners in the two subsystems, the following equations are used:

\[
S_{g,a}^{CGA}(t | \rho) = \text{coef}_{g,a}^{sob,CGA} b_{g,a}^{CGA}(t | \rho) \quad (A.5.17)
\]

\[
S_{g,a}^{SS}(t | \rho) = \text{coef}_{g,a}^{sob,SS} b_{g,a}^{SS}(t | \rho) \quad (A.5.18)
\]

where \( \text{coef}_{g,a}^{sob,CGA} \) and \( \text{coef}_{g,a}^{sob,SS} \) are estimated coefficients.

### A.6 Compensations, contributions and pensions module equations

#### A.6.1 Declared/stipulated compensations and contributions - SPSS

For TCO contributors of gender \( g \) and age \( a \), the annual average compensation \( w_{g,a}^{TCO}(t | \rho) \) (in euros, conditional on \( \rho \)) is projected according to the equation:

\[
w_{g,a}^{TCO}(t | \rho) = \frac{1}{C_{g,a}^{TCO}(t | \rho)} \left( \bar{C}_{g,a}^{CGA}(t | 0) - \bar{C}_{g,a}^{CGA}(t | \rho) \right) w_{g,a}^{CGA}(t) + \\
+ \left[ \bar{C}_{g,a}^{TCO}(t | \rho) - \left( \bar{C}_{g,a}^{CGA}(t | 0) - \bar{C}_{g,a}^{CGA}(t | \rho) \right) w_{g,a}^{TCO}(t-1 | \rho) \right] \frac{h\left(a, g, e_{g,a}^{TCO,sec}(t), e_{g,a}^{TCO,sup}(t)\right)}{h\left(a, g, e_{g,a}^{TCO,sec}(t-1), e_{g,a}^{TCO,sup}(t-1)\right)} \left(1 + \gamma_{sob,SS}(t)\right)
\]

(A.6.1)

where:
- \( w_{g,a}^{CGA}(t) \) is the annual average compensation (in euros) of CGA contributors of gender \( g \) and age \( a \) in year \( t \);  
- \( \gamma_{sob,SS}(t) \) is the variation rate of the average compensation of the TCO in the private sector when composition effects over time are not considered (i.e. changes to the structure for genders, age or the level of schooling of the workers);  
- \( h(\cdot) \) gives the average compensation of TCO contributors (at base year prices) for a specific strata \((g, a)\) as a function of the percentage of these TCO contributors with secondary schooling \( e_{g,a}^{TCO,sec}(t) \) or with higher education \( e_{g,a}^{TCO,sup}(t) \).
In the first component of the equation (A.6.1), the difference \( \bar{c}_{g,a}^{CGA}(t|0) - \bar{c}_{g,a}^{CGA}(t|\rho) \) provides an approximation to the number (in thousands and annual averages) of public employees, of gender \( g \) and age \( a \), registered in the SPSS from 2006 and who in year \( t \) are still active. The difference is multiplied by \( w_{g,a}^{CGA}(t) \) because it is assumed that the average compensation of public employees registered in the SPSS does not differ from what they would have earned if they had been registered in the CGA.

The average declared or stipulated earnings of the TI contributors \( w_{g,a}^{TI}(t) \) is projected by the following equation:

\[
w_{g,a}^{TI}(t) = w_{g,a}^{TI}(t-1) \sum_{j=1}^{7} \alpha_j^{TI} \left\{ t\left(q(j)w_{g,a}^{TI}(t-1) \leq w_{\min}(t-1) \right) \frac{l_{TI}(t)}{l_{TI}(t-1)} \frac{w_{\min}(t)}{w_{\min}(t-1)} + \left[ 1 - t\left(q(j)w_{g,a}^{TI}(t-1) \leq w_{\min}(t-1) \right) \right] \left( 1 + \gamma^{SS, SS}(t) \right) \right\} \quad (A.6.2)
\]

where:
- \( \alpha_j^{TI} \) is the percentage of the number of active TI contributors belonging to the \( j \)-th earnings bracket in the base year;
- \( q = (0.125; 0.375; 0.625; 0.875; 1.25; 1.75; 3) \) is the vector of mid-points of the 7 earnings brackets, corresponding to 7 contributor earnings profiles; \( l_{TI}(t) \) is the legal minimum contribution bound for TI contributors in year \( t \), defined in relation to the mandatory minimum wage;
- \( w_{\min}(t) \) is the mandatory annual minimum wage for year \( t \).

Once the paths have been projected for the number of active TCO and TI contributors in the SPSS, and for their declared average earnings, the projection of the total amount of contributions revenue of the SPSS (in millions of euros), \( r^{SS}(t|\rho) \), is carried out on the basis of the following equation:

\[
r^{SS}(t|\rho) = r^{SS}(t-1|\rho) \cdot \frac{\theta(t)\zeta_{SS(RG)}(t)(\bar{Y}_{\rho,0}^{TCO}(t|\rho) + \bar{Y}_{\rho,0}^{TI}(t) - \bar{Y}_{\rho,0}^{TCO(FP)}(t|\rho)) + \zeta_{SS(FP)}(t)\bar{Y}_{\rho,0}^{TCO(FP)}(t|\rho)}{\theta(t-1)\zeta_{SS(RG)}(t-1)(\bar{Y}_{\rho,0}^{TCO}(t-1|\rho) + \bar{Y}_{\rho,0}^{TI}(t-1) - \bar{Y}_{\rho,0}^{TCO(FP)}(t-1|\rho)) + \zeta_{SS(FP)}(t-1)\bar{Y}_{\rho,0}^{TCO(FP)}(t-1|\rho)} \quad (A.6.3)
\]

where:
- \( \zeta_{SS(RG)}(t) \) is the standard contribution rate of the SPSS (employer and employee) applicable in year \( t \) (currently, this rate is 34.75% of the declared or stipulated earnings);
- \( \zeta_{SS(FP)}(t) \) is the "basic" rate of contribution (employer and employee) for registered public employees in the SPSS from 2006 (currently 23.08%, a rate that includes coverage for old age, disability, death and family allowances but excludes the coverage for the risks of unemployment and temporary absence from work);
- \( \theta(t) \) is the “efficacy level” in collecting the contributions at the standard contribution rate;
- \( \bar{Y}_{g,a}^{TCO} (t \mid \rho) = \bar{C}_{g,a}^{TCO} (t \mid \rho) w_{g,a}^{TCO} (t \mid \rho) \) is the sum of compensations (in thousands of euros) declared in year \( t \) by all TCO contributors of gender \( g \) and age \( a \);
- \( \bar{Y}_{g,a}^{TI} (t) = \bar{C}_{g,a}^{TI} (t) w_{g,a}^{TI} (t) \) is the sum of earnings (also in thousand of euros) declared in year \( t \) by TI contributors of gender \( g \) and age \( a \);
- \( \bar{Y}_{g,a}^{TCO(FP)} (t \mid \rho) = \left( \bar{C}_{g,a}^{CGA} (t \mid 0) - \bar{C}_{g,a}^{CGA} (t \mid \rho) \right) w_{g,a}^{CGA} (t) \) is an approximation to the amount of compensations (in thousands of euros) earned in year \( t \) by the public employees of gender \( g \) and age \( a \) registered in the SPSS from 2006 (that, by construction, will be zero when \( \rho = 0 \), i.e. when the model is used to generate the counterfactual situation where the CGA is not closed).

A.6.2 Compensations and contributions - SPCGA

The dynamic equation to update average earnings per strata is given simply by:

\[
w_{g,a}^{CGA} (t) = w_{g,a}^{CGA} (t - 1) \left( 1 + \gamma^{\text{sal,CGA}} (t) \right) \quad (A.6.4)
\]

where:
- \( w_{g,a}^{CGA} (t) \) is the average compensation (in euros) in year \( t \) of SPCGA contributors of gender \( g \) and age \( a \);
- \( \gamma^{\text{sal,CGA}} (t) \) is the update rate, in year \( t \), of average compensation of SPCGA contributors of the strata \( (g, a) \).

In terms of contributions to the SPCGA, the MISS model calculates first what the contributors are responsible for:

\[
r_{\text{subs,CGA}} (t \mid \rho) = r_{\text{subs,CGA}} (t - 1 \mid \rho) \frac{\xi_{\text{subs,CGA}} (t) \bar{Y}_{g,a}^{CGA} (t \mid \rho)}{\xi_{\text{subs,CGA}} (t - 1) \bar{Y}_{g,a}^{CGA} (t - 1 \mid \rho)} \quad (A.6.5)
\]

where:
- \( r_{\text{subs,CGA}} (t \mid \rho) \) is the total sum of contributions paid to the CGA by contributors (in millions of euros, conditional on \( \rho \)), excluding any contributions from employers and the "State subsidy to the CGA";
- \( \xi_{\text{subs,CGA}} (t) \) is the contribution rate levied on SPCGA contributors (currently 10%);
- \( \bar{Y}_{g,a}^{CGA} (t \mid \rho) = \bar{C}_{g,a}^{CGA} (t \mid \rho) w_{g,a}^{CGA} (t \mid \rho) \) is the amount of compensations (in thousands of euros) earned by SPCGA contributors of gender \( g \) and age \( a \), conditional on \( \rho \).
In relation to contributions to the CGA actually paid by employers, its amount (in millions of euros), \(r_{\text{entid,CGA}}(t \mid \rho)\), is calculated on the assumption that the contributions correspond to a proportion of the amount paid by those registered in the subsystem:

\[
r_{\text{entid,CGA}}(t \mid \rho) = \zeta_{\text{entid,CGA}}(t) r_{\text{subs,CGA}}(t \mid \rho) \tag{A.6.6}
\]

where \(\zeta_{\text{entid,CGA}}(t)\) is the ratio, in year \(t\), of employers’ contributions effectively paid into the CGA and the sum of contributions by those contributors registered. The path of \(\zeta_{\text{entid,CGA}}(t)\) is defined by the model user.

The annual reference amount for employers’ contributions, \(r_{\text{equiv,CGA}}(t \mid \rho)\) (in millions of euros), that would be due to the CGA if all employers’ contributions were at a rate equivalent to the employers’ component of the standard rate in the SPSS, after taking into account the different coverage in the SPSS and the SPCGA, is given by:

\[
r_{\text{equiv,CGA}}(t \mid \rho) = \frac{1}{1000} \zeta_{\text{equiv,CGA}}(t) \bar{y}_{\text{CGA}}(t \mid \rho) \tag{A.6.7}
\]

where \(\zeta_{\text{equiv,CGA}}(t)\) is the "equivalent" rate of employers’ contribution, after adjustment for differences in coverage.

In this way, the MISS model considers three distinct items relating to contributions to the CGA:

\[
r_{\text{input,CGA}}(t \mid \rho) = r_{\text{equiv,CGA}}(t \mid \rho) - r_{\text{entid,CGA}}(t \mid \rho) \tag{A.6.8}
\]

\[
r_{\text{CGA}}(t \mid \rho) = r_{\text{subs,CGA}}(t \mid \rho) + r_{\text{entid,CGA}}(t \mid \rho) + r_{\text{input,CGA}}(t \mid \rho) \tag{A.6.9}
\]

where:

- \(r_{\text{input,CGA}}(t \mid \rho)\) is the amount of employers’ contributions imputed to the State (in millions of euros, conditional on \(\rho\)), these being defined as the difference between the “equivalent” contributions and the employers’ contributions actually paid into the CGA;

- \(r_{\text{CGA}}(t \mid \rho)\) is the total amount of actual and imputed employers’ contributions to the SPCGA (in millions of euros, conditional on \(\rho\)).

A.6.3 New old age and disability pensions - SPSS

The model projects the length of the contributory career of TCO for the years along the horizon on the basis of the following equations:

\[
\hat{\gamma}_{g,a}^{15, TCO}(t) = \begin{cases} 
\max\left\{ \tilde{\gamma}_{g,a}^{15, TCO}(t-1) ; \tilde{\gamma}_{g,a-1}^{15, TCO}(t-1) \right\} & \left( a \leq \tilde{a}^{SS}(t) \right) \\
\hat{\gamma}_{g,a}^{15, TCO}(t) \hat{\gamma}_{g,a-1}^{15, TCO}(t-1) & \left( a > \tilde{a}^{SS}(t) \right) 
\end{cases} \tag{A.6.10}
\]
\[ \hat{a}^{15,TCO}_{g,a}(t) = \begin{cases} \nabla_{g,a}^{21,TCO}(t) + \max \left\{ 0; \frac{\hat{a}^{15,TCO}_{g,a-6}{(t-6)} - \nabla_{g,a}^{21,TCO}(t)}{6} \right\} & (a \leq \hat{a}^{SS}(t)) \\ \hat{a}^{21,TCO}_{g,a}(t-1) \frac{\nabla_{g,a}^{21,TCO}(t-1)}{\hat{a}^{21,TCO}_{g,a-1}(t-1)} & (a > \hat{a}^{SS}(t)) \end{cases} \]  
(A.6.11)

with \( \nabla_{g,a}^{21,TCO}(t) = \min \left\{ \hat{a}^{15,TCO}_{g,a}(t); \max \left\{ \hat{a}^{21,TCO}_{g,a}(t-1); \hat{a}^{21,TCO}_{g,a-1}(t-1) \right\} \right\} \),

\[ \hat{a}^{21,TCO}_{g,a}(t) = \begin{cases} \nabla_{g,a}^{21,TCO}(t) + \max \left\{ 0; \frac{\hat{a}^{21,TCO}_{g,a-10}{(t-10)} - \nabla_{g,a}^{21,TCO}(t)}{10} \right\} & (a \leq \hat{a}^{SS}(t)) \\ \hat{a}^{21,TCO}_{g,a}(t-1) \frac{\nabla_{g,a}^{21,TCO}(t-1)}{\hat{a}^{21,TCO}_{g,a-1}(t-1)} & (a > \hat{a}^{SS}(t)) \end{cases} \]  
(A.6.12)

with \( \nabla_{g,a}^{21,TCO}(t) = \min \left\{ \hat{a}^{21,TCO}_{g,a}(t); \max \left\{ \hat{a}^{21,TCO}_{g,a}(t-1); \hat{a}^{21,TCO}_{g,a-1}(t-1) \right\} \right\} \),

\[ \hat{a}^{40,TCO}_{g,a}(t) = \begin{cases} \nabla_{g,a}^{40,TCO}(t) + \max \left\{ 0; \frac{\hat{a}^{21,TCO}_{g,a-9}{(t-9)} - \nabla_{g,a}^{21,TCO}(t)}{9} \right\} & (a \leq \hat{a}^{SS}(t)) \\ \hat{a}^{40,TCO}_{g,a}(t-1) \frac{\nabla_{g,a}^{40,TCO}(t-1)}{\hat{a}^{40,TCO}_{g,a-1}(t-1)} & (a > \hat{a}^{SS}(t)) \end{cases} \]  
(A.6.13)

with \( \nabla_{g,a}^{40,TCO}(t) = \min \left\{ \hat{a}^{21,TCO}_{g,a}(t); \max \left\{ \hat{a}^{40,TCO}_{g,a}(t-1); \hat{a}^{40,TCO}_{g,a-1}(t-1) \right\} \right\} \), where \( \hat{a}^{dur,TCO}_{g,a}(t) \) is the percentage of TCO workers of gender \( g \) and age \( a \) who had completed \( dur \) or more years of contributory career in year \( t \).

In a similar way, the following is derived for TI:

\[ \hat{a}^{15,TI}_{g,a}(t) = \begin{cases} \max \left\{ \hat{a}^{15,TI}_{g,a}(t-1); \hat{a}^{15,TI}_{g,a-1}(t-1) \right\} & (a \leq \hat{a}^{SS}(t)) \\ \hat{a}^{15,TI}_{g,a}(t-1) \frac{\hat{a}^{15,TI}_{g,a-1}(t-1)}{\hat{a}^{15,TI}_{g,a-1}(t-1)} & (a > \hat{a}^{SS}(t)) \end{cases} \]  
(A.6.14)

\[ \hat{a}^{21,TI}_{g,a}(t) = \begin{cases} \nabla_{g,a}^{21,TI}(t) + \max \left\{ 0; \frac{\hat{a}^{15,TI}_{g,a-6}{(t-6)} - \nabla_{g,a}^{21,TI}(t)}{6} \right\} & (a \leq \hat{a}^{SS}(t)) \\ \hat{a}^{21,TI}_{g,a}(t-1) \frac{\hat{a}^{21,TI}_{g,a-1}(t-1)}{\hat{a}^{21,TI}_{g,a-1}(t-1)} & (a > \hat{a}^{SS}(t)) \end{cases} \]  
(A.6.15)

with \( \nabla_{g,a}^{21,TI}(t) = \min \left\{ \hat{a}^{15,TI}_{g,a}(t); \max \left\{ \hat{a}^{21,TI}_{g,a}(t-1); \hat{a}^{21,TI}_{g,a-1}(t-1) \right\} \right\} \),
\[
\hat{S}_{g,a}(t) = \begin{cases} \\
\n\end{cases}
\]

with \( \hat{S}_{g,a}(t) = \min \{ \hat{S}_{g,a}(t); \max \{ \hat{S}_{g,a}(t-1); \hat{S}_{g,a}(t-1) \} \} \),

\[
\hat{S}_{g,a}(t) = \begin{cases} \\
\n\end{cases}
\]

with \( \hat{S}_{g,a}(t) = \min \{ \hat{S}_{g,a}(t); \max \{ \hat{S}_{g,a}(t-1); \hat{S}_{g,a}(t-1) \} \} \).

The percentages given by the previous equations allow an approximation to the average length of contributors’ careers:

\[
D_{g,a}^{TCO}(t) = \int \min \left\{ 7, \frac{a-15}{2} \right\} \left( 1 - \hat{S}_{g,a}^{15,TCO}(t) \right) + 17.5 \left( \hat{S}_{g,a}^{15,TCO}(t) - \hat{S}_{g,a}^{21,TCO}(t) \right) + 25.5 \left( \hat{S}_{g,a}^{21,TCO}(t) - \hat{S}_{g,a}^{31,TCO}(t) \right) + 35 \left( \hat{S}_{g,a}^{31,TCO}(t) - \hat{S}_{g,a}^{40,TCO}(t) \right) + 40 \hat{S}_{g,a}^{40,TCO}(t)
\]

\[
D_{g,a}^{TI}(t) = \int \min \left\{ 7, \frac{a-15}{2} \right\} \left( 1 - \hat{S}_{g,a}^{15,TI}(t) \right) + 17.5 \left( \hat{S}_{g,a}^{15,TI}(t) - \hat{S}_{g,a}^{21,TI}(t) \right) + 25.5 \left( \hat{S}_{g,a}^{21,TI}(t) - \hat{S}_{g,a}^{31,TI}(t) \right) + 35 \left( \hat{S}_{g,a}^{31,TI}(t) - \hat{S}_{g,a}^{40,TI}(t) \right) + 40 \hat{S}_{g,a}^{40,TI}(t)
\]

where:

- \( D_{g,a}^{TCO}(t) \) and \( D_{g,a}^{TI}(t) \) are the average lengths of careers in year \( t \), of TCO and TI contributors, respectively, of gender \( g \) and age \( a \);
- \( \int(\cdot) \) is the function whose result is the integer part of the argument.

As for the reference compensations for the purposes of calculating statutory new pensions, the equations are:

\[
\begin{align*}
W_{g,a}^{ref,(329/93),TCO}(t | \rho) &= \frac{1}{10} \min_{j=1}^{10} \left[ W_{g,a}^{TCO}(t-j | \rho) \cdot \frac{L_{IPC}(t)}{L_{IPC}(t-j)} \right] \\
W_{g,a}^{ref,(329/93),TI}(t) &= \frac{1}{10} \min_{j=1}^{10} \left[ W_{g,a}^{TI}(t-j | \rho) \cdot \frac{L_{IPC}(t)}{L_{IPC}(t-j)} \right]
\end{align*}
\]
\[
 w_{g,a}^{\text{ref}(35/02),TCO}(t | \rho) = \frac{1}{\min\{40; D_{g,a}^{TCO}(t)\}} \sum_{j=1}^{\min\{40; D_{g,a}^{TCO}(t)\}} \left[ w_{g,a}^{TCO}(t-j | \rho) \frac{L_{SS}^{T}(t \mid \rho)}{L_{SS}^{T}(t-j \mid \rho)} \right]
\]  
(A.6.22)

\[
 w_{g,a}^{\text{ref}(35/02),TI}(t | \rho) = \frac{1}{\min\{40; D_{g,a}^{TI}(t)\}} \sum_{j=1}^{\min\{40; D_{g,a}^{TI}(t)\}} \left[ w_{g,a}^{TI}(t-j | \rho) \frac{L_{SS}^{T}(t \mid \rho)}{L_{SS}^{T}(t-j \mid \rho)} \right]
\]  
(A.6.23)

where:
- \( w_{g,a}^{\text{ref}(329/93),TCO}(t \mid \rho) \) and \( w_{g,a}^{\text{ref}(329/93),TI}(t \mid \rho) \) are the reference compensations, as set down in Decree-Law 329/93, the first being for TCO contributors (conditional on \( \rho \)) and the second for TI contributors, of gender \( g \) and age \( i \) who retire in year \( t \) through old age or disability;
- \( w_{g,a}^{\text{ref}(35/02),TCO}(t \mid \rho) \) and \( w_{g,a}^{\text{ref}(35/02),TI}(t \mid \rho) \) are the reference compensations, as set down in Decree-Law 35/02, the first being for TCO contributors and the second for TI contributors (conditional on \( \rho \)), of gender \( g \) and age \( a \) who retire in year \( t \) through old age or disability;
- \( L^{IPC}(t) \) is the consumer price index without housing; \( L_{SS}^{T}(t \mid \rho) \) is the revaluation index, calculated in accordance with Decree-Law 35/02 (see subsection 2.5.3):

\[
 L^{SS}_{g,a}(t \mid \rho) = L^{SS}(t-1 \mid \rho) \min\left[ \frac{L^{IPC}(t)}{L^{IPC}(t-1)} + 0.005; \frac{L^{IPC}(t)}{L^{IPC}(t-1)} + 0.75 \frac{\bar{T}^{TCO}_{\Theta,\Theta}(t \mid \rho) + \bar{T}^{TI}_{\Theta,\Theta}(t \mid \rho)}{\bar{T}^{TCO}_{\Theta,\Theta}(t-1 \mid \rho) + \bar{T}^{TI}_{\Theta,\Theta}(t-1 \mid \rho)} \right]
\]  
(A.6.24)

The MISS model contains equations for new pensions differentiating for the following regimes:
- Decree-Law 329/93, the most generous, which applies to active contributors who had already completed 15 years of contributions by the end of 2001;
- Decree-Law 35/02 ("pure"), the least favourable, applicable to contributors registered in social security during and after 2002;
- "mixed" regime of Decree-Law 35/02, less favourable than the first but more favourable than the second, consisting of a weighted average of the amount of the new pension calculated according to the two previous regimes, to be applied to new pensioners registered in social security up to 2001 but without having yet completed 15 years of contributions by the end of that year;
- "mixed" regime agreed in 2006 between the government and social partners, to be in force from 2007 to 2016.

The model tries to approximate to the complexity of the rules by considering different profiles of the reference compensation of new pensioners, following the same logic as for the calculation of the average earnings of TI contributors. More precisely, the model

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5 The path to horizon of the CPI without housing is one of the model required inputs, along with the path of the GDP deflator at market prices.
considers seven earnings profiles, defined as percentages of the average of compensations calculated for each strata. The different percentages are the elements of the vector \( q = (0.125; 0.375; 0.625; 0.875; 1.25; 1.75; 3) \). Therefore, for each regime, the equations for the determination of the statutory pension as well as the actual new pension (after confronting the statutory pension with the applicable minimum pension) are the following:

i. For Decree-Law 329/93 regime:

\[
\begin{align*}
& y_{g,a}^{329/93, TCO}(j,t \mid \rho) = \max \left\{ \min \left\{ o(1)D_{g,a}^{TCO}(t) ; 0.80 \right\} ; 0.30 \right\} q(j)w^{ref(329/93), TCO}(t \mid \rho) \cdot \\
& \left[ \Pi^{velh}(t) \right]_{\max \left\{ a^{SS}(t) - a; 0 \right\}} \cdot \max \left\{ 1-t(t \geq 2008)\Phi; \frac{V_{1,65}(2006) + V_{2,65}(2006)}{V_{1,65}(t-1) + V_{2,65}(t-1)} \right\} \\
& y_{g,a}^{329/93, TI}(j,t \mid \rho) = \max \left\{ \min \left\{ o(1)D_{g,a}^{TI}(t) ; 0.80 \right\} ; 0.30 \right\} q(j)w^{ref(329/93), TI}(t \mid \rho) \cdot \\
& \left[ \Pi^{velh}(t) \right]_{\max \left\{ a^{SS}(t) - a; 0 \right\}} \cdot \max \left\{ 1-t(t \geq 2008)\Phi; \frac{V_{1,65}(2006) + V_{2,65}(2006)}{V_{1,65}(t-1) + V_{2,65}(t-1)} \right\}
\end{align*}
\]  

(A.6.25) and (A.6.26)

\[
\begin{align*}
& y_{g,a}^{329/93, TCO}(t \mid \rho) = \sum_{j=1}^{7} \alpha_{j}^{TCO} \left[ t(D_{g,a}^{TCO}(t) < 15) \max \left\{ y_{g,a}^{329/93, TCO}(j,t \mid \rho); x^{15, min(SS)}(t) \right\} + \\
& + t(15 \leq D_{g,a}^{TCO}(t) < 21) \max \left\{ y_{g,a}^{329/93, TCO}(j,t \mid \rho); x^{15-20, min(SS)}(t) \right\} + \\
& + t(21 \leq D_{g,a}^{TCO}(t) < 31) \max \left\{ y_{g,a}^{329/93, TCO}(j,t \mid \rho); x^{21-30, min(SS)}(t) \right\} + \\
& + t(D_{g,a}^{TCO}(t) \geq 40) \max \left\{ y_{g,a}^{329/93, TCO}(j,t \mid \rho); x^{240, min(SS)}(t) \right\} \right] \\
& y_{g,a}^{329/93, TI}(t \mid \rho) = \sum_{j=1}^{7} \alpha_{j}^{TI} \left[ t(D_{g,a}^{TI}(t) < 15) \max \left\{ y_{g,a}^{329/93, TI}(j,t \mid \rho); x^{15, min(SS)}(t) \right\} + \\
& + t(15 \leq D_{g,a}^{TI}(t) < 21) \max \left\{ y_{g,a}^{329/93, TI}(j,t \mid \rho); x^{15-20, min(SS)}(t) \right\} + \\
& + t(21 \leq D_{g,a}^{TI}(t) < 31) \max \left\{ y_{g,a}^{329/93, TI}(j,t \mid \rho); x^{21-30, min(SS)}(t) \right\} + \\
& + t(D_{g,a}^{TI}(t) \geq 40) \max \left\{ y_{g,a}^{329/93, TI}(j,t \mid \rho); x^{240, min(SS)}(t) \right\} \right]
\end{align*}
\]  

(A.6.27) and (A.6.28)

\[
\begin{align*}
& x_{g,a}^{velh(329/93), SS}(t \mid \rho) = x_{g,a}^{329/93, TCO}(t \mid \rho)\nu_{g,a}^{TCO}(t \mid \rho) + x_{g,a}^{329/93, TI}(t \mid \rho)\nu_{g,a}^{TI}(t) \\
& x_{g,a}^{inval(329/93), SS}(t \mid \rho) = x_{g,a}^{329/93, TCO}(t \mid \rho)\nu_{g,a}^{TCO}(t \mid \rho) + x_{g,a}^{329/93, TI}(t \mid \rho)\nu_{g,a}^{TI}(t)
\end{align*}
\]  

(A.6.29) and (A.6.30)

where:
\[ y_{g,a}^{329/93,T} (j,t | \rho) \] is the approximation to the amount (in euros, conditional on \( \rho \)) of the old age or disability statutory pension, i.e. the earnings-related pension based on the worker’s contributory career (without taking minimum pensions into account) that a contributor TCO of gender \( g \) and age \( a \) would receive under the terms of Decree-Law 329/93 if he/she retired in year \( t \) with a career of duration \( D_{g,a}^{T} \( t) \) and reference compensations of \( q(j)w_{g,a}^{ref,T} \( t | \rho) \);

\[ y_{g,a}^{329/93,T,I} (j,t | \rho) , \text{idem} \] for TI contributors (with duration of the contributory career \( D_{g,a}^{T} \( t) \) and reference earnings \( q(j)w_{g,a}^{ref,T} \( t | \rho) \); \( o(1) \) is the first element of vector \( o = (0.02; 0.021; 0.022; 0.0225; 0.023) \) which includes the various legal annual accrual rates of new pensions (set down in Decrees-Law 329/93 and 35/02);

\[ 0 \leq \Pi^{vel}(t) \leq 1 \] is a factor that takes into account the additional annual penalty imposed on early retirements of old age in year \( t \), using the situation in 2005 as the benchmark (by construction, in the case of disability pensions, \( \Pi^{vel}(t) = 1 \));

\( \Phi \) is a binary variable that assumes the value 1 (value 0) when the effect of the "sustainability factor", in force from 2008, is incorporated (not incorporated) in the model on the extreme assumption that the financial penalty on the pension value will not impact on decisions regarding retirement age;

\( V_{g,65}(t) \) is the indicator for life expectancy at 65 years in year \( t \) for individuals of gender \( g \);

\( x_{g,a}^{329/93,T} (\rho) \) is the approximation to the average amount of the new pension (in euros, conditional on \( \rho \)) for TCO contributors of the strata \((g,a)\), after aggregating the 7 profiles and taking into account the minimum pensions grid, which depends on the contributory career duration;

\( x_{g,a}^{329/93,T,I} (\rho) , \text{idem} \) for TI contributors;

\( x_{g,a}^{15, \text{min}(SS)} (t), x_{g,a}^{15-20, \text{min}(SS)} (t), x_{g,a}^{21-30, \text{min}(SS)} (t), x_{g,a}^{31-39, \text{min}(SS)} (t) \) and \( x_{g,a}^{40, \text{min}(SS)} (t) \) are the annual minimum pensions (in euros) in force in year \( t \) for SPSS pensioners with contributory careers of, respectively, less than 15 years, 15 to 20 years, 21 to 30 years, 31 to 39 years and more than 40 years of career;

\( x_{g,a}^{\text{vel}(329/93),SS} (t | \rho) \) is the approximation to the average amount of old age pensions (in euros, conditional on \( \rho \)) for the set of new pensioners of the strata \((g,a)\), originating both from TCO contributors and from TI contributors, if the new pensions were all calculated in accordance with Decree-Law 329/93;

\( x_{g,a}^{\text{vel}(329/93),SS} (t | \rho) , \text{idem} \) for new disability pensioners.

ii. For the "pure" regime of Decree-Law 35/02:

\[ y_{g,a}^{35/02,T} (j,t | \rho) = t(D_{g,a}^{T} (t) \leq 20) \max \{ o(1)D_{g,a}^{T} (t); 0.30 \} q(j)w_{g,a}^{ref}(35/02,T) (t | \rho) + \]
\[ + t(D_{g,a}^{TCO} (t) > 20) \min \left\{ D_{g,a}^{TCO} (t); 40 \right\} \left\{ q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho) \phi(5) \right\} \frac{q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho) \phi(5) \left( q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho) \leq 1.1w_{\min}^{TCO} (t) \right)}{w_{\min}^{TCO} (t)} \]

\[ + \left[ 1.1w_{\min}^{TCO} (t) \phi(5) + \left( q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho) - 1.1w_{\min}^{TCO} (t) \right) \phi(4) \right] \frac{1.1 < \frac{q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho)}{w_{\min}^{TCO} (t)} \leq 2}{w_{\min}^{TCO} (t)} \]

\[ + \left[ (1.1\phi(5) + 0.9\phi(4)) w_{\min}^{TCO} (t) + \left( q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho) - 2w_{\min}^{TCO} (t) \right) \phi(3) \right] \frac{2 < \frac{q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho)}{w_{\min}^{TCO} (t)} \leq 4}{w_{\min}^{TCO} (t)} \]

\[ + \left[ (1.1\phi(5) + 0.9\phi(4) + 2\phi(3)) w_{\min}^{TCO} (t) + \left( q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho) - 4w_{\min}^{TCO} (t) \right) \phi(2) \right] \frac{4 < \frac{q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho)}{w_{\min}^{TCO} (t)} \leq 8}{w_{\min}^{TCO} (t)} \]

\[ + \left[ (1.1\phi(5) + 0.9\phi(4) + 2\phi(3) + 4\phi(2)) w_{\min}^{TCO} (t) + \left( q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho) - 8w_{\min}^{TCO} (t) \right) \phi(1) \right] \frac{8 < \frac{q(j)w_{g,a}^{ref (35/02),TCO} (t | \rho)}{w_{\min}^{TCO} (t)} \leq 9}{w_{\min}^{TCO} (t)} \]

\[ \cdot \left[ \Pi^{velh} (t) \right]_{\max \left[ \delta^{55} (t) - a \right]} \cdot \max \left\{ 1 - t (t \geq 2008) \phi; \frac{V_{1,65} (2006) + V_{2,65} (2006)}{V_{1,65} (t - 1) + V_{2,65} (t - 1)} \right\} \] (A.6.31)

\[ y_{g,a}^{35/02,TT} (j, t | \rho) = t(D_{g,a}^{TT} (t) \leq 20) \max \left\{ \phi(1)D_{g,a}^{IT} (t); 0.3 \right\} q(j)w_{g,a}^{ref (35/02),TT} (t | \rho) + \]

\[ + t(D_{g,a}^{IT} (t) > 20) \min \left\{ D_{g,a}^{IT} (t); 40 \right\} \left\{ q(j)w_{g,a}^{ref (35/02),IT} (t | \rho) \phi(5) \right\} \frac{q(j)w_{g,a}^{ref (35/02),IT} (t | \rho) \phi(5) \left( q(j)w_{g,a}^{ref (35/02),IT} (t | \rho) \leq 1.1w_{\min}^{IT} (t) \right)}{w_{\min}^{IT} (t)} \]

\[ + \left[ 1.1w_{\min}^{IT} (t) \phi(5) + \left( q(j)w_{g,a}^{ref (35/02),IT} (t | \rho) - 1.1w_{\min}^{IT} (t) \right) \phi(4) \right] \frac{1.1 < \frac{q(j)w_{g,a}^{ref (35/02),IT} (t | \rho)}{w_{\min}^{IT} (t)} \leq 2}{w_{\min}^{IT} (t)} \]

\[ + \left[ (1.1\phi(5) + 0.9\phi(4)) w_{\min}^{IT} (t) + \left( q(j)w_{g,a}^{ref (35/02),IT} (t | \rho) - 2w_{\min}^{IT} (t) \right) \phi(3) \right] \frac{2 < \frac{q(j)w_{g,a}^{ref (35/02),IT} (t | \rho)}{w_{\min}^{IT} (t)} \leq 4}{w_{\min}^{IT} (t)} \]

\[ + \left[ (1.1\phi(5) + 0.9\phi(4) + 2\phi(3)) w_{\min}^{IT} (t) + \left( q(j)w_{g,a}^{ref (35/02),IT} (t | \rho) - 4w_{\min}^{IT} (t) \right) \phi(2) \right] \frac{4 < \frac{q(j)w_{g,a}^{ref (35/02),IT} (t | \rho)}{w_{\min}^{IT} (t)} \leq 8}{w_{\min}^{IT} (t)} \]

\[ + \left[ (1.1\phi(5) + 0.9\phi(4) + 2\phi(3) + 4\phi(2)) w_{\min}^{IT} (t) + \left( q(j)w_{g,a}^{ref (35/02),IT} (t | \rho) - 8w_{\min}^{IT} (t) \right) \phi(1) \right] \frac{8 < \frac{q(j)w_{g,a}^{ref (35/02),IT} (t | \rho)}{w_{\min}^{IT} (t)} \leq 9}{w_{\min}^{IT} (t)} \]

\[ \cdot \left[ \Pi^{velh} (t) \right]_{\max \left[ \delta^{55} (t) - a \right]} \cdot \max \left\{ 1 - t (t \geq 2008) \phi; \frac{V_{1,65} (2006) + V_{2,65} (2006)}{V_{1,65} (t - 1) + V_{2,65} (t - 1)} \right\} \] (A.6.32)

\[ x_{g,a}^{35/02,TCO} (t | \rho) = \sum_{j=1}^{2} \delta_{j} \left( D_{g,a}^{TCO} (t) < 15 \right) \max \left\{ y_{g,a}^{35/02,TCO} (j, t | \rho) ; \chi_{<15,\min (SS)}^{15} (t) \right\} + \]

\[ + t(15 \leq D_{g,a}^{TCO} (t) < 21) \max \left\{ y_{g,a}^{35/02,TCO} (j, t | \rho) ; \chi_{15-20,\min (SS)}^{15} (t) \right\} + \]

\[ + t(21 \leq D_{g,a}^{TCO} (t) < 31) \max \left\{ y_{g,a}^{35/02,TCO} (j, t | \rho) ; \chi_{21-30,\min (SS)}^{15} (t) \right\} + \]

\[ + t(31 \leq D_{g,a}^{TCO} (t) < 40) \max \left\{ y_{g,a}^{35/02,TCO} (j, t | \rho) ; \chi_{31-39,\min (SS)}^{15} (t) \right\} + \]

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\[ +t\left(D^{\text{TCO}}_{g,a}(t) \geq 40\right) \max \left\{ y^{35/02,\text{TCO}}_{g,a}(j,t | \rho); x^{\leq 40,\min(\text{SS})}(t) \right\} \] (A.6.33)

\[ x^{35/02,\text{TI}}_{g,a}(t | \rho) = \sum_{j=1}^{7} \alpha^{j^{\text{TI}}} \left\{ \left( D^{\text{TI}}_{g,a}(t) < 15 \right) \max \left\{ y^{35/02,\text{TI}}_{g,a}(j,t | \rho); x^{\leq 15,\min(\text{SS})}(t) \right\} + \\
+ \left( 15 \leq D^{\text{TI}}_{g,a}(t) < 21 \right) \max \left\{ y^{35/02,\text{TI}}_{g,a}(j,t | \rho); x^{15-20,\min(\text{SS})}(t) \right\} + \\
+ \left( 21 \leq D^{\text{TI}}_{g,a}(t) < 31 \right) \max \left\{ y^{35/02,\text{TI}}_{g,a}(j,t | \rho); x^{21-30,\min(\text{SS})}(t) \right\} + \\
+ \left( 31 \leq D^{\text{TI}}_{g,a}(t) \geq 40 \right) \max \left\{ y^{35/02,\text{TI}}_{g,a}(j,t | \rho); x^{\geq 40,\min(\text{SS})}(t) \right\} \right\} \] (A.6.34)

\[ x^{\text{veh}(35/02),\text{SS}}_{g,a}(t | \rho) = \frac{x^{35/02,\text{TCO}}_{g,a}(t | \rho) \cdot y^{35/02,\text{TCO}}_{g,a}(t | \rho) + x^{35/02,\text{TI}}_{g,a}(t | \rho) \cdot y^{35/02,\text{TI}}_{g,a}(t | \rho)}{y^{\text{TCO}}_{g,a}(t | \rho) + y^{\text{TI}}_{g,a}(t | \rho)} \] (A.6.35)

where the notations are exactly the same as for the regime of Decree-Law 329/93.

iii. For the "mixed" regime of Decree-Law 35/02:

This transitory regime is based on a weighted average of the values calculated in terms of the rules of each of the previous "pure" regimes, with end-2001 being the point of reference for the calculation of the weights.

\[ y^{\text{mx}2001,\text{TCO}}_{g,a}(j,t | \rho) = \frac{1}{\min\left\{ D^{\text{TCO}}_{g,a}(t); 40 \right\}} \left\{ t - \Gamma \left( t - \min\left\{ D^{\text{TCO}}_{g,a}(t); 40 \right\}; 2001 \right) \right\} y^{35/02,\text{TCO}}_{g,a}(j,t | \rho) + \\
+ \left[ 2001 - \min\left\{ t - \min\left\{ D^{\text{TCO}}_{g,a}(t); 40 \right\}; 2001 \right\} \right] y^{35/02,\text{TCO}}_{g,a}(j,t | \rho) \cdot \\
\cdot \left[ \Pi^{\text{veh}}(t) \cdot \max\left\{ a^{\text{veh}}(t) - a, 0 \right\} \cdot \max\left\{ 1 - (t \geq 2008) \Phi; \frac{V_{1.65}(2006) + V_{2.65}(2006)}{V_{1.65}(t-1) + V_{2.65}(t-1)} \right\} \right] \] (A.6.37)

\[ y^{\text{mx}2001,\text{TI}}_{g,a}(j,t | \rho) = \frac{1}{\min\left\{ D^{\text{TI}}_{g,a}(t); 40 \right\}} \left\{ t - \Gamma \left( t - \min\left\{ D^{\text{TI}}_{g,a}(t); 40 \right\}; 2001 \right) \right\} y^{35/02,\text{TI}}_{g,a}(j,t | \rho) + \\
+ \left[ 2001 - \min\left\{ t - \min\left\{ D^{\text{TI}}_{g,a}(t); 40 \right\}; 2001 \right\} \right] y^{35/02,\text{TI}}_{g,a}(j,t | \rho) \cdot \\
\]
\[
\left[ \Pi^{\text{veh}(t)} \right]_{\max}^{\left[ \alpha^{\text{veh}}(t) - a, 0 \right]} \cdot \max \left\{ 1 - t(t \geq 2008) \Phi; \frac{V_{1,65}(2006) + V_{2,65}(2006)}{V_{1,65}(t-1) + V_{2,65}(t-1)} \right\}
\] (A.6.38)

\[
x_{g,a}^{\text{max}2001,\text{TCO}}(t | \rho) = \sum_{j=1}^{7} \alpha_{j, a}^{\text{TCO}} \left[ t \left( D_{g,a}^{\text{TCO}}(t) < 15 \right) \right] \max \left\{ y_{g,a}^{\text{max}2001,\text{TCO}}(j, t | \rho); \chi^{15, \min(\text{SS})}(t) \right\} + t(15 \leq D_{g,a}^{\text{TCO}}(t) < 21) \max \left\{ y_{g,a}^{\text{max}2001,\text{TCO}}(j, t | \rho); \chi^{15-20, \min(\text{SS})}(t) \right\} + t(21 \leq D_{g,a}^{\text{TCO}}(t) < 31) \max \left\{ y_{g,a}^{\text{max}2001,\text{TCO}}(j, t | \rho); \chi^{21-30, \min(\text{SS})}(t) \right\} + t(31 \leq D_{g,a}^{\text{TCO}}(t) < 40) \max \left\{ y_{g,a}^{\text{max}2001,\text{TCO}}(j, t | \rho); \chi^{31-39, \min(\text{SS})}(t) \right\} + t(D_{g,a}^{\text{TCO}}(t) \geq 40) \max \left\{ y_{g,a}^{\text{max}2001,\text{TCO}}(j, t | \rho); \chi^{20, \min(\text{SS})}(t) \right\}
\] (A.6.39)

\[
x_{g,a}^{\text{max}2001,\text{TI}}(t | \rho) = \sum_{j=1}^{7} \alpha_{j, a}^{\text{TI}} \left[ t \left( D_{g,a}^{\text{TI}}(t) < 15 \right) \right] \max \left\{ y_{g,a}^{\text{max}2001,\text{TI}}(j, t | \rho); \chi^{15, \min(\text{SS})}(t) \right\} + t(15 \leq D_{g,a}^{\text{TI}}(t) < 21) \max \left\{ y_{g,a}^{\text{max}2001,\text{TI}}(j, t | \rho); \chi^{15-20, \min(\text{SS})}(t) \right\} + t(21 \leq D_{g,a}^{\text{TI}}(t) < 31) \max \left\{ y_{g,a}^{\text{max}2001,\text{TI}}(j, t | \rho); \chi^{21-30, \min(\text{SS})}(t) \right\} + t(31 \leq D_{g,a}^{\text{TI}}(t) < 40) \max \left\{ y_{g,a}^{\text{max}2001,\text{TI}}(j, t | \rho); \chi^{31-39, \min(\text{SS})}(t) \right\} + t(D_{g,a}^{\text{TI}}(t) \geq 40) \max \left\{ y_{g,a}^{\text{max}2001,\text{TI}}(j, t | \rho); \chi^{30, \min(\text{SS})}(t) \right\}
\] (A.6.40)

\[
x_{g,a}^{\text{veeh}(\text{ms}2001),\text{SS}}(t | \rho) = x_{g,a}^{\text{max}2001,\text{TCO}}(t | \rho)v_{g,a}^{\text{TCO}}(t | \rho) + x_{g,a}^{\text{max}2001,\text{TI}}(t | \rho)v_{g,a}^{\text{TI}}(t | \rho) + x_{g,a}^{\text{max}2001,\text{TI}}(t | \rho)\theta_{g,a}^{\text{TI}}(t | \rho)
\] (A.6.41)

\[
x_{g,a}^{\text{veeh}(\text{ms}2001),\text{SS}}(t | \rho) = x_{g,a}^{\text{max}2001,\text{TCO}}(t | \rho)v_{g,a}^{\text{TCO}}(t | \rho) + x_{g,a}^{\text{max}2001,\text{TI}}(t | \rho)v_{g,a}^{\text{TI}}(t | \rho) + x_{g,a}^{\text{max}2001,\text{TI}}(t | \rho)\theta_{g,a}^{\text{TI}}(t | \rho)
\] (A.6.42)

where the notations are also the same as for Decree-Law 329/93.

iv. For the "mixed" regime to be in force from 2007 to 2016:

The difference between this mixed transitory regime and the previous one is related to the reference year for the calculation of the weights: end-2006 instead of end-2001.

\[
y_{g,a}^{\text{max}2006,\text{TCO}}(j, t | \rho) = \frac{1}{\min \left\{ D_{g,a}^{\text{TCO}}(t); 40 \right\}} \left( t - \max \left\{ t - \min \left\{ D_{g,a}^{\text{TCO}}(t); 40 \right\}; 2006 \right\} \right) y_{g,a}^{35/02,\text{TCO}}(j, t | \rho)
\]

\[
+ \left( 2006 - \min \left\{ t - \min \left\{ D_{g,a}^{\text{TCO}}(t); 40 \right\}; 2006 \right\} \right) y_{g,a}^{329/93,\text{TCO}}(j, t | \rho)
\]

\[
\left[ \Pi^{\text{veh}(t)} \right]_{\max}^{\left[ \alpha^{\text{veh}}(t) - a, 0 \right]} \cdot \max \left\{ 1 - t(t \geq 2008) \Phi; \frac{V_{1,65}(2006) + V_{2,65}(2006)}{V_{1,65}(t-1) + V_{2,65}(t-1)} \right\}
\] (A.6.43)
\[
\frac{1}{\min \{D_{g,a}^{TT}(t); 40\}} \left[ t - \max \left\{ t - \min \{D_{g,a}^{TT}(t); 40\}; 2006 \right\} y_{g,a}^{35/02,TT}(j, t | \rho) + 2006 - \min \{D_{g,a}^{TT}(t); 40\} y_{g,a}^{329/93,TT}(j, t | \rho) \right] \\
\cdot \left[ \Pi^{velh}(t) \right]^{\max \{a^{329(t)-a,0}\}} \cdot \max \left\{ 1 - t(t \geq 2008) \Phi; \frac{V_{1,65}(2006) + V_{2,65}(2006)}{V_{1,65}(t-1) + V_{2,65}(t-1)} \right\} (A.6.44)
\]

\[
x_{g,a}^{\text{mx},TCo}(j, t | \rho) = \sum_{j=1}^{7} a_j^{\text{TCo}} \left[ t(D_{g,a}^{TCo}(t) < 15) \max \left\{ y_{g,a}^{\text{mx},TCo}(j, t | \rho); x^{15, \min\{SS\}}(t) \right\} + t(15 \leq D_{g,a}^{TCo}(t) < 21) \max \left\{ y_{g,a}^{\text{mx},TCo}(j, t | \rho); x^{15-20, \min\{SS\}}(t) \right\} + t(21 \leq D_{g,a}^{TCo}(t) < 31) \max \left\{ y_{g,a}^{\text{mx},TCo}(j, t | \rho); x^{21-30, \min\{SS\}}(t) \right\} + t(31 \leq D_{g,a}^{TCo}(t) < 40) \max \left\{ y_{g,a}^{\text{mx},TCo}(j, t | \rho); x^{31-39, \min\{SS\}}(t) \right\} + t(D_{g,a}^{TCo}(t) \geq 40) \max \left\{ y_{g,a}^{\text{mx},TCo}(j, t | \rho); x^{\geq 40, \min\{SS\}}(t) \right\} \right] (A.6.45)
\]

\[
x_{g,a}^{\text{mx},TT}(j, t | \rho) = \sum_{j=1}^{7} a_j^{\text{TT}} \left[ t(D_{g,a}^{TT}(t) < 15) \max \left\{ y_{g,a}^{\text{mx},TT}(j, t | \rho); x^{15, \min\{SS\}}(t) \right\} + t(15 \leq D_{g,a}^{TT}(t) < 21) \max \left\{ y_{g,a}^{\text{mx},TT}(j, t | \rho); x^{15-20, \min\{SS\}}(t) \right\} + t(21 \leq D_{g,a}^{TT}(t) < 31) \max \left\{ y_{g,a}^{\text{mx},TT}(j, t | \rho); x^{21-30, \min\{SS\}}(t) \right\} + t(31 \leq D_{g,a}^{TT}(t) < 40) \max \left\{ y_{g,a}^{\text{mx},TT}(j, t | \rho); x^{31-39, \min\{SS\}}(t) \right\} + t(D_{g,a}^{TT}(t) \geq 40) \max \left\{ y_{g,a}^{\text{mx},TT}(j, t | \rho); x^{\geq 40, \min\{SS\}}(t) \right\} \right] (A.6.46)
\]

\[
x_{g,a}^{\text{velh},(\text{mx},2006)}(j, t | \rho) = \frac{x_{g,a}^{\text{mx},TCo}(j, t | \rho)v_{g,a}^{\text{TCo}}(t | \rho) + x_{g,a}^{\text{mx},TT}(j, t | \rho)v_{g,a}^{\text{TT}}(t | \rho)}{v_{g,a}^{\text{TCo}}(t | \rho) + v_{g,a}^{\text{TT}}(t | \rho)} (A.6.47)
\]

\[
x_{g,a}^{\text{velh},(\text{mx},2006)}(j, t | \rho) = \frac{x_{g,a}^{\text{mx},TCo}(j, t | \rho)v_{g,a}^{\text{TCo}}(t | \rho) + x_{g,a}^{\text{mx},TT}(j, t | \rho)i_{g,a}^{\text{TT}}(t | \rho)}{v_{g,a}^{\text{TCo}}(t | \rho) + i_{g,a}^{\text{TT}}(t | \rho)} (A.6.48)
\]

In the MISS model the amounts of the new old age and disability pensions for the four regimes legally in force are calculated for each strata \((g, a)\) and each year to horizon. Then the model weights these values according to the relative importance assumed for each year \(t\):

\[
x_{g,a}^{\text{velh},SS}(t | \rho) = x_{g,a}^{\text{velh},SS}(t-1 | \rho) \left\{ \Phi_{SS}^{329/93}(t)x_{g,a}^{\text{velh}(329/93),SS}(t | \rho) + \Phi_{35/02}^{35/02}(t)x_{g,a}^{\text{velh}(35/02),SS}(t | \rho) + \Phi_{329/93}^{mx2001}(t)x_{g,a}^{\text{velh}(mx2001),SS}(t | \rho) + \left(1 - \Phi_{329/93}^{329/93}(t) - \Phi_{35/02}^{35/02}(t) - \Phi_{mx2001}^{mx2001}(t)\right)x_{g,a}^{\text{velh}(mx2006),SS}(t | \rho) \right\}
\]

In the MISS model the amounts of the new old age and disability pensions for the four regimes legally in force are calculated for each strata \((g, a)\) and each year to horizon. Then the model weights these values according to the relative importance assumed for each year \(t\):

\[
x_{g,a}^{\text{velh},SS}(t | \rho) = x_{g,a}^{\text{velh},SS}(t-1 | \rho) \left\{ \Phi_{SS}^{329/93}(t)x_{g,a}^{\text{velh}(329/93),SS}(t | \rho) + \Phi_{35/02}^{35/02}(t)x_{g,a}^{\text{velh}(35/02),SS}(t | \rho) + \Phi_{329/93}^{mx2001}(t)x_{g,a}^{\text{velh}(mx2001),SS}(t | \rho) + \left(1 - \Phi_{329/93}^{329/93}(t) - \Phi_{35/02}^{35/02}(t) - \Phi_{mx2001}^{mx2001}(t)\right)x_{g,a}^{\text{velh}(mx2006),SS}(t | \rho) \right\}
\]
+\left\{\varrho^{35/02}(t-1)x_{g,a}^{\text{velh}(35/02),SS}(t-1|\rho)+\varrho^{329/93}(t-1)x_{g,a}^{\text{velh}(329/93),SS}(t-1|\rho)+\varrho^{\text{mx}2001}(t-1)x_{g,a}^{\text{velh}(\text{mx}2001),SS}(t-1|\rho)\right\}

\left\{\varrho^{35/02}(t-1)x_{g,a}^{\text{velh}(35/02),SS}(t-1|\rho)+\varrho^{\text{mx}2001}(t-1)x_{g,a}^{\text{velh}(\text{mx}2001),SS}(t-1|\rho)\right\}

(A.6.49)

where:

- $\varrho^{329/93}(t), \varrho^{35/02}(t), \varrho^{\text{mx}2001}(t)$ and $\varrho^{\text{mx}2006}(t) = 1 - \varrho^{329/93}(t) - \varrho^{35/02}(t) - \varrho^{\text{mx}2001}(t)$ are the proportion of contributors who retire in year $t$, under the terms of, respectively, the Decree-Law 329/93, the new regime defined for Decree-Law 35/02, the "mixed" regime of the same diploma and the "mixed" regime agreed between the government and social partners in October 2006;

- $x_{g,a}^{\text{velh},SS}(t | \rho)$ and $x_{g,a}^{\text{velh},SS}(t | \rho)$ are the average amounts (in euros, conditional on $\rho$) projected respectively for new old age and disability pensions, after the relative importance of the various legal regimes has been taken into consideration.

### A.6.4 New old age and disability pensions - SPCGA

The lengths of the contributory careers of SPCGA new old age and disability pensioners are projected using the available data for the base year and the following dynamic equation:

$$D_{g,a}^{CGA}(t | \rho) = \int \min \left\{ \frac{D_{g,a}^{CGA}(t-1 | \rho) + 1}{1 + (\Xi - 1) \left( \frac{\tilde{N}_{g,a}^{CGA}(t | \rho) + \tilde{I}_{g,a}^{CGA}(t | \rho)}{C_{g,a}^{CGA}(t | \rho) + \tilde{N}_{g,a}^{CGA}(t | \rho) + \tilde{I}_{g,a}^{CGA}(t | \rho)} \right) t} ; T_{CGA}^{t}(t); a - 15 \right\} dt$$

(A.6.51)

where:

- $D_{g,a}^{CGA}(t | \rho)$ is the average length of service in year $t$ for active CGA contributors of gender $g$ and age $a$ (conditional on $\rho$);

- $\Xi$ is a parameter ($\geq 1$) defined as the ratio between the average length of service of new pensioners in strata $(g, a)$ and the average length of service of all active contributors in that strata;
\[-1 - \Phi^{329/93}(t) - \Phi^{35/02}(t) - \Phi^{39/01}(t) T^{CGA}(t) \] is the legally established minimum contributory career length required for receiving a full pension through the SPCGA.

Note that for ages under the legal age of retirement, the first part of the expression of equation (A.6.51) results simply from solving the approximate equality in order to \( D_{g,a}^{CGA}(t) \):

\[
D_{g,a}^{CGA}(t-1 | \rho) + 1 = \frac{1}{C_{g,a}^{CGA}(t | \rho) + \dot{V}_{g,a}^{CGA}(t | \rho) + \dot{I}_{g,a}^{CGA}(t | \rho)} \cdot \left[ C_{g,a}^{CGA}(t | \rho) D_{g,a}^{CGA}(t | \rho) + \left( \dot{V}_{g,a}^{CGA}(t | \rho) + \dot{I}_{g,a}^{CGA}(t | \rho) \right) \Xi D_{g,a}^{CGA}(t | \rho) \right]
\]

This approximate relationship only means that if the new pensioners were to continue to be found in the strata, and if the effects of mortality and of new registrations were taken out, then the average career length in the strata \((g, a)\) in year \(t\) would increase by 1 compared to the strata \((g, a-1)\) in year \(t-1\).

Once the average career length of SPCGA contributors is determined for the strata \((g, a)\) by equation (A.6.51), the average career length of new pensioners from the same strata, \( \bar{D}_{g,a}^{CGA}(t | \rho) \) can be obtained for \(t \geq 2006\) (the values for 2005 being observed) through the equation:

\[
\bar{D}_{g,a}^{CGA}(t | \rho) = \frac{1}{\int \left[ 1 + (a \leq \hat{a}^{SS}(t)) (\Xi - 1) \right] D_{g,a}^{CGA}(t-1 | \rho) } \int \left[ 1 + (a \leq \hat{a}^{SS}(t-1)) (\Xi - 1) \right] D_{g,a}^{CGA}(t-1 | \rho) \] \hspace{1cm} (A.6.52)

In terms of the reference compensation relevant for computing the new old age and disability pensions, three cases have to be taken into account:

- For contributors registered in the CGA after 1994, the reference compensation is calculated by means of the same expression as given for the SPSS in the “pure” regime of Decree-Law 35/02:

\[
w_{g,a}^{ref(35/02),CGA}(t | \rho) = \frac{1}{\bar{D}_{g,a}^{CGA}(t | \rho)} \sum_{j=1}^{\bar{D}_{g,a}^{CGA}(t | \rho)} \left[ w_{g,a-j}^{CGA}(t-j) \frac{L_{SS}^{(t | \rho)}}{L_{SS}^{(t-j | \rho)}} \right] \] \hspace{1cm} (A.6.53)

- For contributors registered in the CGA up to 1993, the reference compensation required for calculation of the new pension first component laid down in the Estatuto de Aposentação is given approximately by the following expression:

\[\text{For simplification, the mortality of SPCGA active contributors is not considered, and it is assumed that there are no new registrations in SPCGA when other contributors of the same age are retiring. In any case, there is in practice negligible mortality for ages under the legal retirement age. Moreover, the second assumption is true when the CGA is closed to new registrations (i.e. when } \rho = 0 \text{).}

\[\text{Note that the index used to revalue past earnings } (L_{SS}^{(t | \rho)}) \text{ is identical to the revaluation index defined for the SPSS.}\]
- Finally, for contributors registered up to 1993 and who have not completed up to 2005 the period of complete service, the reference compensation needed for calculation of the new pension second component laid down in the *Estatuto de Aposentação* is given by the following expression:

\[
W_{g,a}^{ref(EA-2),CGA}(t | \rho) = \frac{1}{\min\{t-2005; \bar{D}_{g,a}^{CGA}(t | \rho)\}} \sum_{j=1}^{\min\{t-2005; \bar{D}_{g,a}^{CGA}(t | \rho)\}} w_{g,a,j}^{CGA}(t-j) \frac{L_{SS}(t-j | \rho)}{L_{SS}(t-j | \rho)}
\]  

(A.6.55)

The latter formula simply restricts the equation (A.6.53) to the years of the contributory career after 2005.

On the basis of the calculations for the duration of the contributory career of new pensioners and the reference compensations, the model determines the old age or disability pension for a new pensioner of the strata \((g, a)\) according to the two main rules that might be applicable:

i. **Contributors registered after 1993** (Decree-Law 35/02, applied to the SPCGA)

\[
\begin{align*}
J_{g,a}^{35/02,CGA}(t | \rho) & = \bar{D}_{g,a}^{CGA}(t | \rho) \left[ w_{g,a}^{ref(35/02),CGA}(t | \rho) \sigma(5) t \left( w_{g,a}^{ref(35/02),CGA}(t | \rho) \leq 1.1 \min(t) \right) + \\
& + \left[ 1.1 \min(t) \sigma(5) + \left( w_{g,a}^{ref(35/02),CGA}(t | \rho) - 1.1 \min(t) \right) \sigma(4) \right] t \left( 1.1 < \frac{w_{g,a}^{ref(35/02),CGA}(t | \rho)}{\min(t)} \leq 2 \right) + \\
& + \left[ (1.1 \sigma(5) + 0.9 \sigma(4)) \min(t) + \left( w_{g,a}^{ref(35/02),CGA}(t | \rho) - 2 \min(t) \right) \sigma(3) \right] t \left( 2 < \frac{w_{g,a}^{ref(35/02),CGA}(t | \rho)}{\min(t)} \leq 4 \right) + \\
& + \left[ (1.1 \sigma(5) + 0.9 \sigma(4) + 2 \sigma(3)) \min(t) + \left( w_{g,a}^{ref(35/02),CGA}(t | \rho) - 4 \min(t) \right) \sigma(2) \right] t \left( 4 < \frac{w_{g,a}^{ref(35/02),CGA}(t | \rho)}{\min(t)} \leq 8 \right) + \\
& + \left[ (1.1 \sigma(5) + 0.9 \sigma(4) + 2 \sigma(3) + 4 \sigma(2)) \min(t) + \left( w_{g,a}^{ref(35/02),CGA}(t | \rho) - 8 \min(t) \right) \sigma(1) \right] t \left( 8 < \frac{w_{g,a}^{ref(35/02),CGA}(t | \rho)}{\min(t)} \right) \right] \left( \frac{w_{g,a}^{ref(35/02),CGA}(t | \rho)}{\min(t)} \right) \\
& \cdot \left[ \prod_{t=t}^{t-1} \left( \max\{2008 - t, 0\} \cdot \frac{v_{165}(2006) + v_{165}(2006)}{v_{165}(t-1) + v_{165}(t-1)} \right) \right]
\end{align*}
\]  

(A.6.56)
The notations are identical to those used for the SPSS. The only point worth noting is that the grid of minimum pensions for the SPCGA is different from the SPSS grid.

ii. Contributors registered up to 1993 (Estatuto de Aposentação, modified in 2005)

For CGA contributors registered up to 1993, the amount of the new pension is the result of a weighted average of two components: the first related to the rule in force in 2005 for registered contributors up to 1993 and the second related to the accrual rule set down in Decree-Law 35/02, but applied only to the years of contributory career after 2005.

\[
y_{g,a}^{Ed,CGA}(t | \rho) = \frac{1}{\tilde{D}_{g,a}^{CGA}(t | \rho) - (t - 2005)} \left[ \tilde{D}_{g,a}^{CGA}(t | \rho) - (t - 2005) \right] w_{g,a}^{ref(E-4),CGA}(t) +
\]

\[
+ (t - 2005) \left[ w_{g,a}^{ref(E-2),CGA}(t | \rho) \rho(5) t \left( w_{g,a}^{ref(E-2),CGA}(t | \rho) \leq 1.1 w_{\min}(t) \right) +
\]

\[
+ \left[ (1.1 \rho(5) + 0.9 \rho(4)) w_{\min}(t) + \left( w_{g,a}^{ref(E-2),CGA}(t | \rho) - 2 w_{\min}(t) \right) \rho(3) \right] \left\{ 2 < \frac{w_{g,a}^{ref(E-2),CGA}(t | \rho)}{w_{\min}(t)} \leq 4 \right\} +
\]

\[
+ \left[ (1.1 \rho(5) + 0.9 \rho(4) + 2 \rho(3)) w_{\min}(t) + \left( w_{g,a}^{ref(E-4),CGA}(t | \rho) - 4 w_{\min}(t) \right) \rho(2) \right] \left\{ 4 < \frac{w_{g,a}^{ref(E-2),CGA}(t | \rho)}{w_{\min}(t)} \leq 8 \right\} +
\]

\[
+ \left[ (1.1 \rho(5) + 0.9 \rho(4) + 2 \rho(3) + 4 \rho(2)) w_{\min}(t) + \left( w_{g,a}^{ref(E-4),CGA}(t | \rho) - 8 w_{\min}(t) \right) \rho(1) \right] \left\{ \frac{w_{g,a}^{ref(E-2),CGA}(t | \rho)}{w_{\min}(t)} > 8 \right\}
\]

\[
\cdot \left[ \Pi^{vcb}(t)^{\max \{ a^{\rho}(t - 2) - a, 0 \}} \cdot \max \left\{ 1 - t (t \geq 2008) \Phi; \frac{V_{1,65}^{E66} (2006) + V_{1,65}^{E66} (2006)}{V_{1,65}^{E66} (t - 1) + V_{1,65}^{E66} (t - 1)} \right\} \right] \right) \right) \right) \right)
\]

After calculating the new old age and disability pensions of the SPCGA for each strata \((g, a)\) and each year along horizon (conditional on \(\rho\)) according to the two legal
regimes, the MISS model proceeds to choose the regime to be applied as a function of the year when the contributory career began:

\[
x_{g,a}^{\text{velh,CGA}}(t | \rho) = x_{g,a}^{\text{velh,CGA}}(t-1 | \rho) \left[ t\left(t - \tilde{D}_{g,a}^{\text{CGA}}(t | \rho) < 1994 \right) \frac{x_{g,a}^{E,CGA}(t | \rho)}{x_{g,a}^{E,CGA}(t-1 | \rho)} + \right.
\]
\[
+ t\left(t - \tilde{D}_{g,a}^{\text{CGA}}(t | \rho) \geq 1994 \right) \frac{x_{g,a}^{35/02,CGA}(t | \rho)}{x_{g,a}^{35/02,CGA}(t-1 | \rho)} \right] \tag{A.6.60}
\]

\[
x_{g,a}^{\text{inval,CGA}}(t | \rho) = x_{g,a}^{\text{inval,CGA}}(t-1 | \rho) \left[ t\left(t - \tilde{D}_{g,a}^{\text{CGA}}(t | \rho) < 1994 \right) \frac{x_{g,a}^{E,CGA}(t | \rho)}{x_{g,a}^{E,CGA}(t-1 | \rho)} + \right.
\]
\[
+ t\left(t - \tilde{D}_{g,a}^{\text{CGA}}(t | \rho) \geq 1994 \right) \frac{x_{g,a}^{35/02,CGA}(t | \rho)}{x_{g,a}^{35/02,CGA}(t-1 | \rho)} \right] \tag{A.6.61}
\]

where the notation is again identical to that used for the SPSS.

### A.6.5 Average pensions and expenditure on disability and old age pensions

After the previous calculations, and with a view to calculating the annual expenditure on pensions in the two subsystems, the MISS model selects the value of the annual pension that a pensioner of gender \( g \) and age \( a \) at the end of \( t \) would receive during this year on the assumption that he/she would receive a pension during the whole year:

\[
z_{g,a}^{\text{inval,CGA}}(t | \rho) = \frac{1}{l_{g,a}(t | \rho)} \left[ z_{g,a}^{\text{inval,CGA}}(t-1 | \rho) \left( 1 + \gamma_{\text{pens,CGA}}(t) \right) \left( \hat{v}_{g,a}^{\text{CGA}}(t | \rho) - \hat{v}_{g,a}^{\text{CGA}}(t | \rho) \right) + x_{g,a}^{\text{inval,SS}}(t | \rho) \right] \tag{A.6.62}
\]

\[
z_{g,a}^{\text{inval,SS}}(t | \rho) = \frac{1}{l_{g,a}(t | \rho)} \left[ z_{g,a}^{\text{inval,SS}}(t-1 | \rho) \left( 1 + \gamma_{\text{pens,SS}}(t) \right) \left[ \hat{v}_{g,a}^{\text{SS}}(t | \rho) - \left( \hat{v}_{g,a}^{\text{TCO}}(t | \rho) + \hat{v}_{g,a}^{\text{TI}}(t) \right) \right] + \right.
\]
\[
+ x_{g,a}^{\text{inval,SS}}(t | \rho) \left( \hat{v}_{g,a}^{\text{TCO}}(t | \rho) + \hat{v}_{g,a}^{\text{TI}}(t) \right) \right] \tag{A.6.63}
\]

\[
z_{g,a}^{\text{velh,CGA}}(t | \rho) = \frac{1}{v_{g,a}(t | \rho)} \left[ z_{g,a}^{\text{velh,CGA}}(t-1 | \rho) \left( 1 + \gamma_{\text{pens,CGA}}(t) \right) \left( \hat{v}_{g,a}^{\text{CGA}}(t | \rho) - \hat{v}_{g,a}^{\text{CGA}}(t | \rho) \right) + x_{g,a}^{\text{velh,CGA}}(t | \rho) \right] \tag{A.6.64}
\]

\[
z_{g,a}^{\text{velh,SS}}(t | \rho) = \frac{1}{v_{g,a}(t | \rho)} \left[ z_{g,a}^{\text{velh,SS}}(t-1 | \rho) \left( 1 + \gamma_{\text{pens,SS}}(t) \right) \left[ \hat{v}_{g,a}^{\text{SS}}(t | \rho) - \left( \hat{v}_{g,a}^{\text{TCO}}(t | \rho) + \hat{v}_{g,a}^{\text{TI}}(t) \right) \right] + \right.
\]
\[
- t\left(a = \hat{a}_{g,a}^{\text{SS}}(t) \right) z_{g,a}^{\text{velh,SS}}(t-1 | \rho) \left( 1 - \sigma_{g,a}(t) \right) + x_{g,a}^{\text{velh,SS}}(t | \rho) \left( \hat{v}_{g,a}^{\text{TCO}}(t | \rho) + \hat{v}_{g,a}^{\text{TI}}(t) \right) + \right.
\]
\[
+ t\left(a = \hat{a}_{g,a}^{\text{SS}}(t) \right) z_{g,a}^{\text{inval,SS}}(t-1 | \rho) \left( 1 + \gamma_{\text{pens,SS}}(t) \right) \hat{v}_{g,a}^{\text{SS}}(t | \rho) \left( 1 - \sigma_{g,a}(t) \right) \right] \tag{A.6.65}
\]

9 To compute the average pension for the outstanding retirees at the end of year \( t \), the relevant pension for a new retiree beginning in July (this is, a pensioner who first received a pension in July of year \( t \)) is the annual amount of the pension that he/she would have received if payment started in January.
where \( z_{g,a}^{\text{inval,CGA}}(t \mid \rho) \), \( z_{g,a}^{\text{inval,SS}}(t \mid \rho) \), \( z_{g,a}^{\text{velh,CGA}}(t \mid \rho) \) and \( z_{g,a}^{\text{velh,SS}}(t \mid \rho) \) are, respectively, the amounts (in euros) of the average pensions defined above, conditional on \( \rho \). The previous equations calculate the average pension as a weighted average, on the one hand of the annual average pension of the retirees carried over from the previous year and, on the other hand, of the annual average pension of new retirees (taking these as if they had received a full pension during the whole year, even if that was not the case).

After the average pensions is computed as described above, the model calculates the annual expenditure on pensions (in millions of euros, conditional on \( \rho \)), of each type and for each one of the subsystems, for the set of the pensioners of each strata \((g,a)\). The following equations are used for that purpose:

\[
d_{g,a}^{\text{inval,CGA}}(t \mid \rho) = \frac{1}{4 \cdot 1000} \left( z_{g,a}^{\text{inval,CGA}}(t \mid \rho) \hat{\gamma}_{g,a}^{\text{CGA}}(t \mid \rho) + z_{g,a+1}^{\text{inval,CGA}}(t \mid \rho) \hat{\gamma}_{g,a+1}^{\text{CGA}}(t \mid \rho) + z_{g,a-1}^{\text{inval,CGA}}(t-1 \mid \rho) \hat{\gamma}_{g,a-1}^{\text{CGA}}(t-1 \mid \rho) \right) \tag{A.6.66}
\]

\[
d_{g,a}^{\text{inval,SS}}(t \mid \rho) = \frac{1}{4 \cdot 1000} \left( z_{g,a}^{\text{inval,SS}}(t \mid \rho) \hat{\gamma}_{g,a}^{\text{SS}}(t \mid \rho) + z_{g,a+1}^{\text{inval,SS}}(t \mid \rho) \hat{\gamma}_{g,a+1}^{\text{SS}}(t \mid \rho) + z_{g,a-1}^{\text{inval,SS}}(t-1 \mid \rho) \hat{\gamma}_{g,a-1}^{\text{SS}}(t-1 \mid \rho) \right) \tag{A.6.67}
\]

\[
d_{g,a}^{\text{velh,CGA}}(t \mid \rho) = \frac{1}{4 \cdot 1000} \left( z_{g,a}^{\text{velh,CGA}}(t \mid \rho) \hat{\gamma}_{g,a}^{\text{CGA}}(t \mid \rho) + z_{g,a+1}^{\text{velh,CGA}}(t \mid \rho) \hat{\gamma}_{g,a+1}^{\text{CGA}}(t \mid \rho) + z_{g,a-1}^{\text{velh,CGA}}(t-1 \mid \rho) \hat{\gamma}_{g,a-1}^{\text{CGA}}(t-1 \mid \rho) \right) \tag{A.6.68}
\]

\[
d_{g,a}^{\text{velh,SS}}(t \mid \rho) = \frac{1}{4 \cdot 1000} \left( z_{g,a}^{\text{velh,SS}}(t \mid \rho) \hat{\gamma}_{g,a}^{\text{SS}}(t \mid \rho) + z_{g,a+1}^{\text{velh,SS}}(t \mid \rho) \hat{\gamma}_{g,a+1}^{\text{SS}}(t \mid \rho) + z_{g,a-1}^{\text{velh,SS}}(t-1 \mid \rho) \hat{\gamma}_{g,a-1}^{\text{SS}}(t-1 \mid \rho) \right) \tag{A.6.69}
\]

These equations are simple adaptations of the general approximation rule to the calculation of annual averages from year-end data (see equation A.1.2). This rule was defined for stock-variables, but its application in the current context is justified, bearing in mind the definition of the variables, \( z_{g,a}^{\text{inval,CGA}}(t \mid \rho) \), \( z_{g,a}^{\text{inval,SS}}(t \mid \rho) \), \( z_{g,a}^{\text{velh,CGA}}(t \mid \rho) \) and \( z_{g,a}^{\text{velh,SS}}(t \mid \rho) \). The reason for dividing by 1000 is to express the annual expenditure on pensions \( d_{g,a}^{\text{inval,CGA}}(t \mid \rho) \), \( d_{g,a}^{\text{inval,SS}}(t \mid \rho) \), \( d_{g,a}^{\text{velh,CGA}}(t \mid \rho) \) and \( d_{g,a}^{\text{velh,SS}}(t \mid \rho) \) in millions of euros, since average pensions are calculated in euros and the numbers of pensioners are expressed in thousands.

It should be noted that the annual average old age and disability pensions for the strata \((g, a)\), in the standard concept of the average pension, can be obtained by dividing the total expenditure for the average stock of pensioners (and multiplying by 1000 to get the results in euros):
\[ \tilde{d}_{\text{inval,CGA}}(t \mid \rho) = 1000 \frac{d_{g,a}^{\text{inval,CGA}}(t \mid \rho)}{\tilde{T}^{\text{CGA}}_{g,a}(t \mid \rho)} \quad (A.6.70) \]

\[ \tilde{d}_{\text{inval,SS}}(t \mid \rho) = 1000 \frac{d_{g,a}^{\text{inval,SS}}(t \mid \rho)}{\tilde{T}^{\text{SS}}_{g,a}(t \mid \rho)} \quad (A.6.71) \]

\[ \tilde{d}_{\text{velh,CGA}}(t \mid \rho) = 1000 \frac{d_{g,a}^{\text{velh,CGA}}(t \mid \rho)}{\tilde{T}^{\text{CGA}}_{g,a}(t \mid \rho)} \quad (A.6.72) \]

\[ \tilde{d}_{\text{velh,SS}}(t \mid \rho) = 1000 \frac{d_{g,a}^{\text{velh,SS}}(t \mid \rho)}{\tilde{T}^{\text{SS}}_{g,a}(t \mid \rho)} \quad (A.6.73) \]

### A.6.6 Survivor pensions

Since it was impossible to adequately model the additional factors that influence the amount of new survivor pensions, the simplest possible solution was adopted in the MISS model: to start from the values observed in 2005 for the average survivor pensions and update them by using the variation in the average old age pension of the subsystem in question:

\[ \tilde{d}^{\text{sob,CGA}}_{g,a}(t \mid \rho) = \tilde{d}^{\text{sob,CGA}}_{g,a}(t-1 \mid \rho) \frac{\tilde{d}^{\text{velh,CGA}}_{g,a}(t \mid \rho)}{\tilde{d}^{\text{velh,CGA}}_{g,a}(t-1 \mid \rho)} \quad (A.6.74) \]

\[ \tilde{d}^{\text{sob,SS}}_{g,a}(t \mid \rho) = \tilde{d}^{\text{sob,SS}}_{g,a}(t-1 \mid \rho) \frac{\tilde{d}^{\text{velh,SS}}_{g,a}(t \mid \rho)}{\tilde{d}^{\text{velh,SS}}_{g,a}(t-1 \mid \rho)} \quad (A.6.75) \]

where \( \tilde{d}^{\text{sob,CGA}}_{g,a}(t \mid \rho) \) and \( \tilde{d}^{\text{sob,SS}}_{g,a}(t \mid \rho) \) are the annual amounts (in euros) in year \( t \) for the average pensions received by survivor pensioners of gender \( g \) and age \( a \), respectively for the SPCGA and for the SPSS.

### A.7 Module of remaining benefits and allowances

#### A.7.1 Unemployment benefit

Let

\[ \tilde{K}^{\text{SS}}_{g,a}(t \mid \rho) = \frac{\tilde{C}^{\text{TCO}}_{g,a}(t \mid \rho) + \tilde{C}^{\text{TI}}_{g,a}(t) - \tilde{C}^{\text{CGA}}_{g,a}(t \mid \rho) - \left( \tilde{C}^{\text{CGA}}_{g,a}(t \mid 0) - \tilde{C}^{\text{CGA}}_{g,a}(t \mid \rho) \right)}{\tilde{E}^{\text{TCO}}_{g,a}(t) + \tilde{E}^{\text{TI}}_{g,a}(t) - \tilde{C}^{\text{CGA}}_{g,a}(t \mid \rho) - \left( \tilde{C}^{\text{CGA}}_{g,a}(t \mid 0) - \tilde{C}^{\text{CGA}}_{g,a}(t \mid \rho) \right)} \quad (A.7.1) \]

be the level of overall coverage of the SPSS for the strata \((g,a)\). Also, let \( \kappa^{\text{elig}}(t) \) be an "eligibility index" for unemployment benefit such that, in 2005, this index assumes the value 1 and an increase (reduction) of the index along the horizon means changes in the law leading to a smaller (bigger) restriction for access to the unemployment benefit for
active contributors of the SPSS. Given \( \lambda_{g,a}(t | \rho) \) and \( \Sigma^{\text{leg}}(t) \), the model calculates the number of beneficiaries with unemployment benefit (in thousands) for the strata \((g,a)\) in year \(t\) through the following equation:

\[
B_{g,a}(t | \rho) = B_{g,a}(t - 1 | \rho) \frac{\bar{D}_{g,a}(t)}{\bar{D}_{g,a}(t - 1)} \frac{\lambda_{g,a}(t | \rho)}{\Sigma^{\text{leg}}(t)} \frac{\bar{S}^{\text{leg}}_{g,a}(t - 1 | \rho)}{\Sigma^{\text{leg}}(t - 1)} \quad (A.7.2)
\]

In turn, the annual average amount (in euros) \( k_{g,a}(t | \rho) \) per beneficiary of unemployment benefit from the strata \((g, a)\) in year \(t\) is projected through the equation:

\[
k_{g,a}(t | \rho) = k_{g,a}(t - 1 | \rho) \cdot \frac{\bar{Y}^{TCO}_{g,a}(t) + \bar{Y}^{TI}_{g,a}(t) - \bar{Y}^{TCO(FP)}_{g,a}(t | \rho)}{\bar{C}^{TCO}_{g,a}(t) + \bar{C}^{TI}_{g,a}(t) - (\bar{C}^{CGA}_{g,a}(t | 0) - \bar{C}^{CGA}_{g,a}(t | \rho))} \cdot \frac{\Sigma^{\text{gen}}(t)}{\Sigma^{\text{gen}}(t - 1)} \quad (A.7.3)
\]

where \( \Sigma^{\text{gen}}(t) \) is an "index of generosity of the unemployment benefits" set exogenously by the model user (\( \Sigma^{\text{gen}}(2005) = 1 \)).

Given \( B_{g,a}(t | \rho) \) and \( k_{g,a}(t | \rho) \), the SPSS expenditure (in millions of euros) on unemployment benefits for beneficiaries of gender \(g\) and age \(a\) will be:

\[
d_{g,a}^{\text{SS}}(t | \rho) = d_{g,a}^{\text{SS}}(t - 1 | \rho) \cdot \frac{B_{g,a}(t | \rho)k_{g,a}(t)}{B_{g,a}(t - 1 | \rho)k_{g,a}(t - 1)} \quad (A.7.4)
\]

**A.7.2 Sickness benefit**

In the MISS model, the number of SPSS contributors (in thousands) belonging to the strata \((g,a)\) with sickness benefit processed in year \(t\), \( B_{g,a}(t | \rho) \), is updated through the following equation:

\[
B_{g,a}(t | \rho) = B_{g,a}(t - 1 | \rho) \frac{\bar{C}^{TCO}_{g,a}(t) + \bar{C}^{TI}_{g,a}(t) - (\bar{C}^{CGA}_{g,a}(t | 0) - \bar{C}^{CGA}_{g,a}(t | \rho))}{\bar{C}^{TCO}_{g,a}(t - 1) + \bar{C}^{TI}_{g,a}(t - 1) - (\bar{C}^{CGA}_{g,a}(t - 1 | 0) - \bar{C}^{CGA}_{g,a}(t - 1 | \rho))} \quad (A.7.5)
\]

As for the value of the average amount of sickness benefit per beneficiary, the updating rule is:
As a consequence, the following equation calculates the expenditure on sickness benefits in year \( t \) for beneficiaries of gender \( g \) and age \( a \) in the SPSS:

\[
d_{g,a}^{SS}(t \mid \rho) = d_{g,a}^{SS}(t \mid \rho) \frac{B_{g,a}^{doe}(t \mid \rho)k_{g,a}^{doe}(t)}{B_{g,a}^{doe}(t \mid \rho)k_{g,a}^{doe}(t \mid \rho)} \tag{A.7.7}
\]

### A.7.3 Maternity, paternity and adoption benefits

The rule for updating the number of beneficiaries of maternity, paternity and adoption benefits is:

\[
B_{g,a}^{mat}(t) = \begin{cases} 
B_{1,a}^{mat}(t-1) - \sum_{j=a-4}^{a} \phi_j(t) \bar{P}_{2,j}^{res}(t) & (g = 1) \\
B_{2,a}^{mat}(t-1) - \sum_{j=a-4}^{a} \phi_j(t) \bar{P}_{2,a}^{res}(t-1) & (g = 2)
\end{cases} \tag{A.7.8}
\]

while the rule for updating the average amount of the benefit for beneficiaries of the strata \((g, a)\) is similar to the one for the sickness benefits:

\[
k_{g,a}^{mat}(t \mid \rho) = k_{g,a}^{mat}(t \mid \rho) \frac{\bar{Y}_{g,a}^{TCO}(t \mid \rho) + \bar{Y}_{g,a}^{HI}(t \mid \rho) - \bar{Y}_{g,a}^{TCO(FP)}(t \mid \rho)}{\bar{C}_{g,a}^{TCO}(t \mid \rho) + \bar{C}_{g,a}^{HI}(t \mid \rho) - \bar{C}_{g,a}^{TCO(FP)}(t \mid \rho)} \tag{A.7.9}
\]

Expenditure on maternity, paternity and adoption benefits for SPSS beneficiaries of gender \( g \) and age \( a \) is:

\[
da_{g,a}^{mat,SS}(t \mid \rho) = da_{g,a}^{mat,SS}(t \mid \rho) \frac{B_{g,a}^{mat}(t \mid \rho)k_{g,a}^{mat}(t)}{B_{g,a}^{mat}(t \mid \rho)k_{g,a}^{mat}(t \mid \rho)} \tag{A.7.10}
\]

### A.7.4 Subsidy for children assistance

The model updates the number of contributors of the strata \((g, a)\) who are beneficiaries of this allowance as follows:
The equations for updating the average amount and expenditure for the beneficiaries of the strata \((g,a)\) are identical to those considered for the other types of benefits associated with temporary leave from work:

\[
B_{g,a}^{\text{ass}}(t | \rho) = B_{g,a}^{\text{ass}}(t-1 | \rho) \left( \frac{\tilde{C}_{TCO}^{g,a}(t | \rho) + \tilde{C}_{f}^{g,a}(t) - \tilde{C}_{TCO(\text{FP})}^{g,a}(t | \rho)}{\tilde{C}_{TCO}^{g,a}(t-1 | \rho) + \tilde{C}_{f}^{g,a}(t-1) - \tilde{C}_{TCO(\text{FP})}^{g,a}(t-1 | \rho)} \right) \sum_{i=1}^{2} \sum_{j=0}^{9} \tilde{P}_{i,j}^{\text{res}}(t) \sum_{i=1}^{2} \sum_{j=0}^{9} \tilde{P}_{i,j}^{\text{ass}}(t-1) 
\]

(A.7.11)

\[
k_{g,a}^{\text{ass}}(t | \rho) = k_{g,a}^{\text{ass}}(t-1 | \rho) \left( \frac{\tilde{Y}_{TCO}^{g,a}(t | \rho) + \tilde{Y}_{f}^{g,a}(t) - \tilde{Y}_{TCO(\text{FP})}^{g,a}(t | \rho)}{\tilde{Y}_{TCO}^{g,a}(t-1 | \rho) + \tilde{Y}_{f}^{g,a}(t-1) - \tilde{Y}_{TCO(\text{FP})}^{g,a}(t-1 | \rho)} \right) \left( \frac{\tilde{C}_{TCO}^{g,a}(t | \rho) + \tilde{C}_{f}^{g,a}(t) - \tilde{C}_{TCO(\text{FP})}^{g,a}(t | \rho)}{\tilde{C}_{TCO}^{g,a}(t-1 | \rho) + \tilde{C}_{f}^{g,a}(t-1) - \tilde{C}_{TCO(\text{FP})}^{g,a}(t-1 | \rho)} \right) \sum_{i=1}^{2} \sum_{j=0}^{9} \tilde{P}_{i,j}^{\text{res}}(t) \sum_{i=1}^{2} \sum_{j=0}^{9} \tilde{P}_{i,j}^{\text{ass}}(t-1) 
\]

(A.7.12)

\[
d_{g,a}^{\text{ass,SS}}(t | \rho) = d_{g,a}^{\text{ass,SS}}(t-1 | \rho) \frac{B_{g,a}^{\text{ass}}(t | \rho)k_{g,a}^{\text{ass}}(t)}{B_{g,a}^{\text{ass}}(t-1 | \rho)k_{g,a}^{\text{ass}}(t-1)} 
\]

(A.7.13)

### A.7.5 Family allowance Abono de familia - SPSS

The model extrapolates the total number of beneficiaries of *abono de familia*\(^{10}\) for the two social security subsystems, \(T_{\@,\@}^{AF,t}\) from the following equation:

\[
T_{\@,\@}^{AF,t}(t) = T_{\@,\@}^{AF,t}(t-1) - \frac{\sum_{g=1}^{2} \sum_{a=0}^{24} \tilde{P}_{g,a}^{\text{res}}(t)}{\sum_{g=1}^{2} \sum_{a=0}^{24} \tilde{P}_{g,a}^{\text{ass}}(t-1)} 
\]

(A.7.14)

To reach the number of beneficiaries of *abono de familia* in the SPSS, the model deducts from the total number of beneficiaries those for whom the CGA has payment responsibility (beneficiaries with a family connection to CGA pensioners):

\[
T_{\@,\@}^{AF,\text{CGA}}(t | \rho) = T_{\@,\@}^{AF,t}(t) - T_{\@,\@}^{AF,\text{CGA}}(t | \rho) 
\]

(A.7.15)

where:

\[
T_{\@,\@}^{AF,\text{CGA}}(t | \rho) = T_{\@,\@}^{AF,\text{CGA}}(t-1 | \rho) \left( \frac{\tilde{C}_{\@,\@}^{\text{CGA}}(t | \rho)}{\tilde{C}_{\@,\@}^{\text{CGA}}(t-1 | \rho)} \right) \sum_{g=1}^{2} \sum_{a=0}^{24} \tilde{P}_{g,a}^{\text{res}}(t) \sum_{g=1}^{2} \sum_{a=0}^{24} \tilde{P}_{g,a}^{\text{ass}}(t-1) 
\]

(A.7.16)

\(^{10}\) The beneficiary of *abono de familia* is the child or young person to whom the benefit is due.
SPSS expenditure per beneficiary of abono de familia (in euros) is simply projected from the value observed in the base year in accordance with an updating rate for family allowances, defined exogenously by the model user:

\[ k^{AF,SS}(t) = k^{AF,SS}(t-1)(1 + \gamma_{PF}(t)) \] (A.7.17)

where \( \gamma_{PF}(t) \) is the above-mentioned rate of annual update of family allowances. In turn, the total SPSS expenditure on abono de familia is given by the equation:

\[ d^{AF,SS}(t | \rho) = d^{AF,SS}(t-1 | \rho) \frac{T^{AF,SS}(t | \rho)k^{AF,SS}(t)}{T^{AF,SS}(t-1 | \rho)k^{AF,SS}(t-1)} \] (A.7.18)

**A.7.6 Other family benefits – SPSS**

The number of SPSS beneficiaries of gender \( g \) and age \( a \) who received some form of household benefits apart from abono de familia in year \( t \) is projected by the equation:

\[ B^{fam,SS}_{g,a}(t | \rho) = B^{fam,SS}_{g,a}(t-1 | \rho) \frac{C^{TCC}_{g,a}(t | \rho) + C^{TT}_{g,a}(t | \rho) + T^{SS}_{g,a}(t | \rho) + S^{SS}_{g,a}(t | \rho)}{C^{TCC}_{g,a}(t-1 | \rho) + C^{TT}_{g,a}(t-1 | \rho) + T^{SS}_{g,a}(t-1 | \rho) + S^{SS}_{g,a}(t-1 | \rho)} \] (A.7.19)

Just as for the abono de familia, the average amount per beneficiary of other family benefits in the SPSS is simply updated bearing in mind the variation rate decided exogenously by the model user:

\[ k^{fam,SS}_{g,a}(t) = k^{fam,SS}_{g,a}(t-1)(1 + \gamma_{PF}(t)) \] (A.7.20)

The equation for SPSS expenditure on other instalments for family expenses to beneficiaries of gender \( g \) and age \( a \) is:

\[ d^{fam,SS}_{g,a}(t | \rho) = d^{fam,SS}_{g,a}(t-1 | \rho) \frac{B^{fam,SS}_{g,a}(t | \rho)k^{fam,SS}_{g,a}(t)}{B^{fam,SS}_{g,a}(t-1 | \rho)k^{fam,SS}_{g,a}(t-1)} \] (A.7.21)

**A.7.7 Family benefits - SPCGA**

Finally, owing to limitations of base information, the model considers a single equation for SPCGA expenditure on overall family benefits due to its pensioners:

\[ d^{AF+fam,CGA}_{\ominus,\ominus}(t | \rho) = d^{AF+fam,CGA}_{\ominus,\ominus}(t-1 | \rho) \frac{T^{CGA}_{\ominus,\ominus}(t | \rho) + T^{CGA}_{\ominus,\ominus}(t | \rho) + S^{CGA}_{\ominus,\ominus}(t | \rho)}{T^{CGA}_{\ominus,\ominus}(t-1 | \rho) + T^{CGA}_{\ominus,\ominus}(t-1 | \rho) + S^{CGA}_{\ominus,\ominus}(t-1 | \rho)}(1 + \gamma_{PF}(t)) \] (A.7.22)