AIREF MODEL FOR FORECASTING PENSION EXPENDITURE IN SPAIN

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Abstract

This document develops a methodology for forecasting the ratio of Social Security's expenditure on contributory pensions over GDP in Spain for the 2048 horizon. The model used offers an integrated framework of the demographic, macroeconomic and institutional components, paying attention to the interaction between these elements and the uncertainty. This tool allows the impact of alternative reforms in legislation to be modelled. In this document, special attention is paid to the impact of the parametric reform of 2011 and the sustainability factor approved in 2013. The model's baseline forecast assumes an increase in pension expenditure over GDP of 2.8 p.p. in 2048 compared to 2018. The reversal of the 2011 reform and the abolition of the sustainability factor could increase expenditure by an additional 3.5 p.p. in 2048.

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Reviewed by Rafael Doménech and Israel Arroyo

Key words: pensions, Social Security, population ageing, demography

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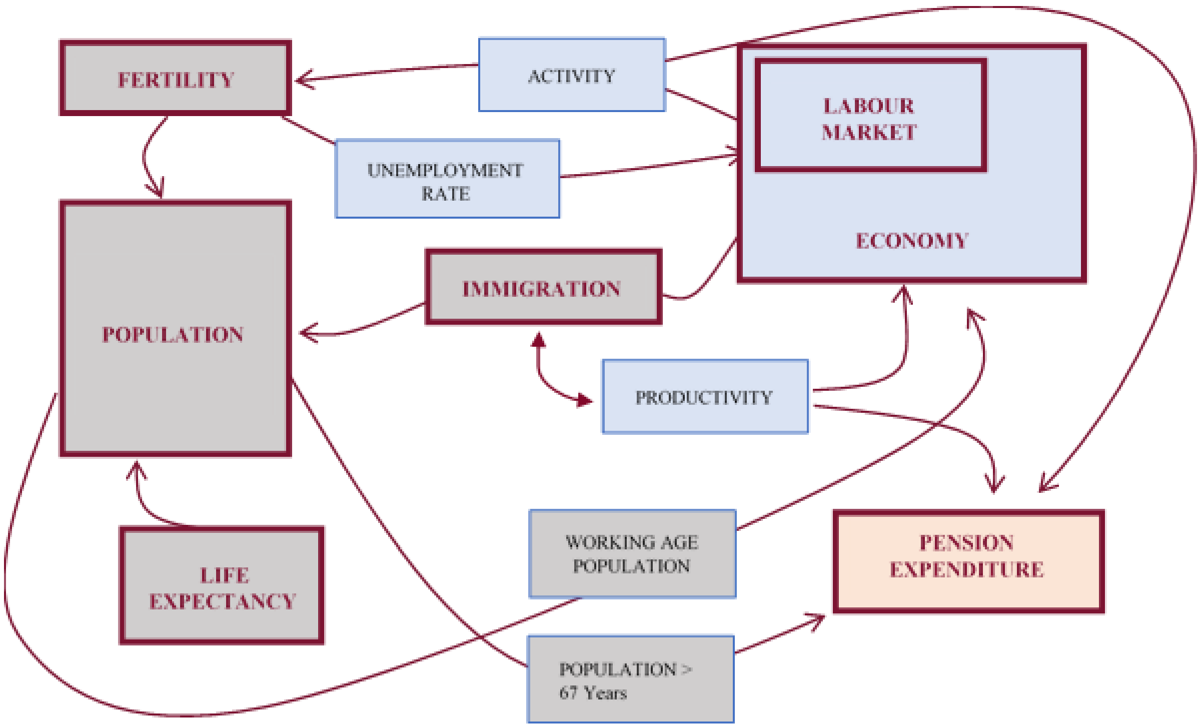
CONTENTS

1. INTRODUCTION

This technical document develops a methodology for forecasting the ratio over GDP of Social Security's expenditure on contributory pensions in Spain for the 2048 horizon. For this, it was first necessary to design a model for forecasting demography and potential Gross Domestic Product (GDP) in the long term, to finally project expenditure on pensions in the coming decades.

The model used offers an integrated macro of the demographic, macroeconomic and institutional components, paying attention to the interaction between these elements, as shown in the following diagram, and the uncertainty.



To address this task, three work modules have been developed: demography, labour market and pension expenditure:

- In the demographic module, the expected evolution of demographic inputs is estimated: fertility rate, life expectancy and immigration, and the total population is obtained by age cohorts. For the estimation of the inputs, the effect that labour market forces can exert on them is taken into account.
- In the labour market module, the evolution of the activity rate, the unemployment rate and labour productivity is projected, which, together with the working-age population, determine the GDP of the economy.

- In the pension module, the expected evolution of pension expenditure is estimated as the product of the number of pensions and the average pension. The number of pensions depends on the flow of registrations and terminations. Registrations, in turn, respond to the ageing of the population, to the activity and unemployment rates in older age and to the regulation of pensions. This legislation also affects the activity rate. The terminations are mainly the result of applying the mortality rates of the demographic scenario. The average pension depends mainly on the evolution of wages and the pension system.

This tool allows the impact of alternative reforms in legislation to be modelled. In this document, special attention is paid to the impact of the parametric reform of 2011 and the sustainability factor approved in 2013.

On the other hand, the baseline scenario considers that the revaluation is made according to the CPI, given the government's decision to update pensions to the CPI in 2018 and 2019 and the agreement of the Toledo Pact to update pensions based on inflation. However, the model includes modeling of the pension revaluation index, the description of which can be found in Annex I.

After this introduction, the second section presents how the macroeconomic scenario has been designed. Together with demography, this scenario defines the framework in which the determinants of pension expenditure are based. The third section explains the general dynamics of the model for the different types of pensions. In the next section, we will go deeper into how retirement rates are projected based on the Continuous Professional Life Sample (CPLS). Finally, some weaknesses and ways to improve the model are presented.

2. LONG-TERM MACROECONOMIC FORECASTS

2.1 General framework

The macroeconomic scenario is based on an integrative approach of building blocks that allows the GDP of the economy to be determined. Thus, GDP is determined by a production function in which total output is determined as a combination of the labour factor (L) and apparent labour productivity (ALP), which includes the effect of the capital and technical progress:

$$GDP = L \times ALP \qquad (1)$$

The labour factor is represented by the number of employed persons and productivity is productivity per employed person.

In turn, the labour factor is estimated as the product of the working age population (WAP) or the population aged between 15 and 74 years, the activity rate (ACT) for this age group and the employment rate, defined as one minus the unemployment rate (U):

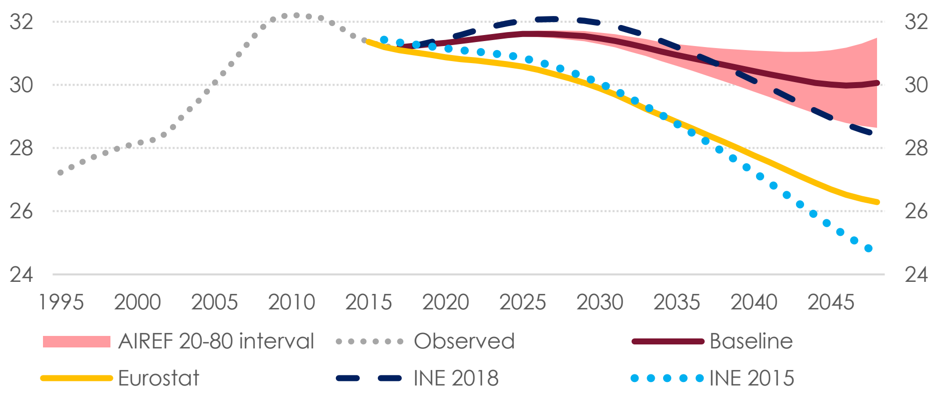
$$L = WAP \times ACT \times (1-U) \qquad (2)$$

Find below an explanation of how the projection of each of these elements has been estimated. Because it is a structural estimate, or independent of the economic cycle, in the first four years of the projection (2018-2021) a link is made between AIReF's short-term (or cyclical) forecasts and the structural values of the components.

2.2 Working age population

The projection of the working age population throughout the period analysed comes directly from AIReF's demographic forecast presented in the document " *Demographic* forecasts*: an integrated vision* " (AIReF, 2018), which in turn uses data from the working papers by Osés and Quilis (2018) and Fernández-Huertas and López (2018). According to this methodology, AIReF expects the working age population to remain stable at around 30 million people. This forecast is separated from those made by the INE (National Statistics Institute) and Eurostat, which project a contraction of the potentially active population to around 26 and 28 million people, respectively.

FIGURE 1. WORKING AGE POPULATION (MILLIONS OF PEOPLE)



Source: LFS (INE), Eurostat and own calculations

2.3 Activity rate

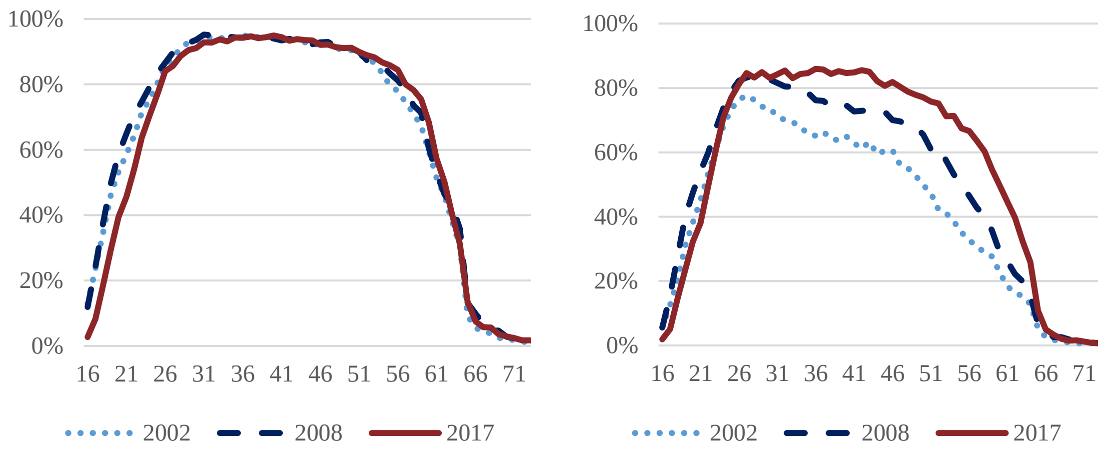
Concept and historical evolution

The activity rate is defined as the active population aged 15 to 74 years within the total population of that age. The historical starting data from 2002 to 2017 are obtained from the microdata of the Labour Force Survey (LFS), which also allows a breakdown by sex and age groups[1].

Regarding the disaggregation carried out, the fact that the male activity rate has remained relatively constant between 2002 and 2017 stands out, while the female rate has experienced a convergence in the direction of the activity rate of men. In spite of this and less significantly, it is also relevant that for younger ages (from 16 to 26 years old) activity rates have not yet recovered their pre-crisis levels, especially in the case of men.

[1] Specifically, the AOI variable is used, which defines the relationship with the activity of the interviewees and includes employed (values 3 and 4), unemployed (values 5 and 6) and inactive (values 7, 8 and 9).

FIGURE 2 ACTIVITY RATE FOR MEN AND WOMEN



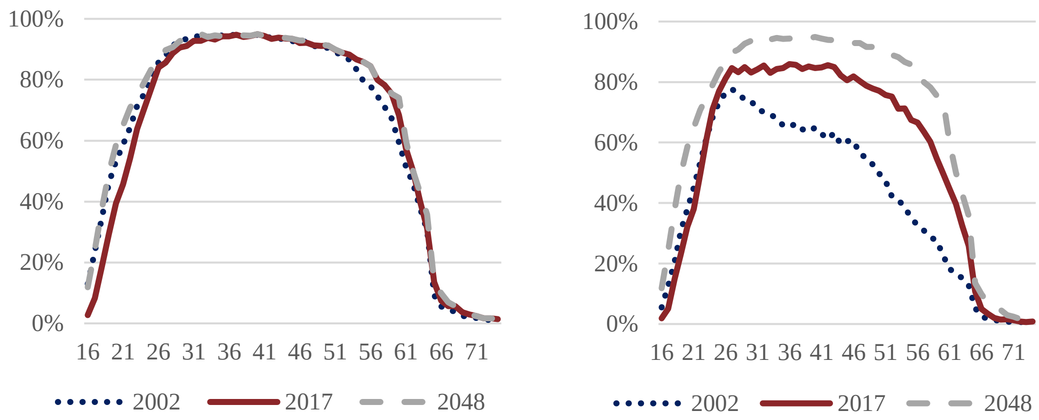
Source: LFS (INE) and own calculations

Inertial simulation

The modelling of the activity rate uses a variant of the cohort simulation model (CSM) of the European Commission (2018), where the aggregate activity rate reflects the interaction of the effect of population ageing and activity curves by sex and age.

The inertial simulation uses the baseline population forecasts, but does not consider the impact of pension system reforms, not even the reform of 2011 beyond what was implemented until 2017. This simulation envisages two processes of convergence of the activity curves. First, the activity curves of men converge in 2027 to their maximum level reached between 2008 and 2017. Second, the activity curves of women converge to those of men in 2048. As a result of these assumptions and their interaction with the ageing of the population, the aggregate activity rate is expected to goes from 64.7% in 2017 to 63.9% in 2048, as can be seen in Figure 5.

FIGURE 3 ACTIVITY RATE FOR MEN AND WOMEN - INERTIAL SCENARIO

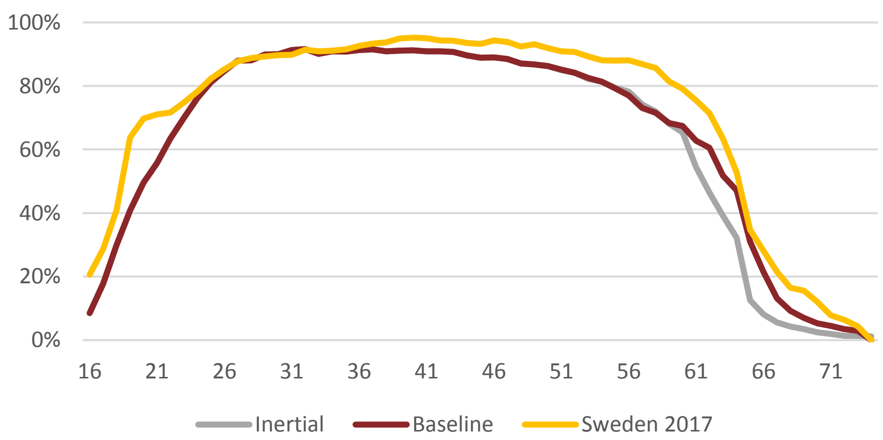


Source: LFS (INE) and own calculations

Baseline scenario

The baseline scenario simulates the impact of the 2011 pension reform, in particular the increase in the ordinary retirement age from 65 to 67 years for workers with careers of under 38.5 years, and the corresponding adjustment of the early retirement age. The impact is concentrated in the ages close to retirement (over 60 years). In the section on retirement registrations, detail is provided on how this result is achieved. In addition, it is observed that this activity rate is approaching, but remains below, the current level of European best performers. Thus, the activity curve by age for Spain foreseen in the baseline scenario for 2048 is still below that of Sweden in 2017 for most age groups.

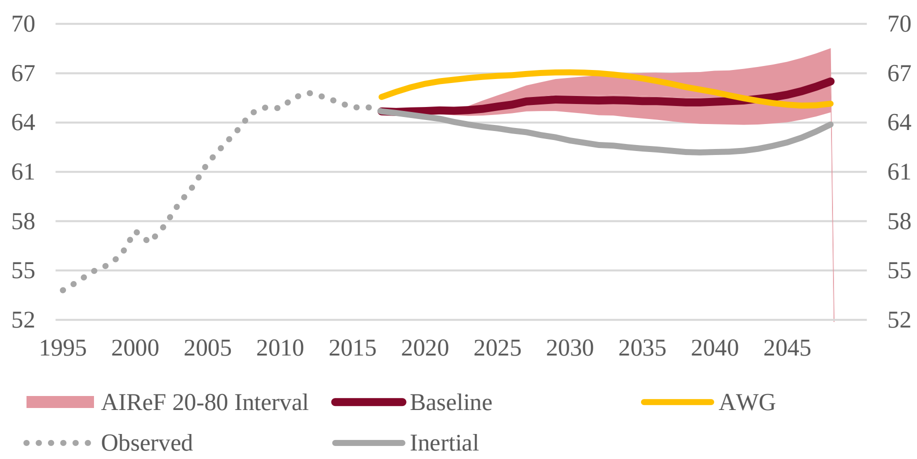
FIGURE 4 ACTIVITY RATE OF BOTH SEXES IN 2048 - INERTIAL AND BASELINE



Source: LFS (INE) and own calculations

As can be seen in Figure 5, between 2017 and 2048 the activity rate of the baseline scenario increases by 1.8 p.p. from 64.7% to 66.5%, compared to 72% in Sweden in 2017. Regarding the inertial scenario in 2048, the 2011 reform has an estimated impact on the activity rate of 2.6 p.p. The Ageing Working Group (AWG) of the European Commission estimates a contraction in the activity rate of 0.4 p.p. between 2018 and 2048, i.e. the negative effect of ageing more than offsets the process of convergence of women's activity rates and the impact of the 2011 reform[2].

FIGURE 5 ACTIVITY RATE



Source: LFS (INE), AWG and own calculations

2.4 Effective age of exit from the labour market

The model used for simulation by cohort (CSM) is a dynamic model based on estimates of rates of entry and exit from the labour market for a *synthetic* generation. The cohort is *synthetic* in the sense that, instead of using longitudinal data of transitions in the labour market, it is assumed that individuals of age e + 1 in year t + 1 are representative of the same generation observed one year before (with age e in year t). This assumption ignores gross entries and exits from the labour market that cancel each other out.

[2]On the other hand, the starting point of the AWG is almost 1 p.p. higher than that of AIReF.

The process to determine the exits from the labour market and the effective retirement age is based on comparing the evolution of the activity rates over time. It is only applied to the ages between the minimum retirement age and the maximum age, which we assume are 50 and 74 years, respectively. At age 75, all the agents of the model are forced out of the labour market.

Probability of permanence (PPerm)

The conditional probability that a person will remain in the labour market at age e and in a year t (conditioned on having been active in year t-1) is calculated as the quotient of the activity rate for that year and age and the activity rate of one year and age prior.

$$PPerm_t^e = \frac{TAct_t^e}{TAct_{t-1}^{e-1}} \qquad (3)$$

Where $0 \leq PPerm_t^e \leq 1$

Probability of exit

The conditional probability of exit at age e is complementary to the probability of permanence.

$$PExit_t^e = 1 - PPerm_t^e \qquad (4)$$

Where $0 \leq PExit_t^e \leq 1$

Probability of not retiring before age e (PNoRet)

Assuming no one retires before the minimum age m (m = 50), the (unconditional) probability of not retiring before age e is given by the product of all conditioned probabilities of permanence between age m and age e-1:

$$PNoRet_t^e = \prod_{i=m}^{e-1} PPerm_t^i = PNoRet_t^{e-1} * (1 - PExit_t^e) \qquad (5)$$

Probability of retiring at age e (PRet)

The probability of retiring at age e is calculated as the product of the (unconditional) probability of not having retired before age e and the (conditional) probability of exit:

$$PRet_t^e = PNoRet_t^e * PExit_t^e \qquad (6)$$

Since we have assumed that everyone retires at a certain age M (M = 75), the sum of the probabilities of retirement between the minimum age m and maximum M must be the unit:

$$\sum_{e=m}^{M} PRet_t^e = 1 \qquad (7)$$

Effective exit age from the labour market (EEALM)

The effective exit age from the labour market is calculated as the weighted sum of retirement ages (between the minimum and maximum retirement age 50-74), where the weights are the probabilities of retirement at each age e, as follows:

$$EEALM_t = \sum_{e=m}^{M} PRet_t^e * e \quad (8)$$

Exits from the labour market

Exits from the labour market provide the link between the macroeconomic scenario and the pension system. For each age e at moment t the exits are calculated as the product of the number of active persons of an age and one year less and the probability of exit for that year and age:

$$Exits_t^e = Active_{t-1}^{e-1} * PExit_t^e = WAP_{t-1}^{e-1} * TAct_{t-1}^{e-1} * PExit_t^e \quad (9)$$

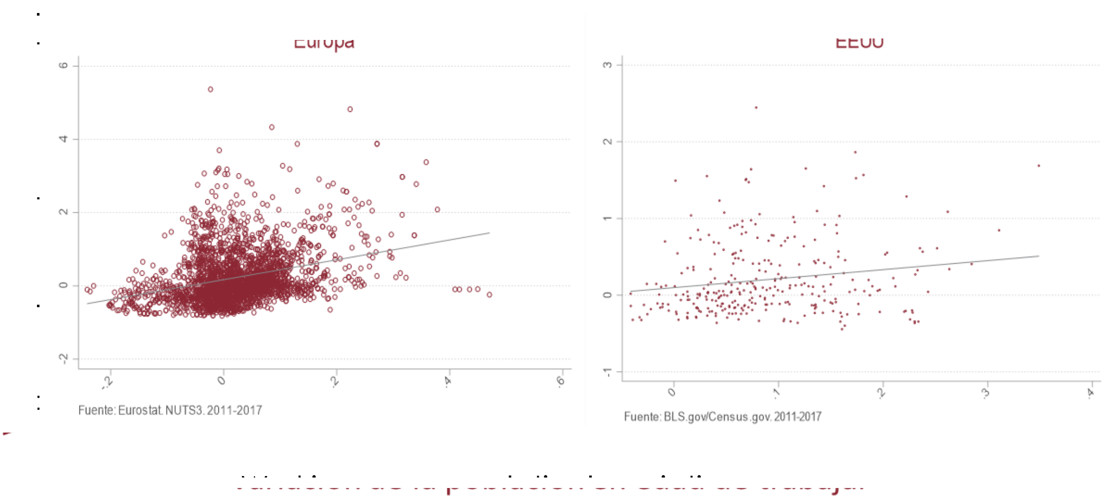
2.5 Unemployment rate

The unemployment rate is defined as the ratio of unemployed persons aged between 15 and 74 years to the active population of that same age. The historical data from 2002 to 2017 is obtained from the LFS, as well as its disaggregation by age.

A scenario of decline in the working age population in a context of maintenance of labour demand leads to labour shortage processes and decreases in the structural unemployment rate.

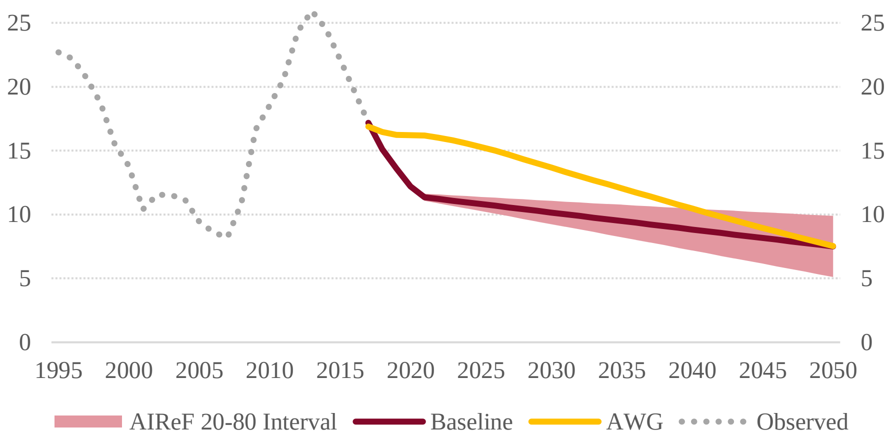
The economic literature and the experiences of other countries support this hypothesis. When analysing the effect of an ageing shock on unemployment, LaCroix et al. conclude that, if the mobility of capital is limited, the resulting labour shortage reduces the unemployment rate and increases the activity rate. In this sense, it can be seen that the regions most affected by depopulation tend to experience a decline in their long-term unemployment rate (see Figure 6). The key assumption, contrary to general intuition, is that the labour factor is more mobile than the capital (historically, examples such as the migratory experience from Europe to the US or Argentina in the nineteenth and twentieth centuries stand out). Elements such as institutions (belonging to the EU, for example) or infrastructures could be behind the restrictions on the mobility of capital.

FIGURE 6. RELATIONSHIP BETWEEN DEPOPULATION AND UNEMPLOYMENT RATE



Therefore, AIReF assumes a progressive convergence to the unemployment rate of 7.8% in 2048 from current levels[3]. The level reached in 2048 is similar to that of the AWG, but AIReF's baseline scenario implies a faster convergence in line with the institution's short-term forecasts.

FIGURE 7 UNEMPLOYMENT RATE



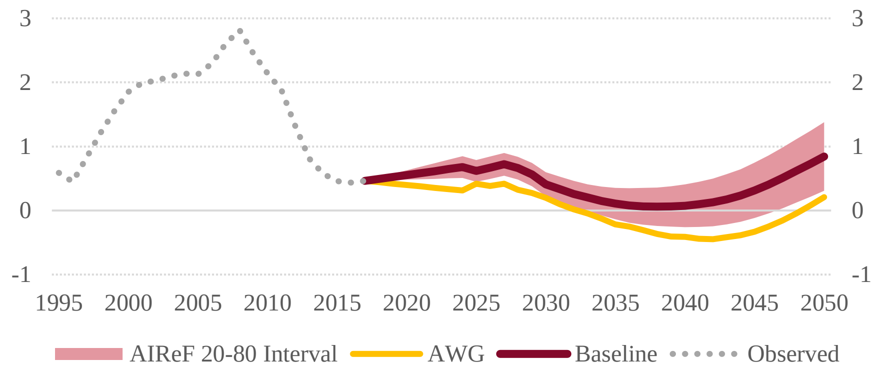
Source: LFS (INE), AWG and own calculations. Historical smoothed as average of 15 years

[3]An identical distribution of the rate of unemployment by sexes and cohorts to that observed in the base year is assumed.

2.6 Contribution of the labour factor to GDP

The contribution of the labour factor is the result of combining the assumptions about the working age population, the activity rate and the unemployment rate and, by construction it coincides with the growth in the number of employed persons.

FIGURE 8. LABOUR FACTOR (CONTRIBUTION TO GDP GROWTH)

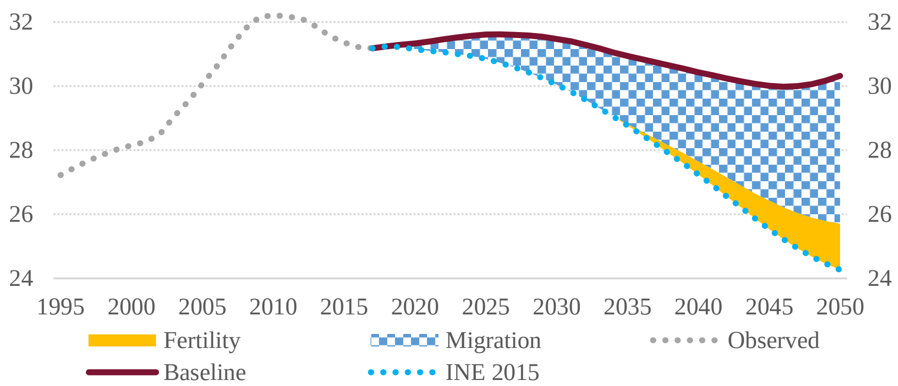


Source: LFS (INE), AWG and own calculations. Historical smoothed as average of 15 years

In its baseline scenario, AIReF projects an average contribution of the labour factor of 0.6 p.p. GDP for the 2018-2048 period. The slightly increasing trend of the first years is due to the favourable evolution foreseen for the unemployment rate and the activity rate, which, in turn, benefits from the impact of the 2011 pension reform up to 2027. In the last five years of the projection the labour factor benefits from a slowdown in the pace of exit from the labour market as a result of the retirement of the entire *baby boom* generation in the previous decades. Eurostat's demographic assumptions lead to a slightly negative contribution of the labour factor in the macroeconomic scenario of the AWG.

The progressive growth observed after 2040 is due to the growth of the working age population, which is 80% explained by immigration and 20% by the increase in the birth rate.

FIGURE 9 WORKING AGE POPULATION (MILLIONS OF PEOPLE)



Source: AIReF's estimates, INE

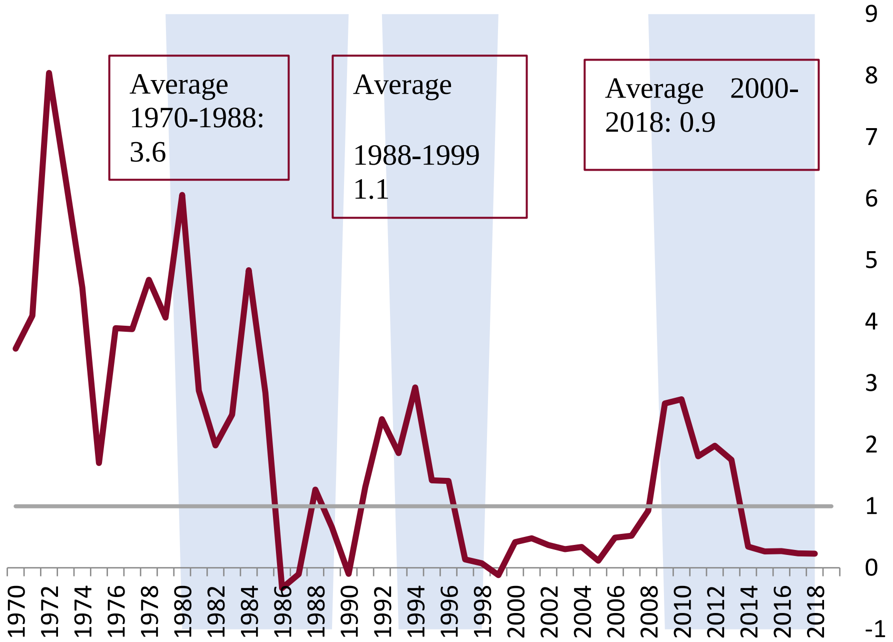
Note: The Japanisation scenario is defined by a simple extension of the latest observations: net migratory flows (50 thousand per year) and fertility (1.3 children per woman).

2.7 Productivity

The historical contribution of labour productivity remained around 1 p.p. per year from 1985 to 2017.

FIGURE 9 EVOLUTION OF THE PRODUCTIVITY OF THE LABOUR FACTOR

(RATE OF VARIATION)



Source: National Accounts (INE) and own calculations.

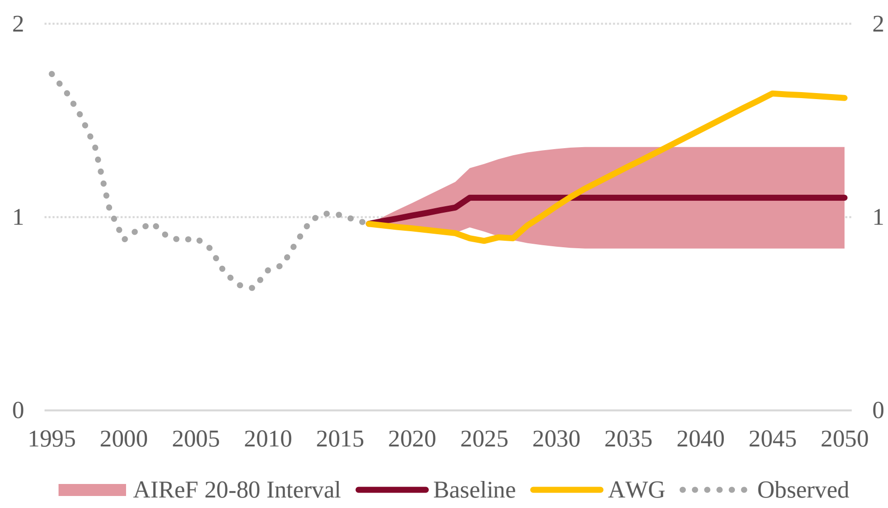
Note: the shaded areas represent years of negative output gap

There is no consensus on the evolution of productivity in the coming years. Authors such as Gordon foresee low productivity and weak growth due to the absence of technological break-throughs, stagnant educational improvements, deterioration of the environment, ageing population, high levels of debt and inequality. In turn, Mandel-Swanson believes that Gordon underestimates the impact of the digital revolution and Baldwin foresees increases in productivity due to globalisation.

Regarding the impact of immigration, the evidence in the US (Peri, 2012) shows a positive effect on productivity (increase of 1% immigration means 0.5% more income per capita), through efficient specialisation of immigrants and natives, according to the comparative advantage of each group. In turn, the evidence in Spain (Kangasniemi et al. 2008) shows a negative impact on productivity during the last *boom*, by focusing on sectors with average productivity lower than the jobs of nationals.

AIReF assumes that productivity growth converges to 1.1% in 2024, which leads to an average increase in productivity of 1% between 2018 and 2048. This growth is lower than the 1.2% predicted by the AWG.

FIGURE 10. PRODUCTIVITY

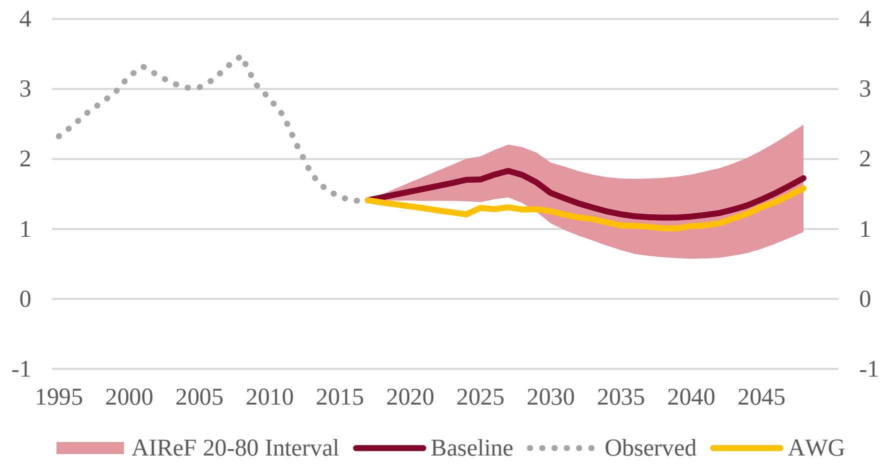


Source: National Accounts (INE), AWG and own calculations. Historical smoothed as average of 15 years

2.8 Real GDP

The average growth of real GDP can be derived from the assumptions about the inputs of equation (1), at the beginning of this section, which amounts to 1.6% for the 2018-2048 average, with the upper and lower bands standing at 2% and 1.1%, respectively. The AWG forecasts an average growth of 1.1%, 0.5% below AIReF.

GRAPH 11. POTENTIAL REAL GDP



Source: National Accounts (INE), AWG and own calculations. Historical smoothed as average of 15 years

Finally, historical regularities are used as controls to close the coherence between the demographic and macroeconomic scenario:

TABLE 1: HISTORICAL REGULARITIES OF THE EVOLUTION OF GDP

		1981-2017	AIReF 2018-2048		AWG 2018-2048
			Baseline	Range	
	Activity rate	57.9	65.4	+/- 1	66.3
	Unemployment rate	16.7	10.0	+/- 1.2	12.6
A	Contribution of labour	1.1	0.6	+/- 0.1	-0.1
B	Productivity	1.2	1.0	+/- 0.2	1.2
A+B	Real GDP	2.3	1.6	+/- 0.4	1.1
	GDP per capita	1.4	1.0	+/- 0.3	1.0

The baseline scenario implies a GDP growth in volume of 1.6%, below the 2.3% of historical experience. Something similar happens with GDP per capita. By composition of growth, a slight bias towards productivity is observed in the projection period with respect to the historical figures. In the case of the AWG, future growth of 1.1% is lower than that of AIReF and is fully explained by productivity.

2.9 Other macroeconomic assumptions

Inflation: it is assumed that the GDP deflator and the CPI converge at a rate of 1.8% in 2022. This rate corresponds to the objective of the ECB to keep inflation rates below 2% in the medium term, but close to this value. The AWG assumes an inflation rate of 2%.

Wages: the average wage is obtained from the INE's annual labour cost survey. For its projection, an evolution according to productivity is estimated. According to standard microeconomic theory, there is a direct relationship between wage growth and productivity growth both in the short term and in the long term, confirmed by international empirical evidence (Meager and Speckesser, 2011).

2.10 Estimation of uncertainty

Definition of the bands

Uncertainty is possibly the most complex element to accurately capture in such a long-term horizon in which a large number of differing variables interact. To obtain representative results, a decision was made to estimate the volatility of the main demographic inputs (fertility, mortality, migration) and macroeconomic inputs (activity rate, unemployment rate and productivity) with different techniques, incorporating the interaction between them as much as possible. Percentiles 20 and 80 are represented. For the other variables (such as GDP or pension expenditure), the bands are a reflection of the effect of the uncertainty in these inputs on the corresponding variable and is not the uncertainty of the series itself. This approach, which is not exempt from limitations, has the advantage that it allows the development of complete scenarios corresponding to a different degree of optimism/pessimism about the evolution of the inputs.

Demographic variables

The methodology followed by AIReF to prepare its projections combines the classical framework of the component method with specific probabilistic models for the main inputs of said method (fertility, survival and migration). In this way, we have the granularity provided by the first (e.g. breakdown of the population by age and sex) alongside an econometric approach that allows us to generate probabilistic scenarios and incorporate relevant economic information into the projections. The fertility and mortality models, once estimated, allow the stochastic parameters to be projected through Monte Carlo simulation, generating the corresponding confidence intervals. For the case of migration, the confidence intervals associated with the projections have been obtained through simulation by bootstrap resampling. A more detailed description can be found in AIReF (2018), Fernández-Huertas and López-Molina (2018) and Osés and Quilis (2018).

Find below the estimated uncertainty of the main demographic variables, plotted in the preceding sections:

TABLE 2. UNCERTAINTY OF DEMOGRAPHIC VARIABLES

	AIReF 2048	
	Baseline	Range
Fertility	1.83	+/- 0.08
Life expectancy at birth	86.8	+/-2.4
Annual migration (thousands of people)	380	+/- 114
Population (millions of people)	30.06	+/- 1.41

Macroeconomic variables

The estimation of the uncertainty that surrounds the projection of the macroeconomic variables is based on the historical behaviour of the shocks that have affected the same, encapsulated in its contemporary matrix of variances and co-variances. Technically, it uses a multivariate model of time series to quantify such matrix and, through Monte Carlo simulation, generate the percentiles that define the uncertainty at the different forecasting horizons.

The series involved in this exercise are: the unemployment rate, the rate of activity, the growth of apparent labour productivity defined as the ratio between GDP (Gross Domestic Product) and the number of full-time equivalent jobs and the population aged 16 years or over in terms of the LFS (Labour Force Survey). The sample used has a quarterly frequency, available since 1980, and the data source is the database of the REMS model (BDREMS).

The multivariate time series model used is a Bayesian Autoregressive Vector (BVAR). The prior used, of Minnesota type (Litterman, 1984; Karlsson, 2015), is calibrated with little restriction, in order to minimally condition the estimation of the variability of the shocks. In particular, no prior is imposed on the estimation of the covariance matrix, which is carried out jointly. Finally, 10,000 Monte Carlo simulations are conducted to calculate the percentiles that quantify the uncertainty at the different forecasting horizons.

Table 1 shows the average values along with the ranges of uncertainty of the main macroeconomic variables.

Pension variables

The projection of the variables number of pensions and average pension, from which pension expenditure is estimated in nominal terms, do not have their own uncertainty. Thus, the uncertainty about the number of pensions depends on the uncertainty associated with demography. Uncertainty about the average pension is linked to uncertainty about productivity and composition effects by cohorts associated with demography. All this means that the nominal expenditure on pensions is affected by both demographic and macroeconomic uncertainties.

3. PENSION MODEL

3.1. Data used for the expenditure profile of the base year

The data to develop the starting profiles of pension expenditure come from the registry data sent annually by the General Directorate for the Management of Social Security (DGOSS) to AIReF. Files from 2009 to 2017 have been used. There are three files per year corresponding to registrations, terminations and stock of pensions (see annex II for more detail of the information used). Compared to the CPLS, used to project retirement registrations, the registry data covers the entire population.

3.2. General mechanics of the model

The objective is to estimate Social Security's expenditure on contributory pensions, which represent practically 90% of public pensions in Spain[4]. Expenditure is estimated for the three types of pension: retirement, disability and survivor's. The latter includes pensions for widows, orphans and in favour of family members.

The model was originally developed in the Directorate General for Macroeconomic Analysis (DGAMEI) of the Ministry of Economy for the preparation of the results for Spain of the Ageing Reports from 2009 to 2018.

The mechanics of the model are based on the breakdown of the expenditure (E) into annual average pension (Pm) and number of pensions (N) for each year t:

$$E_t = Pm_t * N_t \qquad (10)$$

If the average monthly pension is used, it must be multiplied by 14, which is the number of annual payments.

The expenditure can also be broken down by sex and age. We incorporate age "e" in the formulation and ignore sex to simplify:

$$E_t = \sum_{e=0}^{100} Pm_t^e N_t^e \qquad (11)$$

This is the stock of pensions that increases with the flow (positive) of entries or registrations and decreases with the flow (negative) of exits or terminations.

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[4] Public pensions in Spain are 89% contributory of Social Security, 9% contributory of Civil Servants of the State and 2% non-contributory of Social Security.

The registrations are determined exogenously and will depend on the demographic and macroeconomic assumptions. The terminations (T) for a certain age and year are determined by applying the INE mortality rates to the number of pensions of an age less than the previous year:

$$T_t^e = N_{t-1}^{e-1} * Mort_t^e \qquad (12)$$

The number of pensions of a given year and age is the stock of the previous year, plus the new registrations minus the terminations of that year and that age:

$$N_t^e = N_{t-1}^{e-1} + R_t^e - T_t^e \qquad (13)$$

With regard to the amount of the pension, for the registrations the general rule is that they evolve according to the growth of productivity (Δpv_t) and the CPI (ΔCPI_t):

$$PmR_t^e = PmR_{t-1}^{e-1} * (1 + \Delta pv_t + \Delta CPI_t) \qquad (14)$$

The average pension upon terminations for an age is given by the weighted average of the stock of an age less than the previous year, updated by the CPI of that year (or the revaluation rule that is alternatively chosen), and of the year's registrations, according to the following formula:

$$PmT_t^e = \frac{N_{t-1}^{e-1} * Pm_{t-1}^{e-1} * (1+\Delta CPI_t) + R_t^e * PmR_t^e}{N_{t-1}^{e-1} + R_t^e} \qquad (15)$$

The average pension for an age and year is the weighted average of the stock of the previous year plus the registrations minus the terminations, according to the following expression:

$$Pm_t^e = \frac{N_{t-1}^{e-1} * Pm_{t-1}^{e-1} * (1+\Delta CPI_t) + R_t^e * PmR_t^e - T_t^e * PmT_t^e}{N_{t-1}^{e-1} + R_t^e - T_t^e} \qquad (16)$$

This dynamic is applied for each type of pension, except for the specificities explained in the following sections.

3.3. Retirement pensions

Basic concepts

The retirement benefit covers the loss of income suffered by a person when, having reached the established age, they cease to work as an employee or self-employed, thus ending their working life, or reduces their working hours and wages under the terms legally established.

The retirement pension is a collection right that is generated throughout the working life of a worker and is received once the worker has retired from the world of work and has reach the age and number of years in which contributions were paid required by law.

Retirement pension registrations are closely related to exits from the labour market and activity rates. Thus, an increase in the activity rate at a certain age will produce a reduction in the number of retirements of that age. The treatment of the number and amount of retirement pensions registered is analysed in the section on the CPLS. The dynamics of the stock of pensions and of terminations follows the general pattern.

3.4. Disability pensions

Basic concepts

The permanent disability pension is an economic benefit that covers the loss of salary or professional income that a person suffers when, being affected by a pathological or traumatic process resulting from an illness or accident, their work capacity is reduced or eliminated in a presumably definitive manner.

The amount depends on the degree of disability recognised: partial, total, absolute and severe disability. The general percentage applied on the regulatory base is 52% of the regulatory base, although it exceeds 100% in severe disabilities.

According to statistical convention, disability pensions are classified as retirement pensions when the beneficiary reaches 65 years of age.

Number of disability registrations

Disability registrations are calculated by multiplying the projection of employed persons by the probability of becoming disabled of the base year (ProbDis), constant for the entire projection period:

$$RDis_t^e = Employed_{t-1}^e * ProbDis^e \qquad (17)$$

The probability of becoming disabled is calculated as the quotient of disability registrations over the number of employed persons of the base year:

$$ProbDis^e = \frac{RDis_{base}^e}{Employed_{base}^e} \qquad (18)$$

It is assumed that there cannot be disability registrations at ages over 64 years as these are considered to be retirement.

Number of pensions and disability pension terminations

The profile of disability pension terminations is different from that of the general population. Therefore, the observed terminations are broken down into "terminations due to mortality" and "other terminations".

The mortality terminations (TMort) of year t are obtained by applying the mortality rate to the sum of the number of pensions (NDis) of the previous year and the registrations (RDis) of that year:

$$TMort_t^e = (NDis_{t-1}^{e-1} + RDis_t^e) * Mort_t^e \qquad (19)$$

To estimate the other terminations (OT), first those of the base year are estimated, which are obtained as the difference between the total of terminations and the observed mortality terminations of that year:

$$OT_{base}^e = TDis_{base}^e - TMort_{base}^e \qquad (20)$$

Second, the fixed coefficient "other disability terminations" (ODT) for the entire projection period is calculated.

$$ODT^e = \frac{OT_{base}^e}{TMort_{base}^e} \qquad (21)$$

And finally, the projection of the other terminations, the total terminations (TDis) and the number of disability pensions (NDis) are calculated:

$$OT_t^e = TMort_t^e * ODT^e \qquad (22)$$
$$TDis_t^e = TMort_t^e + OT_t^e \qquad (23)$$
$$NDis_t^e = NDis_{t-1}^{e-1} + RDis_t^e - TDis_t^e \qquad (24)$$

Average disability pension

The average pension upon registration and the total average pension are calculated according to the general mechanism. The only specialty lies in the average pension upon termination.

To calculate the average pension upon termination, a distinction is made between those under and over 65 years of age. The latter have milder degrees of disability and their treatment is analogous to that of retirement pensions. In fact, from the statistical point of view they will be integrated with retirement pensions, with the key identifier J.

Beneficiaries under 65 years old concentrate the most severe disabilities, which give the right to higher pensions and which have especially high mortality rates. This means that the average pension upon termination is systematically higher than that of the stock of pensions, contrary to what happens in retirement, for example. Specifically, in recent years it has been observed that the average disability pension upon termination for people under 65 is around 15% higher than the average disability pension. Hence, the formula used is the following:

$$PmT_t^e = 1.15 * Pm_{t-1}^{e-1} \qquad (25)$$

Retirement disability adjustment

Finally, according to convention, disability pensions are classified as retirement pensions when the beneficiary reaches 65 years. Disability pensions for people over 65 are called key pensions J.

3.5. Widowhood pensions

Basic concepts

The widowhood pension is the benefit granted to those persons who have had a matrimonial bond or have been de facto partners of the deceased person, as long as both parties meet the established requirements. Thus, the deceased must be affiliated with Social Security or be receiving a pension for retirement or permanent disability. The surviving spouse must prove they have been married at least one year before the death, have shared children or be a de facto couple at least two years before the death.

The economic benefit received, as a general rule, is 52% of that which would have been received by the originator, extendible to 70% for pensioners with family responsibilities and for whom the pension is the main source of income, without annual returns exceeding a certain amount. In addition, since 2019, pensioners who are at least 65 years of age, who do not work, who do not receive another pension and who do not have income above a certain threshold benefit from a 60% percentage.

Number of widowhood registrations

Widowhood registrations depend on the deaths (terminations) of the originators: active (TAct), permanently disabled (TDis) and retired (TRet) of people of the opposite sex.

$$\mathrm{Death}_t^e = \mathrm{TAct}_t^e + \mathrm{TDis}_t^e + \mathrm{TRet}_t^e \tag{26}$$

Thus, the coefficient of registrations over deaths for women (CRWidW) is calculated as the proportion of widowhood registrations in the base year with respect to the deaths of possible male originators ($DeathM_{base}^{e+2}$) two years older. It is assumed that the average age of men is 2 years older than that of their wives[5].

$$CRWidW^e = \frac{RWidW_{base}^e}{DeathM_{base}^{e+2}} \tag{27}$$

The coefficient is kept constant for the entire projection period, so that the registrations depend on the predicted deaths of men:

[5] Average difference 2000-2017 according to Marriage Statistics of the INE: 2.4 years

$$RWidW_t^e = CRWidW^e * DeathM_t^{e+2} \qquad (28)$$

For men, the registrations are calculated analogously using the deaths of women two years younger.

The total number of pensions and widowhood pension terminations does not present specificities with respect to the standard calculation.

Average widowhood pension

The optimum would be to calculate the widowhood registrations according to the situation of the specific originator (with their specific regulatory base, employment situation...) and of the pensioner (family responsibilities, income...). As all this information is not available, the pension is calculated according to the general procedure.

Below, the total widowhood pensions, registrations and terminations according to the general mechanics, have been calculated. In addition, the possibility of incorporating the additional increases in the percentage applied to the base that is legislated is incorporated. For example, for 2018 and 2019 the cumulative increase of 15% (percentage increase from 52% to 60%) is included for widowhood pensions for those over 65 years of age, who do not work, who do not receive another pension and who do not have income above a certain threshold. In addition, this measure does not affect minimum pensions, since the minimum supplement they receive from the State will fall by the same proportion as this increase. It is estimated that there are around 400,000 beneficiaries, or 17% of widowhood pensioners.

3.6. Orphanhood pensions

Basic concepts

The orphanhood pension consists of an economic benefit that is granted to the descendants of deceased persons, as long as they comply with the established requirements, mainly the deceased's contributions and the beneficiary's age. When a person dies and leaves minor children or adolescents, they are entitled to an orphanhood pension paid by the Social Security system. The percentage applied to the regulatory base is generally 20%.

Number of orphanhood registrations

Orphanhood pension registrations depend on the deaths of the originators: active, permanent disabled and retired, as in the case of widowhood. The age difference between parents and orphans is estimated at 35 years, in line with data from the INE. The starting point is the coefficient of orphanhood registrations over deaths of both sexes by age groups of 35 years plus ($DeathMW_t^{e+35}$). In this way, the coefficient of registrations is calculated as:

$$CROrph^{e} = \frac{ROrph_{base}^{e}}{DeathMW_{base}^{e+35}} \quad (29)$$

And the orphanhood registrations are calculated as:

$$ROrph_{t}^{e} = CROrph^{e} * DeathMW_{t}^{e+35} \quad (30)$$

Number of orphanhood calculations

The right to an orphanhood pension is normally extinguished upon turning 21 years of age or upon turning 25 years of age, when the orphan's income is lower than the minimum wage. It is also extinguished by the death of the orphan, by adoption, by marriage or by disappearance of the orphan's disease. Therefore, disability pension terminations will occur mainly at around the 20 years of age of the orphan and are not related to mortality. Given that terminations do not depend fundamentally on mortality, the procedure has been to calculate the coefficient of terminations (CT) by age in the base year and project the terminations:

$$CTOrph^{e} = \frac{TOrph_{base}^{e}}{NOrph_{base-1}^{e-1} + ROrph_{base}^{e}} \quad (31)$$

$$TOrph_{t}^{e} = CTOrph^{e} * (NOrph_{t-1}^{e-1} + ROrph_{t}^{e}) \quad (32)$$

The number of pensions and average pensions are calculated according to the standard procedure.

3.7. Pensions in favour of relatives

Basic concepts

The pension in favour of relatives is an economic benefit that is granted to those relatives who have lived together and depended financially on the deceased and meet the requirements. The percentage applied to the regulatory base generally amounts to 20%. It is required to have lived with the deceased relative, not be entitled to a public pension and have no means of subsistence.

Specificities in favour of relatives

Registrations in favour of relatives depend on the deaths of originators (active, permanent disabled and retired). The coefficient of registrations due to death uses the deaths of both sexes and all ages as denominator ($DeathMW_t$):

$$CRFR^{e} = \frac{RFR_{base}^{e}}{DeathMW_{base}} \quad (33)$$

$$RFR_{base}^{e} = CRFR^{e} * DeathWM_{t} \quad (34)$$

In the other elements, the calculations are analogous to orphanhood pensions.

4. CPLS AND RETIREMENT RATES

4.1 CPLS: concept and content

The Continuous Professional Life Sample (CPLS, or MCVL in Spanish) is an excerpt of individual anonymised data, from the Social Security databases, in addition to others that are taken from the Continuous Municipal Register (INE) and from the annual summary of withholdings and income on account of Personal Income Tax (Model 190) of the AEAT (Spanish Tax Agency). The CPLS is prepared annually by the Directorate General of Planning for the Social Security (DGOSS in Spanish).

This set of microdata extracted from Social Security records in a given year represents 4% of the people in the reference population (about 25 million affiliates and pension beneficiaries) and contains more than one million records. It reproduces the work history of the people selected since 1980.

The CPLS is structured around several tables, of which the following are used in this exercise:

- **Contribution bases:** reflects the monthly amount, in cents of euro, of the contribution bases of the people selected for the CPLS. *From this file, the contribution bases of the entire working life for the individuals are obtained.*
- **Pensions/Benefits:** The pension table shows the fundamental characteristics of the pensions received, or have been received in the past, by the persons included in the sample, such as the type of pension (disability, retirement, widowhood, etc.), the date on which it was recognised and the amount of the different payment concepts that are integrated into it. *This file identifies individuals who have begun to receive a retirement pension in the base year.*
- **Persons:** Includes a row or record for each individual selected for the Sample, collecting their essential characteristics from the Social Security databases and the Municipal Register in columns. *From this file the data referring to the date of birth and sex of the individual are used.*

The objective is to obtain a file with the personal characteristics and the contribution careers, with the gaps integrated, of all persons who retire in the base year. For each individual, all the contribution bases of each period are added up, ordered chronologically and placed in a single row. The age and sex of each individual is obtained from the person file. With the benefits file, all individuals who have not retired in the base year are eliminated. The contribution gaps are filled in accordance with current legislation. After the 2011 reform, article 209 of the General Social Security Law indicates that the first 48 gaps will be integrated with the minimum base and the rest with half the minimum base. Before the 2011 reform, all gaps were integrated with the minimum base. The minimum base for each year is obtained from Social Security's economic and financial annex.

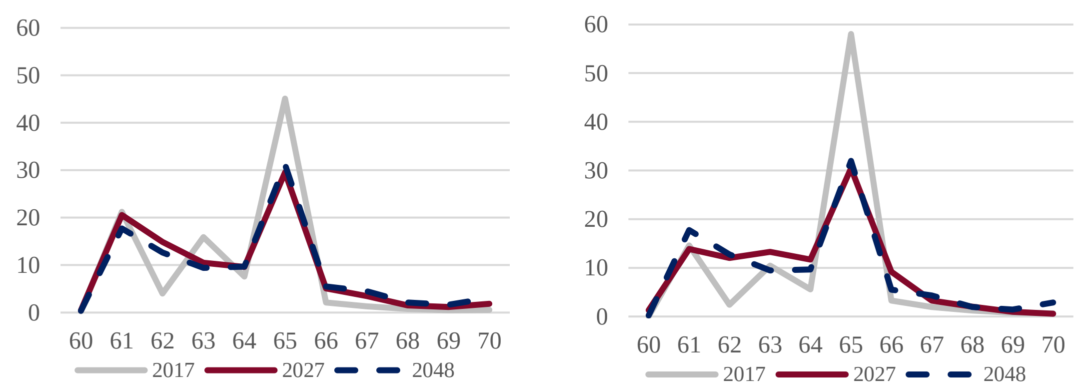
4.2 Retirement rates in the inertial scenario

In the medium term, the main determinant of the flow of new retirees is exits from the labour market between 60 and 70 years of age. For this reason, it is assumed that the retirements will converge in the medium term (2027) to the exits from the labour market that, in turn, depend on the activity rates.

As indicated in the section on the activity rate, in the inertial scenario it is assumed that there are two changes in the medium and long term: a return to the activity rates observed before the crisis and a convergence of women to men. Thus, in the first place, it is assumed that in 2027 men's activity rates will reach the maximum level observed between 2008 and 2017. The difference between these two years is especially noticeable in the early ages, which can be explained by a delay in access to the labour market resulting from high youth unemployment. It is foreseen that, depending on the consolidation of the recovery, we will return to the pre-crisis situation, which, on the other hand, can be assimilated to that observed in other countries around us. Secondly, it is assumed that the activity rates of women continue to approach that of men until their full equalisation in 2048.

Retirements are equal to exits from 2027 onwards. As can be seen in the figure, in the case of men, as early as 2027, the distribution of retirements is bimodal with a peak at the earliest retirement age of 61 years, and another at age 65. In the case of women, this bimodal distribution is reached some years later according to when their careers converge to those of men. In 2048 the distributions for both sexes are identical.

FIGURE 12. RETIREMENT RATES FOR MEN AND WOMEN. INERTIAL SCENARIO



Percentage of retirements of each age over the total of retirements from 60 to 70 years

Source: AIReF

In the inertial scenario, retirement pensions registered by sex and age grow in line with productivity and the CPI. Furthermore, an additional growth is assumed for women's average pension of 0.1% per year, which reflects the convergence to a 37-year career that entitles individuals to 100% of the regulatory base[6].

4.3 2011 pension reform

The CPLS provides information on the contribution bases and thus enables us to calculate the average pension upon retirement with different regulations in relation to the retirement age, to the contribution career or to the percentages applicable to calculate the pension. In this section we explain the legislative changes of the 2011 reform, which adjusts various parameters of the system throughout a transitional period that ends in 2027. For simplicity, we will consider only the two extremes of the 2011 reform, that is, the pre-reform situation of 2011 ("legislation in 2011") and the legislation foreseen at the end of the transitional period ("legislation in 2027"), which remains constant from then on. However, the legislation in force in the intervening years has been taken into account in the modeling.

If the age and career criteria are met (see table), the monthly retirement pension is calculated as the product of the regulatory base (RB), the percentage applied to the regulatory base (PCTRB) and, where appropriate, the premium or penalty coefficients (P):

$$Pension = RB * PCTRB * P \tag{35}$$

[6] With data from the CPLS 2017, the average career of women is 33 years, which corresponds to a percentage of 91% of the regulatory base. It is assumed that the 9-point gap closes in 2100 (82 years) and that it does so in a linear fashion, that is, 0.1 p.p. per year (9/82).

TABLE 3: RETIREMENT AGE ACCORDING TO CONTRIBUTION CAREER

	Legislation in 2011		Legislation in 2027	
	Age	Required career	Age	Required career
Ordinary long career	65	35	65	38.5
Ordinary short career	65	15	67	15
Early long career	61	30	61	38.5
Early short career	61	30	63	33
Partial long career	61	30	63	36.5
Partial short career	61	30	65	33

In the first place, the regulatory base is the average of the contribution bases of the last years prior to retirement updated with the CPI at the time of retirement. It is calculated as the sum of the contribution bases divided by the number of contribution bases considered. The reform has increased the years taken into account to calculate the regulatory base from 15 to 25 years from 2022 onwards[7]. Since contributions are paid 12 times a year and 14 pension payments are received, the average of the last years is divided by 14 instead of 12. Thus, the formula for calculating the regulatory base for month 0 with the applicable legislation in 2011 is as follows:

$$\mathrm{RB}_0 = \frac{1}{14*15} * \left(\sum_{j=1}^{24} CB_{t-j} + \sum_{j=25}^{180} CB_{t-j} \frac{\Delta CPI_{t-25}}{\Delta CPI_{t-j}} \right) \quad (36)$$

[7] In months, the 2011 reform goes from considering the last 180 months to the last 300 months from 2022 onwards

Note that the contribution bases of the two most recent years are recorded at their nominal value, while the previous ones are adjusted for the evolution of the CPI.

With the applicable legislation in 2027 the formula is identical, but taking into account a 25-year contribution career, that is:

$$\mathrm{RB}_0 = \frac{1}{14*25} * \left(\sum_{j=1}^{24} CB_{t-j} + \sum_{j=25}^{300} CB_{t-j} \frac{\Delta CPI_{t-25}}{\Delta CPI_{t-j}} \right) \qquad (37)$$

Secondly, the percentage applicable to the regulatory base PCTRB corrects the RB for the number of years in which contributions were made, so that only pensioners with long enough careers will be entitled to one hundred percent of their RB.

With the 2011 legislation, if we call n the number of years in which contributions were paid, the PCTRB formula is as follows:

$$PCTRB \begin{cases} 0 & If\ n > 15 \\ 0.5 + 0.033(\mathrm{n} - 15) & \mathrm{If}\ 15 \leq \mathrm{n} < 25 \\ 0.8 + 0.02(\mathrm{n} - 25) & \mathrm{If}\ 25 \leq \mathrm{n} < 35 \\ 1 & \mathrm{If\ n} \geq 35 \end{cases} \qquad (38)$$

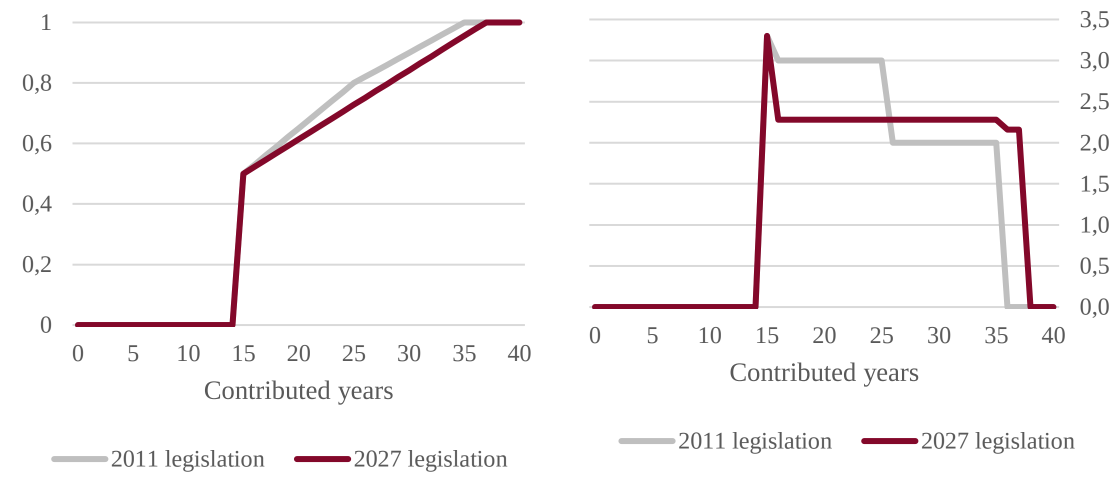
It is observed that the annual accrual rate is zero in the first years and becomes a maximum as of year 15, with an annual accrual rate of 3.3% (0.5/15). In the following years, the accrual rate falls to 3% and, from year 25 to year 35, it becomes 2%. From then on, additional contributions do not improve the pension, so the accrual rate is zero.

With the 2027 legislation, the PCTRB formula becomes the following:

$$PCTRB \begin{cases} 0 & If\ n > 15 \\ 0.5 + 0.0228(\mathrm{n} - 15) & \mathrm{If}\ 15 \leq \mathrm{n} < 35.67 \\ 0.9712 + 0.0216(\mathrm{n} - 35{,}67) & \mathrm{If}\ 35.67 \leq \mathrm{n} < 37 \\ 1 & \mathrm{If\ n} \geq 37 \end{cases} \qquad (39)$$

The profile of the accrual rate flattens out compared to the previous legislation, going from 3.3% in the first 15 years, to 2.28% in the following 20 years and to 2.16% from then until 37 years. Thereafter, the accrual rate remains zero.

FIGURE 13. PERCENTAGE APPLIED TO THE REGULATORY BASE (PCTRB) AND ACCRUAL RATE (ANNUAL %)



Source: AIReF

Finally, the total premium or penalty coefficient P is calculated as a function of the age as 1 plus the product of the number of years until the person reaches ordinary retirement age multiplied by the p coefficient of annual premium or penalty:

$$P_i = 1 + p_i * (age_i - OrdinaryAge_i) \quad (40)$$

This means that if the worker retires at an age above the ordinary age at which he/she is entitled to retire according to the duration of his/her career he/she receives a premium (coefficient higher than 1) and if he/she retires at a lower age (early retirement) he/she receives a penalty (coefficient lower than 1). As can be seen in the table of the annual age coefficients, the 2011 reform makes early retirement more costly and delayed retirement more beneficial:

TABLE 4. ANNUAL PENALTY COEFFICIENTS BY AGE

	Legislation 2011	Legislation 2027
Not possible to retire	Less than 30 years	Less than 33 years
7.5%	Between 30 and 34 years	Between 33 and 38.5 years
7%	Between 35 and 37 years	Between 38.5 and 41.5 years
6.5%	Between 38 and 39 years	Between 41.5 and 44.5 years
6%	Over 40 years	Over 44.5 years

TABLE 5. ANNUAL PREMIUM COEFFICIENTS BY AGE

	Legislation 2011	Legislation 2027
0%	Less than 35 years	Less than 25 years
2%	Between 35 and 40 years	Up to 25 years
2.75%	-	Between 25 and 37 years
3%	Over 40 years	-
4%	-	Over 37 years

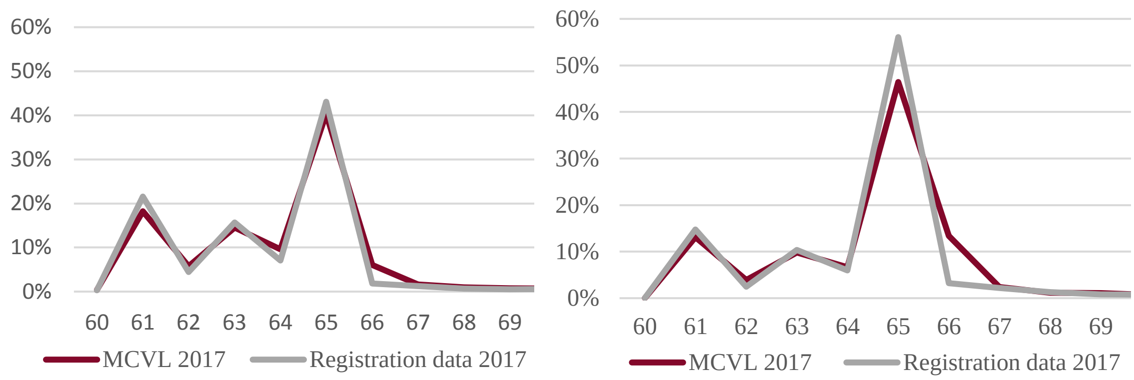
Partial early retirement is calculated analogously but only for the proportional part of the day in which the pensioner does not work. In addition, this type of benefits does not have a reduction coefficient by age.

Once the pension is calculated according to the formula, the benefit is limited within the caps given by the amount of the maximum pension and the minimum pension (there are several of these depending on the personal and family situation). Then it is possible to represent the profile by sex and age group of the retirement pension registered.

4.4 Retirement rates in the baseline scenario

The starting point is therefore the profile of retirements with the current legislation in the base year. As can be seen in the figure, the profile obtained from the CPLS is very similar to that of the pensions actually observed.

FIGURE 14. RETIREMENT RATES FOR MEN AND WOMEN IN 2017



Percentage of retirements of each age over the total of retirements from 60 to 70 years

Source: AIReF

The next step is to apply the current regulations every year to the retirements observed in the base year. As the 2027 legislation is more restrictive than the 2011 one in terms of age and contribution careers, there will be a proportion of individuals who will not be able to retire, or "block of non-retirees".

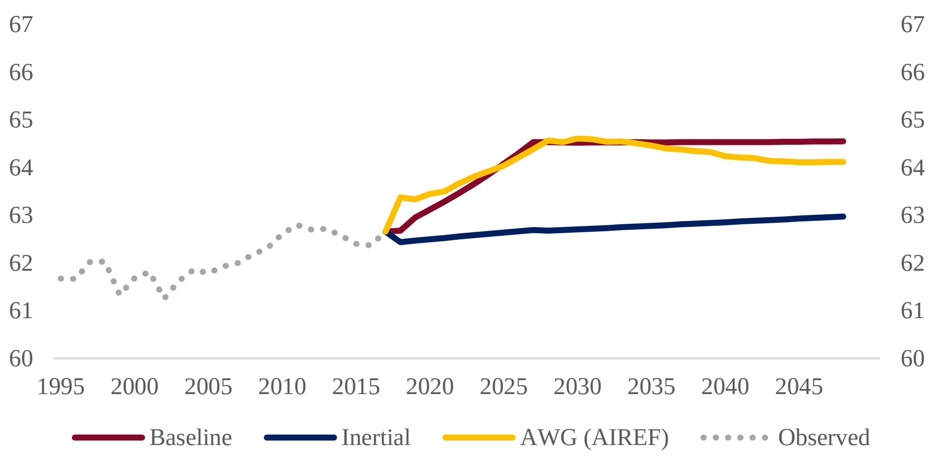
On this point some assumptions are made:

- The people who want to retire every year are identical in terms of age, sex and contribution career to those of the base year. This assumption can be limiting if the economy is in an upward or downward cycle. In addition, it ignores all information regarding the stock of contributors in the sample.
- All workers who do not meet the retirement requirements in a given year continue to work with the same contribution base for another year.
- The block of non-retirees will retire as soon as their age and contribution career permit.

The dynamics of the block of non-retirees will determine that the new retirees will grow older year after year, with an indeterminate impact on the total number of retirements. That is to say, if the 2011 reform causes the total number of pensions to decline, it is not so much because a reduction in the total number of retirements is expected, but because they are more biased towards more advanced ages that will receive fewer years of pension on average.

The effective age of exit from the labour market is affected by the 2011 reform via an increase of almost 2 years, going from 62.7 years to 64.6 years in 2048. On the other hand, if the reform had not been implemented, the increase would be a few months, with the effective retirement age standing at 63 years by 2048 (see figure 15).

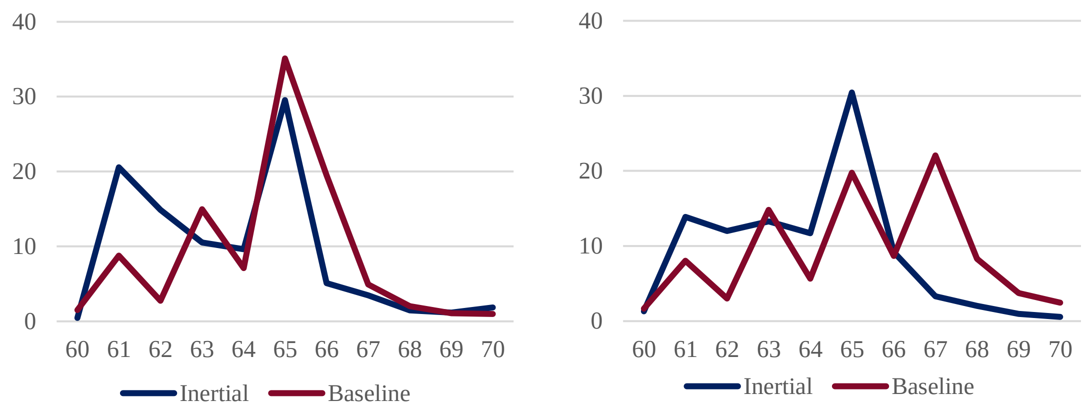
FIGURE 15. EFFECTIVE AGE OF EXIT FROM THE LABOUR MARKET (BOTH SEXES)



Source: OECD's historical values, assumptions for 2018-2048 of AIReF and AWG

Retirement rates are adjusted in line with the estimated impact of the 2011 reform. In both sexes the 2011 reform causes a reduction in the proportion of retirements at 61 years that move to 63 years, as a result of tightening the requirements to access early retirement. However, at the ordinary retirement age a different impact is observed by sex. Thus, as men mostly have long careers, the modal retirement age is still 65 years. In the case of women, a significant proportion has careers less than 38 and a half years, which generates a new peak at 67 years. The profile of 2027 is maintained until 2048.

FIGURE 16. RETIREMENT RATES FOR MEN AND WOMEN IN 2027.

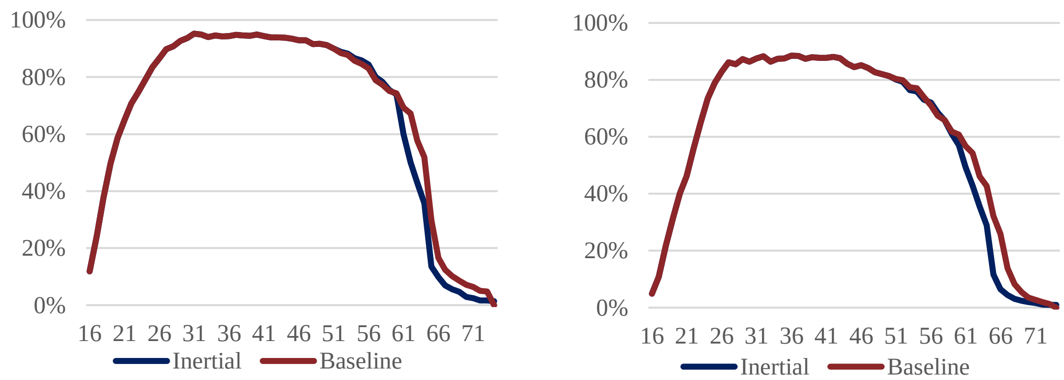


Percentage of retirements of each age over the total of retirements from 60 to 70 years

Source: AIReF

The change in the profile of the retirements requires a commensurate change in the activity rates, which are displaced upwards for older workers, as was seen in aggregate form in figure 4.

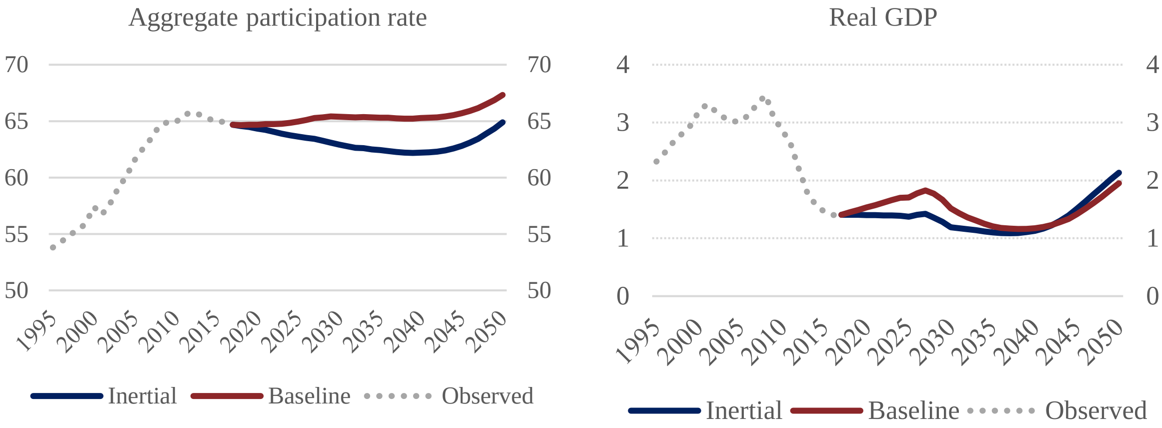
FIGURE 17. ACTIVITY RATES FOR MEN AND WOMEN IN 2027.



Source: AIReF

In aggregate terms, the 2011 reform increases the activity rate, standing at 2.6 pp above its inertial level in 2048. In turn, the greater activity accelerates economic growth, which grows by 1.6% in the 2018-2048 average compared to 1.4% in the inertial scenario.

FIGURE 18. IMPACT OF THE 2011 REFORM ON MACROECONOMICS



Source: AIReF

4.5 Average pension of retirements in the baseline scenario

In the baseline scenario there are two adjustments regarding the inertial scenario, corresponding to the 2011 reform and the sustainability factor. The first adjustment consists of transferring the impact observed with the CPLS directly to 2027 in the model to avoid modest changes in the legislation. This includes the effect of the extension of the calculation period, variations in the applicable percentage and premiums and penalties, as well as the composition effect of retirees who fail to meet the requirements to retire in a given year and must wait for one or two more years.

The second adjustment is the sustainability factor, applied since 2023. The following is the formula defined in the law according to which:

$$SF_t = SF_{t-1} * LifeExpVar_t \qquad (41)$$

Where SS is the sustainability factor and LifeExpVar is an approximation to the year-on-year variation in life expectancy at 67 years, obtained from the mortality tables of Social Security retirees. This variation remains constant in five-year periods. For the first two five-year periods the value of this variable is:

$$LifeExpVar_t = \left(\frac{LifeExp_{2012}}{LifeExp_{2017}}\right)^{\frac{1}{5}} \text{ for t=2019-2023} \qquad (42)$$

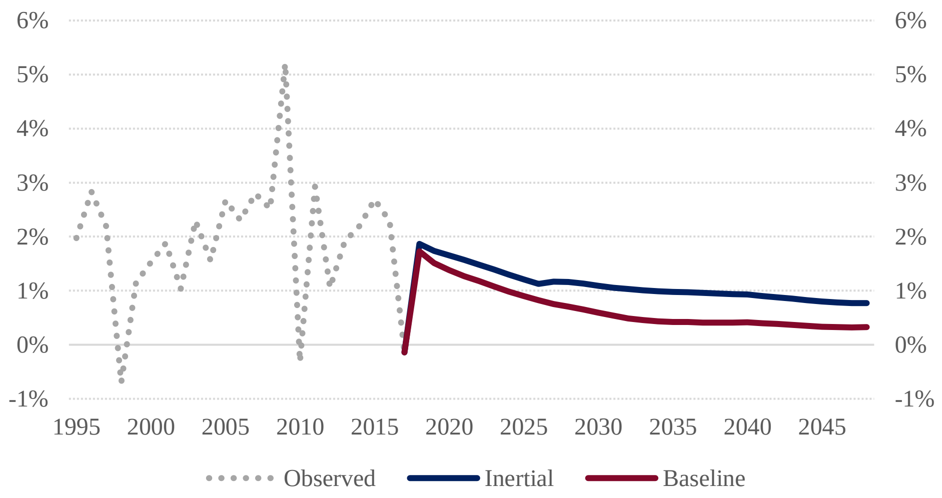
$$LifeExpVar_t = \left(\frac{LifeExp_{2017}}{LifeExp_{2022}}\right)^{\frac{1}{5}} \text{ for t=2024-2028} \qquad (43)$$

The Social Security mortality tables have not been published, so AIReF uses its own estimates of the evolution of life expectancy for the total population. It is assumed that it begins to be applied after 2023, as agreed in the GSB for 2018.

With these data the sustainability factor starts from a level equal to 1 in 2022 and drops to 0.9 in 2048.

As a whole, it is estimated that both reforms generate a reduction of the average real pension upon retirement of 18% with respect to the inertial scenario, slightly more than half explained by the sustainability factor. Figure 19 shows how the average growth of pensions upon retirement, deflated by the CPI, go from growing by 1.1% in the 2018-48 average in the inertial scenario to 0.7% in the baseline scenario.

FIGURE 19. REAL AVERAGE PENSION UPON RETIREMENT (VARIATION RATE)



Source: DGOSS, INE and own calculations

5. MAIN RESULTS OF THE PENSION MODEL

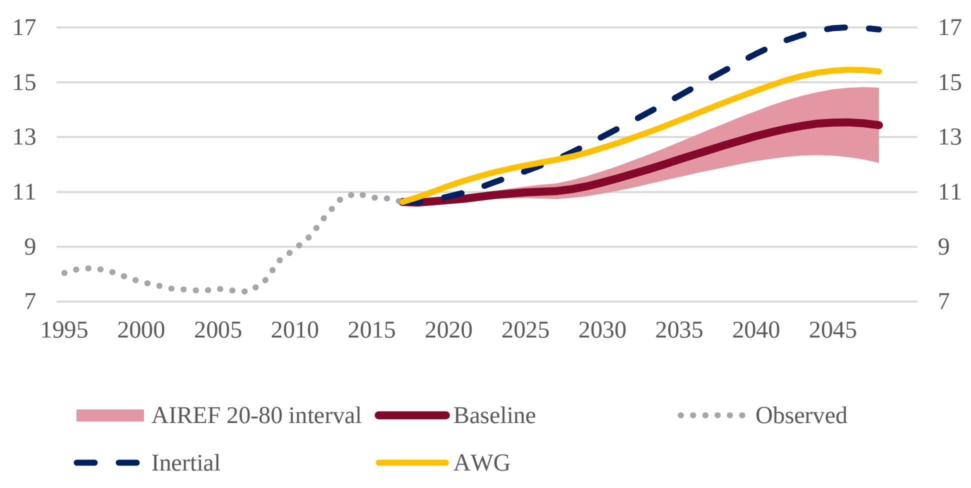
According to AIReF's baseline scenario, the estimated growth of pension expenditure over GDP is moderate until the end of the 20s, accelerates during the 30s coinciding with the retirement of the *baby boom* generation and stabilises from 2045. In 2048, expenditure reaches 13.4% GDP, 2.8 p.p. more than in 2018, with a confidence interval that places it between 12% and 14.8% GDP. It is recalled that the baseline scenario uses the central assumptions of demography and macroeconomic evolution and incorporates the impact of the 2011 reforms and the sustainability factor.

TABLE 6. EVOLUTION OF PENSION EXPENDITURE AT DIFFERENT TIME HORIZONS

Scenario	Year	Expenditure (% GDP)		Coverage rate	Increased expenditure
		Value	Range		% GDP
Baseline	2018	10.6		57	
	2023	10.9	+/- 0.1	58	0.3
	2028	11.1	+/- 0.3	58	0.5
	2038	12.7	+/- 0.8	56	2.1
	2048	13.4	+/- 1.4	53	2.8
Inertial	2048	16.9		60	6.3
AWG assumptions	2048	15.4		51	4.8

Source: historical values of the INE and Social Security, AIReF's assumptions for 2018-2048

FIGURE 20 PENSION EXPENDITURE (% GDP)



Source: LFS (INE), Eurostat, AWG and own calculations

The inertial simulation uses the same assumptions as the baseline simulation, with the difference that it does not include the reforms of 2011 and 2013, that is, it indicates the pension's expenditure that Social Security would have to assume if the reforms were not applied. Thus, the ratio of expenditure to GDP would rise to 16.9%. Of the additional 3.5 pp, 2.9 p.p. correspond to the 2011 reform and 0.6 p.p. to the sustainability factor.

Finally, the scenario called "AWG Assumptions"[8] corresponds to the demographic and macroeconomic forecasts published by the AWG up to 2048 incorporated as inputs into AIReF's model. That is, the forecasts of GDP, inflation, salary, productivity and working-age population come from the AWG and AIReF has used them within the model to estimate pension expenditure over GDP. The result is a pension expenditure over GDP of 15.4% in 2048.

The following is a breakdown of the estimation of the variables that generate pension expenditure over GDP in 2048 for the baseline, inertial and AWG scenarios. In other words, the following table shows the origin of the difference in pension expenditure over GDP in 2048.

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[8] Note that the AWG Ageing Report includes the expenditure of the entire public pension system in aggregate form: contributory pensions of Social Security and State Civil Servants and non-contributory pensions, while the present analysis focuses on the contributory pensions of Social Security. For this reason and to facilitate the evaluation of the impact of the assumptions, it was decided to apply the same AIReF model to the demographic and macroeconomic assumptions agreed in the AWG.

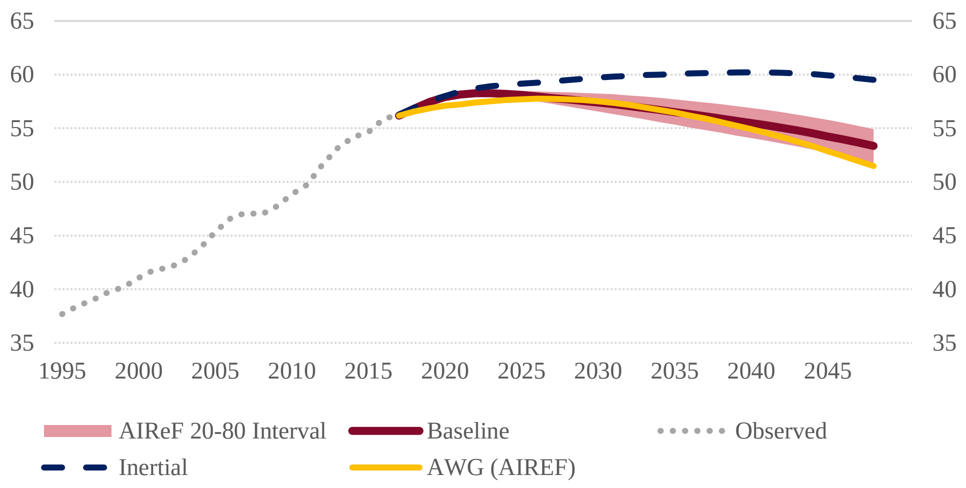
TABLE 7. INPUTS OF PENSION EXPENDITURE IN DIFFERENT SCENARIOS

		Baseline		Inertial		AWG assumptions	
	2018	2048	Rate%	2048	Rate%	2048	Rate%
No. Pensions (millions)	9.68	15.09	56%	16.40	69%	14.81	53%
Average pension (current €)	952	2,074	118%	2,321	144%	2,255	137%
Nominal GDP (M€)	1,217	3,261	168%	3,149	159%	3,039	150%
Expenditure/GDP	10.6	13.4	27%	16.9	59%	15.4	45%
Promemoria:							
CPI	106	180	71%	180	71%	191	81%

It is observed that the baseline scenario is the one that predicts a lower growth of expenditure in terms of GDP, of 27% between 2018 and 2048. Its growth is mainly explained by the evolution of the average pension (+ 118%) and to a lesser extent by the increase in the number of pensions (+ 56%). The inertial scenario, or without reforms, implies a greater growth of expenditure over GDP than in the baseline scenario, due mainly to the greater growth of the average pension in the absence of reforms and, to a lesser extent, the greater growth in the number of pensions. On the other hand, the "AWG assumptions" scenario foresees an increase in pension expenditure over GDP of 45% between 2018 and 2048, 18 p.p. more than in the baseline scenario. This discrepancy is explained in equal parts by a higher average pension and a lower GDP. Eliminating the CPI differential between the AWG and AIReF would reduce the differences in 2048 between both institutions by half for pension expenditure and for the average pension.

Finally, the coverage rate, defined as the average pension over the average wage, presents a slightly declining trend from values of 57% to reach 53% in 2048. The coverage rate has been growing steadily over the past 30 years, the result of a more mature labour market with more complete contribution careers and the parameterisation of the system. Once the first effect has been expended and the effect of the parameterisation by the 2011 reforms and the sustainability factor has been contained, there would be a reduction in the coverage rate, although gradual, to a level similar to that reached in 2013 (see Figure 21). The expected evolution with the assumptions of the AWG is very similar.

FIGURE 21. COVERAGE RATE (AVERAGE PENSION/WAGE)



Source: historical values of the INE and Social Security and assumptions for 2018 – 2048 of AIReF and AWG

6. FUTURE IMPROVEMENTS

In demography, migratory flows are the determinant with the greatest uncertainty and that have undergone the greatest revisions by international agencies. It is therefore necessary to be aware of the academic developments that occur in the field. Likewise, it would be convenient to have a short to medium term model that would serve as a link with the structural estimate.

In the macroeconomic block, the component with the greatest uncertainty is productivity. It would be convenient to make break down the contribution of capital and the total productivity of the factors and study the determinants of each of them. In relation to the activity rate, there is scope to refine the inertial simulation, either in line with the Commission’s developments using the cohort model, or by developing an approach similar to that used to project the fertility and mortality curves.

In the pension model, the key piece of the modelling is the microsimulation of retirements. There is ample room for improvement in this aspect, from a more sophisticated recreation of the projection of the contribution careers, using all the information contained in the different editions of the CPLS or the introduction of incentive and/or alternative functions that allow the decision to retire to be modelled, replacing the hypotheses established by econometrically estimated parameters with real data. It would also be very useful for Social Security to provide the mortality tables of the population considered in each pension class to refine the estimate of terminations. As for the scope of the exercise, it could be extended to State Civil Servants and non-contributory pensions.

Possibly the most complex aspect to address in a long-term horizon is that of uncertainty. In future work, it should be assessed how to integrate the uncertainty of the different components of the model in a coherent way, including the interaction between them.

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Annex I: Modelling of the Pension Revaluation Index (PRI)

a) Definition of the PRI

Although AIReF's baseline scenario considers that pensions are updated with the CPI, the General Social Security Law establishes that the system's contributory pensions have to be revalued with the PRI. The government has agreed that pensions in 2018 and 2019 will be revalued according to the CPI, as occurred before the 2013 reform. The Toledo Pact has also agreed to update pensions with inflation. Therefore, although the PRI is still in force, AIReF considers that a constant and more likely policy scenario is the revaluation in line with the CPI. In any case, the model allows the impact of applying the PRI to be simulated.

The General Social Security Law stipulates that Social Security contributory pensions, including the amount of the minimum pension, will be increased at the beginning of each year according to the PRI foreseen in the corresponding GSB Law. Article 58 of the General Social Security Law (Royal Decree-Law 8/2015) establishes that the PRI, applicable from January 1, 2014 to the contributory pensions of the Social Security system and of the State Civil Servants, including the amount of the minimum pension, is determined according to the following mathematical expression:

$$PRI_{t+1} = \overline{g}_{I,t+1} - \overline{g}_{p,t+1} - \overline{g}_{s,t+1} + \alpha \left[\frac{Rev^*_{t+1} - E^*_{t+1}}{E^*_{t+1}}\right] \qquad (44)$$

Where:

$t + 1$ = Year for which the revaluation is calculated.

$\overline{g}_{I,t+1}$ =Arithmetic moving average centred on t + 1, of eleven values of the variation rate expressed as per-unit unit of revenue of the Social Security system.

$\overline{g}_{p,t+1}$ = Arithmetic moving average centred on t + 1, of eleven values of the variation rate expressed as per-unit of the number of contributory pensions of the Social Security system.

$\overline{g}_{s,t+1}$ = Arithmetic moving average centred on t + 1, of eleven values of the substitution effect expressed as per-unit. The substitution effect is defined as the year-on-year variation of the system's average pension in a year, in the absence of revaluation in said year.

Rev^*_{t+1} = Geometric moving average centred on t + 1 of eleven values of the amount of Social Security system revenue.

E^*_{t+1} = Geometric moving average centred on t + 1 of eleven values of the amount of Social Security system expenditure.

α = Parameter of correction speed of the structural imbalance between revenue and expenditure, which will take a value between 0.25

and 0.33. The value of the parameter will be reviewed every five years. During the 2014-2018 period, the alpha value will be 0.25.

In any case, the result obtained may result in an annual increase in pensions of less than 0.25%, or higher than the percentage change in the CPI in the annual period prior to December of year t, plus 0.50%.

The PRI, in addition to being the ultimate mechanism to guarantee the system's sustainability, was conceived as a marker regarding the existence and magnitude of the financial imbalance of Social Security. As indicated in the Report of the Committee of Experts on the sustainability factor (2013), its "mere calculation, even before it has been applied, already has a very high intrinsic value in that it provides an accurate and understandable picture of the existence, or otherwise, of a deficit in the long term that needs to be corrected. " The transparency framework established by the PRI allows authorities and citizens to respond in advance to demographic and economic challenges.

b) Calculation of the PRI

The method used by AIReF consists of an iterative solution that guarantees the consistency between the PRI, pension expenditure and the substitution effect for each of the years forecasted. In line with AIReF's Working Paper 1/2015, the calculation of the PRI is specified as an under-identified equation problem, in which the PRI formula of each year must be met, subject to the restriction that the average total pension and the average retirement pension are updated according to said PRI. The identification of the system of equations is obtained recursively, adding an additional assumption, namely that the total Social Security expenditure (which depends on the average pension) is equal to the revenue from 2095 onwards. The impact of this assumption on the result for the base years is minimal, since the system in the environment resulting from the assumptions made for the evolution of revenue, number of pension registrations and terminations and CPI is stable.

The steps of the iteration are the following:

1. The historical data of the different series used in the projection are obtained and the exogenous series are projected: number of registrations (R) and terminations (T) and average pension upon registration (PmR). The average pension of terminations (PmT) is linked to the evolution of the variable itself and of the total average pension delayed by one period. It is assumed that revenue grows in line with nominal GDP (unit elasticity).
2. An initial path is proposed in which the PRI is equal to 0.25% for all years, which allows the values of the initial path of average pension with and without revaluation, substitution effect (g_S) and pension expenditure (E) to be obtained, according to the following formulas:

$$\mathrm{Pm}_t = \frac{R_t * PmR_t + P_{t-1} * Pm_{t-1} * (1+PRI_t) - T_t * PmT_t}{R_t + P_{t-1} - T_t} \qquad (45)$$

$$\text{PmNoReval}_t = \frac{R_t * PmR_t + P_{t-1} * Pm_{t-1} - T_t * PmT_t}{R_t + P_{t-1} - T_t} \quad (46)$$

$$g_{S,t} = \frac{\text{PmNoReval}_t}{\text{Pm}_{t-1}} - 1 \quad (47)$$

$$E_t = Pm_t * P_t \quad (48)$$

3. The first iteration of the PRI is calculated for each year of the 2017-95 period:

$$PRI_t^{(1)} = \bar{g}_{I,t} - \bar{g}_{P,t} - \bar{g}_{S,t}^{(1)} + \alpha * \left[\frac{Rev_t^*}{E_t^{*(1)}} - 1\right] \quad (49)$$

Where the superscript refers to the value generated in the iteration (k). The exogenous variables do not carry superscript because they maintain constant values in each iteration.

4. Once the PRI path has been obtained for all the years of projection, it is used to re-estimate the substitution effect and the total expenditure for that period. Thus, the process is repeated iteratively, so that each iteration uses the values obtained in the previous iteration as a base path:

$$\text{Pm}_t^{(k)} = \frac{R_t * PmR_t + P_{t-1} * Pm_{t-1}^{(k)} * (1 + PRI_t^{(k-1)}) - T_t * PmT_t^{(k)}}{R_t + P_{t-1} - T_t} \quad (50)$$

$$\text{PmNoReval}_t^{(k)} = \frac{R_t * PmR_t + P_{t-1} * Pm_{t-1}^{(k)} - T_t * PmT_t^{(k)}}{R_t + P_{t-1} - T_t} \quad (51)$$

$$g_{S,t}^{(k)} = \frac{\text{PmNoReval}_t^{(k)}}{\text{Pm}_{t-1}^{(k)}} - 1 \quad (52)$$

$$E_t^{(k)} = \text{Pm}_t^{(k)} * P_t \quad (53)$$

$$PRI_t^{(k)} = \bar{g}_{I,t} - \bar{g}_{P,t} - \bar{g}_{S,t}^{(k)} + \alpha * \left[\frac{Rev_t^*}{E_t^{*(k)}} - 1\right] \quad (54)$$

The process is repeated until the desired convergence is achieved. Specifically, the iterative process is interrupted when the difference between an iteration k and k-1 for each of the periods of the forecasting horizon is less than 0.0001, in accordance with the legal requirement.

c) Results with application of the PRI

If the PRI formula is applied with the current revenue and expenditure forecasts and keeping all policies unchanged, the resulting index would be lower than the floor of the 0.25% set in the law for the entire 2020-2048 period. Thus, with a revaluation of 0.25%, pension expenditure over GDP would increase by 0.7 p.p. of GDP with respect to the 2018 expenditure. That is to say, the expenditure in

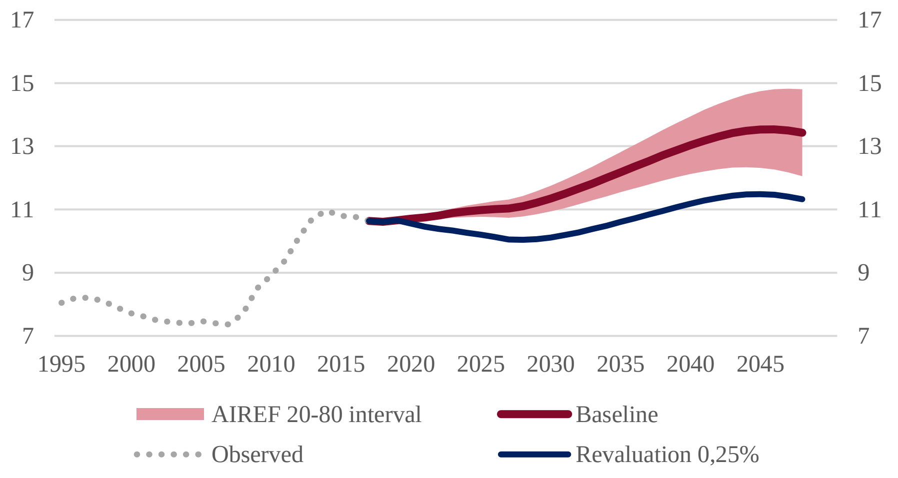
2048 would be 2.1 p.p. lower than AIReF's baseline scenario. Said savings would be achieved at the cost of a reduction in the coverage rate in 2048, which would go from 53% to 45%. In conclusion, the reduction of pension expenditure over GDP would imply a loss of purchasing power for pensioners.

Table 8: pension expenditure Baseline scenario vs PRI

Scenario	Year	Expenditure (% GDP)		Coverage rate	Increased expenditure
		Value	Range		% GDP
Baseline	2018	10.6		57	
	2048	13.4	+/- 1.4	53	2.8
Revaluation 0.25%	2048	11.3		45	0.7

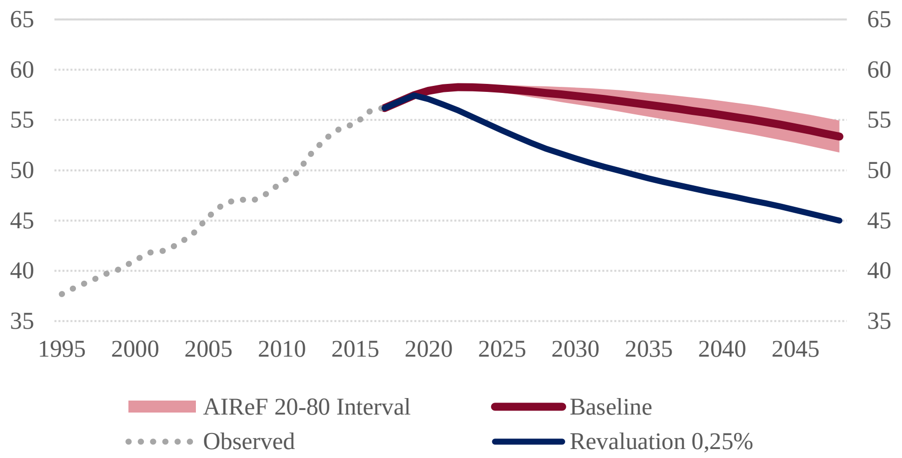
Source: historical values of the INE and Social Security, AIReF's assumptions for 2018-2048

FIGURE 22 PENSION EXPENDITURE (% GDP)



Source: LFS (INE), Eurostat and own calculations

FIGURE 23. COVERAGE RATE (AVERAGE PENSION/WAGE)



Source: historical values of the INE and Social Security, AIReF's assumptions for 2018-2048

Annex II: Detail of DGOSS data

The specific information used of the data from the DGOSS is detailed in this annex. The fields used are age, sex, class, minimum retirement pension indicator, maximum retirement pension indicator, number of pensions and pension expenditure.

TABLE 7: PENSION CLASSES

Class	File code
Retirement	20, 21, 22, 23, 25, 26
- Minimum	20, 21, 22, 23, 26
- Maximum	20, 21, 22, 23, 26
- Uncapped	20, 21, 22, 23, 26
- Partial	25
Full disability	11, 12, 13, 14
Key J	J1, J2, J3, J4
Widowhood	31, 32
Orphanhood	41, 42
In favour of relative	51, 52, 53, 54

A table is prepared with the number of pensions and pension expenditure for each group (registrations, terminations and stock), year, class, sex and age group.

People aged 100 and over are accumulated at age 100 and those older than 100 are eliminated, in such a way that the number and total expenditure for all ages from 0 to 100 years is calculated.

Finally, the average pension is calculated by grouping, year, class, sex and age group as the quotient between the expenditure and the number of pensions.