

# TECHNICAL DOCUMENT ON THE ADEQUACY, EQUITY AND CONTRIBUTION OF THE PENSION SYSTEM. SPECIAL ATTENTION TO THE IMPACT OF THE 2021-2023 REFORM

TECHNICAL DOCUMENT 4/25

April 24<sup>th</sup>, 2025



Independent Authority  
*for* Fiscal Responsibility



Independent Authority  
for Fiscal Responsibility

The Independent Authority for Fiscal Responsibility (AIReF) was created with the mission of ensuring strict compliance with the principles of budgetary stability and financial sustainability enshrined in Article 135 of the Spanish Constitution.

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# 1 . INTRODUCTION

**The analysis of the adequacy, equity and contribution of the pension system and the effect of the reforms complements the sustainability perspective.** This approach forms part of AIReF's proposals and commitments in the Opinion on the Sustainability of the General Government published in 2023.

In this document, AIReF analyses these characteristics from an **intra-generational approach**, in which it compares the results for the different individuals in the cohort, defining the cohort as the group of individuals who have retired in a given year. It complements the analysis with an **inter-generational approach**, in which it analyses the differences in the system's treatment of pensioners depending on the year in which they retire due to changes in both life expectancy and prevailing legislation.

In this technical document, AIReF will consider that the **adequacy** of a pension system is defined as the capacity of the benefit to replace the income that was received during the working life<sup>1</sup>. Under this approach, the analysis may be performed using indicators such as the generosity rate or the replacement rate. The generosity rate is defined as the ratio of the average pension to the

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<sup>1</sup> Alternatively, an adequacy perspective may be adopted such as the coverage of basic needs, i.e. the fight against poverty. The older population in Spain has lower poverty rates than the population as a whole. In 2020, the poverty rate for the over-65s was 11.3%, while for the total population it was 15.4% (Pensions at a Glance 2023).

average wage<sup>2</sup>, while the **replacement rate**, on which the analysis will focus, represents the ratio between the initial pension and the wage received at the time of retirement.

In this document, the **equity** of a pension system will be defined as the absence of differences in the returns that the pension system provides to each individual. As discussed above, the analysis is performed from two approaches. **Intra-generational equity** seeks to ensure that there are no unjustified differences in the treatment provided by the pension system to subgroups of the same age group or cohort<sup>3</sup>. **Inter-generational equity** measures differences in the pension system's returns and adequacy over time, to analyse whether particular cohorts receive different returns depending on the year of retirement. These equity analyses require the comparison of flows paid or received in different periods and thus unify the monetary units to assess them at the same point in time and therefore require adopting an actuarial approach. Both perspectives can be analysed through the Internal Rate of Return (**IRR**), which is defined as the discount rate that equals the present value of contributions over the working life and the present value of pensions over retirement. This indicator is analysed by calculating its value for each individual, which makes it possible to identify differences between different groups that may be justified by objectives such as redistribution or closing the gender gap, or be an indicator of inter- or intra-generational inequity.

The **contribution** of a system measures the relationship between the social contributions paid by workers throughout their working lives and the contributory benefits received in retirement. This is one of the fundamental principles of the Toledo Pact. A system will be considered contributory if there is proportionality between what an individual contributes and what he or she receives, regardless of how cost-effective the system is<sup>4</sup>. For a system to be contributory, it should consider the contribution bases of the entire working life, and the initial retirement pension should be calculated in proportion to that contribution.

The **sustainability analysis** carried out by AIReF in the 2023 Opinion and which has been updated in the Opinion that this technical document accompanies provides a comprehensive approach to the public accounts as a whole. This

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<sup>2</sup> This indicator is not measured on the basis of microdata, but on the basis of aggregate indicators of the economy, and will therefore not be subject to this study.

<sup>3</sup> A sub-group is considered to be the group of people who retire during a given year.

<sup>4</sup> A system is considered to be not only contributory, but actuarially fair if for every euro contributed, the individual receives approximately one euro of pension in equivalent monetary units.

document **will not focus on analysing whether the system is sustainable in actuarial terms**, for which the IRR should not exceed the expected growth of GDP – nominal or real depending on whether the IRR is defined in nominal or real terms – because AIReF considers that the question of the sustainability of the public accounts cannot be answered solely by analysing whether the pension system is actuarially fair.



## 2. METHODOLOGY

The adequacy analysis is performed, as mentioned in the introduction, through the replacement rate – defined as the ratio between the initial pension and the wage received at the time of retirement, or through the generosity rate – calculated as the ratio between the average pension of the system and the average wage of the economy. The former indicator is estimated for each individual retiring, while the latter is estimated in aggregate terms for the economy. In this document, **an individual-by-individual analysis** is performed **using the microdata available, whereby the appropriate indicator of adequacy is the replacement rate**. The Opinion analyses the evolution of the generosity rate and the impact of the reforms on it.

Lastly, **the contribution and equity analyses are performed through the internal rate of return**, the calculation of which is specified in Section 2.3 of this document.

### 2.1. Data exploitation

**The analysis is based on microdata from the Continuous Professional Life Sample (CPLS)**. The CPLS is a set of anonymised microdata that combines information from the Social Security, the Tax Agency and the continuous census of the National Statistics Institute (INE) to reflect the full employment

history — since records began — and as recipients of contributory benefits or unemployment benefits of the selected individuals, which amount to 4% of the total population. The two available versions of the CPLS, without tax data and with tax data, are used. The CPLS with tax data makes it possible to complete the information on individuals' wages, for which the contribution bases available in the CPLS without tax data do not provide a complete picture<sup>5</sup>, in order to analyse the adequacy of the benefits received.

The CPLS only includes affiliates registered with the Social Security system or beneficiaries of contributory Social Security pensions. Accordingly, beneficiaries of non-contributory pensions and workers or pensioners under the Special Regime of Civil Servant Pensioners are excluded from the analysis.

The 2023 CPLS<sup>6</sup> is used, the latest edition available at the time of the study. The registrations of retirement pensions occurring in the base year are extracted. After taking the registration of retirement pensions, a survival bias is introduced in the analysis due to the exclusion of those individuals who made contributions during their professional career but who will not receive a retirement pension due to their premature death.

The CPLS consists of a number of tables. Those used are listed below.

- **Contribution bases:** this table reflects the monthly amount of the contribution bases of the persons selected for the CPLS. The contribution bases for the entire working life of individuals are extracted from this table.
- **Pensions / benefits:** the pensions table contains detailed information of the benefits currently received or received in the past by the sampled individuals. This file identifies individuals who have started to receive a pension in the base year (registration for retirement). It also contains most of the data necessary, apart from the contribution bases, to estimate the initial pension that corresponds to them: months contributed, type of retirement, supplements received, etc.
- **Persons:** this includes one row or record for each natural person selected for the sample. Data on gender, date of birth, nationality, etc. are extracted from this file.
- **Affiliates:** this table contains all the information about the working life of each individual. A row is generated for each registration of each

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<sup>5</sup> Contribution bases are capped, so the CPLS without tax data does not provide information on the wage distribution of individuals in the upper income bracket.

<sup>6</sup> For the CPLS with tax data, the 2023 CPLS for retirement data is combined with the 2022 CPLS for tax data, as 2022 will be the last full year in which those retiring in 2023 were able to work.

individual in the sample. The working life of each individual is extracted from this table.

- **Tax data:** this table contains information on the remuneration declared in the 190 tax form.

The aim is to obtain a file with the personal and employment characteristics and the contributions made of the people retiring in the base year. AIReF has extended the analysis to include new descriptive and income variables, so that this operation is used both for analyses on the impact of changes in legislation and to estimate the return or generosity of the system between groups and over time. Files are generated in which the contribution gaps are filled in<sup>7</sup> (to estimate the pension corresponding to each individual) according to the latest regulation and a file in which the gaps have not been filled in (to measure the return of the system).

In addition, the CPLS registers are subjected to a filter exercise in which atypical data, data with no age noted, etc., are eliminated. After this initial filter, international agreements are eliminated from the analysis because no information is available on contribution bases abroad, and hence there is incomplete information for these individuals on their working lives, and the cases of less common regimes.

The entire analysis has been replicated for other editions of the CPLS, in order to contrast the evolution of individuals' behaviour. In general, the target population is similar for the CPLS for all years, although there are changes in behaviour, which have been specified in [Box 3 of the Opinion](#) and in the *Technical Document on the methodology for estimating pension spending. Results*.

## 2.2. Replacement rate

The **replacement rate**, as mentioned above, is defined as **the ratio between the initial pension and the wage received at the time of retirement**. This indicator reflects the adequacy of the system, as it shows the change in purchasing power at retirement. A unitary replacement rate means that the initial pension will be identical to the wage that was being received. The higher the replacement rate, the higher the adequacy of the system.

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<sup>7</sup> Contribution gaps are defined as periods during which an individual has not paid Social Security contributions. Current legislation determines that these gaps are completed for the calculation of the initial pension. The first 48 months are integrated with the minimum base and the rest of the months with 50% of it. In the case of women, the latest reform establishes that as long as there is a gender gap, the gaps will be integrated with 100% of the minimum base.

The **initial pension** is calculated by applying to the regulatory base the percentage corresponding to the years contributed, the limit of the maximum amount and the rewards and penalties in the event of delayed or early retirement, and adds the supplements corresponding to the individual<sup>8</sup>, where applicable. The regulatory base is obtained by adding the contribution bases of the last 25 years or the best 27 of the last 29 years — whichever option is more beneficial for the beneficiary — in accordance with the transitional system in force until 2043. From 2044 onwards, the best 27 of the last 29 years will be selected. To obtain the regulatory base, the contribution gaps are completed in accordance with the regulations, and the contribution bases are updated with the Consumer Price Index (CPI) except for the last two years, which are taken at their nominal value. Once the percentage corresponding to the regulatory base has been applied, the amount obtained is limited if it exceeds the maximum pension established for each year, or is topped up to the minimum pension if it is lower. In the case of delayed retirement, individuals with a lump-sum marker — new in the 2023 edition of the CPLS — will not have an additional percentage on the initial pension, but the amount of the lump-sum will be added to the pension spending at a later stage.

Although the theoretical formula for the replacement rate uses **the wage of the period immediately prior to the date of retirement** as the **denominator**, a series of adjustments must be made to obtain this variable on an individual-by-individual basis. On the one hand, there are individuals with discontinuous working careers which, for one reason or another, mean that they do not make contributions — or make contributions that are much lower than the historical trajectory — in the periods immediately prior to registration for retirement. To avoid an upward bias in the replacement rate, the maximum value of the contribution bases of the last four years is taken. In addition, those individuals with no contribution base in the last period are excluded. Furthermore, the CPLS contribution base table does not include the full wage of those individuals whose contribution base is capped at the maximum base. This means that taking only the contribution base again generates an overestimation of the replacement rate for the high income brackets. To avoid this, the CPLS without tax data is supplemented by the CPLS with tax data. As a result of this series of obstacles, a mixed formula is defined to obtain the replacement rate in which the maximum value between the tax data and the last four years of contribution bases is taken.

$$Tasa\ de\ reemplazo_t = \frac{Pens_t}{Salario_{t-1}} \quad [1]$$

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<sup>8</sup> In particular, the minimum supplement, the maternity supplement and the gender gap supplement.

Where:

$$Salario_{t-1} = \text{máximo}(BC_{t-4:t}; Retribución_{t-1}) \quad [2]$$

t being the year of retirement.

Furthermore, the analysis excludes the regime for self-employed workers, the special regime for domestic workers and residents in the Basque Country and Navarre because these groups are not obliged to provide tax information<sup>9</sup> and therefore the CPLS with tax data does not contain complete information. In addition, for the self-employed, until the 2022 reform, contributions — and thus pensions — were not linked to income received. The 2022 reform, after the full entry into force of which the self-employed will pay contributions based on their income, has a transitional application regime which means that in the 2023 CPLS it does not yet make sense to study the replacement rate for this group.

All forms of compatibility of work and pension are also excluded in order to avoid distortions in the estimation.

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<sup>9</sup> Except for self-employed persons working as employees

### BOX 1. PROBLEMS OF ESTIMATING REPLACEMENT RATES

The replacement rate is an indicator linked to the adequacy criterion in the analysis of pension systems, understood as the capacity of the benefit to replace the income received prior to retirement. It is used particularly frequently in "pay as you go" (PAYG) systems, as it allows an **evaluation of the generosity of the system and its effectiveness in providing an adequate income** in relation to the beneficiary's previous employment history.

There is no single formula for calculating the replacement rate, as it may vary depending on the source consulted. In this regard, the rate may be gross or net, individual or aggregate, and may consider different wage levels. Specifically, the OECD estimates it as the net pension (after taxes and social contributions) divided by net pre-retirement income. However, Eurostat estimates it as the median gross pension (65-74 years of age) divided by the median gross wage (55-64 years of age). Although in both estimates the estimated value for Spain is higher than the average, the value presented in the second estimate is about 10 points lower.

Cross-country comparisons reveal significant differences in the generosity of the system. In the case of Spain, the net replacement rate is systematically above the OECD and EU-27 average. Both estimates also show that, in general, the southern European countries (Spain, Portugal, Italy) have higher replacement rates than central and northern European countries. However, the order is not maintained. In the case of the Eurostat estimate, Spain has the highest replacement rate, which is not seen in the OECD estimate, despite being in the upper range of the distribution.

TABLE B\_1.1 REPLACEMENT RATE. OECD ESTIMATE

Country	2018		2020		2022	
	Men	Women	Men	Women	Men	Women
France	73.6	73.6	74.4	74.4	71.9	71.9
Germany	51.9	51.9	52.9	52.9	55.3	55.3
Italy	91.8	91.8	81.7	81.7	82.6	82.6
Netherlands	80.2	80.2	89.2	89.2	93.2	93.2
Portugal	89.6	89.6	90.3	90.3	98.8	98.8
<b>Spain</b>	<b>83.4</b>	<b>83.4</b>	<b>80.3</b>	<b>80.3</b>	<b>86.5</b>	<b>86.5</b>
United Kingdom	28.4	28.4	58.1	58.1	54.4	54.4
OECD average	58.6	57.6	62.4	61.3	61.4	60.6
EU-27 average			67.6	66.9	68.1	67.5

Source: OECD

**TABLE B\_1.2: REPLACEMENT RATE. EUROSTAT ESTIMATE**

Countries	2016	2017	2018	2019	2020	2021	2022	2023
EU-27	59	60	59	57	57	58	58	58
Germany	50	50	48	47	46	48	48	49
<b>Spain</b>	<b>65</b>	<b>70</b>	<b>69</b>	<b>68</b>	<b>70</b>	<b>76</b>	<b>75</b>	<b>77</b>
France	67	67	66	65	61	59	60	59
Italy	68	69	72	72	71	74	74	75
Portugal	65	70	68	69	67	67	68	61
United Kingdom	58	61	61	61	61	61	61	61
Netherlands	50	52	53	54	53	52	55	53

Source: Eurostat

In the case of the estimate made by AIReF based on microdata using the methodology indicated, the average value is closer to the Eurostat estimate than to the OECD estimate. In addition, the estimate based on the microdata shows differences between the replacement rate for men and women, due to the substantial differences in the contributions made during the working life of the two groups, something that is not observed in the OECD estimate.

### 2.3. Internal rate of return

The internal rate of return (IRR) **is defined as the discount rate that equates the present value of contributions made over the working life and the present value of pensions over retirement.**

For its calculation, contribution bases are taken from 1981, the first year with complete information in the CPLS<sup>10</sup>. In addition, the monthly bases are transformed into annual variables. **The contribution rate calculated for the retirement contingency of 21% is applied** to these contribution bases. To obtain this rate, the ratio between the cost of retirement pensions in 2023 and the contributions for common contingencies in the same year is considered. For the purposes of this document, this is considered to be the proportion of common contingencies that is necessary to be able to cover retirement pensions<sup>11</sup>. However, there is no consensus in the literature on the rate to be used<sup>12</sup>, so a sensitivity analysis of the IRR to a change in this assumption is added. Specifically, for each 1% reduction in the rate considered to be

<sup>10</sup> For longer contribution records, the remaining months of contributions are considered to have been made on the same contribution base as the first data.

<sup>11</sup> The ratio takes a value of around 0.75, which is applied to the common contingency rate of 28.3% to obtain 21%.

<sup>12</sup> Most authors use assumptions ranging from 16% to 24%.

allocated to pensions, the IRR increases by 0.16 percentage points, whereby, for the range selected by most of the literature, the IRR could vary between slightly more than 5% and 6.5%.

Furthermore, we start from the initial pension calculated at the time of retirement and revalue it with the expected CPI to obtain the pensions received in the following periods. To determine the last period in which benefits are received, life expectancy by year, gender and age from AIReF's demographic projections<sup>13</sup> is applied. Differences in life expectancy according to other variables such as income level or the status of retirement pension beneficiaries are therefore disregarded. This life expectancy is only applied at retirement according to year, age and gender, i.e. static tables are used and not dynamic ones.

$$\sum_{t=0}^T \frac{Cotiz_t}{(1+TIR)^t} = \sum_{t=T+1}^F \frac{Pens_t}{(1+TIR)^t} \quad [3]$$

Where:

$t=0$ : first entry into the labour market.

$t=T+1$ : time of retirement.

$t=F$ : cut-off age at death in line with life expectancy. Life expectancy<sup>14</sup> is assigned by gender and age to all individuals.

*Cotiz*: contribution paid in each period, calculated as the product of the contribution rate and the contribution base.

*Pens*: pension received in each period.

In this case, for partial retirements, those who combine work and pension and flexible pensions, the assumption is made that, if they have not reached the statutory retirement age, they will retire in full when they reach it. If they have already reached the statutory retirement age, they are considered to work one more year to retire with the full pension.

**The IRR** can be expressed in nominal or real terms. Throughout this study, we have chosen to analyse **in nominal terms**.

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<sup>13</sup> As the revaluation rate is the CPI, almost constant at 2% over the projection horizon, there is no major difference between performing the estimate on the basis of life expectancy or applying survival probabilities.

<sup>14</sup> The life expectancy used is that of AIReF's demographic projections.

# 3. RESULTS

The results are organised into two blocks. The first analyses the variables described for individuals in the same cohort, understood as individuals retiring in the same year (intra-generational analysis). The second block analyses the evolution of the variables over time (inter-generational analysis).

## 3.1. Intragenerational analysis

Based on the use of the CPLS described in Section 2.1, the IRR and replacement rate have been analysed according to various variables, both numerical (regulatory base, months of contributions, age, etc.) and categorical (gender, type of pension<sup>15</sup>, educational level, National Classification of Economic Activities (CNAE), etc.). Of all the results, those that are most decisive in determining the variable under analysis are presented.

From this first analysis, a cluster analysis is carried out, in which it is studied how the combination of these variables determines groups for which there are marked differences in the variables to be studied.

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<sup>15</sup> Pensions will be minimum if they receive the minimum pension supplement, maximum if they are above the average pension for the year, or uncapped which will include all other pensions.

### 3.1.1. Variable-by-variable analysis

Although both variables — the IRR and the replacement rate — are correlated, since they both reflect the income provided by the pension, there are clear differences due to the point in time at which this income is measured. While the replacement rate only looks at the time of retirement, the IRR has a more global perspective, as it looks at the individual's entire working and pension life. This is reflected in clear differences in the results for both variables, which will be highlighted in the following sections.

#### 3.1.1.1 Replacement rate

For the replacement rate, it should be noted that it is **an indicator for which estimates can vary greatly depending on the data sources**, the assumptions made and the very definition of the variable<sup>16</sup>.

In global terms, the first thing to note **is the high level of this rate when compared with peer countries, as can be seen in Box 1. Problems of estimating** replacement rates. According to Eurostat and OECD data, Spain has a replacement rate almost 20 points higher than the EU average. There also seems to be an upward bias in this ratio for Mediterranean countries.

As the replacement rate is an indicator of the immediate income provided by the pension, it can be seen that **all the variables that increase the percentage to be applied to the regulatory base will be key in its determination**. It can be seen that **the determining variables for the replacement rate are age, months of contributions and, in a more cross-referenced manner<sup>17</sup>, the type of pension**.

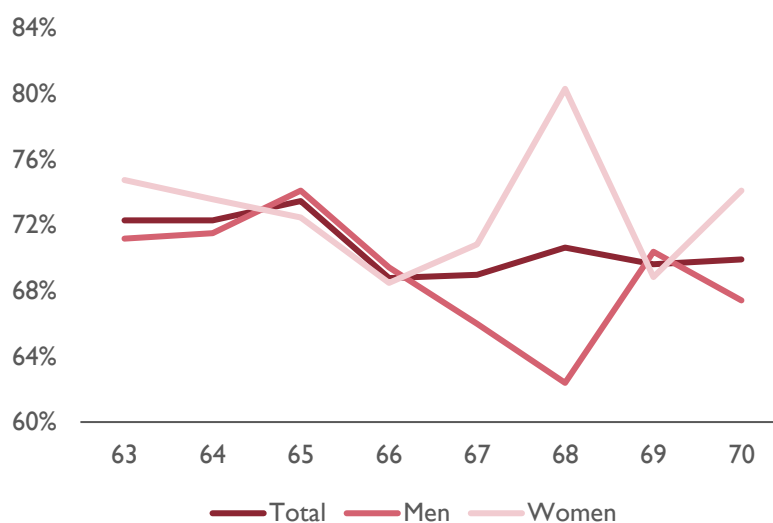
According to the 2023 CPLS microdata, the average replacement rate is 71.7%. There are small differences by gender, with men having a slightly higher rate of 71.9% and women a slightly lower rate of 71.5%. However, when analysing the replacement rate by age and gender, it can be seen that, except for individuals aged 65 and 66, it is women who have a somewhat higher replacement rate. In particular, for ages 67 and 68, women have a higher rate than men, due to the abundance of minimum pensions at these ages for women.

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<sup>16</sup> The initial pension, the pension of an age group, and the median pension may be considered. High age salaries, the last salary, taking into account taxes, not taking into account taxes, etc. may also be considered.

<sup>17</sup> The impact of the type of pension on the replacement rate is only observed when the analysis is performed differentiating by the length of the contributions made.

**FIGURE 1. EVOLUTION OF THE REPLACEMENT RATE BY AGE AND GENDER**

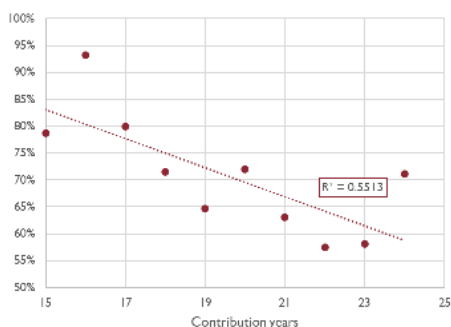


Source: CPLS 2023

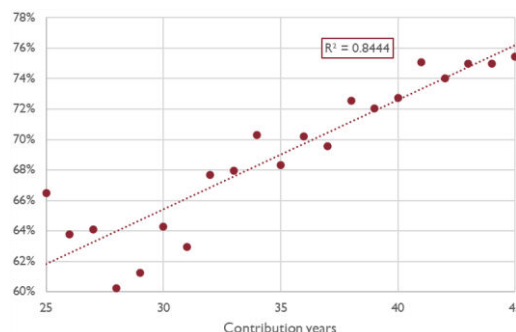
Firstly, there are two ranges in the relationship between the replacement rate and the number of years of contributions. **For contribution records of less than 25 years, the trend is negative:** the more years of contributions, the lower the replacement rate. However, for contribution records of 25 years or more, there is a **positive correlation between the replacement rate and years of contributions.** This negative relationship for short contribution records is due to the fact that the proportion of minimum pensions is high. For these pensions, the replacement rate will be higher the fewer the number of years of contributions made, since the decrease in the percentage of the regulatory base is partially offset by the minimum pension supplements.

**FIGURE 2. REPLACEMENT RATE BY YEARS OF CONTRIBUTIONS**

**FIGURE 2.A. SHORT CONTRIBUTION RECORDS (UNDER 25 YEARS)**



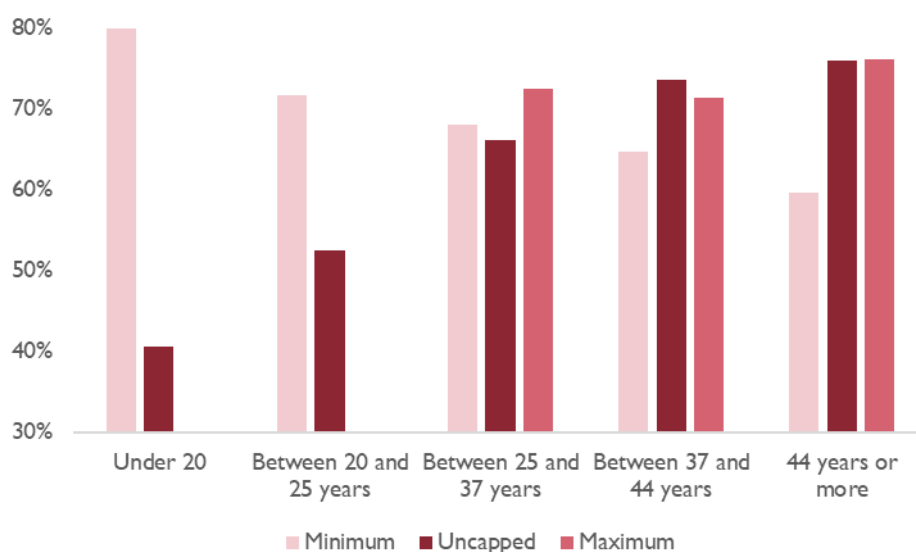
**FIGURE 2.B. LONG CONTRIBUTION RECORDS (OVER 25 YEARS)**



Source: AIReF and CPLS

Indeed, if we distinguish by years of contributions and type of pension, we can see that the positive correlation does not hold in the case of minimum pensions, for which the replacement rate falls as the number of years of contributions increases. This is because, although shorter contribution records have higher penalties, these penalties are offset by the minimum pension supplements.

**FIGURE 3. EVOLUTION OF THE REPLACEMENT RATE BY YEARS OF CONTRIBUTIONS AND TYPE OF PENSION**



Source: CPLS 2023

### 3.1.1.2 IRR

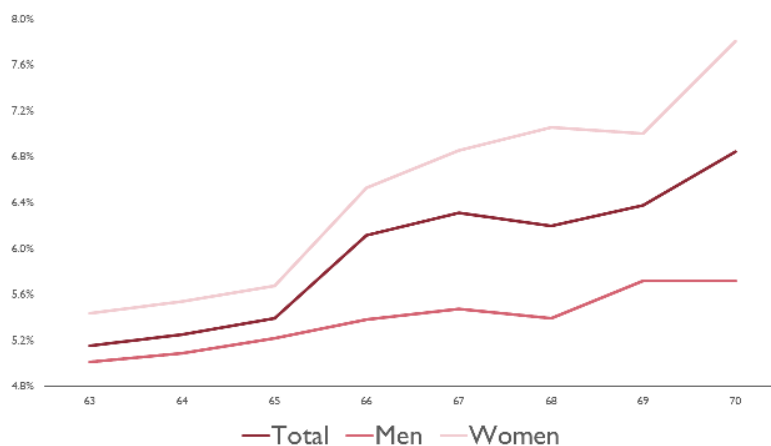
**On average, the IRR is 5.7%, with women's IRR being 6.2%, while men's IRR is 5.4%.** Specifically, **a higher IRR is observed for women at all ages.** These differences increase with increasing age. While for 63 year olds, the difference is only 0.4 points, for 66 year olds the difference is more than 1 point.

In the case of the **IRR**, as it is a global indicator, **the determining factors will be those that increase or decrease the pension without there having been consideration in terms of contributions.** An example of these factors is the differences in life expectancy by gender, which will be reflected in a significant difference in the IRR for this variable<sup>18</sup>. Another example would be receiving minimum pension supplements (increasing the pension that would be obtained with the general formula) or receiving the maximum pension (decreasing the pension that would be obtained with the general formula). Furthermore, an increase in the contributions made increases the IRR due to

<sup>18</sup> Women have a longer life expectancy than men.

the progressive nature of the reduction percentages of the regulatory base. From the age of 38, the percentage applied to the regulatory base is 100%, which produces certain distortions in the IRR for long contribution records.

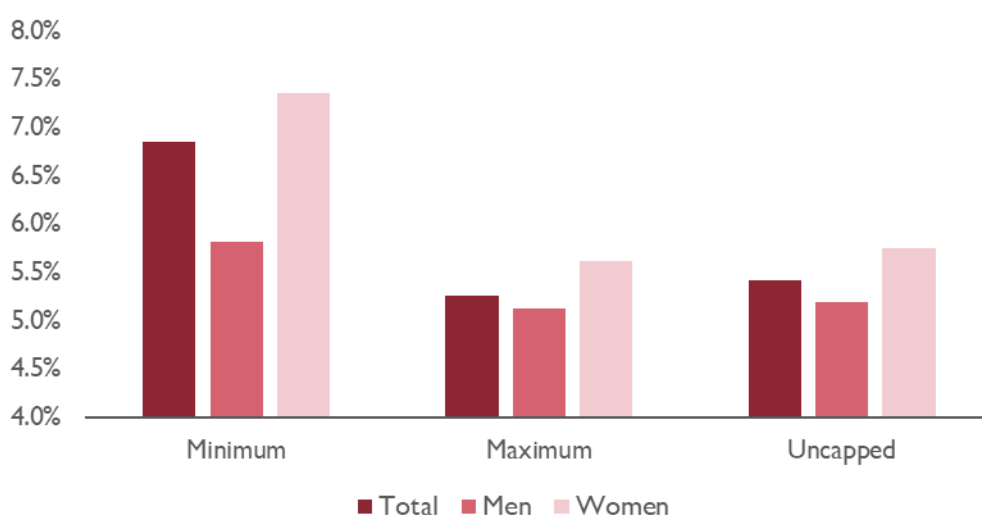
**FIGURE 4. EVOLUTION OF NOMINAL IRR BY AGE AND GENDER**



Source: CPLS 2023

In the case of the type of pension, due to prevailing legislation, the difference between men and women is maintained and it is observed that **the IRR will be higher for minimum pensions and slightly lower for maximum pensions**, as the legislation includes an increase and a decrease in the pension through minimum pension supplements and the determination of a maximum pension that limits the regulatory base.

**FIGURE 5. EVOLUTION OF THE NOMINAL IRR BY TYPE OF PENSION AND GENDER**



Source: CPLS 2023

### 3.1.2. Cluster analysis

The above analyses show an **interrelationship between the determinant variables**. In other words, it seems that there is some combination of variables that defines specific groups in which the IRR is higher and other combinations in which the same is true of the replacement rate. AIReF has carried out various analyses that help to identify these interrelationships.

#### 3.1.2.1 Methodology

Three types of analysis have been made with the aim of identifying these correlations: First, a decision tree analysis, second, a Random Forest analysis and, lastly, a principal component analysis, together with a cluster analysis.

##### Decision trees

The decision tree analysis aims to find groups of people with a similar IRR. Since this variable is continuous, we will use regression trees, a type of machine learning model designed to predict continuous variables. These models iteratively divide the data space into more homogeneous subsets, making it easier to predict the dependent variable by assigning it to one of these groups.

While decision trees are not usually the most accurate technique to make predictions, our aim is not to classify new cases, but to identify patterns within the sample. In this regard, regression trees are a suitable tool to segment the data and find groups with similar characteristics.

The process of constructing the tree is iterative: at each step, a variable (qualitative or quantitative) and an optimal threshold are selected to split the dataset into two subsets. The process starts with a single region at the root of the tree and, as it proceeds, the prediction space is split into smaller regions. Each further split generates two downward sloping branches, forming the hierarchical structure characteristic of decision trees.

To perform this binary split, at each node of the tree, the algorithm selects both the variable and the threshold that result in the most significant reduction in variance for the target variable (similar to how ANOVA methods work).

Mathematically, this is formulated as follows: let  $X_1, \dots, X_p$  be the predictor variables and  $s$  be all the possible threshold values of these, then, for all  $j$  and  $s$ , we define the planes

$$R_1(j, s) = \{X \mid X_j < s\} \quad y \quad R_2(j, s) = \{X \mid X_j \geq s\} \quad [4]$$

where  $\{X | X_j < s\}$  refers to the region of the prediction space where  $X_j$  is smaller than  $s$ . Thus, the values of  $j$  and  $s$  are sought that minimise the Residual Sum of Squares (RSS), which follows the equation:

$$RSS = \sum_{i: x_i \in R_1(j,s)} (y_i - \hat{y}_{R_1})^2 + \sum_{i: x_i \in R_2(j,s)} (y_i - \hat{y}_{R_2})^2 \quad [5]$$

where  $\hat{y}_{R_1}$  is the mean of the response variable for the observations in  $R_1(j, s)$  and  $\hat{y}_{R_2}$  is the mean of the response variable for the observations in  $R_2(j, s)$ .

Subsequently, this process is repeated, looking for the best predictor along with its threshold value, except this time instead of splitting the entire dataset, one of the two previously identified regions is split. This splitting continues until a stopping criterion is met, such as reaching a maximum depth or a minimum number of samples at a node. In our case, the algorithm will stop when there are no splits that significantly reduce the variance, i.e. there is no variable and threshold combination that reduces the residual sum of squares significantly.

### Random forests

Second, random forests combine multiple regression trees to improve regression tree predictions and reduce model overfitting.

This technique works by constructing many decision trees, each with a random subset of the explanatory variables, and obtaining the final prediction of the models by averaging the values predicted by all the trees.

The subsets of data are generated by Bootstrap Sampling (sampling using replacement), and have the same size as the dataset, which implies that there are observations that can be repeated. For each subset, a regression tree is built for the IRR, as explained earlier, resulting in the total number of trees.

These methods have been performed to validate the predictions made by the regression trees, where observations that have not been used to train the models have then been used to validate the accuracy of the models created.

### Principal component analysis

Finally, a Principal Component Analysis (PCA) has been carried out, with the aim of finding relationships in the variables, reducing the dimensionality of the dataset and thus being able to group the different individuals within the different clusters in a simpler way.

The PCA is an unsupervised learning technique that reduces the number of dimensions in large datasets to principal components that retain most of the original information. It does this by transforming potentially correlated variables into a smaller set of variables, called principal components.

Given a dataset with  $n$  observations and  $p$  variables, we seek to transform the existing variables into up to  $p$  principal components ( $Z_i$ ), which are linear combinations of the original variables:

$$Z_j = a_{j1}X_1 + a_{j2}X_2 + \dots + a_{jp}X_p, \quad [6]$$

where the coefficients  $a_{jk}$  are chosen such that  $Z_j$  is orthogonal to the other principal components and maximises the remaining variance, with  $Z_1$  being the component that captures most of the variance in the data,  $Z_2$  being the second most and so on.

The linear combinations are obtained from the variance-covariance matrix:

$$C = \frac{1}{n-1}X^T X \quad [7]$$

And the principal components are obtained by solving the eigenvalue and eigenvector problem.

Based on these results, the optimal number of components is chosen so as to explain most of the variance without unnecessarily increasing the complexity of the model. To do this, the elbow method is used, which consists of analysing how the amount of variance explained varies as the number of components increases. In this method, the cumulative explained variance is plotted as a function of the number of components and the point at which adding more components no longer provides a significant improvement (i.e. where the curve starts to flatten, forming a kind of "elbow") is sought.

On this reduced-dimensionality dataset we perform the analysis using the K-means algorithm, grouping the data into  $K$  groups (or clusters).

This method seeks to minimise the distance between the points in a cluster and the centre of each cluster by minimising the Within-Cluster Sum of Squares, i.e.

$$J = \sum_{j=1}^K \sum_{x_i \in C_j} |x_i - \mu_j|^2 \quad [8]$$

Where  $C_j$  is the set of points assigned to the  $j$ -th cluster, and  $\mu_j$  is the cluster centroid  $j$ , and  $|x_i - \mu_j|^2$  is the squared Euclidean distance between each point and its centroid.

The clustering algorithm works as follows: Initially, random centroids are initialised and each observation is assigned to the cluster whose centroid is closest in terms of Euclidean distance. Then, the centroids of each cluster are recalculated as the average of the points assigned to that group:

$$\mu_j = \frac{1}{|C_j|} \sum_{x_i \in C_j} x_i. \quad [9]$$

These steps are then repeated iteratively until the centroids and points do not change cluster between iterations.

In our case, the PCA and clustering methods have been combined to reduce the dimensions and find clusters of the data, allowing us to find groups with similar IRR.

In addition to the use of these three methods, simple linear regressions have also been performed, which show similar results in terms of the significance of the variables chosen to separate the groups, thus strengthening the results obtained.

### 3.1.2.2 Results

Based on the information analysed with the analyses described above, clusters are generated according to the key variables and the threshold values identified by the tree. These thresholds have been clearer in the case of the IRR than in the case of the replacement rate. This generates 72 cells according to four groups of months of contributions, two groups by gender, three by type of pension and three by time of retirement (early, statutory or delayed)<sup>19</sup>.

The decision tree reveals what could only be inferred from the individual analyses. The variables that most affect the IRR are the months contributed, gender, age and the type of pension received, while the replacement rate is strongly determined by the record of contributions made and, in a cross-cutting manner, by the type of pension. The analysis was performed for the whole sample and for subgroups of the sample: men, women, self-employed, general scheme, etc.

#### Replacement rate

In the case of the replacement rate, the clustering techniques described above do not show clear groups of combinations of individuals having a number of characteristics and presenting a differentiated replacement rate, as it is strongly determined by the record of contributions made.

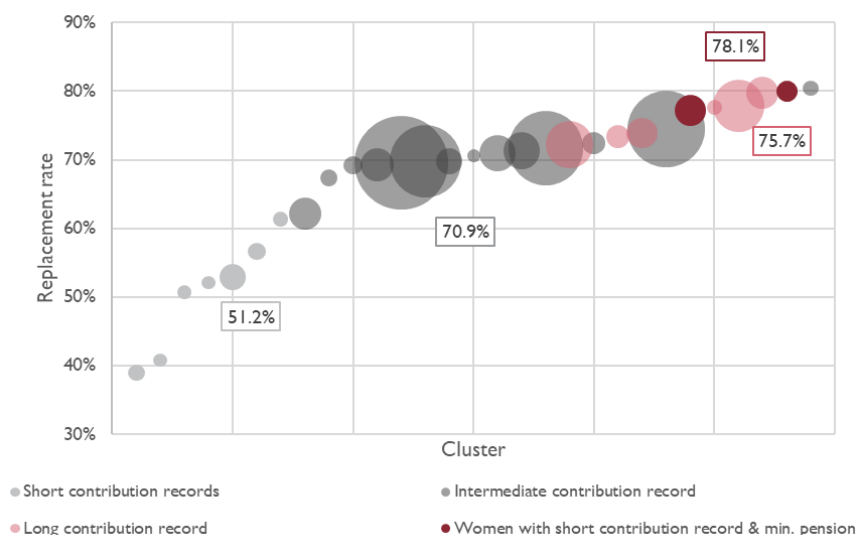
However, **the results do show two groups with a higher replacement rate and one with a much lower rate.** Women with a short contribution record who receive the minimum pension and men and women with maximum or uncapped pensions who have contribution records have a higher replacement rate than the average. In contrast, although they are not very

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<sup>19</sup> Tables with the breakdown of the results for each of the 72 cells are shown in the annex.

numerous groups, it is the short contribution records, except for women with minimum pensions, that show a much lower replacement rate.

**FIGURE 6. RESULTS OF THE CLUSTER ANALYSIS. IDENTIFICATION OF GROUPS WITH DIFFERENTIATED REPLACEMENT RATES<sup>20</sup>**



Note: The size of the circle indicates the number of individuals within the group, i.e. a larger circle indicates a larger group.

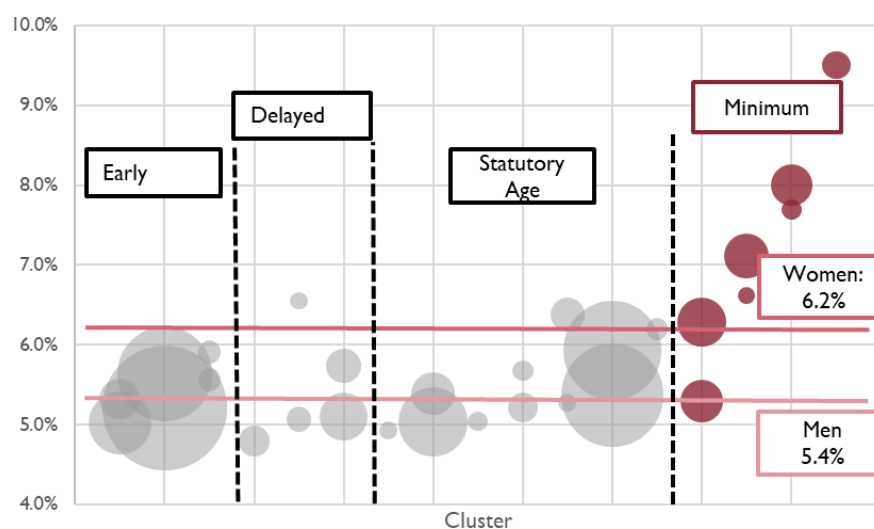
Source: CPLS 2023

## IRR

The results point to **a higher IRR for three differentiating factors, women, older people and people receiving minimum pensions**. The first block is determined by the longer life expectancy of women. For the next two blocks, there is a correlation between the two. The higher IRR for older ages is related to people retiring later in order to qualify for the minimum pension. The higher IRR for the minimum pension is due to minimum pension supplements, which, although necessary, distort equity. In this case, there is also a correlation between the length of contributions made and the IRR they receive, but this will be in the opposite direction to that observed for the replacement rate and of a lower intensity. **In the case of the IRR, longer contribution records have lower returns than shorter ones**. This is more pronounced in the case of minimum pensions.

<sup>20</sup> The complete table (for replacement rate and IRR) can be found in the annex. Only groups with more than 40 cases are selected for the figure.

**FIGURE 7. RESULTS OF THE CLUSTER ANALYSIS: IDENTIFICATION OF GROUPS WITH DIFFERENTIATED IRR**



Note: The size of the circle indicates the number of individuals within the group, i.e. a larger circle indicates a larger group.

Source: CPLS 2023

Three conclusions can be drawn from this analysis: there is a group of minimum pensions with short contribution records with a very high IRR and women have a higher IRR than men in all the groups analysed because of their longer life expectancy. It also appears that the IRR of people who retire at the statutory retirement age is somewhat higher than that of those who bring forward or delay retirement.

### 3.2. Intergenerational analysis: impact of the reform

Apart from the differences identified for individuals within the same cohort, it is necessary to analyse **how changes in legislation and life expectancy modify the adequacy and equity of the system according to the legislation in force in the year of retirement**. These analyses are carried out for the estimation of the IRR under an assumption in which life expectancy evolves in accordance with AIR<sup>e</sup>F's demographic scenario and another in which life expectancy remains constant at the value of 2024 in order to isolate its upward pressure on the IRR. This distinction is not made in the case of the replacement rate, as life expectancy does not affect this indicator.

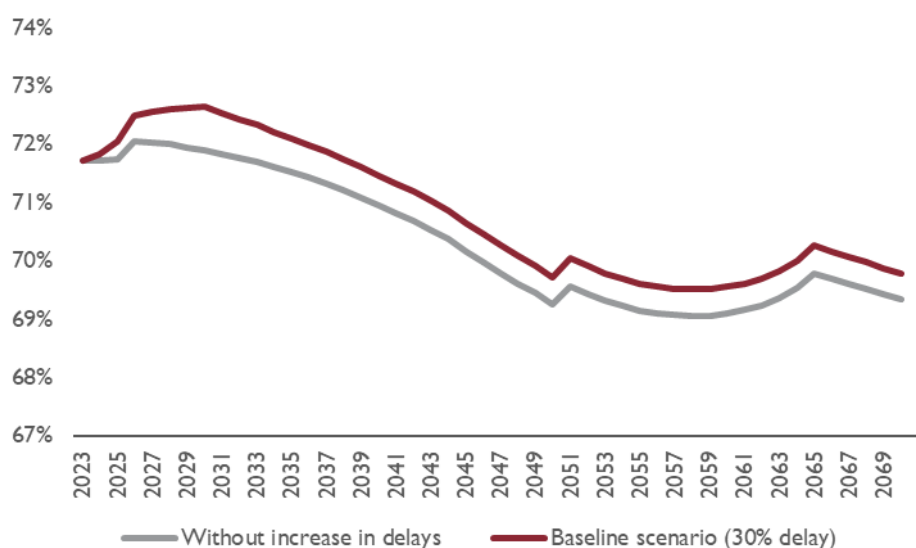
AIR<sup>e</sup>F's baseline scenario assumes that the percentage of people delaying retirement increases from 8% of the CPLS in 2023 to 30% in 2030. In addition, the percentage of people choosing the lump-sum option will increase from 18% to 35%. The increase in delays has hardly any effect on the IRR, although

it does have an effect on the replacement rate. Accordingly, when analysing the replacement rate, a scenario with the 2023 reform without an increase in delays is analysed separately from the baseline scenario described above. In the case of the IRR, only the baseline scenario will be analysed.

### 3.2.1. Replacement rate

The 2021-2023 reform and the full rollout of the 2011 reform **raises the replacement rate up to 2027** by increasing minimum pensions to reach the poverty threshold, **but then starts a downward path from 72.4% in 2027 to a level around 70%** from 2050, with some recovery in 2051 and 2065 due to increases above maximum pensions in those years. In this case, life expectancy is not a determining factor. However, the assumptions made about delays do affect the replacement rate, by increasing the initial pension by the rewards. The increase will be larger the more individuals opt for the average pension increase instead of the lump-sum payment. In the case of the baseline scenario, the assumptions adopted cause the replacement rate to increase by almost 1 point after the full increase in delays.

**FIGURE 8. EVOLUTION OF THE REPLACEMENT RATE OVER TIME. WITH AND WITHOUT INCREASE IN DELAYS**



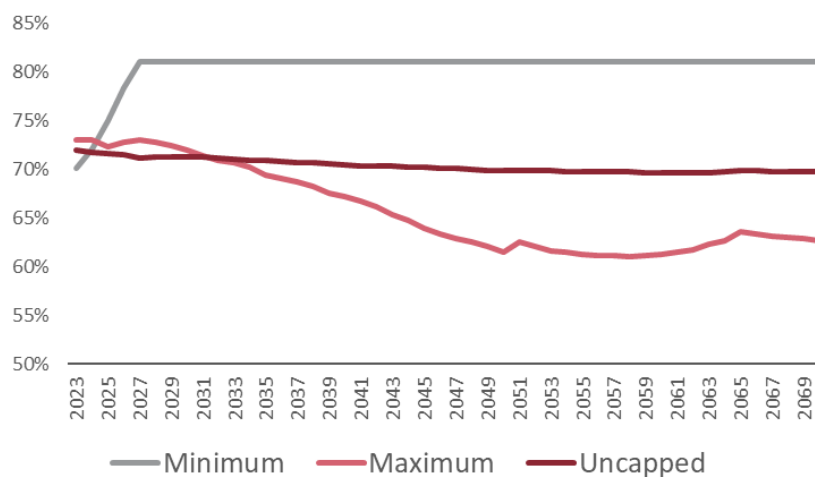
Source: AIReF and CPLS 2023

When distinguishing **by type of pension, clearly differentiated forecasts can be observed**. The reform limits the real growth of maximum pensions until 2050, while increasing minimum pensions above the CPI in order to reach the poverty threshold<sup>21</sup> in 2027. This results in an increase in the replacement rate

<sup>21</sup> Approximately 9% growth until 2027.

of minimum pensions by almost 10 points and a decrease in the replacement rate of maximum pensions by more than 15 points. For uncapped pensions, the replacement rate is reduced by about 4 points.

**FIGURE 9. EVOLUTION OF THE REPLACEMENT RATE OVER TIME. TYPE OF PENSION**



Source: AIReF and CPLS 2023

### 3.2.2. IRR

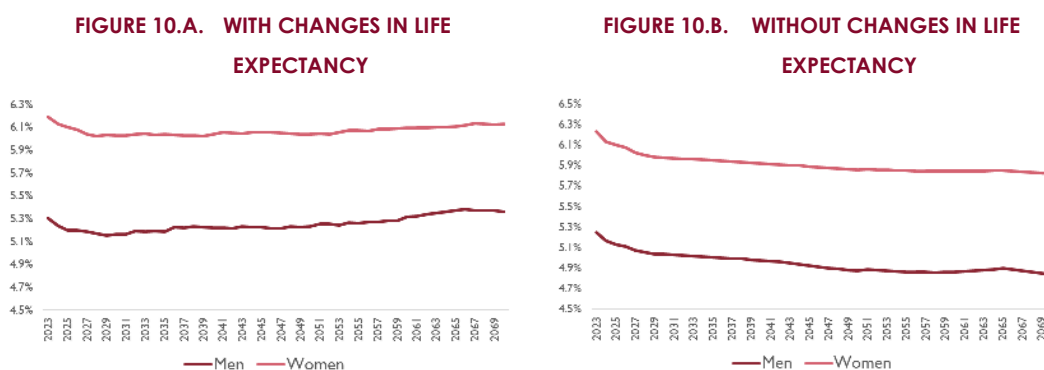
The introduction of **the 2021-2023 reform increases the IRR, mainly due to the repeal of the Pension Revaluation Index (IRP)<sup>22</sup> and the Sustainability Factor (SF)**. Furthermore, once the initial increase occurs, if the increase in life expectancy is not taken into account, the IRR starts a downward path until 2050, both because of the recent reform and the full rollout of the 2011 reform. By 2050, there is a slight increase due to the increase in the maximum pension, before stagnating in 2065, when the effects of the reform would have taken full effect. In the case of considering the increase in life expectancy, the IRR starts an upward path in 2029, after the 2011 reform and the MEI are fully rolled out. Overall, **the increase in life expectancy leads to an increase in the IRR of about 0.4 points** by 2070, 0.5 points for men and 0.3 points for women.

The evolution of the **IRR by gender shows a slight convergence of the IRR for men if life expectancy is taken into account**, due to the assumptions made about a certain approximation to the life expectancy of women, reducing the

<sup>22</sup> The Pension Revaluation Index (IRP) established that pensions would be revalued each year using this index, which was estimated on the basis of, among other things, the deficit of the Social Security system, establishing that in the event of a situation in which the public accounts were not healthy, pensions would be revalued by 0.25% each year.

gap by about 0.2 points, from the difference of almost 1 point that currently exists.

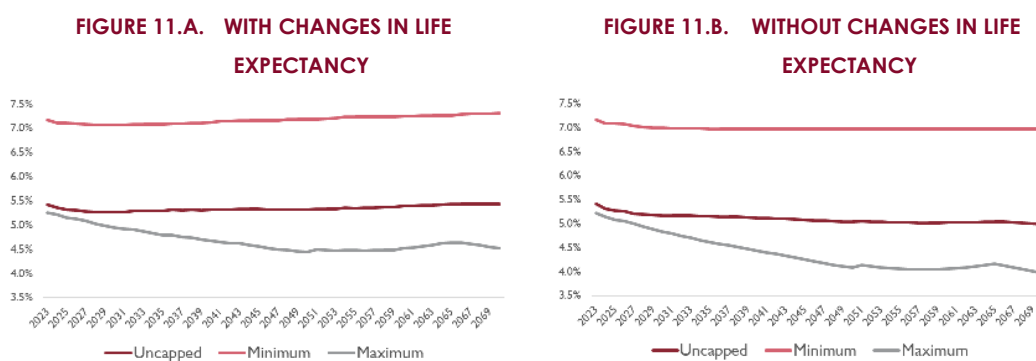
**FIGURE 10. EVOLUTION OF IRR BY GENDER**



Source: AIReF and CPLS 2023

A comparison of the evolution of **the IRR by type of pension shows that the reform mainly affects maximum pensions**. In the case of minimum pensions, if the evolution of life expectancy is not taken into account, the reform does not seem to have an impact on the IRR, as the measures that reduce the IRR are almost entirely offset by the increase in minimum pensions to reach the poverty threshold.

**FIGURE 11. EVOLUTION OF IRR BY TYPE OF PENSION**



Source: AIReF and CPLS 2023

### 3.3. Impact of the 2021-2023 reform, measure-by-measure

In this analysis, the results will be presented eliminating the impact of the increase in life expectancy in the case of the IRR, so that the changes that each measure has produced on the return of the system can be analysed more clearly. As mentioned above, **the impact of increased life expectancy on the IRR is a gradual increase that reaches 0.4 points by 2070**.

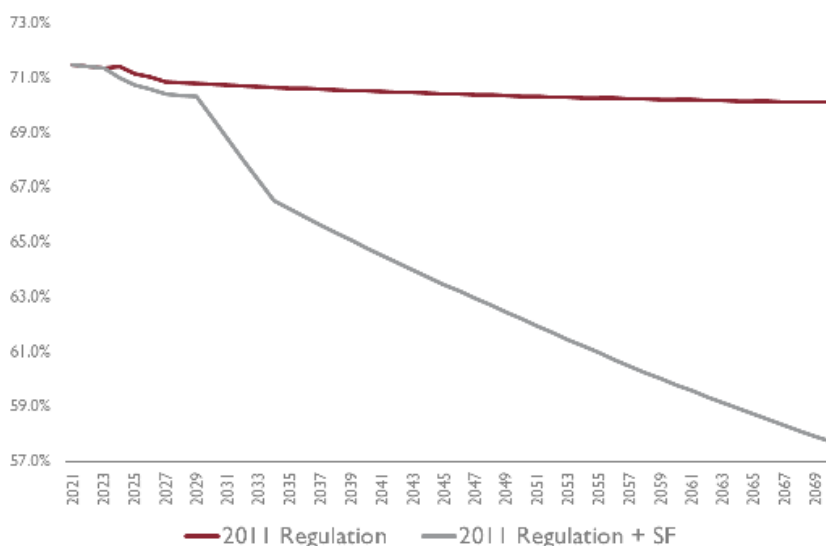
The measures that have been assessed are: the repeal of the Pension Revaluation Index and the Sustainability Factor, the change of penalties for early retirement, the change of incentives to delay retirement (distinguishing between receiving an increase in the initial pension or a lump-sum payment on retirement), the change in the number of years taken into account for the calculation of the regulatory base, the different evolution of the maximum pension and the maximum base, the increase in minimum pensions until the poverty threshold is reached in 2027 and the introduction of the MEI and the Solidarity Contribution.

### 3.3.1. Impact on the replacement rate

Prior to the 2021-2023 reform, the Pension Revaluation Index and the Sustainability Factor were in force but still inoperative.

In the case of the replacement rate, by its very definition, the repeal of the Pension Revaluation Index has no effect, since it acted on the revaluation of existing pensions, and the replacement rate is estimated with the initial pension. However, the Sustainability Factor acted directly on the initial pension. Had it entered into force, there would have been a reduction in the replacement rate from almost 72% in 2023 to 62% by 2050 and 58% by 2070.

**FIGURE 12. EVOLUTION OF THE REPLACEMENT RATE BEFORE THE REFORM, WITH IRP AND WITH SF**



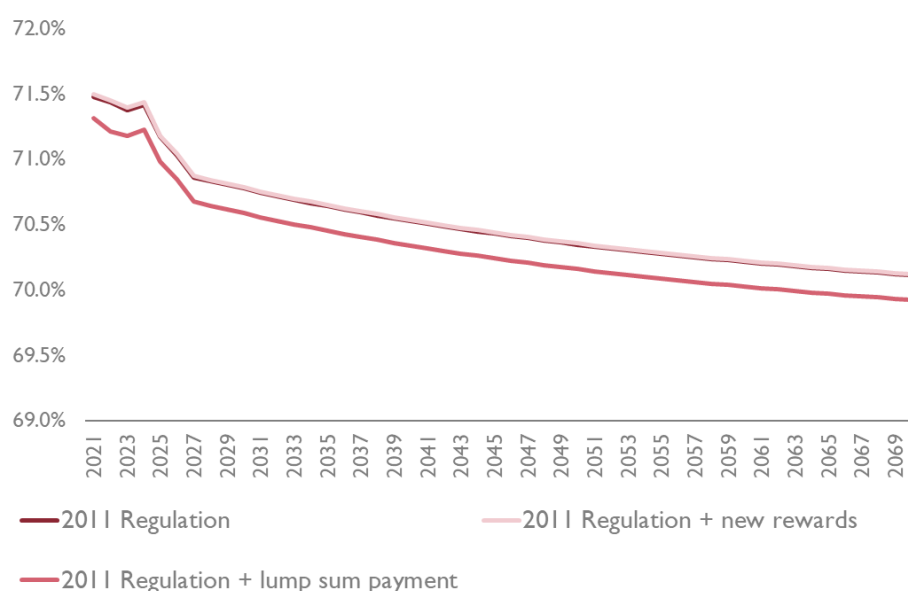
Source: AIReF and CPLS 2023

The 2021 reform, as described above, modifies the incentives to delay retirement and the penalties for early retirement. In the case of the replacement rate, these measures have a direct effect on the initial pension. In the case of **the penalties, there has been a behavioural change between**

**2021 and 2023 that shifts the impact on the replacement rate from negative to positive.**

In the case of incentives to delay retirement, **the impact is very different when opting for an increase in the average pension** (greater increase in the replacement rate the more people delay retirement) **or for receiving a lump-sum payment** (greater decrease in the rate the more people delay retirement). The difference in the replacement rate in these scenarios is visible only in the reduction of the replacement rate in the case of selecting the lump-sum option.

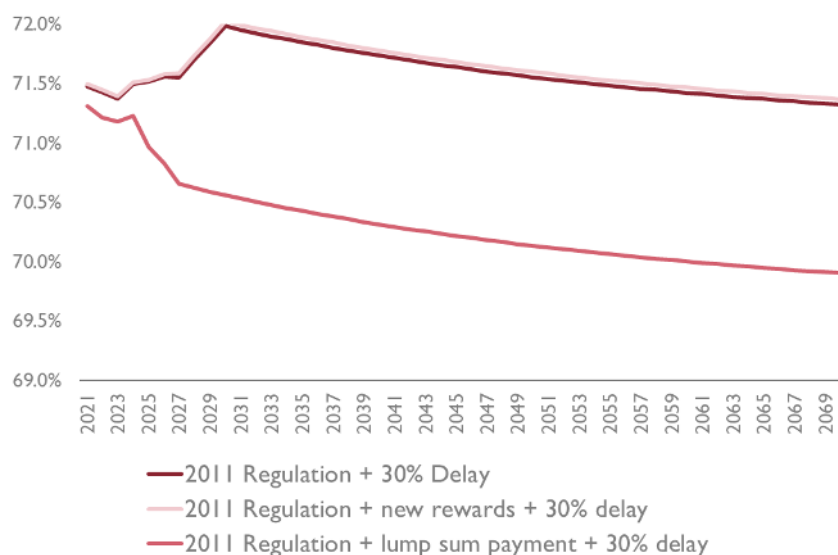
**FIGURE 13. EVOLUTION OF THE REPLACEMENT RATE ACCORDING TO THE INCENTIVE RECEIVED. THERE IS NO INCREASE IN THE NUMBER OF PEOPLE DELAYING RETIREMENT**



Source: AIReF and CPLS 2023

However, by introducing **AIReF's baseline scenario** assumption **that 30% of people delay retirement, the replacement rate will increase by almost 2%** if people who delay retirement opt for a pension increase, with that increase being slightly higher with the new, more generous rewards than the previous ones. However, if people who delay retirement choose the lump-sum option, the replacement rate is hardly affected.

**FIGURE 14. EVOLUTION OF THE REPLACEMENT RATE ACCORDING TO THE INCENTIVE RECEIVED. AIReF BASELINE SCENARIO (30% OF PEOPLE DELAY RETIREMENT)**

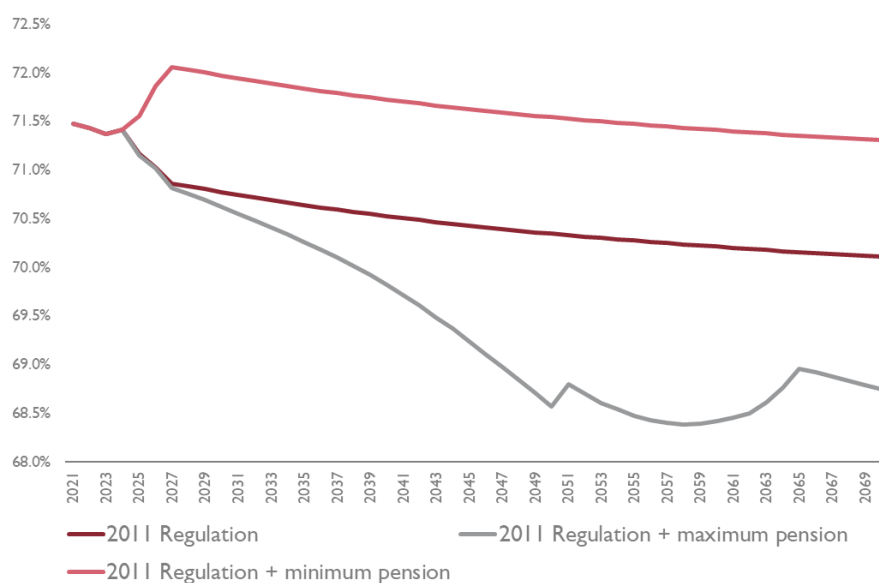


Source: AIReF and CPLS 2023

In the case of the increase in the number of years to be taken into account for the regulatory base, the impact is a small increase during the transitional period, followed by a slight reduction as from 2045.

Finally, the different evolution of the maximum pension and the maximum base reduces the replacement rate until 2050 and then the impact of the increase in the maximum pension on the replacement rate is observed. The increase in minimum pensions to reach the poverty threshold improves the replacement rate until 2027, an improvement that is sustained for the rest of the projection period.

**FIGURE 15. EVOLUTION OF THE REPLACEMENT RATE WHEN THE MAXIMUM PENSION IS INTRODUCED**



Source: AIReF and CPLS 2023

Lastly, in the case of the replacement rate, none of the measures affecting the contribution rate have any impact. Thus, **the MEI and the Solidarity Contribution do not change the replacement rate.**

**TABLE 1. IMPACT ON REPLACEMENT RATE OF 2021-2023 REFORM**

	Replacement rate		
	2023	2050	2070
<b>Before 2021-2023 reform</b>	<b>71.7%</b>	<b>62.2%</b>	<b>57.7%</b>
Increase in pensions with the CPI (elimination of IRP)	0.00%	0.00%	0.00%
Elimination of sustainability factor	0.00%	8.15%	12.40%
Early Retirement	0.00%	0.00%	0.00%
Incentives for delayed retirement (%)	0.02%	0.01%	0.01%
Incentives for delayed retirement (lump sum)	-0.19%	-0.19%	-0.19%
Determination of years for calculating initial pension	0.00%	0.00%	0.00%
Evolution of maximum pension different from Maximum Contribution Bases	0.00%	-1.78%	-1.36%
Increase in minimum pension	0.00%	1.20%	1.20%
Inter-generational Equity Mechanism	0.00%	0.00%	0.00%
Solidarity contribution	0.00%	0.00%	0.00%
<b>After the 2021-2023 reform</b>	<b>71.7%</b>	<b>69.7%</b>	<b>69.8%</b>

Source: AIReF and CPLS 2023

### 3.3.2. Impact on IRR

In this analysis, we will consider that life expectancy remains constant, so that the impact of the reform on the IRR can be analysed in isolation from the assumptions on the evolution of life expectancy.

We begin the analysis by calculating how the IRR would have evolved over the years had there been no reform. Before the 2021-2023 reform, the Pension Revaluation Index and the Sustainability Factor were in force, albeit still inoperative. In a first step, the evolution of the IRR of the previous legislation is compared with the resulting IRR if the Pension Revaluation Index or the Sustainability Factor had come into force.

The **Sustainability Factor**, by acting on the initial pension, has a **progressive impact**, barely perceptible in the first few years, which accumulates over time. However, **the Pension Revaluation Index has an immediate impact**, acting on existing pensions, which is sustained over time. Together, both measures reduce the IRR by 1 point by 2050 and by almost 2 points by 2070.

**FIGURE 16. EVOLUTION OF THE PRE-REFORM IRR. WITHOUT IRP, WITHOUT SF AND WITHOUT EITHER**



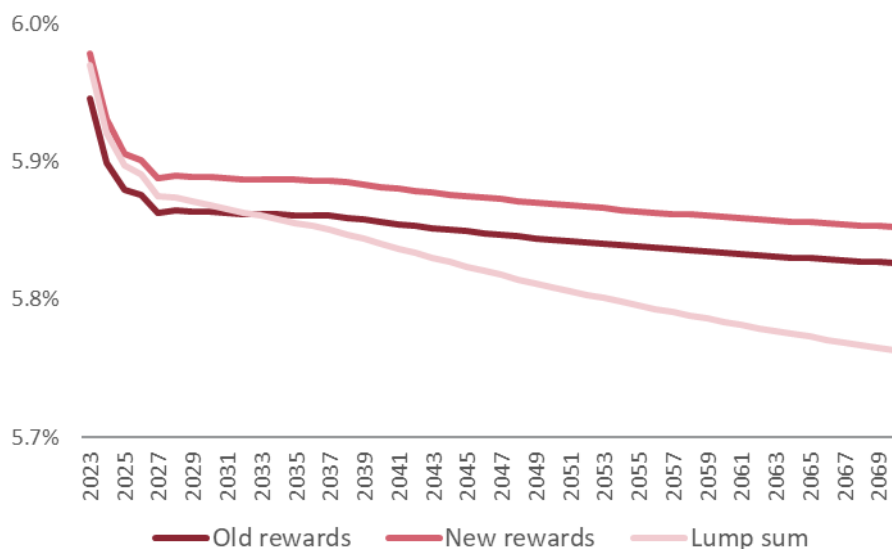
Source: CPLS 2023

The 2021 reform modifies the incentives and penalties for delaying and bringing forward the decision to retire. None of these measures, nor the increase in the number of years for the calculation of the regulatory base, have a major impact on the system's IRR if analysed without assuming changes in agents' decisions.

However, if we consider that the percentage of people who choose to delay retirement is 30% in 2023 and we analyse the IRR under three scenarios, under

the previous legislation and only modifying the incentives, one in which everyone takes the old rewards, another with the new rewards and another with the lump-sum payment, we do observe differences in the IRR. The new rewards, being somewhat larger, increase the system's IRR. However, the lump-sum payment reduces it.

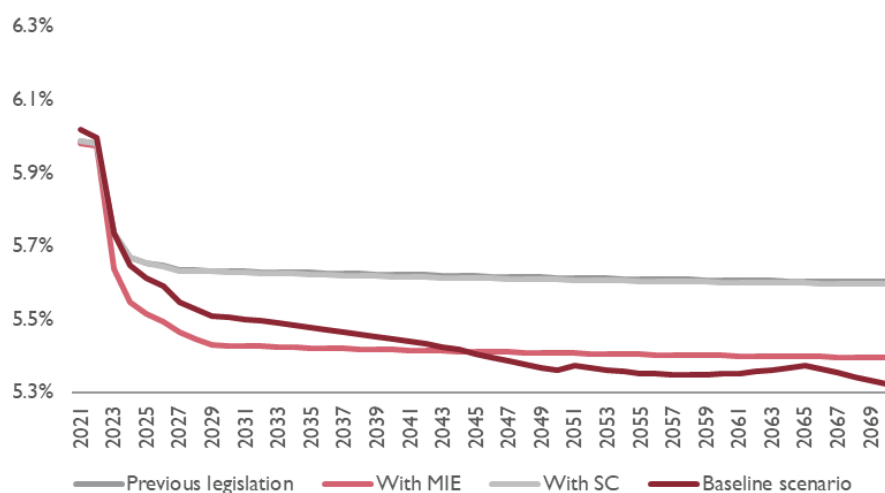
**FIGURE 17. EVOLUTION OF THE IRR WITH DELAYED RETIREMENT ACCORDING TO THE INCENTIVE RECEIVED**



Source: CPLS 2023

The reform approved a series of measures whose rollout was gradual and which have an impact on the return of the system **through the rate on social contributions**. These are the increase in contributions through the MEI and the Solidarity Contribution. As can be seen, **both reduce the system's IRR**, although the Solidarity Contribution, as it does not affect many individuals, does so less markedly.

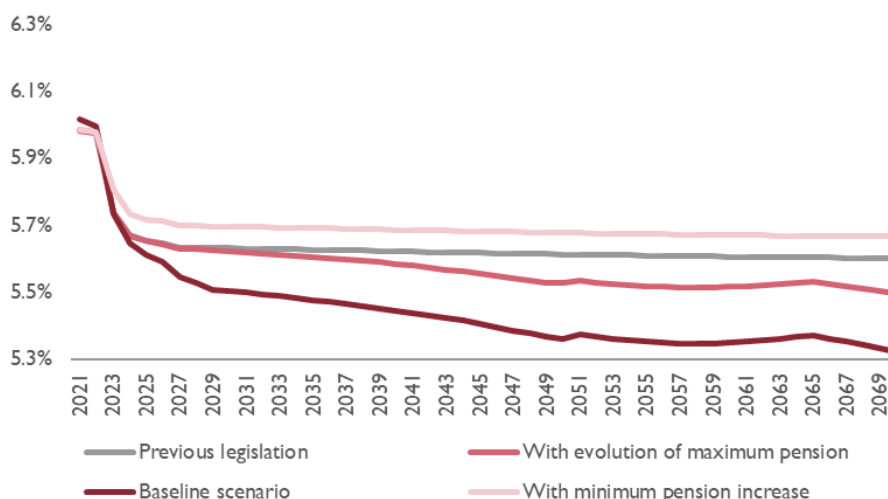
**FIGURE 18. EVOLUTION OF THE IRR WITH THE INTRODUCTION OF THE MEI AND THE SOLIDARITY CONTRIBUTION**



Source: AIReF and CPLS 2023

Finally, the reform also establishes **growth patterns for the maximum and minimum pensions**. The former reduces the system's IRR gradually over the projection period, while the latter produces an almost immediate increase in the system's IRR which is then sustained over time.

**FIGURE 19. EVOLUTION OF IRR WHEN INTRODUCING EVOLUTION OF MAXIMUM AND MINIMUM PENSION**



Source: AIReF and CPLS 2023

Although the reforms **are not exactly additive**, it can be observed that the **evolution of the IRR of the baseline scenario is similar to accumulating the measures with the greatest impact**, which would be the MEI and the evolution of maximum and minimum pensions.

**TABLE 2. IMPACT ON IRR OF 2021-2023 REFORM. NO INCREASE IN LIFE EXPECTANCY**

	IRR		
	2023	2050	2070
<b>Before 2021-2023 reform</b>	<b>5.2%</b>	<b>4.7%</b>	<b>4.5%</b>
Increase in pensions with the CPI (elimination of IRP)	0.51%	0.45%	0.45%
Elimination of sustainability factor	0.00%	0.39%	0.61%
Early Retirement	0.02%	0.02%	0.01%
Incentives for delayed retirement (%)	0.00%	0.00%	0.00%
Incentives for delayed retirement (lump sum)	0.00%	-0.02%	-0.03%
Determination of years for calculating initial pension	0.00%	0.00%	0.00%
Evolution of maximum pension different from Maximum Contribution Bases	0.00%	-0.09%	-0.11%
Increase in minimum pension	0.07%	0.06%	0.06%
Inter-generational Equity Mechanism	-0.10%	-0.21%	-0.21%
Solidarity contribution	0.00%	-0.01%	-0.01%
<b>After the 2021-2023 reform</b>	<b>5.7%</b>	<b>5.3%</b>	<b>5.3%</b>

Source: AIReF and CPLS 2023

In the case of estimating **the IRR taking into account the increase in life expectancy**, the IRR in 2070 increases by the 0.4 points mentioned above. However, **the impact of each of the measures would be the same.**

**TABLE 3. IMPACT ON IRR OF 2021-2023 REFORM. WITH INCREASE IN LIFE EXPECTANCY**

	IRR		
	2023	2050	2070
<b>Before 2021-2023 reform</b>	<b>5.2%</b>	<b>5.0%</b>	<b>4.9%</b>
Increase in pensions with the CPI (elimination of IRP)	0.51%	0.48%	0.50%
Elimination of sustainability factor	0.00%	0.37%	0.57%
Early Retirement	0.02%	0.00%	0.00%
Incentives for delayed retirement (%)	0.00%	0.00%	0.00%
Incentives for delayed retirement (lump sum)	0.00%	0.00%	-0.01%
Determination of years for calculating initial pension	0.00%	0.00%	0.00%
Evolution of maximum pension different from Maximum Contribution Bases	0.00%	-0.08%	-0.10%
Increase in minimum pension	0.07%	0.06%	0.06%
Inter-generational Equity Mechanism	-0.10%	-0.20%	-0.19%
Solidarity contribution	0.00%	-0.01%	-0.01%
<b>After the 20221-2023 reform</b>	<b>5.7%</b>	<b>5.6%</b>	<b>5.7%</b>

Source: AIReF and CPLS 2023

# 4. CONCLUSIONS

**AIReF performs an analysis of the adequacy, equity and contribution of the system.** This analysis is based on two perspectives, one intra-generational and the other inter-generational. The first studies the differences between people in the same cohort, understood as individuals retiring in the same year. From an inter-generational point of view, we analyse how changes in legislation and life expectancy affect the assessment of these characteristics.

**Within the intra-generational analysis, the adequacy analysis of the Spanish pension system shows a high level of the replacement rate, compared with that of other European countries, for all the groups analysed, albeit with differences between them.** The replacement rate differs according to various variables, although the determining factor is the contributions made, i.e. the longer period in which contributions are made, the higher the percentage received of the regulatory base and, therefore, the higher the replacement rate. However, the pension system itself makes it difficult to observe this relationship by establishing minimum pension supplements, which increase the replacement rate, and the maximum pension, which reduces it. In general, minimum pensions are associated with fewer years of contributions made while maximum pensions tend to occur with more years of contributions, which distorts the relationship. In addition, after a certain number of years of contributions, 38 in 2027, 100% of the regulatory base is already received, so

that increasing the length of contributions made from then on will not increase the replacement rate in the same way.

**AIReF estimates the nominal IRR of the pension system at 5.7% in 2023, albeit with differences between individuals.** The level of IRR provides information on the contributory nature of the system, one of its fundamental principles according to the Toledo Pact, and makes it possible to analyse the equity of the system and the impact of the reforms, but it is not an overall indicator of sustainability in the case of Spain. This level of IRR implies that, for every euro of social contributions, a worker will obtain on average 1.6 euros<sup>23</sup> in retirement. The macroeconomic context also influences the IRR, mainly through inflation, wages and the general labour market situation, so it also varies according to the year of retirement.

**The joint equity and contribution analysis shows that the main characteristics that determine the differences between the IRR of individuals in the same cohort are gender and pension type (minimum, uncapped<sup>24</sup> or maximum).** The analysis shows that women generally obtain a higher IRR, 6.2% on average in 2023, than men, 5.4% on average, due to their longer life expectancy. In addition, part of the minimum pensions, those associated with relatively fewer years of contributions made, show the highest return in the system, mainly due to minimum pension supplements. Cross-checking the main variables shows that the group that obtains the highest returns are women who receive the minimum pension after retiring at a late age with a shorter contribution record. Generally speaking, a longer contribution record corresponds to a lower return.

**Within the inter-generational analysis, we first assess the evolution of the characteristics over time for the different groups.** The most affected groups are minimum and maximum pensions.

**Secondly, AIReF focuses on the impact over time of the measures adopted in the 2021-2023 reform.** The first conclusion is that the measures that affect adequacy are not always those that affect equity and the contribution of the system.

**The 2021-2023 reform increases the replacement rate by 0.4 points in 2023, rising to 12 points in 2070, mainly due to the repeal of the Sustainability Factor.**

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<sup>23</sup> Estimated from 2023 CPLS data. Contributions and pension flows are updated with CPI and GDP growth.

<sup>24</sup> For the purposes of this document, uncapped pensions are considered to be those whose calculation is not affected by the upper and lower limits defined by the minimum and maximum pension.

The other reforms that clearly impact the replacement rate would be, negatively, choosing the lump-sum payment if retirement is delayed and the evolution of the maximum pension below the wage level and, positively, the evolution approved for minimum pensions to reach the poverty threshold.

**For the replacement rate, the change in individuals' behaviour has a clear impact.** Increased delays push the replacement rate upwards, as long as they do not opt for a lump-sum payment. However, measures affecting contributions have no impact on this indicator. Furthermore, the repeal of the Pension Revaluation Index does not affect the replacement rate, but it does affect the generosity rate<sup>25</sup>, and thus the adequacy of the system.

**The increase in life expectancy increases the IRR by an additional 0.4 points in 2070, an increase that is not offset by the reforms introduced between 2021 and 2023, even eliminating the impact of the repeal of the Pension Revaluation Index and the SF.** Over time, the IRR increases, mainly due to the increase in life expectancy. If life expectancy remains constant, we see that the approved reforms reduce the IRR with significant differences by pension type. Specifically, it is observed that the reform impacts mainly on a reduction in the return of maximum pensions and an increase in the IRR of minimum pensions.

**The reform has an impact on the system's IRR of an increase of 0.6 points in 2050 and 0.8 points in 2070.** This impact is stable both with increasing life expectancy and if we consider no increases in life expectancy. When evaluating the impact of the reform on the IRR, it is necessary to consider both revenue and expenditure measures.

**The reforms with the greatest impact on the IRR are those that directly modify revenue or expenditure, and not so much those that are based on modifying the behaviour of agents.** In this regard, the reforms with the greatest impact on the IRR have been, on the one hand, the elimination of the Pension Revaluation Index and the Sustainability Factor and the increase in minimum pensions to reach the poverty threshold in 2027, which increase it, and, on the other, the MEI and the increase in the maximum pension in line with the CPI, which reduce the IRR. However, the change in behaviour in terms of bringing forward or delaying retirement has hardly any effect on the system's return. In contrast, these reforms that increase the retirement age also raise the replacement rate by increasing the initial pension.

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<sup>25</sup> Understood as the average pension in the system divided by the average wage in the economy.



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## ANNEX I. CLUSTER TABLE

Pension Type	Gender	Years Contributed	Retirement Type	Pensión media	IRR average	Replacement Rate	Cases
Max	Men	Between 25 and 44	Early	3011	5.1%	66.0%	18
Max	Men	Between 25 and 44	Delayed	3418	5.1%	69.2%	87
Max	Men	Between 25 and 44	Statutory	3163	5.2%	72.4%	133
Max	Men	More than 44 years	Early	2976	4.9%	50.9%	4
Max	Men	More than 44 years	Delayed	3445	5.1%	73.4%	24
Max	Men	More than 44 years	Statutory	3164	5.0%	77.7%	56
Max	Women	Between 25 and 44	Early	3083	5.3%	55.2%	11
Max	Women	Between 25 and 44	Delayed	3361	5.6%	70.4%	31
Max	Women	Between 25 and 44	Statutory	3154	5.7%	80.4%	63
Max	Women	More than 44 years	Delayed	3185	5.8%	62.3%	3
Max	Women	More than 44 years	Statutory	3148	5.6%	83.2%	12
Min	Men	Between 20 and 25	Early	447	6.6%	71.1%	4
Min	Men	Between 20 and 25	Delayed	559	7.0%	50.4%	17
Min	Men	Between 20 and 25	Statutory	560	6.6%	70.5%	43
Min	Men	Between 25 and 44	Early	730	5.6%	67.4%	77
Min	Men	Between 25 and 44	Delayed	720	5.2%	62.1%	30
Min	Men	Between 25 and 44	Statutory	816	5.3%	62.2%	267
Min	Men	More than 44 years	Early	1102	4.8%	42.8%	1
Min	Men	More than 44 years	Delayed	1235	4.3%	44.0%	2
Min	Men	More than 44 years	Statutory	960	4.9%	52.1%	45
Min	Men	Under 20 years	Early	578	7.0%		1
Min	Men	Under 20 years	Delayed	442	8.1%	46.2%	32
Min	Men	Under 20 years	Statutory	408	7.7%	61.4%	57
Min	Women	Between 20 and 25	Early	511	7.1%	73.2%	24
Min	Women	Between 20 and 25	Delayed	419	8.1%	125.0%	21
Min	Women	Between 20 and 25	Statutory	472	7.1%	69.3%	290
Min	Women	Between 25 and 44	Early	667	5.9%	56.6%	76
Min	Women	Between 25 and 44	Delayed	597	6.2%	116.4%	17
Min	Women	Between 25 and 44	Statutory	614	6.3%	70.9%	340
Min	Women	More than 44 years	Statutory	765	5.4%	90.2%	11
Min	Women	Under 20 years	Early	367	8.3%	97.6%	15
Min	Women	Under 20 years	Delayed	385	9.5%	80.0%	114
Min	Women	Under 20 years	Statutory	360	8.0%	77.2%	243
Uncapped	Men	Between 20 and 25	Early	880	5.7%	43.3%	3
Uncapped	Men	Between 20 and 25	Delayed	683	5.5%	42.2%	14
Uncapped	Men	Between 20 and 25	Statutory	883	5.3%	50.7%	46
Uncapped	Men	Between 25 and 44	Early	1702	5.2%	69.6%	2181
Uncapped	Men	Between 25 and 44	Delayed	1325	5.1%	71.3%	333
Uncapped	Men	Between 25 and 44	Statutory	1538	5.4%	74.5%	1496
Uncapped	Men	More than 44 years	Early	1842	5.0%	72.3%	560
Uncapped	Men	More than 44 years	Delayed	1501	4.8%	73.3%	134
Uncapped	Men	More than 44 years	Statutory	1780	5.0%	77.9%	677
Uncapped	Men	Under 20 years	Early	1023	5.1%	28.8%	1
Uncapped	Men	Under 20 years	Delayed	561	5.8%	31.6%	29
Uncapped	Men	Under 20 years	Statutory	528	5.5%	34.1%	24
Uncapped	Women	Between 20 and 25	Early	550	5.1%	46.1%	13
Uncapped	Women	Between 20 and 25	Delayed	808	6.3%	64.4%	38
Uncapped	Women	Between 20 and 25	Statutory	749	6.4%	52.9%	173
Uncapped	Women	Between 25 and 44	Early	1450	5.6%	69.8%	1292
Uncapped	Women	Between 25 and 44	Delayed	1234	5.7%	69.8%	173
Uncapped	Women	Between 25 and 44	Statutory	1360	5.9%	71.7%	1384
Uncapped	Women	More than 44 years	Early	1602	5.3%	73.9%	235
Uncapped	Women	More than 44 years	Delayed	1551	5.1%	79.3%	36
Uncapped	Women	More than 44 years	Statutory	1671	5.4%	79.8%	268
Uncapped	Women	Under 20 years	Early	402	5.1%	42.4%	2
Uncapped	Women	Under 20 years	Delayed	415	6.6%	40.8%	46
Uncapped	Women	Under 20 years	Statutory	434	6.2%	39.0%	69