Thinking in Vertical: A Practical Application of the Two-Stage Pension System in Spain

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Abstract: Public pay-as-you-go pension systems are affected by sustainability problems due to the increasing longevity of the population. These problems come to light when there is unsustainable growth in pension expenditure in relation to GDP. The usual arrangement is for public systems to be complemented by private systems that provide a lifetime annuity paid alongside the public pension. This approach, which is horizontal in its way of thinking, is the one that all countries apply; in it, we can expect to find lifetime annuities, which are expensive because they have to take increasing longevity into account, as well as sustainability problems in the public accounts. Therefore, in this paper, we put forward a system that maintains the complementarity between private and public, but considers it from a vertical point of view. By this, we mean that over a certain period of time, the private system would provide the pension in the form of a temporary income, without the need to consider such a high longevity risk, and then in the following period, the public system would take over. We apply the model to Spain, one of the countries whose pension systems are most affected by problems of sustainability, and observe a decrease in the relationship between pension expenditure and GDP using this two-stage model as opposed to the current system, for the period 2025–2068. This decrease can be achieved without decrease of benefits, change in the retirement age or increase of the contribution level.

Keywords: sustainability of the pension system; expenditures of pension schemes; pay-as-you-go; capitalization/fully funding; annuity

JEL Classification: H55

1. Introduction

The problem of pensions dominates economic policies [1] in most countries of the world. This is due to both the number of people affected—contributors and pensioners—and the proportion of GDP taken up by spending on pensions, which in the case of Europe was 11.3% in 2019 [2].

Longevity, resulting not only from the greater survival of the population but also from lower birth rates, is testing the sustainability and sufficiency of pension systems worldwide. Countries with pay-as-you-go (PAYG) systems experience problems of financial sustainability that have led them to carry out parametric reforms. Various parameters can be reformed in public PAYG pension systems. According to [3], these have included: raising the effective age of retirement by increasing the legal age of retirement, making early retirement more difficult, increasing the minimum contribution period, reducing the replacement rate with stricter indexation of benefits, reducing the amount of pension as a proportion of earnings, and introducing a longer contribution period for determining the initial pension.
Structural-type reforms can also be carried out. These include implementing automatic adjustment mechanisms, whereby pension system parameters automatically adjust to changes in various indicators such as life expectancy, and other demographic ratios or funding balances. Such mechanisms are present in half of OECD countries [4]. Finally, a total structural reform would involve changing the PAYG system into a capitalization system, an option that so far has not been introduced fully in any country. In the case of Chile applies capitalization in its pension system, but this did not involve a transition from a fully-fledged PAYG system.

Retirement pension models are based on what is known as the three-pillar system [5]. As Willmore points out: “Traditionally, specialists have divided pensions into three pillars: (1) Public pensions. (2) Occupational pensions. (3) Personal pensions”. A report from [6] defines the three pillars as non-contributory (basic pension), contributory (forced saving), and contributory (voluntary saving). In this definition, the first pillar is an anti-poverty pillar, while the second is a forced-saving pillar that provides benefits only to the contributor, and the third pillar comprises voluntary savings.

The weight of each pillar varies greatly from country to country [7], and we find cases such as the Netherlands, Iceland, and Denmark where 70%, 95%, and 68% of their replacement rates, pension as a proportion of final salary, come from capitalization, respectively, as opposed to others like Turkey and Spain where the complementary pillar is minimal.

Regardless of the way the pension system’s pillars are designed, in all countries, the complementarity between them is structured along horizontal lines. This means that it is during one’s passive life—understood as a single stage—that the benefits obtained from the PAYG and capitalization systems are received, both at the same time.

The two-stage model, which was devised by the economist José Antonio Herce [8], involves the existence of a PAYG pillar and a capitalization pillar, but considered from a vertical point of view. According to this new model, once retirement age is reached, two stages are established. During the first, which covers the period between the legal retirement age and whichever age is determined as marking advanced age, the pensioner will receive a pension funded by capitalization, and this will be a term annuity (this means that survival probabilities as well as a financial valuation are taken into account in its calculation). In the second stage, which covers from advanced age until death, the pensioner will receive a lifetime pension funded by PAYG. The authors in [8–13] all introduced and developed the two-stage model, with [12] even being thought worthy of mention by Nobel Prize winner Robert C. Merton in one of his investigations [14]. With the same basic idea but using a different approach due to the very nature of the pension models in the countries they deal with, ref. [15] proposed a longevity insurance to accompany the capitalization coverage in Chile, Colombia, Mexico, and Peru. Along similar lines and in the specific case of Chile, refs. [16,17] put forward a technical proposal for advanced age insurance.

In the present paper, we take the basic idea of a two-stage system and design a way to introduce the model in one of the countries most concerned about the future of its pensions: Spain. The paper’s contribution is the “real” implementation of the two-stage model and an analysis of the effect it would have on the relationship between pension expenditure/gross domestic product (GDP) over the period 2025–2068.

A two-stage pension system could be implemented at any time because it does not need any reserves, which would indeed be needed if the move were made from a PAYG system to a capitalization system, for example. Any design for a two-stage system would need to retain a number of premises to enable the agents involved (contributors, pensioners, insurance companies, Social Security) to see how their positions were improved or at least maintained, and therefore for them to support its implementation, as follows:

- It must be guaranteed that contributors would make the same contributions in the two-stage system as in the classical pension system.
The legal age of retirement would remain the same for both models, and therefore when the two-stage system is introduced, the population would continue to retire at the same age as in the classical system.

Existing pensioners at the time the two-stage system was introduced would continue to receive the same public retirement pension and private annuity income as they did before the new model came into effect.

Those who retire after the two-stage system comes into effect would receive at least the same income during their retirement as they would if the classical system continued to apply. This would guarantee that there was no reduction in terms of sufficiency after the two-stage model was applied.

The system’s entry into effect would mean that insurance companies would no longer insure longevity risk through lifetime annuities and would instead provide temporary incomes using the planned savings made by workers for the purpose. Refs. [8,18–21] demonstrated the insurance companies’ problem of adverse selection as regards life annuities compared to temporary incomes.

The aim of this paper is not to prove, from a theoretical point of view, any absolute superiority of one system with respect to the other one, but rather to develop the application of the two-stage model in Spain and to empirically illustrate the pros and cons of the proposal in a concrete case. In [11], from an individual point of view, the authors showed that under some assumptions, the two-steps system has a higher internal rate of return than the standard system for workers.

The remainder of the paper is as follows. In Section 2 we present the pension expenditure indicator and the variables that need to be projected in order to calculate it. In Sections 3 and 4 we set out the two-stage model and project its implementation in Spain for the period 2025–2068, since this is one of the countries whose pension systems are facing the biggest demographic and unsustainability problems both now and in the future. In Sections 5 and 6 we design temporal applications for the model and consider various choices for advanced age, which enable us to analyze different ways of implementing the model. The paper ends with a Section 7 of discussion on the model, our conclusions, and bibliographical references.

2. The Pension Expenditure Indicator

From an aggregate point of view, pension expenditure expressed in relation to GDP depends on three types of factor [22]. The first of these is demographic in nature as this expenditure is inextricably linked to retirement pensions and spending on pensions increases in line with increases in the size of the corresponding age group in relation to the working-age population (i.e., when the dependency ratio increases). The second is related to the situation in the labor market: the lower the proportion of the working-age population actually working (i.e., the employment rate), the lower GDP will be, and therefore pension expenditure expressed in these terms will be higher. The third and final factor concerns the relationship between the average pension and the average rate of production in the economy, which is the product of the ratio between the average pension and the average wage (the replacement rate for pensions) and the weight of wages as part of GDP (wages as a proportion of GDP). Thus, the higher the replacement rates for pensions, the greater the spending on pensions. Similarly, given the employment and replacement rates, this spending will also be higher when wages account for a higher proportion of GDP. It is important to know that given the employment rate and average wage, a higher proportion of wages as part of GDP implies lower apparent productivity at work. Therefore, the formula for estimating pension expenditure/GDP is the following:

\[
\frac{PE}{GDP} = \frac{NP \times AP}{GDP}
\]

where PE denotes pension expenditure, GDP denotes gross domestic product, NP denotes number of pensions, and AP denotes average pension.

The regular reports published by both Eurostat and the Economic Policy Committee (EPC) estimate pension expenditure projections (baseline scenario). In the case of the EPC, the pension expenditure
indicator includes gross public pension (i.e., before tax and compulsory social security contributions) as a percentage of GDP. This is the sum of different categories of pension benefits, some of which (e.g., disability pensions) may be paid to people who have not yet reached the standard retirement age. The projections are made based on Eurostat population projections—EUROPOP2010—and commonly agreed underlying economic assumptions prepared by the European Commission (DG ECFIN) and the Economic Policy Committee (Ageing Working Group). In most countries, it can be seen that pension spending as part of GDP is growing, and in the European Union as a whole, this growth is forecast to reach 1.3 points of GDP over the period 2020–2040 and 1.6 over the period 2020–2060.

3. Projections of the Variables That Determine the Pension Expenditure Indicator

In order to estimate pension expenditure in relation to GDP, in accordance with Formula (1), we need to estimate the number of pensions (NP), the average pension (AP), and the future value of the gross domestic product (GDP).

3.1. Number of Pensions (NP)

Demographic risk and the increased survival of those over the legal age of retirement are determining factors in any analysis of a pension system’s expenditure. We therefore need to find information, if possible, from projections and estimates provided by the relevant country’s statistical services on the number of people that survive to different ages above the legal age of retirement. Thus, we have

\[ l_y^x : \text{number of people alive at age } \text{"}x\text{"} \text{ during year } \text{"}y\text{"} \]

\[ \forall y = y_1, y_2, \ldots, y_n \]

\[ \forall x = x_r, x_{r+1}, \ldots, w \]

where \( x_r \) denotes the legal age of retirement, \( w \) denotes the highest age of survival, \( y_1 \) denotes the first year the new system applies, and \( y_n \) denotes the final year of projection.

The population over the legal retirement age may or may not receive a pension from the contributory system. In order to make projections of future retirement pensions, we need to analyze the structure of previous retirement pensions for the purposes of obtaining an estimate of the system’s coverage rate. This is defined as the percentage of the population with a contributory retirement pension in relation to the total population of retirement age or over. If the coverage rate varies according to age group, this needs to be taken into account and included in the future projection of the number of pensions. The coverage rate can be obtained using the following formula:

\[ CR_{y_0}^x = \frac{l_y^x}{P_{y_0}^x} \]

where \( y_0 \) denotes the year in which information about the real coverage rate is obtained, \( CR_{y_0}^x \) denotes the coverage rate at age “\( x \)” during year “\( y_0 \)”, \( l_y^x \) denotes the number of people surviving to exact age “\( x \)” during year “\( y_0 \)”, and \( P_{y_0}^x \) denotes the number of people receiving a contributory retirement pension who survive to exact age “\( x \)” during year “\( y_0 \)”.

To project the value of the coverage rate for the necessary years, the following formula is used:

\[ CR_x^y = CR_{x-1}^{y-1} \]

\[ \forall x > x_r \]

If according to the available historical data, it is seen that the new pensions awarded, i.e., new pensioners joining the system, are increasing year after year, this change needs to be included in order
for the number of new pensions to be estimated. The coverage rate for the legal retirement age therefore has to be obtained using the following formula:

\[
CR_y^{x_r} = CR_{y-1}^{x_r} (1 + ICR_{x_r})
\]  

(5)

where \(ICR_{x_r}\) denotes the annual increase in coverage rate. We will consider that the coverage rate pension will increase with a constant value. This is a limitation of our work because we do not take into account the substitution effect of the labor market, the active and inactive and unemployed population at each age. \(CR_y^{x_r}\) denotes the coverage rate at legal retirement age “\(x_r\)” during year “\(y\)”.

To calculate the number of people aged “\(x\)” who receive a contributory pension every year “\(y\)”, we multiply the estimated coverage rate by the estimated population:

\[
l_{P_y}^{x} = l_{y}^{x} CR_{x_r}^{y}
\]  

(6)

Therefore, the number of pensions for any year “\(y\)”, with a legal retirement age of “\(x_r\)” is obtained using the following formula:

\[
NP_y = \sum_{x=x_r} CR_{x_r}^{y} l_{P_y}^{x}
\]  

(7)

3.2. Average Pension (AP)

As a starting point, we obtain the average pension by age from the official Social Security data (http://www.seg-social.es/wps/portal/wss/internet/EstadisticasPresupuestosEstudiosEstadisticas). It is assumed that the initial pension for new entrants is calculated according to the RW:

\[
P_y^{x_r} = P_{y-1}^{x_r} (1 + RW)
\]  

(8)

where \(P_{y}^{x_r}\) denotes the annual public PAYG retirement pension at age “\(x_r\)” during year “\(y\)”, and \(RW\) denotes the annual real revaluation of wages.

The retirement pension at age “\(x\)” during year “\(y\)” is increased with respect to the pension at age “\(x - 1\)” during year “\(y - 1\)” in line with the \(RP\). If this was not the case according to the data observed, the increase in \(RP\) would be equal to 0:

\[
P_y^{x} = P_{y-1}^{x-1} (1 + RP)
\]  

(9)

where \(RP\) denotes the annual revaluation of public PAYG retirement pension.

3.3. Gross Domestic Product (GDP)

The GDP for a year is calculated based on the previous period in accordance with the following formula:

\[
GDP_y = GDP_{y-1} (1 + IGDP)
\]  

(10)

where \(GDP_y\) denotes gross domestic product during year “\(y\)”, and \(IGDP\) denotes the official projection for annual increase in GDP, taking account the European Union makes projections of the increase in GDP for each country.

4. The Two-Stage Model

The two-stage model assumes complementarity between pillars but from a different perspective to that applied until now. Instead of each pillar complementing each other horizontally, which is what happens in all current systems, complementarity in the two-stage model takes place vertically. The authors in [8–13] all set out a two-stage theoretical model, analyzing its actuarial aspects and definition.
Figure 1 shows a diagram of what happens to contributions and benefit payments in a classical system and in the two-stage system.

![Diagram of contributions and payments in a classical system and a two-stage system. Source: Own elaboration.](image)

Next, we show what the spending on public contributory retirement pensions is for the current model and what it would be under the two-stage system.

### 5. Pension Expenditure

There is a basic hypothesis underlying application of the two-stage system in that it assumes the existence of complementary savings. The following also apply: taking into account that year $y_1$ is the first year in which the new system comes into effect:

- Those who retire in or retired prior to year $y_1$ receive a public pension following the calculation rules of the current system and will receive their complementary savings in the form of a lifetime annuity.
- Those who retire after $y_1$ will receive a term annuity to cover the years between the legal retirement age and advanced age and a public pension following the new system’s rules from advanced age until they die.

All pensioners, whether they receive a public pension calculated under the rules of the current system or those of the two-stage system, will receive the following annual income:

$$IP_x^y = P_{PV_x}^{(2)y} + a_x^y = P_{x}^{(2)y}$$ (11)

where $IP_x^y$ denotes income received by pensioners of age “$x$” during year “$y$”, $P_{PV_x}^{(2)y}$ denotes the annual public retirement pension received by pensioners of age “$x$” during year “$y$” from the current PAYG system, $a_x^y$ denotes the complementary pension in the classical system received by pensioners of age “$x$” during year “$y$”, and $P_{x}^{(2)y}$ denotes the annual retirement annuity received by pensioners of age “$x$” during year “$y$” under the new system.

It needs to be taken into account that

$$P_x^{(2)y} = P_{PV_x}^{(2)y} = a_x^y \text{ when } x < x_a$$ (12)

$$P_x^{(2)y} = P_{PV_x}^{(2)y} = a_x^y \text{ when } x > x_a$$ (13)

Being,

$$a_{x+1}^y = a_x^{y-1}(1 + RP) \text{ and } a_{x+1,l}^y = a_{x,l}^{y-1}(1 + RP)$$
where \( P_{2y}^{\text{PAYG}} \) denotes the term private retirement pension received by pensioners of age “\( x \)” during year “\( y \)” from capitalization under the new system, \( P_{2y}^{\text{PAYG}} \) denotes the deferred public retirement pension received by pensioners of age “\( x \)” during year “\( y \)” from PAYG under the new system, \( x_{y} \) denotes the complementary pension that the pensioner, of age “\( x \)” during year “\( y \)” will receive temporarily from the legal retirement age to advanced age, and \( x_{y} \) denotes advanced age.

Determining advanced age is fundamental when it comes to designing a two-stage model and it needs to consider population longevity. This could be life expectancy at the legal retirement age, which would mean 80 or 85 years in many countries. However, this would give rise to social and political costs that would make it difficult for the system to be implemented due to the large amount of capital needed and because of the lengthy deferral involved before receipt of the public Social Security pension, which could generate mistrust and a sense of being unprotected.

For this reason, we believe that advanced age should be determined according to the average level of complementary savings in the country in question.

In order to obtain the relation between this advanced age and the level of saving, the following steps need to be taken. For each advanced age value selected, we can compute the price of a term annuity bearing in mind that:

- \( \tilde{a}_{y,x:y-x} \) denotes the price of a term annuity from retirement age to advanced age (insurer’s price), and \( C_{y} \) denotes the funded capital needed at retirement age.

To begin with, we compute the first two elements (\( a_{y,x}^{y} \) and \( a_{y,x}^{y} \)) using two conditions:

* Condition 1: actuarial equivalence at retirement age between the two complementary pensions:

\[
\tilde{a}_{y,x}^{y} \cdot \tilde{a}_{y,x}^{y} = a_{y,x}^{y} \cdot \tilde{a}_{y,x:y-x}^{y}
\]  

* Condition 2: the same initial pension at retirement age in the classical and the two-stage systems:

\[
a_{y,x}^{y} = P_{y}^{y} + a_{y,x}^{y}
\]  

From conditions (14) and (15), we can obtain the values of \( a_{y,x}^{y} \) and \( a_{y,x}^{y} \), and substituting the value of \( a_{y,x}^{y} \) in (15) into Formula (14) directly gives us

\[
\tilde{a}_{y,x}^{y} \cdot \tilde{a}_{y,x}^{y} = \left( P_{y}^{y} + a_{y,x}^{y} \right) \cdot \tilde{a}_{y,x:y-x}^{y}
\]  

Thus, we get

\[
a_{y,x}^{y} = P_{y}^{y} \cdot \frac{\tilde{a}_{y,x:y-x}^{y}}{\tilde{a}_{y,x:y-x}^{y} - \tilde{a}_{y,x:y-x}^{y}}
\]  

and

\[
a_{y,x}^{y} = P_{y}^{y} \cdot \frac{\tilde{a}_{y,x}^{y}}{\tilde{a}_{y,x:y-x}^{y} - \tilde{a}_{y,x:y-x}^{y}}
\]  

Note that these two values depend on the advanced age and the level of initial PAYG pension for each cohort. Having obtained the values of \( a_{y,x}^{y} \) and \( a_{y,x}^{y} \), we can easily obtain an equilibrium relation between the parameters, in order to generate a good two-stage procedure:

\[
C_{y} = P_{y}^{y} \cdot \frac{\tilde{a}_{y,x}^{y} \cdot \tilde{a}_{y,x:y-x}^{y}}{\tilde{a}_{y,x}^{y} - \tilde{a}_{y,x:y-x}^{y}}
\]  

This relation can be used in two different ways for a well-defined amount of initial PAYG pension \( P \):

- If we fix the advanced age, the formula tells us the level of funded capital required at retirement.
If we know the available capital, the relation gives us the value of the appropriate advanced age \( x_0 \).

Below, we provide two tables showing the structure of pension expenditure in the classical system and in the two-stage system if introduced now. To make the representation easier, we work on the assumption that advanced age begins two years after the legal retirement age. Table 1 shows the number of people involved and the public pension they would receive if the classical system were maintained. Table 2 shows the case of the two-stage system being applied from year \( y_1 \). Given that from the time the two-stage system comes into effect, there are still pensioners that receive their pension according to the classical system, this table shows the number receiving a public pension under the rules of the classical system and, in the shaded cells, the number receiving a pension under the rules of the new system.

**Table 1.** Public pension expenditure in the classical system for each “age” and in each “year”.

| Ages \( x \) | \( y_1 \) | \( y_2 \) | \( y_3 \) | \( y_4 \) | \( \ldots \ldots \) | \( y_n \) |
|------------|---------|---------|---------|---------|----------------|---------|
| \( x \)    | \( p_{0x} \) | \( p_{1x} \) | \( p_{2x} \) | \( p_{3x} \) | \( \ldots \ldots \) | \( p_{nx} \) |
| \( x + 1 \)| \( p_{0x} \) | \( p_{1x} \) | \( p_{2x} \) | \( p_{3x} \) | \( \ldots \ldots \) | \( p_{nx} \) |
| \( x + 2 \)= \( x_0 \) | \( p_{0x} \) | \( p_{1x} \) | \( p_{2x} \) | \( p_{3x} \) | \( \ldots \ldots \) | \( p_{nx} \) |
| \( x + 3 \)= \( x_0 + 1 \) | \( p_{0x} \) | \( p_{1x} \) | \( p_{2x} \) | \( p_{3x} \) | \( \ldots \ldots \) | \( p_{nx} \) |
| \( x + 4 \)= \( x_0 + 2 \) | \( p_{0x} \) | \( p_{1x} \) | \( p_{2x} \) | \( p_{3x} \) | \( \ldots \ldots \) | \( p_{nx} \) |
| \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) |
| \( w = 1 \) | \( p_{0w} \) | \( p_{1w} \) | \( p_{2w} \) | \( p_{3w} \) | \( \ldots \ldots \) | \( p_{nw} \) |
| \( w \) | \( p_{0w} \) | \( p_{1w} \) | \( p_{2w} \) | \( p_{3w} \) | \( \ldots \ldots \) | \( p_{nw} \) |
| TOTAL public pension expenditure | \( \sum_{x=x_0}^{n} p_{x} \) | \( \sum_{x=x_0+1}^{n} p_{x} \) | \( \sum_{x=x_0+2}^{n} p_{x} \) | \( \sum_{x=x_0+3}^{n} p_{x} \) | \( \sum_{x=x_0+4}^{n} p_{x} \) | \( \sum_{x=x_0+5}^{n} p_{x} \) |

\( p_{x} \) is the number of people aged “\( x \)” who receive a contributory pension every year “\( y \)”. \( p_{x} \) is the annual public retirement pension received by pensioners of age “\( x \)” during year “\( y \)" from the current pay-as-you-go (PAYG) system.

**Table 2.** Public pension expenditure in the two-stage system beginning in \( y_1 \), where \( x_0 = x + 2 \) for each “age” and in each “year”.

| Ages \( x \) | \( y_1 \) | \( y_2 \) | \( y_3 \) | \( y_4 \) | \( \ldots \ldots \) | \( y_n \) |
|------------|---------|---------|---------|---------|----------------|---------|
| \( x \)    | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) |
| \( x + 1 \)| \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) |
| \( x + 2 \)= \( x_0 \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) |
| \( x + 3 \)= \( x_0 + 1 \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) |
| \( x + 4 \)= \( x_0 + 2 \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) |
| \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) |
| \( w = 1 \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) |
| \( w \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) | \( \ldots \ldots \) |
| TOTAL public pension expenditure | \( \sum_{x=x_0}^{n} p_{x} \) | \( \sum_{x=x_0+1}^{n} p_{x} \) | \( \sum_{x=x_0+2}^{n} p_{x} \) | \( \sum_{x=x_0+3}^{n} p_{x} \) | \( \sum_{x=x_0+4}^{n} p_{x} \) | \( \sum_{x=x_0+5}^{n} p_{x} \) |

\( P_{pb_y} \) is the deferred public retirement pension received by pensioners of age “\( x \)” during year “\( y \)” from PAYG under the new system.

In this example, it is trivial that the expenditures of pension the two first years \( (y_1\) and \( y_2\) are greater in the traditional system than in the two-step system (transition period linked to the choice of
advanced age). Indeed, in these years, the pension amounts in the new system are identical to the traditional ones but for fewer people; for instance, for the first year example has
\[
\sum_{i=x}^{w} l p^y_i f^y_i x > \sum_{i=x+1}^{w} l p^y_i f^y_i x
\]
This relation is no longer automatically fulfilled from year \(y_3\) (decrease in the number of retirees in the new system but with a simultaneous increase in the public pension).

An analysis would have to be carried out to discover whether the effect of reducing the number of people would offset the increase that comes about in the amount of the PAYG pension, which is greater under the new system’s rules than under the rules of the previous system. The purpose of the next section is to check this eventual compensation between the two effects on a long-term basis for the Spanish system.

6. Implementing a Two-Stage Model for the Spanish Pension System

The public pension system in Spain is a PAYG system that generates a replacement rate of 72.3% [7], which is one of the highest in the OECD (mean 52%). This almost covers the public pension system, and political messages about the system being guaranteed by the “pension piggy bank” have contributed to complementary systems being poorly developed. However, Spain has the lowest birth rate in the Euro zone and one of the highest survival rates among OECD countries, exceeded only by Japan. The Covid-19 pandemic may have an effect on survival rates and this would have to be estimated, but at the time this paper is written, it cannot be calculated. Nevertheless, the effect would be the same regardless of whether it applied to the classical model or the two-stage model. As a result, the public pension system had a cash deficit of 16.793 million € in 2019, representing 1.34% of GDP [23]. This situation has led to two unprecedented reforms of Spanish regulations over recent years: the reform of 2011 with Law 27/2011 of 1 August, on updating, adapting, and modernizing the Social Security system, the application of which culminates in 2027; and that of 2013 with the Royal Decree Law 5/2013 of 15 March, on measures fostering the continuation of the working life of workers over retirement age and encouraging active ageing. Although this reform is technically almost perfect, due to social pressure was practically shelved in 2018 with Royal Decree Law 28/2018 of 28 December, for the revaluation of public pensions and other urgent measures in social, work, and employment matters. The authors in [4,24] made their projections prior to 2018 and in them applied the reform of 2013, although the measures in this were ultimately not applied.

We analyzed expenditure only on contributory retirement pensions, not widow’s, orphan’s, dependent’s, or disability pensions. It is important to bear this in mind given that most reports and organizations that analyze pension spending, e.g., the Ageing Report, Pensions at a Glance, the Bank of Spain, and the Foundation for Applied Economic Studies (FEDEA), take all contributory pensions into account. In the case of Spain, contributory retirement pensions account for 60% of total spending on pensions.

The aim of this section is to compare current spending on public contributory retirement pensions in Spain with the spending that would result from implementing a two-stage model that we consider would come into effect in 2025. The idea of it coming into effect in 2025 is justified for two reasons:

- It corresponds to the year the “baby boom” generation will start to retire in Spain.
- The transition period for implementing the 2011 reform will be virtually complete and in 2025, the amount of the initial pension will be calculated according to the contribution bases of the previous 25 years and the retirement age; the entitlement age to a 100% pension will be 68.

Applying the two-stage system in 2025 means that:

- Those who retire before 2025 will receive their public retirement pension under the rules of the current system, from the legal retirement age until they die.
Those who retire in and after 2025 will receive the new public retirement pension, the amount of which will be the same as they would have received in the form of a public pension from the current system plus the yearly payments received as a life annuity on the basis of private savings made, from advanced age until they die.

We assumed in our central scenario that advanced age begins at age 69, 2 years after the legal retirement age, which is 67, following Law 27/2011 of 1 August, on updating, adapting and modernizing the Social Security system. The choice of this small, deferred period is motivated by the limited development of pension savings in Spain, the data can be found in [25–27], 0.5% of GDP in 2016 [24]. Indeed, if we fix the advanced age, then Formula (19) will give us the level of necessary saving to invest in the fully funded scheme at the legal retirement age. Therefore, we chose the advanced age in order to take into account the low levels of private savings detected in Spain; sensitivity with respect to this advanced age is presented hereafter.

We show our working hypotheses in Table 3; and it should be pointed out that, although the figures are justified and approved, any possibly incorrect estimate will have the same effect on the spending figure obtained regardless of the model:

| X (Years Old) | CR2020 (Source: Social Security) | p2020 x |
|---------------|---------------------------------|---------|
| 65–69         | 63%                             | 18,457  |
| 70–74         | 65%                             | 17,172  |
| 75–79         | 64%                             | 15,172  |
| 80–84         | 60%                             | 13,297  |
| Over 85       | 58%                             | 12,009  |

Another hypothesis

\( IGDP = 1.8\% \)

A long-term estimate is considered, following OECD forecasts, regardless of annual values such as that for 2020, which will have reductions in amounts of GDP due to the Covid-19 pandemic

\( RW = 1\% \)

Life annuity: we use the life table National Statistics Institute (INE) Survival Tables 2020–2068, National Statistics Institute (INE). (Available at: https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736177004&menu=ultiDatos&idp=1254735573002) with a correction of 5 years.

\( x_r = 67 \)

\( x_d = 69 \)

\( CF = 40,277 \) Calculated using Formula (20)

\( GDP^{2019} = 1,429,140,000,000 \)

The life tables of the official Spanish statistical agency were used for calculations related to term annuity. In the case of life annuity, these tables were corrected by 5 years. This increase was considered as an example to analyze our model, taking into account the differences between the expected life of tables like Eurostat, National Statistics Institute (INE), and Social Security in Spain, in order to make a more cautious assessment of the longevity risk. The value of GDP is from INE, official Spanish statistical agency.

We show in Figures 2–4 the evolution of the relevant variable to obtain the pension expenditures, and we can observe the different values of these variables in relation with the system.

Figure 2 shows the evolution of the population that would receive a contributory retirement pension from the public pension system according to the classical model, for the case of Spain from 2020 to 2068. It can be seen that the increase in the number of recipients grows steadily over the years analyzed, and this effect can also be seen in the higher ages.
Figure 2. Projection of population receiving a contributory retirement pension in Spain under the classical model: 2020–2068. Source: Own elaboration.

Figure 3 shows the projected number of pensioners that would receive a public Social Security pension should the current system be maintained compared to the number that would receive one if the two-stage system were applied. It can be seen that until 2025, when the new system comes into effect, the number of pensioners is the same in each model. From that year onwards, the number of pensioners receiving a retirement pension from the two-stage system is lower than the number that would receive a public pension if the classical system were maintained.

Figure 4 breaks down the population receiving a pension under the two-stage system, showing those who continue to receive a pension from the previous system (i.e., those who retired prior to 2025) and those who receive a pension calculated under the rules of the new system (i.e., those who retire in 2025 and after; naturally, these do not appear until 2027 because that denotes advanced age at age 69, two years later than the effective retirement age considered).
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Figure 3. Projection of pensioners in the classical system and in the two-stage system: 2020–2068. Source: Own elaboration.

Figure 4. Distribution of pensioners receiving a public retirement pension in the two-stage system: 2025–2068. Source: Own elaboration.

Figure 5, taking the considered hypotheses into account, shows the evolution of the pension expenditure/GDP relationship for Spain over the period 2020–2068 in the case where the current system is maintained and where a two-stage system is applied and comes into effect in 2025. We see that there is a reduction in the size of the indicator, which is at its highest in the early years of the two-stage system. We also see that the differential decreases after 2050, which is because, from that year onwards, the entire pensioner population receives a public retirement pension calculated according to the new system and is therefore larger than that received under the classical system. Nevertheless, the fact that the population receiving a pension is limited to those aged 69 and over continues to have the effect of reducing expenditure.
In Figure 5, we see what the effect on the pension expenditure/GDP relationship would be if, with the system being introduced in 2025, advanced age began at 68 or 70. The capital that one would need to have saved varies depending on whether advanced age begins at 68 or 70. Applying formula (20), we obtained the following results for various advanced age values with the aim of giving an idea of the savings effort that would have to be made depending on the age chosen.

In addition, as can be seen in Figure 7, the reduction in pension spending is greater as the advanced age value increases.
The figure confirms that, as far as pensions are concerned, the sooner a start is made in solving problems, (2025 rather than 2030) the better.

Sustainability on the two-stage system, the reduction is the same, regardless of when the system came into effect in 2030 and for the three advanced age values considered.

Figure 8 shows the pension expenditure/GDP relationship in the case where the system comes into effect in 2030 and for the three advanced age values considered.

The effect of increasing the value for advanced age is the same as that observed if the system were implemented in 2025. In Figure 9, using the data from above, we see how the savings in expenditure that come about in the case of applying the system in 2025 are greater than if it were applied in 2030. In 2063, when all pensioners in the system are receiving a public retirement pension based on the two-stage system, the reduction is the same, regardless of when the system came into effect. The figure confirms that, as far as pensions are concerned, the sooner a start is made in solving problems, (2025 rather than 2030) the better.
For the application of this model, the starting point is the consideration that the percentage of savings that goes to the capitalization system and the pay-as-you-go system is the same for all contributors. In this way, it is possible that old age can be the same for everyone.

Even so, the situation of those who contribute to the pay-as-you-go system and do not have the capacity to make pension savings was explored. In that case, the mechanism for these individuals to receive the public pension from the legal retirement age could be arbitrated. From a policy perspective, the authorities that design the application of this system are the ones that have to set the minimum salary and pension values to determine which population is the one that could receive a minimum contributive public pension from the legal retirement age. At the other extreme, there would be individuals with important savings in capitalization, where we could think that the amount of the public pension would have to be equal to the private pension. To avoid this risk, maximum pension amounts will be stipulated, an aspect that must also be regulated by the legislator when the model is applied.

7. Discussion

In the previous sections, we have developed an empirical study, showing how we could implement the two-stage model in a given environment (Spain). The aim of the research was to propose a practical application of the model, as described for instance in [10–12]. For this purpose, we have of course stylized many aspects, by proposing a macro economic study, and this, in order to compare two possible decumulation techniques, was applied to a given pension architecture. Of course, the complete implementation of such a two stage pension system in real life raises many other issues. In this section, we address various questions around such a potential implementation and highlight some limitations of this study.

• The proposal assumes that we have a first pillar from the social security—PAYG (pay-as-you-go) mandatory scheme—and a second pillar from the employer—occupational fully funded pension schemes. We assume these two systems exist and normally these two systems are paid in the classical way under the form of lifetime annuities. The mechanism could therefore be applied in practice in countries where these two pillars are generalized. In countries with low levels of occupational pensions, the system could be nevertheless applied, but it would generate advanced ages close to retirement age. Of course, in such cases, a development of a second fully funded pillar supplemental to social security would be highly recommended.
In our spirit, the system concerns collective pension schemes (from the State and from the employer); the purpose is not to integrate in this new joined decumulation process, private savings or individual wealth.

The system concerns the decumulation aspect; it can be perfectly combined with other parametric or structural reforms of the first pillar. For instance, we could imagine a classical defined benefit (DB) system, first transformed into a notional defined contribution (NDC) system and then applying the two steps methodology. The proposal concerns the decumulation order; it does not prevent structurally reforming the first pillar (better link between contributions and benefits, actuarial fairness, etc.). The method is but an additional tool and not the unique panacea in order to solve the sustainability and the adequacy of a pension architecture.

For simplicity of presentation, we used classical periodical life tables with adjustments for the pricing of lifetime annuities for the mortality model. Of course, we could have used much more complicated and up to date mortality models but the most important point, well documented and observed on many insurance markets, is the existence of a significant safety margin, used by insurers, for the pricing of lifetime annuities with respect to general population figures.

Another important issue in terms of mortality is the heterogeneity of the longevity in relation with socio-economic conditions. It is well known that lower socio economic groups have a shorter life expectancy than higher ones. This evidence generates, in many social security systems, a form of regressive redistribution from the poorer categories to the rich ones (see for instance [27–29]). One of the disadvantages of the two-step mechanism is that it could exacerbate this inequality by postponing the payment of social security benefits. However, the main origin of these discriminations can be found in the basic architecture of the first pillar itself. The best solution could probably be, then, first to change the basic PAYG pillar into a system taking into account the longevity heterogeneity (for instance by introducing variable statutory retirement ages by socio economic classes—see [30]—or by implementing a progressive pension formula). A two-step mechanism can then be introduced and adapted to this corrected basic PAYG pillar.

8. Conclusions

Applying a two-stage system to the Spanish situation would bring about a reduction in the pension expenditure/GDP relationship that would not occur if the classical system were maintained. This would naturally generate an improvement in the system’s sustainability, given that the change would have no effect on the amount of money coming in.

This result could seem counterintuitive at first sight, taking into account the fact that in the considered shift to a two-stage model, there is no reduction in benefits and no change in the retirement age or in the contribution level.

There are two reasons for this reduction in expenditure. The first one is the elimination of the risk of adverse selection that arises when the public system is complemented by a term annuity instead of a lifetime annuity. In a fairly priced environment, there would be no distortion for lifetime annuity but we know that in the real world, insurers apply more important loadings for lifetime annuities than for term annuities. This extra charge can be avoided in the two-stage model.

The second aspect is related to the time horizon of the expenses. At issuance, the two-stage model allows the State to delay some social security expenses. This timing aspect can be particularly interesting taking into account the expected time profile of the pension expenditures in the next decades (see the baby boom effect).

The two-stage system can be implemented without a transitional period beyond that deemed necessary for psychological reasons. The introduction of any parametric or automatic reform would also be compatible with the application of the two-stage system.

Beside these advantages, there are also some concerns to address. In particular, among the difficulties in implementing the two-stage solution, we can point out two main challenges: the risk diversification and the definition of advanced age in relation to the available funded capital at retirement age.
In an uncertain economical and demographical environment, the horizontal classical model can benefit from the imperfect correlation between economic growth and market returns. This advantage disappears for a great part in the two-stage model. The initial pensions received by retirees under the new system will come from capitalization and therefore be subject to interest risk. A way of immunizing portfolio management will need to be established in order to guarantee that this risk does not affect the temporary private income that the pensioner receives from the legal age of retirement up until advanced age.

Deciding when advanced age begins is fundamental to the appropriate development of the system. It will not always be possible for it to be as closely associated with longevity as we would like it to be, since this would often make the system unviable because of the social and political risk involved. Even when advanced age is determined based on the average pension savings accumulated by the population, a great effort in communication would have to be made in order for the model to be implemented as it should be. The inheritance effect and the belief that it is preferable for Social Security to begin paying pensions and that the individuals should be free to look after their own pension savings are two problems to be solved in order for the model to be applied. An information campaign would therefore have to be carried out in which no effort was spared, and the tenets and teachings of behavioral theory would have to be taken into account in the design of this campaign.

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