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EARLY RETIREMENT REDUCTIONS COVERED BY A DC PENSION PLAN: CASE STUDY ANALYSIS FOR PORTUGAL

EMÍLIO JÚNIOR RIBEIRO AGUIAR

SUPERVISOR: Fátima Pires de Lima

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Abstract

In Portugal, population ageing is challenging the financial sustainability of the Social Security system. Throughout the years many legislative amendments have been introduced in the Social Security System, with the goal to make it self-sustainable, but it is struggling to deliver it without restricting old-age benefits due to the increase of the elderly population. Inevitably, this leads to negative impacts in the old-age retirement pensions. Past administrations have combined these reforms with measures to reinforce the establishment of the funded private pension sector, giving it a more prominent role, so as to diversify the sources of retirement income.

In the context of increasing the individual responsibility for the adequacy of retirement income. This paper analyses the old-age benefits with special focus in the early retirement option, given the heavy penalties inherent to this option. Also, examines the possibility of fund a DC pension plan to fully mitigate those penalties.

Keywords: old-age retirement benefit, early retirement pension benefits, Social Security sustainability, contribution rate, funded private pensions schemes, DC pension plans.

Resumo

Em Portugal, o envelhecimento da população desafia a sustentabilidade financeira do sistema de Segurança Social. Ao longo dos anos, muitas emendas legislativas foram introduzidas no sistema de Previdência Social com o objetivo de torná-lo auto-sustentável, todavia existe uma dificuldade para entregá-lo sem restringir os benefícios de aposentadoria devido a evolução demográfica. Inevitavelmente, isso leva a impactos negativos nas pensões de aposentadoria por idade. As administrações anteriores combinaram essas reformas com medidas que reforçam o estabelecimento de esquemas privados de fundos de pensões, dando-lhe um papel mais preponderante, de forma a diversificar as fontes de renda de aposentadoria.

No contexto de aumento da responsabilidade individual pela adequação da renda de aposentadoria. Esta dissertação analisa a pensão de velhice com especial enfoque nas reformas antecipadas, dada a forte penalização que existe. Além disso, verifica-se a possibilidade de um plano de contribuição definida para mitigar totalmente essas reduções. Portanto, são descritos os dois sistemas, o público e o complementar.

Palavras-chave: pensão de velhice, reforma antecipada, sustentabilidade da Segurança Social, taxa de contribuição, esquema privado de pensões, plano de contribuição definida.

Contents

List of Abbreviations

AFPFIPP	Portuguese Association of Pension and Equity Investment Funds (*Associação Portuguesa de Fundos de Investimento Pensões e Patrimónios*)
ASF	Portuguese Insurance and Pension Funds Supervisory Authority (*Autoridade de Supervisão de Seguros e Fundos de Pensões*)
CPI	Consumer Price Index
CSI	*Complemento Solidário para Idosos*
DB	Defined Benefit
DC	Defined Contributions
EC	European Commission
EET	Exempted-Exempted-Taxed
EU	European Union
FCR	Retirement Certificate Fund (*Fundo dos certificados de reforma*)
FCR-A	Retirement Certificate Fund Accumulation phase
FCR-U	Retirement Certificate Fund Pay-out phase
GDP	Gross Domestic Product
IMF	International Monetary Fund
LE	Life Expectancy
N	Years of relevant contributions to Social Security
NRA	Normal Retirement Age
OECD	Organisation for Economic Co-operation and Development
PAYG	Pay-As-You-Go
PPR	Personal Retirement Plans (*Planos de Poupança Reforma*)
PUC	Projected Unit Credit
RC	Collectible Income
RE	Reference Earnings
RPC	*Regime Público de Capitalização*
RR	Replacement Rate
SF	Sustainability Factor
SS	Social Security
SSI	Social Support Index
TB	Target Benefit
TTE	Taxed-Taxed-Exempted

1. Introduction

The main goal of a pension system is to ensure an adequate income to its members after they cease to be active workers either by reaching an old-age or by becoming disabled. Demographic developments as: low levels of birth rates and life expectancy increases have been challenging the pension systems design, provoking an increase debate of how to sustain a healthy pension system (World Bank, 1994). These developments have been reducing the labour force and rising the old-age dependency ratio[1]. National Social Security pensions systems based on the payment of the pensions promised on a pay-as-you-go (PAYG) method, see their expenditures (pension's payments) increase and the revenues (contribution's revenues) decrease.

Hence, PAYG pension systems see themselves struggling to maintain their financial sustainability, defined as the capacity to finance itself autonomously without depending on the state national budget or on state debt to fulfil the pension promises. Unlike pension funds, the back-up for the pension promise of defined benefit[2] (DB) is not funded through assets or corporate profits but through the power to tax, which facilitates the transfer of longevity risks and other risks arising from the performance of the economy away from the elderly (da Silva et al., 2004). Therefore, not tackling the sustainability issue over the short and long term will weaken the system and endangering future generations.

Portugal's past governments, facing the above challenges have been reforming its pension system (European Commission, 2018a), linking the normal retirement age (NRA) to the life expectations gains, introduced the sustainability factor leading to one of the heaviest penalties for early retirements among OECD countries (OECD, 2019a) and so on.

While the demographic pressure subsists the need to continue reforming Pillar II [3] system will be necessary (OECD, 2019a). On top of these demographic issues, there is an increasing pressure on the economy due to jobless and low growth in many developed countries (Stewart, 2014), which also is the case of Portugal. As a result, these countries will have to experience a growing role for funded pension systems as a complement to the PAYG system (Stewart, 2014) or lose part of the current social protection on elderly.

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[1] Old-age dependency ratio is the number of individuals aged 65 and over per every 100 people of working age defined as those between 15 and 64.
[2] On a DB pension plan the benefit formula is defined and the contributions values necessary to fund the pension defined unknown.
[3] According with OECD Taxonomy the Pillar II englobes the pension coming from mandatory and earning-related contributions.

This paper will focus on the individual personal effort to mitigate the impacts of a decrease on the benefits granted under Pillar II and on delaying the age to access the old-age pension, by contributing to Pillar III[4] via a pension fund. As well as, in the growing individual awareness of the amount of effort (contributions), that will be needed, especially for early retirements where the public scheme has been significantly penalizing the early-access to them. In the light of this, we will assess the possibility to overcome these cuts through a defined contribution[5] (DC) pension plan. That way, individuals benefit from the rate of return and life cycle theory of savings (Deaton, 2005).

In the next chapter, we will briefly describe the structure of the Portuguese pension system in particular regarding the social security system, and the benefits provided in case of an old-age retirement and in case of an early retirement.

The following chapter, we will present the complementary system and display some data available relative to how the pension funds' assets are invested, what has been the past returns achieved and how are individual's contributions to pension funds are taxed.

Finally, we present a case study showing the replacement ratio that can be achieved by an individual after suffering the early retirement penalties and what would be the target contribution rate required, to be performed by the individual to the complementary system, in order to be able to ask for an early retirement, while keeping the expected replacement ratio before suffering the early retirement penalties. Considering the benefits granted by the social security system and the one achieved on the complementary system.

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[4] According with OECD Taxonomy the Pillar III englobes the pension coming from voluntary and earning-related contributions.

[5] DC – the contribution formula is defined and the benefit at retirement will correspond to the pension/annuity that can be bought. So, in this case contributions are defined while the benefits are unknown.

2. Portuguese Pension system

According with the Portuguese basic social security law no. 4/2007, the Portuguese pension system is divided by three sub-systems, being the first and second systems mandatory and justified by behavioral dimensions failing to act in accordance with the expectations of rational economic and financial theory (Mitchell and Utkus, 2003).

The first system called **social protection system** aims to act as a first layer of social protection for the elderly. Guarantees a universal minimum income in old-age being its main components: i) the minimum pension from earnings-related scheme, between 21% and 30% of the average wage depending on years of contributions, ii) the means-tested old-age social pension at 11% of the average wage (*pensão social do regime não contributivo*), and iii) the Solidarity Supplement for Elderly, CSI (*Complemento Solidário para Idosos*) up to 29% of the average wage for those whose total income is under a certain threshold (OECD, 2019a).

The second system called **social security system** has the goal to provide compensation for the loss or reduction of occupational earnings, in certain events[6], being mandatory with benefits that are earned related. It covers the general regime applicable to the majority of employees and self-employed workers.

The third system called **complementary system** is a voluntary option to allow individuals to complement the benefits granted by social security system. This system is funded and comprise occupational and personal pension plans.

This paper will be mainly focused on the social security and the complementary system, since the aim is to evaluate the impact of an early retirement pension according to the social security system, and to propose a voluntary savings strategy to mitigate those impacts through the complementary system. So, throughout this chapter it will be presented in more detail the recent amendments occurred on the social security previdential system, such as the penalties introduced on the early retirement pensions and the changes introduced to the age-to-access the old-age pension. It will be displayed the formulae to compute those values, together with a brief description of how the complementary system is organized in Portugal and some major features of the pension plans that are included in the system.

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[6] Sickness, maternity, paternity and adoption, unemployment, old-age, and death.

2.1. Social Security System

Under this system, the Portuguese Social Security sets the rules to provide social protection against disability, sickness, maternity, occupational disease, unemployment, and retirement benefits to its beneficiaries.

To fund the promised benefits a compulsory contribution of 34.75% of the monthly base salary is required under the general regime (11% paid by the employee and the remaining 23.75% by the employer). From the overall contribution rate, 20.21% is allocated to finance old-age benefits; 4.29% to disability benefits; 2.44% to survivor benefits; the remainder 7.81% to finance sickness and maternity, occupational disease and unemployment benefits (*Lei n.º 110/2009, de 16 de setembro, artigo 51.º*).

In the recent years, the Social Security System has suffered many reforms, being with major relevance to this study were the reforms introduced by:

- Law n.º 9/1999 introduced the possibility of early retirement at age 55 with at least 30 years of contributions and a penalty of 4.5% for each year of anticipation regarding the NRA;
- Law n.º 187/2007 changes the pension formula for disability and old-age benefit and sets a penalty of 0.5% per each month of anticipation regarding NRA, in case of early retirement;
- Law n.º 167-E/2013 defines the formula to increase every year the NRA proportionally to the gains in the average of life expectancy at age 65;
- Law n.º 10/2016 defines that until the revision of early retirement pension benefits, the early retirement is only possible for those aged 60 or above, and with 40 or more years of contributions.
- Law n.º 119/2018 introduced the concept of personal retirement age and ends the application of the sustainability factor for those who ask for an early retirement with at least 60 years of age while have completed 40 years of contributions to the system.

As one can see, past governments have been active in reforming the system because of adverse demographics (declining birth rates and increasing longevity), and the upward pressure on pension expenditure (European Commission, 2018a). Although, those measures have improved the sustainability of the system in the long-term, the sustainability is not yet ensured. In addition, it has curtailed lower pensions to a lesser degree than other social benefits, thus relatively protecting retirees, but increasing the risk of poverty on future generations (European Commission, 2016b).

The Portuguese pension system as a whole, relies mainly on the social security system and it is mostly based on Pay-as-You-Go (PAYG) with a defined benefits pension plan.

2.1.1. Old-age retirement benefit

All the employed and self-employed workers are compulsively covered by the social security system.

The old-age retirement benefit was designed to be the main source of income in old-age and has been under enormous pressure as the successive amendments mentioned above show. The major concern is the deficit between contributions received and benefits paid, as following figure displays.

Figure 1: Contributions and expenditure for the general social security scheme and civil servant scheme

Contributions and expenditure on earning-related and minimum pensions, % of GDP

General scheme
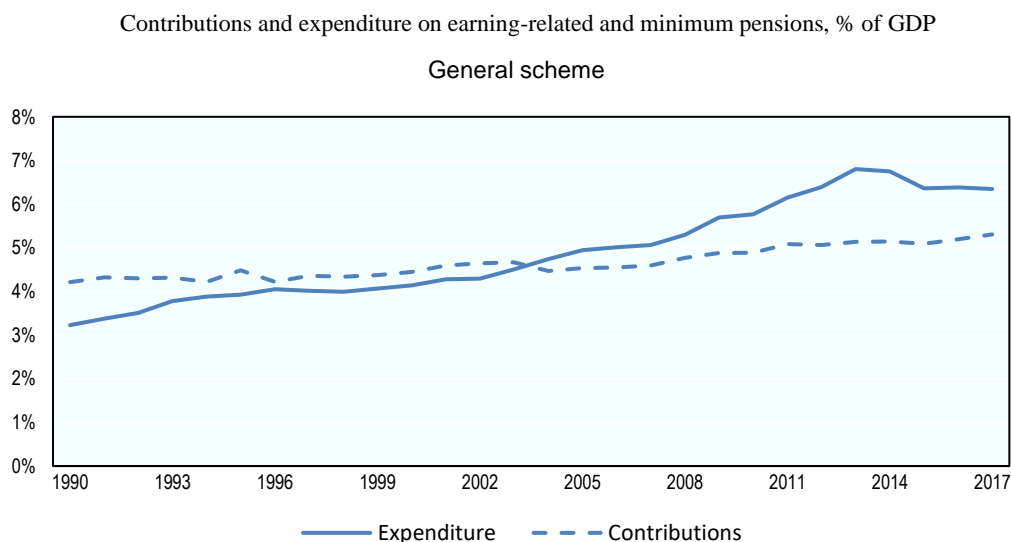
Source: OECD 2019, "OECD Reviews of Pension Systems: Portugal".

To be able to access the old-age retirement pension, the beneficiary must fulfill some eligibility conditions, such as reaching the normal retirement age (NRA) and gather a minimum number of annual contribution (at least 15 years of relevant contributions[7]). However, to receive the full pension, the minimum contributory period required is 40 years.

The NRA increases every year accordingly with the proportion of two-thirds of the increase, verified two years prior to the retirement year, on the life expectancy at the age of 65. The following formula shows how it is calculated the NRA increment to be added to the value of

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[7] One year of relevant contribution must have, at least, 120 days of record contributions to SS.

66 according to decree-law nº 167-E/2013. For 2020, the NRA was set at 66 years plus 5 months, and for 2021 at 66 years plus 6 months.

Equation 1: NRA Increment

$$m_n = \sum_{i=2015}^{n} (LE_{i-2} - LE_{i-3}) \times 12 \times \frac{2}{3} \ (1)$$

Note: «m» corresponds to the integer number of months to be added to the pensionable age in 2014 (66); «n» corresponds to the year of pension entitlement; «LE» corresponds to the average life expectancy at 65.
Source: Decreto-Lei n.º 167-E/2013, de 31 de dezembro.

This amendment leads to important changes as it decreases the old-age dependency ratio[8] by tightening the access to the public pension (European Commission, 2018c).

The table below, summarizes the process to calculate the old-age benefit value, once participants have reached the requirements to access it and can be characterized into one of the pension benefit echelons, under the conditions mentioned below.

Table 1: Pension benefit formula

Pension Benefit Formula		
20 years or less of contributory career	21 years or more of contributory career	
P = RE x 2% x N	**Revenue Echelon (RE/SSI)**	**Pension formula**
	RE <= 1.1 SSI	RE x 2.3% x N
	1.1 SSI < RE <= 2 SSI	$(1.1 \ SSI \times 2.3\% \times N) + [(RE–1.1 \ SSI) \times 2.25\% \times N]$
	2 SSI < RE <= 4 SSI	$(1.1 \ SSI \times 2.3\% \times N) + (0.9 \ SSI \times 2.25\% \times N) + [RE – 2 \ SSI) \times 2.2\% \times N]$
	4 SSI < RE <= 8 SSI	$(1.1 \ SSI \times 2.3\% \times N) + (0.9 \ SSI \times 2.25\% \times N) + (2 \ SSI \times 2.2\% \times N) + [(RE – 4 \ SSI) \times 2.1\% \times N]$
	RE > 8 SSI	$(1.1 \ SSI \times 2.3\% \times N) + (0.9 \ SSI \times 2.25\% \times N) + (2 \ SSI \times 2.2\% \times N) + (4 \ SSI \times 2.1\% \times N) + [(RE – 8 \ SSI) \times 2\% \times N]$

Note: SSI - Social Support Index; RE – Reference Earning; SF – Sustainability Factor; LE – Life Expectancy; N – Contributory Career.
Source: *Instituto da Segurança Social and Decreto-Lei Nr. 187/2007 de 10 de Maio.*

The reference earnings (RE) corresponds to the average of the annual wages of the best 40 years with record contributions to SS (adjusted by Consumer Price Index – CPI – excluding housing (75%) and annual wages increases (25%)). This adjustment disregards partially the increase on labour productivity and, as a result, leads to lower pensions for a full career of contributions compared to wages uprating only (European Commission, 2018c). For a specific

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[8] The number of pensioners might increase less than the population above the age of 65 years, leading to a lower coverage ratio as people start to draw pension benefits later.

participant, the higher it is his/her real-wage growth, lower will be his future replacement ratio (RR).

Another important feature of the pension benefit formula is the global accrual rate that corresponds to the product of the accrual rate by the contributory period with a maximum of 40 years. Furthermore, this rate varies between 2% and 2.3%, depending on the echelons defined by the ratio between the RE and the Social Support Index[9] (SSI) value.

The accrual rate largely determines the generosity of the system along with other factors, which can be measured through the average accrual rate of an average wage worker's career. According to the OECD (2019a) that rate is estimated to be 1.88%[10] for Portugal, standing out as one the highest rates among OECD countries, this means that according to OECD an average wage participant with a full contributory career (40 years of contributory period) can expect a 75.2% (1.88%x40) of RR.

Pension benefit value is annually updated according to the amount of the pension income and GDP real growth, alongside with the CPI, excluding housing, in the following manner:

Table 2: Pension benefit update (in-payment)

	Social Support Index Update Formula		
	Real GDP growth < 2%	2% ≤ Real GDP growth < 3%	Real GDP growth ≥ 3%
SSI update	CPI change rate (a)	(a) + 20% real GDP growth [min.: (a) + 0.5 p.p.]	(a) + 20% real GDP growth

Note: SSI - Social Support Index; CPI Consumer Price Index, excluding housing.

Source: *Instituto da Segurança Social* and *Decreto-Lei Nr. 187/2007 de 10 de Maio.*

2.1.2. Early retirement benefit

The early access to the old-age retirement benefit is currently defined under the law n. º 187/2007 after all its amends, being possible on one of the following events:

a) after reaching 60 years old with a minimum of 40 years of relevant contributions fulfilled at the age of 60.

b) after reaching 60 years old with a minimum of 48 years of relevant contributions or with a minimum of 46 years of relevant contributions but on this case having started to contribute to the SS prior to 17 years old.

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[9] In 2020, SSI value is 438,81 increasing 0,7% regarding 2019.

[10] For someone entering the labour market at age 20 in 2018 and retiring at NRA, then need to work 47 years and 2 months. 2.22% * 40/ (47+2/12) = 1.88%, 2.22% is for a 40-year career instead.

c) because of a particularly painful or exhausting professional activity with an early retirement age recognized by law.

d) because of temporary actions for specific protection to activities or companies with an early retirement age established by law.

e) because of long-term unemployment after reaching 57 years old, under particular conditions established by law.

f) after reaching 60 years old with a minimum of 40 years of relevant contributions.

Early retirement benefit amounts are computed accordingly with the formula mentioned to calculate the old-age retirement benefit, applying the following penalties depending on the events previously mentioned:

- for events in a) it is applied a penalty of 0.5% per each month of anticipation relatively to the NRA.

- for events in b) and c) no penalties are considered.

- for events in d) and e) specific legislation determines the conditions and penalties to be applied.

- for events in f) it is applied a penalty coming from the application of the sustainability factor, along with the 0.5% for each month of anticipation relatively to the NRA.

On this work we will pay particular attention to the penalties applied in case of early retirement under the event a) and f) mentioned above and propose a defined contribution plan with the goal to mitigate these penalties.

The Sustainability Factor (SF) is a penalty coming from the increases on the life expectation at 65 and is computed accordingly with the following formula:

Equation 2 Sustainability factor

$$SF = \frac{LE_{2000}}{LE_{n-1}} \ (2)$$

This approach causes a relevant decrease in early-retirement opportunities, once this penalization increases over time. Other Members States of the European Commission (EC) have enforced similar reforms (European Commission, 2018d). The EC projects that the average exit age will increase up to 66 and 5 months by 2070, in Portugal, and the effective

exit age will be before NRA[11], which to a certain degree may lead to a large projection drop on the pensions benefit value.

2.2. Complementary System

Aging is challenging the sustainability of social security system. To overcome potential issues related with low old-age pension values, the complementary system allows individuals to voluntarily save for retirement.

The complementary system comprises a public personal funded scheme and various private personal and occupational (professional) funded schemes. The public pension scheme offers a voluntary DC plan of public capitalization regime. Private schemes encompass mainly three types of savings vehicles such as defined benefit, defined contributions and hybrid pension plans.

According to IMF (2019) this complementary system remains underdeveloped. However, there are directives at the European level (IORP II Directive) to develop it as a key diversifier source of income in old-age as well as an alternative to budgetary sources (European Commission, 2016b).

2.2.1. Public Capitalization Regime

The Public Capitalization Regime (*RPC*) was introduced by the law n. º 26/2008, which set the establishment and operation of the voluntary public regime of regular contributions and individual accounts as a complement to the mandatory regime. This personal pension plan is managed by the Institute of Management of Capitalization Funds of the Social Security[12], and complies two independent portfolios under management, retirement certificate fund "FCR", one for the accumulation phase ("FCR-A") and the other one for pay-out phase ("FCR-U").

In 2018, the RPC recorded only a total of 1750 beneficiaries making contributions to the fund (IGFCSS, 2019). The lack of publicity of the government can explain the disinterest about RPC, since in 2019 the number of memberships increased by 11%, after a publicity carried on national television (OECD, 2019b).

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[11] One year and eight months early for men and two years and one month for women.
[12] Instituto de Fundos de Gestão de Capitalização da Segurança Social, "IGFCSS".

The public capitalization regime allows for three possible levels of contribution over the subscriber monthly remuneration[13]: 2%, 4% and 6% (the last one available only for subscribers with age equal or above to 50). In 2017, 45% of the active members' contribution rate was 4%, 32% selected 2%, and 21% selected 6%. This regime encompasses those who are covered by the SS mandatory regime and both the employer and/or the employee can voluntary make contributions to it.

2.2.2. Private Funded Scheme

The law n. º 386/86 was the first legal framework to set the rules regarding the establishment and operation of private pension funds in Portugal. Law No. 12/2006, reinforce the regulatory framework for pension fund entities. Afterwards, the government took another step towards the development of this sector by transposing the EU directive (2009/138/CE) into national legislation, the law No. 147/2015. This amendment facilitates the activity of insurance companies and pension funds by eliminating the legislative differences among EU States. Finally, the law No. 27/2020 transposes the EU directive (2016/2341/CE) on the supervision of occupational pension plans and establishes the current legal regime for the constitution and operation of private pension funds in Portugal.

Private schemes can be either personal or occupational pension plans. The latter is generally associated with professional, social groups or by agreement between workers' associations and trade unions. Generally, these types of plans are associated with closed[14] pension funds, while personal plans are integrated into open pension funds as it does not require association of any type between its members. The occupational pension plans can be defined benefit ("DB") or defined contributions ("DC") while personal pension plans are DC.

Authorities have been encouraging the build-up of funded private pension savings to ease off the burden of the social security scheme (European Commission, 2018c) and still be able to maintain income adequacy in old-age.

2.2.2.1. Occupational pension plans

In Portugal, private schemes coverage rate is lower than in most of the OECD countries (Table 3). In 2017, occupational pension plans covered only 2.5% of the working population (defined

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[13] The monthly remuneration is the same considered as a contribution base for mandatory social security system (previdential system).
[14] Closed: have one sponsor or in the case of having more than one, all the sponsors share a business, professional or association.

as those aging between 15 and 64 years). DB schemes represent 92% of the assets under management, as it is presented on the figure 2. Additionally, most of the contributions are done by employers. This huge relevance of DB in comparison with DC has historical precedence as it was the most common type of plan offered when pension funds started and has been accumulating contributions for several years. However, there is a downward trend of the relative significance of DB pension plans. Much explained by the fact that most DB pension plans are now closed to new entrances due to difficulties in managing their inherent risks and to keep the funding costs under control. As displayed by figure 4, the number of DC plans are increasing each year while the number of DB plans is remaining stable.

The average contribution level is quite different between DB and DC in occupational schemes. In 2017, the average contribution per active DB member represented more than half of the Portuguese annual average wage[15]. For DC schemes this was about 5% (OECD, 2019a). Possible explanations for this disparity may come from the projected unit credit (PUC) funding method[16] and the annual decreases in the discount rates used to value the liabilities. PUC implies the recognitions of annual actuarial loses regarding the past years of service, requiring higher contributions than the normal annual cost to keep the value of the funding level, whilst DC plans are funded by nature, as they transfer the major risks to the participants. So, the membership tendency is not followed by the same shift on the amount of record contributions as it is displayed on figure 3.

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[15] Average annual wages per full time-time and full-year equivalent employee in the total economy. Obtained by dividing the national account-based total wage bill by the average number of employees in the total economy, then multiplied by the average of weekly hours per full-time employee.
[16]The Projected Unit Credit funding method is the method used to set the funding requirements on the majority of the DB pension schemes.

Table 3: Voluntary pension plan coverage rates in selected OECD countries

	Occupational	Personal	Total
Czech Republic	x	52.6	52.6
Denmark	x	18	18
Estonia	x	12.3	12.3
Finland	6.6	19	25.6
France	24.5	5.7	..
Germany	57	33.8	70.4
Greece	1.3	..	..
Hungary	..	18.4	..
Iceland	x	45.2	45.2
Ireland	38.3	12.6	46.7
Italy	9.2	11.5	20
Japan	45.4	13.4	50.8
Korea	x	24	24
Latvia	0.3	11.4	..
Lithuania	..	..	69.5
Luxembourg	5.1	..	..
Netherlands	x	28.3	28.3
New Zealand	6.8	74.8	..
Norway	..	26.7	..
Poland	1.6	66.6	..
Portugal	2.5	14.7 - 17.2	17.2
Slovak Republic	x	19	19
Slovenia	7	..	37.8
Spain	..	..	26.1
Sweden	X	24.2	24.2
United Kingdom	..	..	43
United States	40.8	19.3	..

Source: OECD Pension Markets in Focus 2018 (Lithuania and Spain); ASF (Portugal occupational plan coverage). *Instituto Nacional de Estatística* (Portugal personal plan coverage). OECD Pensions at a Glance 2017 (all other countries). Coverage rate being the number of active members of a pension plan over the working age population (i.e. individuals aged 15 to 64 years old).

Figure 2: Contributions to occupational plans by type. 2010-2017

Real contributions to occupational plans by type in millions of EUR (2017 EUR).
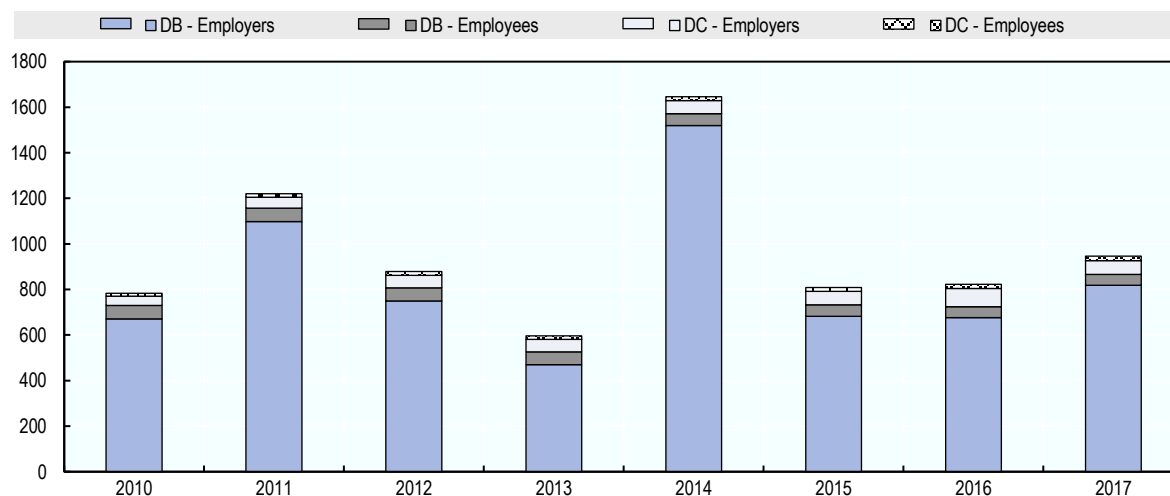
Note: Figures are expressed in real terms, deflated using average gross wage.

Source: ASF.

Figure 3: Occupational pension plans – contributions and membership

Share of occupational plan membership   Share of occupational plan contributions
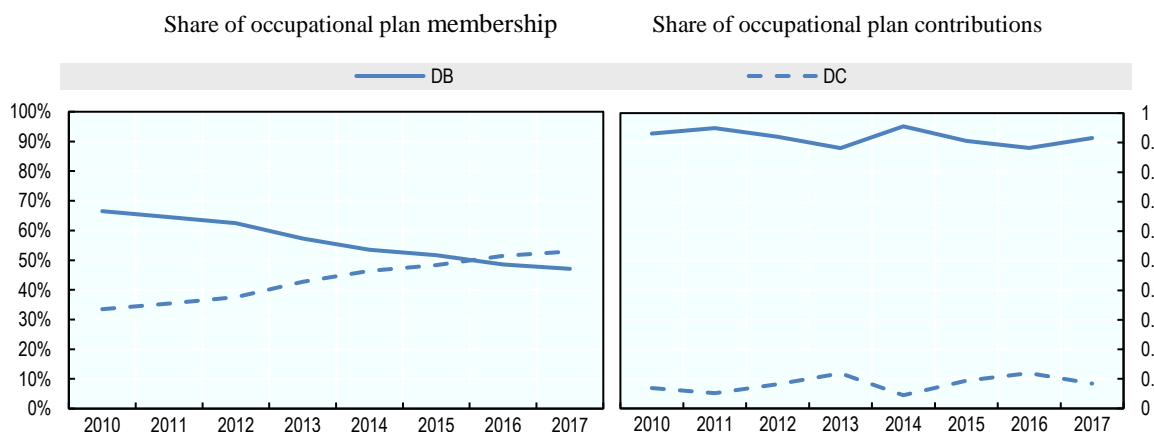
Source: ASF publications of Estatísticas de Fundos de Pensões (Membership); ASF (contributions).

Figure 4: Number of professional pension plans by type of plan
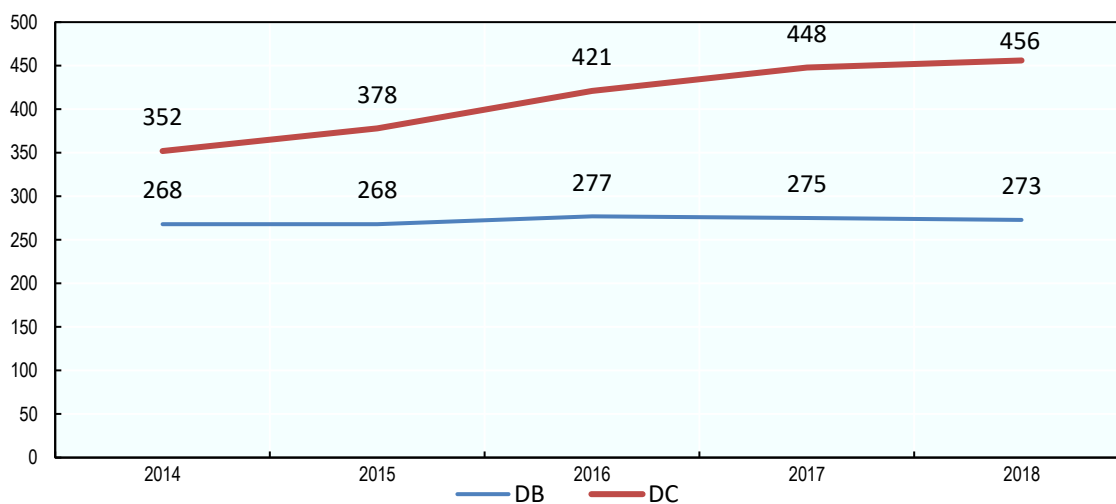
Source: Annual report of insurance sector of 2018.

2.2.2.2. Personal pension plans.

The most common type of personal pension plans in Portugal are called *Planos de Poupança Reforma* (PPR). PPR are pension schemes of individual membership that can be funded by three types of saving vehicles: i) insurance contracts (84% of accounts), it has this relevance because it has been seen appealing for their prudent risk profile, as well as, for their guaranteed capital returns; ii) investment funds (13% of accounts) and iii) pension funds (3% of accounts) according to the (ASF, 2019a).

Regarding contributions, the numbers of personal plan accounts shrunk with the beginning of the last financial crisis in 2010 (figure. 5). The contribution level was also hit by the financial crisis and fell similarly. Notwithstanding, PPR insurance contract rate of contribution, (as previously mentioned represents most of the contributions made) has been recovering since then. The average contribution over the period 2015 - 2017 vary between 6% - 8.5% of the average annual wage in the economy (OECD, 2019a).

Figure 5: Number of personal plan accounts. 2000-2017
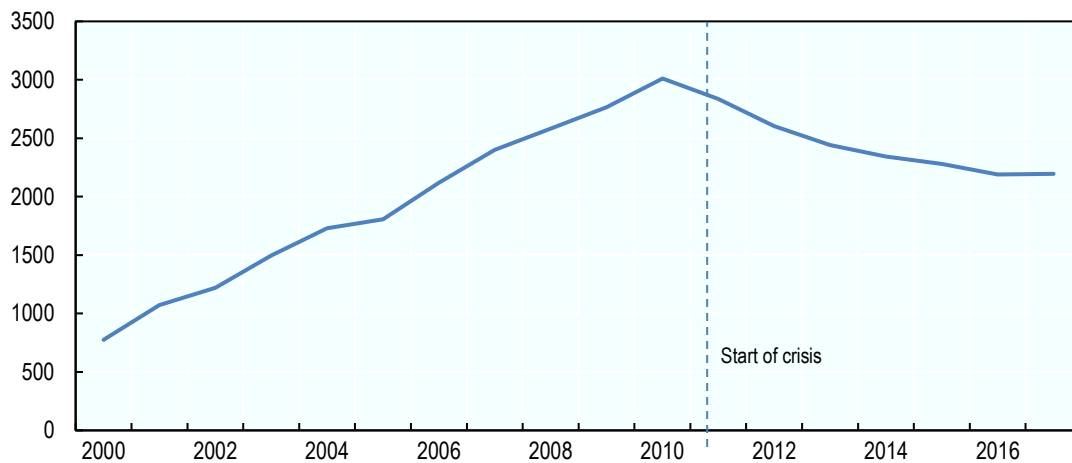
Source: OECD Reviews of Pension Systems Portugal.

3. Portuguese pension funds asset allocation and tax

In this chapter we will show how the pension funds assets are being invested, what has been the past returns achieved, and how are individual's contributions to pension funds taxed. The goal is to show that the complementary system allows for some tax reliefs and other benefits that make them more competitive when compared to other investment options and to forecast a credible annual rate of return.

3.1.   Pension fund assets.

Pension fund assets in the OECD area declined in 2018, inverting a tendency of sustainable growth since the last financial crisis. For that year, real investments rates of return of pension plans were negative in 3.2% on average. These losses were verified in 26 out of 31 reporting OECD countries and in Portugal was not different, which verified a negative annual variation of 1.8%. Nevertheless, 2018 was an outlier in the upward trend, as in 2019 nominal rate of investment was 3.32% (ASF, 2019b).

The decline in assets as a percentage of GDP verified on table 4 was a consequence of the negative real investment returns in most countries. Furthermore, the relevance of pension assets as a percentage of GDP is significantly lower in Portugal than in many other OECD countries, which may be due to the "pension generosity" of the social security system and to the high old-age dependency ratio as it is negatively associated with private savings according to Amaglobeli et al. (2019).

The limited development and the low penetration of private pension schemes lead some international institutions (i.e. IMF) to recommend enhancing the equity of the public pension system and curbing the growth of the social security deficits, which can be achieved by reducing the accrual rates for the largest earning brackets to make the average gross replacement rate more convergent to EU average levels (IMF, 2019). This would have the collateral effect of encouraging higher earners to save through private pension schemes (IMF, 2019).

Table 4: Total assets in funded and private pension plans, as % of GDP, 2008-2018

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
OECD countries											
Australia	96.7	84.8	91.7	94.5	93.3	104.1	111.7	121.6	124.2	135.5	140.7
Austria	4.3	4.9	5.1	4.8	5.1	5.6	5.8	6.0	5.9	6.0	5.5
Belgium	3.2	4.0	3.6	4.1	4.5	5.0	5.7	5.9	6.8	12.2	10.9
Canada	102.3	114.5	123.5	123.7	126.6	134.5	142.3	154.8	157.4	159.5	155.2
Czech Republic	4.8	5.5	5.9	6.1	6.7	7.3	7.9	8.1	8.4	8.8	9.2
Denmark	147.0	159.4	171.4	180.9	190.0	185.5	202.6	200.8	205.5	205.7	198.6
France	6.1	8.0	8.5	8.4	8.8	9.3	8.7	8.9	10.3	10.7	10.4
Germany	4.6	5.3	5.4	5.5	6.1	6.1	6.6	6.6	6.8	6.9	6.9
Ireland	33.8	42.4	45.0	42.3	46.0	50.9	57.7	42.7	37.6	35.9	33.9
Italy	3.9	4.8	5.3	5.7	6.6	7.4	8.3	8.6	9.3	9.7	9.8
Japan	27.9	29.5	28.6	29.2	29.8	30.2	31.2	30.6	29.3	28.8	28.3
Mexico	10.8	12.6	13.5	13.6	14.9	15.6	16.5	16.3	16.1	16.8	16.2
Netherlands	103.6	108.8	118.9	125.4	142.7	146.6	157.2	168.6	182.2	184.3	173.3
Norway	5.9	7.2	7.5	7.2	7.4	8.1	8.8	9.7	10.2	10.5	9.8
Poland	10.9	13.3	15.6	14.7	17.0	18.7	9.6	8.8	9.2	10.1	8.5
Portugal (1)	12.2	13.3	11.8	8.1	9.2	9.5	10.7	10.9	10.7	19.5	19.3
Slovak Republic	4.6	6.2	7.2	8.2	9.4	9.7	10.4	10.2	11.1	11.8	11.7
Slovenia	3.8	5.0	5.8	6.0	6.3	6.4	6.8	6.9	7.0	7.0	6.8
Spain	11.3	12.4	12.4	12.5	13.2	14.1	14.6	14.3	13.9	13.5	12.5
Sweden	54.5	52.3	53.3	60.6	66.5	68.0	75.3	75.2	80.4	90.6	88.0
Switzerland	89.7	101.6	102.0	100.7	107.4	126.8	134.1	135.3	140.0	149.2	142.4
United Kingdom	61.3	73.1	81.2	87.8	94.6	96.9	96.7	97.6	107.6	108.3	104.5
United States	94.7	112.1	119.7	116.5	123.2	135.6	136.7	131.8	135.5	146.0	134.4

Note: Note: The total amount of investments of providers of funded and private pension plans is taken as a proxy of the total amount of assets in funded and private pension plans. (1) The drop of investments in 2011 is the result of the transfer of part of the liabilities of bank pension funds (i.e. pension funds sponsored by banks and having as beneficiaries their employees) to the Public Retirement System. Data cover closed and open pension funds and personal retirement saving funds (established as pension funds or as collective investment schemes managed by investment companies), and since 2017 personal plans offered by life insurance companies as well, which explain the huge increase observed in 2017.

Source: OECD Global Pension Statistics.

3.2. Asset allocation.

Portuguese pension funds' investments are relatively conservative compared to other OECD countries. In 2018 the investments were made predominantly on bills and bonds, assuming 77.86% of the portfolio for the public pension scheme's accumulation phase (IGFCSS, 2019), and 70.7% of the portfolio of funded private pension schemes (OECD, 2019b).

3.3. Private pension scheme Performance.

According to OECD (2019a) the average annual rate of nominal returns of private pension schemes were 3.7% and 2.2% in real terms in the past 15 years (Table 5). However, there were periods of negative returns because of the Portuguese crisis as well as the global financial crisis in 2008.

Table 5: Nominal and real geometric average annual investment rates of return of pension assets, net of investment expenses, over the last 5 and 10 years, at 31/12/2018.

Selected OECD countries	Nominal			Real		
	5-year annual average	10-year annual average	15-year annual average	5-year annual average	10-year annual average	15-year annual average
Australia	8.7	6.6	7.3	6.7	4.4	4.7
Austria	2.7	3.8	3.1	1.2	1.9	1.2
Belgium	4.3	6.0	5.3	2.8	4.1	3.3
Canada	6.5	7.5	6.6	4.7	5.7	4.8
Chile	6.5	7.4	6.7	3.1	4.7	3.3
Czech Republic	0.8	1.4	2.1	-0.5	-0.1	0.0
Denmark	4.9	5.9	5.8	4.2	4.6	4.2
Estonia	2.3	4.2	2.6	0.7	2.2	-0.7
Germany	3.5	3.9	4.0	2.5	2.7	2.5
Israel	4.1	7.1	..	4.2	5.8	..
Italy	2.2	3.2	3.2	1.7	2.0	1.7
Korea	3.6	4.1	4.0	2.3	2.2	1.7
Latvia	1.5	3.6	2.8	0.0	2.2	-1.0
Lithuania	3.1	..	..	1.7	..	..
Luxembourg	2.5	3.7	..	1.5	2.0	..
Mexico	4.2	6.4	..	0.0	2.3	..
Netherlands	6.1	7.7	6.1	4.9	6.0	4.4
Norway	4.9	6.2	5.9	2.3	4.0	3.7
Portugal	2.8	3.3	3.7	2.2	2.2	2.2
Slovak Republic	1.8	1.7	..	1.1	0.4	..
Slovenia	5.0	5.1	..	4.3	3.8	..
Spain	2.2	3.4	..	1.6	2.1	..
Switzerland	3.1	4.2	3.3	3.1	4.2	2.9
Turkey	9.8	9.5	..	-1.5	0.1	..

Note: This Table is based on the annual nominal and real net investment rates of return reported in the statistical annexes of this publication. The 5, 10 and 15-year annual averages are calculated over the periods Dec 2013-Dec 2018, Dec 2008-Dec 2018 and Dec 2003-Dec 2018 respectively, except for Australia (June 2013-June 2018, June 2008-June 2018 and June 2003-June 2018).
Source: OECD Global Pension Statistics.

3.4. Tax treatment of retirement saving funded pension plans

Most of the European countries offer a tax exemption[17] to stimulate savings for retirement. There are two types of tax exemption:

i) "Taxed-Taxed-Exempted" (TTE), being contributions and returns from investments taxed at the moment they occur, and the future benefits received from the pension fund exempted. Most of OECD countries have this type of tax exemption.

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[17] A tax exemption is the monetary exemption of persons, property, income, or transactions from taxes that would otherwise be levied on them.

ii)   "Exempted-Exempted-Taxed" (EET), known as tax-deferred, being contributions and investment returns exempted from taxation at the moment they occur, and the benefits received from the pension fund taxed. With this type of tax exemption, taxes are just deferred to a later date.

Many countries across Europe, including Portugal, have a complex tax regime regarding the type of contributions (mandatory or voluntary) and contribution source (employer or individual). In Portugal, regarding the employer's contribution to pension funds, we find a variant of "EET" along with a tax system incentive for individual's contributions, as most OECD countries have.

3.4.1. Taxation of employer's contributions

Employers' contribution to an occupational pension fund that grants vested rights to their employees, can benefit from a tax exemption if all the following requirements are met:

- All permanent workers of the company must be enrolled in the pension plan and the benefits must be established in accordance with an objective criterion that applies to all workers;
- At the time of retirement, at least two thirds of the benefits must be paid as monthly annuity;
- The pension plan must provide, exclusively, benefits in case of old-age retirement, early retirement, pre-retirement, post work health benefits, disability or death benefits and follows the general social security rules in what concerns the age to access the benefits and the possible beneficiaries;
- The pension funds must be set following the Portuguese legislation or managed by institutions for occupational retirement provision to which Directive 2003/41 / EC of the European Parliament applies;
- The total annual contributions made by the employer can't exceed 15% of the annual total costs with wages and salaries;

Following all the above conditions, we may find different situations:
- the employer's contributions are performed to an employee's individual account with vested rights, then the employer's contributions are considered as expenses or as work income. So, those contributions are tax deductible from the employer's taxable profits.

The employer's contributions are not considered as a taxable income of the employees, until the moment the employee or its beneficiary withdraws its pension benefit.

- If the employer's contributions are not performed to an employee's individual account (as is the case of the DB pension plans) or did not grant vested rights, then the employer's contributions can be deducted as a cost with social utility services and the employee will be subjected to taxation only when pension benefit withdrawal occurs.

When the above conditions are not met, as in case of employer's contributions to PPR or RPC, the employer's installments will be considered as a taxed income, on the moment the contribution is performed. But the employee may benefit from a tax relief as in the case of individual contributions, which will be presented below in more detail.

3.4.2. Taxation of employer's contributions

The individual contributions to an occupational pension fund, a PPR or a RPC aren't tax-exempt but benefit from a tax relief of 20% of the amount of the annual contribution up to a deduction limit depending on age, on the annual income and on the sum of the values of all tax reliefs that include reliefs coming from health expenses, health insurance, aged care and education as following tables display. Afterwards, when benefits are withdrawn only the capital income part (gains/profit) is subject to taxation with a tax exemption subject to the length of the investment period and the withdraw reason.

Table 6: Deductions limits by scheme type and participant age

	Public scheme	Private schemes
Under 35	400	400
35-50 (inclusive)	350	350
over 50	350	350

Source: AFPFIPP website.

Table 7: Deduction limits by annual collectable income

Collectable income	Limit
Under €7 091	No limit
€7 091 - €80 640 (inclusive)	€1 000 + {(€2 500 - €1 000) x (80 640€ - RC)/(€80 640-€7 091)}
Over €80 640	1000

Source: *Estatuto de Beneficios fiscais.*

For example, an individual aged 30 and with a sum of other tax reliefs equal to 1 600€:

- can deduct 20% of the value of contributions subject to a limit of 400€ if its annual income is below 7 091€.

- can deduct 20% of the value of contributions subject to a limit of 228.84€ if its annual income is of 40 000€.

- cannot benefit for a tax relief if its annual returns are above 80 640€.

4. Case study: Early retirement penalties and DC complement

We are going to carry out the calculations of the future pension entitlements for early retirees under today's framework legislation. We will take three different participants and consider to each of them three distinct wage levels: the national minimum wage, the economy-wide average wage and two times the economy-wide average wage. This will broaden our analysis of future income in old-age for different type of workers allowing to assess the efficacy of the existing means-tested benefits (differentiate workers by income level). We assume that after starting to contribute to SS the participants have no careers breaks along the way.

The participants under scope have joined the public system with age 20, 22 and 25 and their current age are 20, 40 and 50, they are named participant 1, 2 and 3, respectively.

Accordingly, with the eligibility conditions to be able to access an early retirement pension the beneficiary will need to have at least 60 years old and a minimum of 40 years of relevant contributions. So, the eligibility demands our participants to have 60 years, 61years and 4 months and 64 years and 4 months, respectively, to be able to access an early retirement pension.

Regarding the voluntary DC pension plan, participants 2 and 3 join the scheme in 2020 and participant 1 is assumed to join in 2030. The major reason for this assumption is the life cycle theory, stating that in theory savings takes place in middle-age when earnings are high and demand for precautionary savings increase (Deaton, 2005). The next table summarizes the participant's data, presenting their personal NRA forecasted according to the Law n.º 119/2018 and the country-specific United Nations (UN) evolution of the life expectancy at 65.

Table 8: Participants information

Participant	Date of birth	Current age	Date of joining the public scheme (joining age)	Date of joining the DC pension plan (joining age)	Earliest early retirement age	Personal NRA
Type 1	01/01/2000	20	01/01/2020 (20 years old)	01/01/2030 (30 years old)	60 years	67 years and 2 month
Type 2	01/01/1980	40	01/01/2002 (22 years old)	01/01/2020 (40 years old)	61 and 4 months	66 years and 7 months
Type 3	01/01/1970	50	01/01/1995 (25 years old)	01/01/2020 (50 years old)	64 and 4 months	66 years and 9 months

Source: Performed by the author.

Our goal is to foresee the individual contributory effort to a voluntary DC pension plan that would fully mitigate the inherent penalties of retiring before the personal NRA. Thus, we aim to find the contributions rate, expressed as a percentage of the annual wage, that will allow each participant to have access to an old-age pension at the earliest retirement age, keeping the same expected replacement ratio as if he/she retires at his/her personal NRA.

In order to find the contribution rate mentioned earlier, some economic and demographic assumption needs to be taken.

4.1. Economic and demographic assumptions

Economic growth, wage growth and inflation will affect the level of the benefit, so assumptions regarding these economic variables have been set. To catch up on those factors, we'll set the assumptions values based on the average of the past data of the last 15 years and those taken in OECD report assumptions (i.e. "OECD Reviews of Pension Systems: Portugal"). This will be our base scenario. Additionally, we'll assume that individual earnings grew in line with the economy-wide average. This means that the individual remains at the same point in the earnings distributions throughout the contributory period.

Baseline assumptions:

- Annual real rate of return after fees on funded pension plans: 2.73%. This value reflects the average of annual real net rate of investment returns of funded and private pension operating in Portugal, during the period 2003-2018, according to OECD (2013c) and (2019b).

- Annual inflation: 2%. National central banks' monetary policy target for inflation is 2%. OECD also uses this rate in its pension benefit calculation. Although, inflation is currently quite lower than that. Notwithstanding, we see it as a conservative approach.

- Annual nominal rate of return net of fees on funded pension plans: 4.73%. It is the sum of the preceding two factors.

- Annual wage growth: 3%. It is the value considered in many OECD reports (i.e. OECD Reviews of Pension Systems Portugal), so, it seems reasonable to have the same assumption for the calculations. Meaning that the annual real wage increases is assumed at 1%.

- Discount rate (for actuarial calculations), in the light of actuarial fairness, which requires that the present value of lifetime contributions equals the present value of lifetime benefits (Queisser and Whitehouse, 2006). The nominal rate of return is the

market rate of return on investment under the period in scope and, therefore, is the benchmark for assessing actuarial fairness.

- Annual revalorization of social security reference wages: 2.25%. These corresponds to 75% of the annual inflation rate plus 25% of the annual wages increases (DL – n. º 187/2007, art. 27º).

The demographic assumptions relevant to the scope of this work are the mortality table and the life expectation improvements based on country-specific from United Nations (UN)/World Bank population database 2100. Estimates, 1950 – 2020.

- LE – Life expectancy at exact age, e(x), for both sexes combined, by region, subregion and country, 1950-2100.
- Mortality table - Life table survivors at exact age, l(x), for both sexes combined, by region, subregion and country, 1950-2100.

Table 9: Baseline Scenario

Parameters	Value
Inflation	2%
Nominal-wage growth	3%
Real-wage growth	1.00%
Nominal rate of return	4.73%
Real rate of return	2.73%

Source: Performed by the Author.

4.2. Participants analysis

4.2.1. Participant type 1: Impact of an early retirement

The expected value of the old-age pensions were computed considering the Law n. º 187/2007 and its successive legislative amended and the baseline assumptions mentioned earlier.

The participant 1 may have access to the early retirement option at 60 years old, and at that age, the expected replacement ratio before the penalty will vary between 74.17% - 77.71% depending on his/her current annual wage. As displayed on the next table, a participant type 1 with an annual wage equal to two times the annual national average salary has a lower RR than a participant type 1 with a wage equal to the annual national average salary. That reflects the means-tested implied in the old-age pension DB formulae.

The law n. º 119/2018 ends the applicability of the SF for this participant, when it verifies the simultaneous condition of completing 40 years of relevant contributions and having at least 60

years old. However, it is still in place a 0.5% penalty per anticipated month regarding his/her personal NRA, the calculated penalty is 43.0% once his/her projected NRA is at 67 years and two months. What decreases the RR to 42.28% – 44.29%, depending on the participant current level of annual wage.

Table 10: Participant type 1 replacement ratio

	Replacement rate* without penalty	Penalty - 0.5% per anticipated month relatively to the personal NRA	Replacement rate*
Minimum wage **	77.71%	43.0%	44.29%
Average wage	76.41%	43.00%	43.56%
Two times average wage	74.17%	43.00%	42.28%

Note: * relative to the last monthly salary.

Source: Performed by the Author.

The final RRs are much lower than participants' last annual salary. The drop narrows the possibility of accessing this option without any back-up savings, pointing out that this is a best-case scenario (i.e. for someone starting his work life nowadays) because the penalty resulting from the SF is not applied.

4.2.2. Participant type 1: Target contribution rate for the DC pension plan

To widen up the retirement under this option, it was assumed to be set a DC pension plan at the age of 30, in 2030, with the contributions rate defined to target a benefit (TB) equal to the expected loss on the RR coming from the application of the early retirement penalty.

To find the value of the required contribution rate α the following formula is applied:

Equation 3: Expected Contribution rate

$$\alpha = \frac{TB_{IR} \times a^*_{IR} \times (1+i)^{-(IR-x)}}{W_x \times \ddot{a}_{\overline{IR-x}|\,i,j}} \quad (3)$$

Where IR is retirement age, x is participant's age, TB_{IR} is target benefit at retirement age , W_x is wage at age x and $\ddot{a}_{\overline{IR-x}|\,i,j}$ is (IR - x) years term annuity-due , a^*_{IR} is whole life annuity , i is nominal rate of return and j is annual wage growth.

The whole annuity values at retirement age were computed considering a nominal rate of return of 4.73% and Portugal's UN mortality table projections through the following formula:

Equation 4: Whole life annuity

$$\ddot{a}_x = 1 + v\,P_x + v^2\,{}_2P_x + v^3\,{}_3P_x + \ldots = \sum_{t=0}^{\infty} v^t\,{}_tP_x \quad (4)$$

Where, ${}_tP_x = \frac{l_{x+t}}{l_x}$; ${}_tP_x$ is the survival probability of being alive at age x and surviving until the age of x + t, and l(x) is life survivors at exact age of x, $v = \frac{1}{1+i}$, the discount rate i is the nominal rate of return.

For this participant, the required contributions rates are 12.08%, 11.44% and 11.10% depending on his/her annual wage level as one can see on table 11. Given the high contributions rates results, the best-case scenario for this participant would be to join a DC pension scheme once he/she starts working. This will lead to contribution rates to be at around 10%. Although, empirically savings seem to only start in middle age (Deaton, 2005).

Further on our analysis, we identified what is the youngest age to access the early retirement that will allow an individual contribution rate below 8.5% to keep the RR before applying the early penalty. The youngest age is at age 62 plus 4 months, which is still much lower than his/her personal NRA of 67 years and two months, being the required individual contributions rates between 6.62% and 7.21% depending on the annual wage level of the participant.

Table 11: Participant 1 Retirement dates comparison: earliest early retirement date vs. α under 8.5%

Annual Wage Level	Early retirement penalties			α % - annully contribution		
	Earliest early retirement date (age 60y)	Delaying retirement (age 62y + 4m)	Δ	Earliest early retirement date (age 60y)	Delaying retirement (age 62y + 4m)	Δ
Minimum wage	43.00%	29.00%	-32.6%	12.08%	7.21%	-40.3%
Average wage	43.00%	29.00%	-32.6%	11.44%	6.83%	-40.3%
Two times average wage	43.00%	29.00%	-32.6%	11.10%	6.62%	-40.3%

Source: calculated for this study.

4.2.3. Participant type 2 and type 3: Impact of early retirement penalties.

Different from participant 1, participant 2 and 3 already have joined the public scheme and are assumed to join a voluntary DC pension scheme in 2020. To access past contributory career of these participants we assumed their past annual wage were aligned with the past nation's minimum wage, and with the past national average wage. To revalue past wages, the coefficients known for 2020, according the *Portaria n. º 179/2020,* were considered until 2020, afterwards, the baseline scenario was assumed, as displayed on table 10. The participants' current age is 40 and 50, for type 2 and type 3 respectively, and they will be able to access to the early retirement with the age 61 years and 4 months and 64 years and 4 months, respectively. At that age, the RR with no penalty will be between 72.06% - 77.11% and 69.69% - 78.53%, respectively, depending on the annual wage level.

Contrasting with the participant type 1, participants type 2 and 3 will not be able to record 40 years of relevant contributions at the age of 60, which implies that they will suffer an additional penalty coming from the sustainability factor, thus decreasing the early retirement benefit in about 20% for both cases as one can see on the next table. The penalty of 0.5% per anticipated month regarding the personal NRA is 31.5% and 14.5%, respectively. These two penalties will lead to an expected RR between 38.04% - 40.71% and 47.23% - 53.22%, for participant type 2 and 3, respectively depending on their annual wage level.

Table 12: Participant 2 replacement ratio

Annual wage Level	Replacement rate* without penalty (61y and 4m)	Replacement rate* appliying only the SF	Replacement rate* at early retirement with both penalties
Minimum wage**	72.06%	49.36%	38.04%
Average wage	77.11%	52.82%	40.71%
Two times average wage	75.04%	51.40%	39.61%

Note: * relatively to the last monthly salary ** the value of the minimum wage as increased more on the   past than the value of average wage, that is the reason for a lower replacement rate.

Source: Performed by the Author.

Table 13: Participant 3 replacement ratio

Annual Wage Level	Replacement rate* without penalty (64y and 4m)	Replacement rate* applying only the SF	Replacement rate* at early retirement with both penalties
Minimum wage*	69.69%	59.58%	47.23%
Average wage	78.53%	67.14%	53.22%
Two times average wage	76.50%	65.40%	51.84%

Note: * relatively to the last monthly salary. ** the value of the minimum wage as increased more on the past than the value of average wage, that is the reason for a lower replacement rate.

Source: Performed by the Author.

4.2.4. Participant type 2 and 3: Target contribution rate for the DC pension plan

As illustrated by the previous tables, the transitions to an early retirement leads to a huge fall in the income level. So, to cope with the retirement penalties these two participants are assumed to join a voluntary DC pension through the same process defined for participant type 1. The target contribution rates to be set to keep the RR before applying both penalties vary between 18.72% - 20.03% and 18.37% – 20.70% for participant type 2 and 3, respectively, depending on the annual wage level.

Given the high values achieved for the target contribution rates, we have considered the same exercise made for the participant type 1 of finding the lower early retirement age that would allow a target contribution rate below 8.5% to keep the RR before penalties. As displayed on the next two tables, none of the participants in analysis have achieved that target contribution rate, retiring at most one year before their personal NRA. Meaning that in this case the Participants would need to start to fund a personal DC pension plan sooner, if they want to keep the replacement rate before penalties and a target contribution rate below 8.5%, that way increasing their assets accumulation phase period.

Table 14: Participant 2 Retirement dates comparison: earliest early retirement date vs. α under 8.5%

Annual Wage Level	Early retirement penalties			α % - annually contribution		
	Earliest early retirement date (61y+4m)	Delaying retirement (65y+4m)	Δ	Earliest early retirement date (61y+4m)	Delaying retirement (65y+4m)	Δ
Minimum wage	47.21%	29.81%	-36.8%	18.72%	8.81%	-52.9%
Average wage	47.21%	29.81%	-36.8%	20.03%	9.21%	-54.0%
Two times average wage	47.21%	29.81%	-36.8%	19.49%	8.95%	-54.1%

Source: Performed by the Author.

Table 15: Participant 3 Retirement dates comparison: earliest early retirement date vs. α under 8.5%

Annual Wage Level	Early retirement penalties			α % - annually contribution		
	Earliest early retirement date (64y+4m)	Delaying retirement (65y+4m)	Δ	Earliest early retirement date (64y+4m)	Delaying retirement (65y + 4m)	Δ
Minimum wage	32.23%	27.77%	-13.9%	18.37%	14.44%	-21.4%
Average wage	32.23%	27.77%	-13.9%	20.70%	16.23%	-21.6%
Two times average wage	32.23%	27.77%	-13.9%	20.17%	15.80%	-21.7%

Source: Performed by the Author.

4.3. Sensitivity Analysis

With the goal to assess the level of risk and find how dependent is the old-age benefit level on a specific factor we have performed a sensitivity analysis allowing for some changes on the base line assumptions. We started by taking the baseline assumptions, and examined the impact of positive and negative variation of 50 basis points on the factors in use.

Table 16: Sensitivity analysis

Parameters	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
	- Ceteris paribus - Inflation decreases 0.5%	- Ceteris paribus - Inflation increases 0.5%	- Ceteris paribus - Real rate of return decreases 0.5%	- Ceteris paribus - Real rate of return increases 0.5%	- Ceteris paribus - Wage growth decreases 0.5%	- Ceteris paribus - Wage growth increases 0.5%
Inflation	1.5%	2.5%	2.0%	2.0%	2.0%	2.0%
Nominal wage growth	2.5%	3.5%	3.0%	3.0%	2.5%	3.5%
Real-wage growth	1.00%	1.00%	1.00%	1.00%	0.50%	1.50%
Nominal rate of return	4.23%	5.23%	4.23%	5.23%	4.73%	4.73%
Real-rate of return	2.73%	2.73%	2.23%	3.23%	2.73%	2.73%

Source: Performed by the Author.

Scenario 1 results

Table 17: Impact on the Replacement ratio - Baseline scenario vs. Scenario 1

Annual Wage Level	Replacement rate *								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenario 1	Δ	Base scenario	Scenario 1	Δ	Base scenario	Scenario 1	Δ
Minimum wage	77.71%	78.02%	0.40%	72.06%	72.36%	0.43%	69.69%	69.99%	0.44%
Average wage	76.41%	76.71%	0.39%	77.11%	77.43%	0.42%	78.53%	78.87%	0.43%
two times average wage	74.17%	74.44%	0.37%	75.04%	75.34%	0.41%	76.50%	76.82%	0.42%

Note: * without penalty and relatively to the last monthly salary. RR with penalty has the same variation.
Source: Performed by the Author.

Table 18: Impact on the annual contribution rate - Baseline scenario vs. Scenario 1

Annual Wage Level	DC pension plan - α % - annully contribution								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenario 1	Δ	Base scenario	Scenario 1	Δ	Base scenario	Scenario 1	Δ
Minimum wage	12.08%	12.80%	5.92%	18.72%	19.75%	5.52%	18.37%	19.32%	5.18%
Average wage	11.44%	12.12%	5.91%	20.03%	21.13%	5.52%	20.70%	21.77%	5.17%
two times average wage	11.10%	11.76%	5.89%	19.49%	20.56%	5.51%	20.17%	21.21%	5.16%

Source: Performed by the Author.

Scenario 2 results

Table 19: : Impact on the Replacement ratio - Baseline scenario vs. Scenario 2

Annual Wage Level	Replacement rate *								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenario 2	Δ	Base scenario	Scenario 2	Δ	Base scenario	Scenario 2	Δ
Minimum wage	77.71%	77.41%	-0.39%	72.06%	71.75%	-0.42%	69.69%	69.39%	-0.43%
Average wage	76.41%	76.12%	-0.39%	77.11%	76.79%	-0.42%	78.53%	78.19%	-0.43%
two times average wage	74.17%	73.89%	-0.37%	75.04%	74.73%	-0.41%	76.50%	76.17%	-0.42%

Note: * without penalty and relative to the last monthly salary. RR with penalty has the same variation.
Source: Performed by the Author.

Table 20: Impact on the annual contribution rate - Baseline scenario vs. Scenario 2

Annual Wage Level	DC pension plan - α % - annully contribution								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenario 2	Δ	Base scenario	Scenario 2	Δ	Base scenario	Scenario 2	Δ
Minimum wage	12.08%	11.43%	-5.41%	18.72%	17.77%	-5.07%	18.37%	17.50%	-4.78%
Average wage	11.44%	10.82%	-5.41%	20.03%	19.01%	-5.06%	20.70%	19.72%	-4.77%
two times average wage	11.10%	10.51%	-5.39%	19.49%	18.51%	-5.05%	20.17%	19.21%	-4.76%

Source: Performed by the Author.

Scenario 1 and 2 – ceteris paribus – decrease/increase inflation factor in 50 basis points and comparing against the base scenario. These variations show none or very small differences among the wage levels and participants.

The increase (decrease) of inflation has negative (positive) effects in the nominal-wage growth factor, decreases (increases) from 3% to 2.5% (3.5%), however, do not affect the real-wage growth factor, remaining constant at 1%. Analysing replacement ratios results from both scenarios, DB formulae seem to be inflation-adjusted, this might be achieved through SSI and RE parameters where it evolves in line with inflation, fully and partially (75%), respectively. Another factor analysed is the contribution rates to DC plans. Scenario 1 and 2 project an increase/decrease of this factor for all participants and wage levels, respectively. Inflation affects nominal rates of return, as a consequence, this will affect the expected savings rates to achieve the TB at retirement, as we can see at formula 3 where most of the factors includes the nominal rate of return.

Scenario 3 results

Table 21: Impact on the annual contribution rate - Baseline scenario vs. Scenario 3

Annual Wage Level	DC pension plan - α % - annully contribution								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenario 3	Δ	Base scenario	Scenario 3	Δ	Base scenario	Scenario 3	Δ
Minimum wage	12.08%	13.08%	8.25%	18.72%	19.80%	5.76%	18.37%	19.08%	3.86%
Average wage	11.44%	12.38%	8.25%	20.03%	21.18%	5.76%	20.70%	21.50%	3.86%
two times average wage	11.10%	12.02%	8.25%	19.49%	20.61%	5.76%	20.17%	20.95%	3.86%

Source: Performed by the Author.

Scenario 4 results

Table 22: Impact on the annual contribution rate - Baseline scenario vs. Scenario 4

Annual Wage Level	DC pension plan - α % - annully contribution								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenario 4	Δ	Base scenario	Scenario 4	Δ	Base scenario	Scenario 4	Δ
Minimum wage	12.08%	11.15%	-7.74%	18.72%	17.69%	-5.50%	18.37%	17.69%	-3.73%
Average wage	11.44%	10.56%	-7.74%	20.03%	18.93%	-5.50%	20.70%	19.93%	-3.73%
two times average wage	11.10%	10.25%	-7.74%	19.49%	18.42%	-5.50%	20.17%	19.41%	-3.73%

Source: Performed by the Author.

Under these two scenarios, only real rate of return factor is at test, having a negative/positive variation of 0.5 percentage points, keeping all other factors unchanged. This change does not affect the value of the participant's pension entitlements, but certainly affect the DC pension plan. As mentioned before, DC plans are by nature fully funded, that is, the market value of plan's assets equals the liability of the sponsor to the plan's beneficiaries (Bodie et al., 1988). Here the nominal rate of return decreases/increases as much as scenario 1 and 2, respectively. Assuming 4.23% for scenario 1 and 3, and 5.23% for scenario 2 and 4. Looking at the positive/negative variation of the real rate of return (scenario 3 and 4) and as illustrated on previous tables, these scenarios have much more pronounced effects on savings rates than inflation's scenarios. What can lead us to conclude that the investment performance of the pension fund is the major source of risk to the participants (Bodie et al., 1988).

Scenario 5 results

Table 23: : Impact on the Replacement ratio - Baseline scenario vs. Scenario 5

Annual Wage Level	Replacement rate *								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenaro 5	Δ	Base scenario	Scenaro 5	Δ	Base scenario	Scenaro 5	Δ
Minimum wage	77.71%	83.45%	7.39%	72.06%	76.18%	5.72%	69.69%	72.68%	4.30%
Average wage	76.41%	82.12%	7.46%	77.11%	81.69%	5.94%	78.53%	82.02%	4.45%
two times average wage	74.17%	79.87%	7.69%	75.04%	79.56%	6.03%	76.50%	79.94%	4.50%

Note: * without penalty and relatively to the last monthly salary. RR with penalty has the same variation.
Source: Performed by the Author.

Table 24: Impact on the annual contribution rate - Baseline scenario vs. Scenario 5

Annual Wage Level	DC pension plan - α % - annully contribution								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenaro 5	Δ	Base scenario	Scenaro 5	Δ	Base scenario	Scenaro 5	Δ
Minimum wage	12.08%	12.01%	-0.62%	18.72%	18.71%	-0.06%	18.37%	18.46%	0.48%
Average wage	11.44%	11.38%	-0.55%	20.03%	20.06%	0.15%	20.70%	20.83%	0.63%
two times average wage	11.10%	11.07%	-0.34%	19.49%	19.54%	0.24%	20.17%	20.30%	0.68%

Source: Performed by the Author.

Scenario 6 results

Table 25: : Impact on the Replacement ratio - Baseline scenario vs. Scenario 6

WAnnual Wage Level	Replacement rate *								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenario 6	Δ	Base scenario	Scenario 6	Δ	Base scenario	Scenario 6	Δ
Minimum wage	77.71%	72.54%	-6.66%	72.06%	68.23%	-5.32%	69.69%	66.85%	-4.07%
Average wage	76.41%	71.23%	-6.78%	77.11%	72.86%	-5.51%	78.53%	75.22%	-4.21%
two times average wage	74.17%	69.01%	-6.96%	75.04%	70.84%	-5.59%	76.50%	73.24%	-4.26%

Note: * without penalty and relatively to the last monthly salary. RR with penalty has the same variation.
Source: Performed by the Author.

Table 26: Impact on the annual contribution rate - Baseline scenario vs. Scenario 6

Annual Wage Level	DC pension plan - α % - annully contribution								
	Participant type 1			Participant type 2			Participant type 3		
	Base scenario	Scenario 6	Δ	Base scenario	Scenario 6	Δ	Base scenario	Scenario 6	Δ
Minimum wage	12.08%	12.16%	0.65%	18.72%	18.72%	0.04%	18.37%	18.28%	-0.49%
Average wage	11.44%	11.50%	0.51%	20.03%	20.00%	-0.17%	20.70%	20.57%	-0.63%
two times average wage	11.10%	11.14%	0.32%	19.49%	19.44%	-0.25%	20.17%	20.03%	-0.68%

Source: Performed by the Author.

These two scenarios – ceteris paribus – only have changed the real-wage growth factor in negative/positive 0.5 percentage points. Consequently, both scenarios have small impacts on savings rates, however, do have effects in the RRs. Scenario 6 rises the real-wage factor to 1.5%, consequently, nominal-wage growth factor increases to 3.5% as inflation remains constant. This will reduce the RR for all wage level, although, the minimum wage level has a slightly smaller decrease. Scenario 5 has declined the real-wage growth factor in the same level

and as illustrated on previous tables, results are similar, but in the opposite direction. Social security provides DB pension benefits, and this is defined in nominal terms through reference earnings. So, as illustrated in scenario 6, real wage growth has increased by 0.5 percentage points. Despite what we would first think, this imposes a real loss on participants, relative to their last working salary. These results are in line with OECD report (i.e. "OECD Reviews of Pension Systems: Portugal") and what was earlier mentioned in this paper (an increase of this factor leads to lower pensions).

9. Conclusion

As observed earlier in this paper, in the context of ageing, Portugal's past government has introduced many legislative amendments to the social security previdential system, mainly focusing on improving the financial sustainability. In the light of actuarial neutrality[18], the public system has linked retirement to life expectancy gains and penalises early retirements, as demonstrated by the decrease of the replacement ratio, this plays an important role. For the cases in analysis, it decreases permanently pensions around one-third and one-fifth for participant type 1 and 2, and participant type 3, respectively. Leading in all cases to replacement rate under 50% relative to the last working salary.

The points to highlight are: these "cutbacks" have been put into force among all OECD countries with demographic developments issues, and the so-called financial sustainability of the system is yet not ensured (OECD, 2019a), therefore, younger workers might be at some level of risk, once, on one side, have not acquired much pension rights and, on the other one, actuarial neutrality is under government considerations, especially for early retirements.

While these reforms are implemented in the public system, private funded schemes have been under scope by the Portuguese government. As mentioned, proper legislation has been introduced towards the development of this sector by having all the regulatory framework needed. Several private companies operate in this sector along with the government offering Defined Contribution pension plans. That way not only the Portuguese government but also several others try to offset these "cutbacks" (Bodie et al., 1988).

In the context of increasing the individual responsibility for the income adequacy of retirement income. The projections carried out have demonstrated that it is possible to create a DC plan to achieve a specific target to fully mitigate those penalties in force, in case of early retirement. Participant 1 shows expected savings rates of 12%, verifying small variations among salary levels in analysis, while participant 2 and 3 around 20%, and smaller in about 2% in the case

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[18] It is defined as a marginal concept which deals with the effect of working one additional year. It requires that the present value of accrued pension benefits for working one additional year is the same as in the year before (meaning that benefits increase only by the additional entitlement earned in that year). Conversely, retiring one year earlier should reduce the pension amounts both by the entitlements that would have been earned during that year and by the longer duration for which the pension must be paid.

were earns are in line with the national minimum wage. It is important to mention that we've found the average rate contribution to the complementary system was 6% - 8.5% between 2015 – 2017 (OECD, 2019a) in Portugal. Then, all the participants in analysis must contribute more than the average contribution, with especial attention to participant type 2 and 3 where savings rates should be between 2 and 3 times the average rate contribution. Additionally, results demonstrate no much difference among wage levels but do show among the participants in analysis. Nevertheless, the design of the DC pension plan is flexible enough to cope with an individual's retirement benefit targets.

The results show explicitly that DC plan fund growth is related to expected return and annuity rate and the length of the investment period, subject to the simple insight that an amount invested at an earlier stage compounds for longer than an amount invested later. Therefore, participant 1 has the lowest expected savings rates and also can take advantage of the flexible design of DC plans, demonstrated by setting the contribution rate interval that allows for an early retirement still. So, it is key to start contribution in early ages.

Sensitivity analysis demonstrates the specificities of Social Security scheme, replacement rates, relative to the last working salary, are not much sensitive to changes in inflation. This was assessed by scenario 1 and 2, where inflation – ceteris paribus – decreases/increases by 0.5% and RR have verified very small changes. Another point is when there is an increase of the real-wage factor (scenario 6), the replacement rate relative to the last salary will decrease. These results are related with macro-economic balances of the system (OECD, 2019a). The results from scenario 1, 2, 5 and 6 demonstrate that the benefit level is price-indexed whether than wage-indexed. Also, it reveals that the main source of uncertainty is the real rate of return, scenario 3 and 4 have highest and lowest expected contribution rates, when this factor decreases or increases, respectively.

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Appendix

Table 27: NRA improvements

Year of retirement (n)	NRA
2020	66 years and 7 months
2021	66 years and 8 months
2022	66 years and 9 months
2023	66 years and 10 months
2024	66 years and 11 months
2025	66 years and 12 months
2026	67 years and 0 months
2027	67 years and 1 months
2028	67 years and 2 months
2029	67 years and 3 months
2030	67 years and 3 months
2031	67 years and 4 months
2032	67 years and 5 months
2033	67 years and 6 months
2034	67 years and 6 months
2035	67 years and 7 months
2036	67 years and 8 months
2037	67 years and 9 months
2038	67 years and 9 months
2039	67 years and 10 months
2040	67 years and 11 months
2041	67 years and 11 months
2042	68 years and 0 months
2043	68 years and 1 months
2044	68 years and 2 months
2045	68 years and 2 months
2046	68 years and 3 months
2047	68 years and 4 months
2048	68 years and 4 months
2049	68 years and 5 months
2050	68 years and 6 months
2051	68 years and 6 months
2052	68 years and 7 months
2053	68 years and 8 months
2054	68 years and 8 months
2055	68 years and 9 months
2056	68 years and 10 months
2057	68 years and 11 months
2058	68 years and 11 months
2059	68 years and 12 months
2060	69 years and 1 months

Source: Performed by the Author.

Table 28: Sustainability Factor for each year

Year of retirement (n)	Sustainability Factor
2020	0.847
2021	0.842
2022	0.837
2023	0.833
2024	0.829
2025	0.825
2026	0.821
2027	0.817
2028	0.813
2029	0.809
2030	0.806
2031	0.803
2032	0.799
2033	0.796
2034	0.793
2035	0.789
2036	0.786
2037	0.783
2038	0.780
2039	0.777
2040	0.774
2041	0.771
2042	0.768
2043	0.765
2044	0.762
2045	0.759
2046	0.756
2047	0.753
2048	0.750
2049	0.748
2050	0.745
2051	0.742
2052	0.739
2053	0.737
2054	0.734
2055	0.731
2056	0.729
2057	0.726
2058	0.723
2059	0.721
2060	0.718

Source: Performed by the Author.

Table 29: Past wages revalorization, annex I

Annex I	
year	Coefficients
1995	1.616
1996	1.567
1997	1.534
1998	1.493
1999	1.460
2000	1.420
2001	1.360

Source: *Portaria n.º 179/2020 de 3 de agosto.*

Table 30: Past wages revalorization, annex II

Annex II	
year	Coefficients
2002	1.368
2003	1.318
2004	1.284
2005	1.252
2006	1.213
2007	1.181
2008	1.146
2009	1.146
2010	1.126
2011	1.085
2012	1.056
2013	1.048
2014	1.048
2015	1.043
2016	1.035
2017	1.020
2018	1.007
2019	1.000
2020	1.000

Source: *Portaria n.º 179/2020 de 3 de agosto.*

The first two tables of this appendix display the expected retirement ages and the sustainability factor in the coming years, calculations based on the country-specific projections of UN/World Bank. The following tables show the coefficients used in the calculations to revalue past wages (Consumer Price Index – CPI – excluding housing (75%) and annual wages increases (25%))).