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Pension Schemes Design for New Forms of Employment in Portugal

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Dissertation presented as partial requirement for obtaining the Master's degree in Statistics and Information Management

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PENSION SCHEMES DESIGN FOR NEW FORMS OF EMPLOYMENT IN PORTUGAL

by

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ABSTRACT

The growth of new forms of employment related with the increase of the flexibility in the labor market or the widespread use of more sophisticated information and communication technology raises concerns on future pension entitlements due to earning instability and fragmented unemployment periods, making the pension schemes design for new forms of employment a topic of growing importance. Considering little studies about the impact of unemployment periods and earning instability on pension entitlements and the inadequacy of the actual Portuguese defined benefit (DB) system for non-standard forms of work, the aim of this paper is to evaluate the pension wealth provided by a different pension schemes design for new forms of employment in Portugal using a case study method considering different earnings profiles and unemployment spells. We adopt the Poisson Lee-Carter stochastic mortality model to project future mortality rates and the cohort life expectancy for the male Portuguese population and compute the pension wealth for current (2021) DB Portuguese pension model and four other pension schemes design. Pension wealth expressed as multiple of gross annual individual earnings and actuarial fairness are assessed to decide the adequacy and financial sustainability of the pension schemes. Additionally, we create a retirement product to analyze its impact on the current (2021) DB Portuguese pension model. We find that not only the defined benefit but also the other four pension schemes design are not well designed to address the earning instability, short and fragmented unemployment periods characteristic of new forms of employment. Furthermore, the application of a retirement product in the defined benefit scheme shows not only the improvement of the financial sustainability of the defined benefit plan but also the prevention of loss of income at retirement. Our results evidence the importance of reinforcing and developing alternatives sources of income in the retirement for workers in the new forms of employment, namely for those with lower earnings. Both governments/pension market and citizens would take advantages from this development.

KEYWORDS

New Forms of Employment; Pension Schemes Design; Pension System; Lee-Carter Model; Pension Wealth; Unemployment periods

RESUMO

O crescimento das novas formas de emprego relacionado com o aumento da flexibilidade no mercado de trabalho ou o uso generalizado de tecnologia de informação e comunicação mais sofisticada suscita preocupações sobre direitos de pensão futuros devido a instabilidade salarial e períodos de desemprego fragmentado, tornando o desenho dos esquemas de pensão para novas formas de emprego um tópico de importância crescente. Considerando poucos estudos sobre o impacto de períodos de desemprego e instabilidade salarial nos direitos de pensão e a inadequação do actual sistema português de benefício definido (BD) para formas de trabalho não standard, o objectivo deste artigo é avaliar a riqueza de pensão fornecida por um desenho diferente de planos de pensão para as novas formas de emprego em Portugal usando o método de caso de estudo considerando diferentes perfis salariais e períodos de desemprego. Nós adotamos o modelo estocástico de mortalidade Poisson Lee-Carter para projectar taxas futuras de mortalidade e esperança de vida coorte para a população masculina portuguesa e calculamos a riqueza de pensão para o actual (2021) plano de pensão de benefício definido português e outros quatro desenhos de planos de pensão. Riqueza de pensão expressa como múltiplo de salários individuais anuais bruto e equivalência atuarial são avaliados para decidir a adequação e sustentabilidade financeira dos planos de pensão. Adicionalmente, nós criamos um produto de reforma para analisar o seu impacto no atual (2021) modelo de pensão de BD português. Nós descobrimos que não só o benefício definido mas também os outros quatro desenhos de planos de pensão não estão bem desenhados para lidar com a instabilidade salarial, períodos curtos e fragmentados de desemprego característicos das novas formas de emprego. Além disso, a aplicação do produto de reforma no plano de benefício definido mostra não só o melhoramento da sustentabilidade financeira do plano de benefício definido, mas também a prevenção da perda de rendimento na reforma. Nossos resultados evidenciam a importância de reforçar e desenvolver fontes alternativas de rendimento na reforma para trabalhadores nas novas formas de emprego, nomeadamente para aqueles com salários mais baixos. Tanto governos/mercados de pensões e cidadãos tirariam vantagens deste desenvolvimento.

PALAVRAS CHAVES

Novas Formas de Trabalho; Desenho de Planos de Pensões; Sistema de Pensão; Modelo Poisson Lee-Carter; Riqueza de Pensão; Períodos de Desemprego

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LIST OF ABBREVIATIONS AND ACRONYMS

AE   Gross Annual Individual Earnings

AW   Average Wage

CGA   *Caixa Geral de Aposentações*

DB   Defined Benefit

DC   Defined Contribution

DG EMPL   Directorate-General for Employment, Social Affairs and Inclusion

EU   European Union

EU28   European Union including United Kingdom

Eurofound European Foundation for the Improvement of Living and Working Conditions

FDC   Funded Defined Contribution

G20   Multilateral platform of 20 world's major developed and emerging economies

ICT   Information and Communication Technology

ILO   International Labour Organization

IOPS   International Organisation of Pension Supervisors

LC   Lee-Carter Model

NDC   Notional Defined Contribution

NSE   Non-Standard Forms of Employment

OECD   Organization for Economic Co-operation and Development

P   Points Scheme

PAYG   Pay-as-you-go

PW   Pension Wealth

RGSS   General Social Security Scheme

RSP   Retirement Saving Plan

SPC   Social Protection Committee

UK   United Kingdom

VAT   Value Added Tax

1. INTRODUCTION

In several countries, the full-time work employment contract is considered the standard model of the employment relationship and due to this fact, this form of work is the most protected by the work regulation, namely by the social security system. The present form of social security was based on preconditions and presuppositions verified on the labour market in more than fifty years ago (Schoukens & Barrio, 2017).

Digitalization, globalization, and demographic and climate change are major trends that are transforming the labor markets. In particular, the growth of the flexibility in the world of work and in enterprise strategies or the widespread use of more sophisticated information and communication technology (ICT), may originate new forms of employment (Eurofound, 2015, 2020), which is included in non-standard forms of employment (NSE) (OECD, 2019). Overall, non-standard work accounts for more than 33% of global work in OECD nations (OECD, 2019). According to Eurofound (2015), nine categories of new forms of employment were identified and they can either be clustered in a new model of employment relationship or new work patterns. Namely, seven of the nine categories exist in Portugal, even if on only a marginal scale. Available data and research on these employment forms continue to be scarce as well as their impact on social insurance systems (Eurofound, 2020).

The pension schemes generate old-age pension benefit, consumption smoothing, increase national savings, macroeconomic stability, income redistribution, and promote intergenerationally fair arrangements (Barr & Diamond, 2008; Bravo, 2012a, 2012b, 2015, 2016, 2019; Bravo et al., 2013, 2014, Almeida, 2021). The traditional social security systems, particularly concerning old-age pension, are work-related schemes in which employee and employer contributions are withheld (Schoukens & Barrio, 2017). The employer is responsible for paying contributions (financing), which is one of the reasons for the identification of the (main) employer being an important aspect of social security (Schoukens & Barrio, 2017).

The upbringing of the atypical forms of work both in importance and diversity alongside with the changes in the core features of the typical forms of work such as employment relationship, labor stability, income security, and protection by labour legislation present challenges for social security, namely for benefit levels related with old-age pensions, putting in check the characteristics that were the pillars for the distinction between the standard and non-standard work (Schoukens & Barrio, 2017). In particular, the increasing number of work arrangements that do not fall neither in employment or self-employment notion; the schedules of work are becoming more flexible adding more difficult to make a distinction between traditional full-time work and unusual part-time work relationships; the bilateral character of the employment relationship is being challenged with the emerging of new forms of labor relations which includes one employer to many employees, many employers to one employee or many employers to many employees; labour stability and income security are the elements where the changes were more visible due to the large decrease in work protection law in Europe (Eurofound, 2020; Schoukens & Barrio, 2017). Therefore, non-standard forms of employment challenge the social security system (particularly related with pensions) due to difficult to define the notion of "work", to identify the employer, and to operate with the labor and income instability (Schoukens & Barrio, 2017).

Pension systems are base of most welfare states and they can be structured into two basic philosophies: Bismarckian systems, which are characterized by benefits closely connected to contributions paid graduated and based on wages or salaries during the working lifetime, and Beveridgean systems, which are characterized by universal basic flat-rate benefits mainly financed from the state budget (Kolmar, 2007; Ochel, 2008; Schoukens & Barrio, 2017). The purpose of the Beveridge model is to ensure a minimum pension for subsistence hence in most countries associated with this system philosophy, the Beveridge model is complemented by occupational and private schemes and they used are more widespread (Conde-Ruiz & González, 2016; Ochel, 2008; Schoukens & Barrio, 2017).

The non-standard forms of work can be considered a challenge both for Bismarck and Beveridge systems (Schoukens & Barrio, 2017). On one hand, the several career-break spells and lower incomes, features of most non-standard forms of employment, result in low access (and low benefits) in the Bismarckian model because benefits are closely tight to contribution paid. On the other hand, non-standard workers may not sometimes qualify for the occupational and private pension systems that complemented the Beveridgean model; the attempts to settle residence requirements or other limits in several Beveridgean models result in restricted access to social security benefits for migrant workers and the diminution of interest in the Beveridge system if the standard workers support almost entirely the (co-) finance of the basic universal schemes (Schoukens & Barrio, 2017).

The Portuguese pension system includes a public pension pillar which is a mandatory and earnings-related defined benefit (DB) scheme (Bravo & Herce, 2020; Social Protection Committee (SPC) & European Commission (DG EMPL), 2018a). According to Almeida (2021) and Bravo & Herce (2020), the actual Portuguese DB system is not adequate for non-standard forms of employment workers. Studies related with the impact of non-standard forms of employment (NSE) common features (earning instability, short and fragmented unemployment periods) in the retirement incomes in old-age are scarce, with very few studies about this theme being example studies performed by Almeida (2021) and Bravo & Herce (2020).

This study extends the little literature on pension schemes design for new forms of employment in Portugal. Considering the existence of new forms of employment in Portugal and the inadequacy of the actual Portuguese DB system for non-standard forms of employment workers, the aim of this paper is to estimate the pension wealth provided by a different pension schemes design for new forms of employment in Portugal.

To measure the pension wealth provided by different pension schemes design to a worker in a new form of employment in Portugal, we used a case study method in the simulation study as in Almeida (2021) and Bravo & Herce (2020). First, we adopt the Poisson Lee-Carter age-period stochastic mortality model to project future mortality rates and to forecast the cohort life expectancy for the male Portuguese population. Next, we describe the case study method and present the assumptions used. Then, pension wealth at retirement age is estimated for current (2021) defined benefit (DB) Portuguese pension model and four other pension schemes design found worldwide - defined contribution (DC), points, notional DC supplemented by funded DC and defined benefit complemented by DC. Pension wealth expressed as multiple of gross annual individual earnings and actuarial fairness are analyzed to decide the adequacy and financial sustainability of the pension schemes. Additionally,

we create a retirement product to determine its impact on the current (2021) defined benefit (DB) Portuguese pension model.

We find that defined benefit (DB), defined contribution (DC), points, notional DC supplemented by funded DC and DB complemented by DC pension schemes design analyzed in our study are not well designed to address the earning instability, short and fragmented unemployment periods characteristic of new forms of employment workers. Results show an unfair balance between the pension adequacy and financial sustainability of the pension schemes studied. Additionally, the application of a retirement saving plan in the defined benefit scheme shows the improvement of the financial sustainability of the defined benefit plan and the prevention of loss of income at retirement. These results were obtained for case study of only a male worker and under a controlled range of financial and demographic assumptions hence no gender impact was analyzed, the sample is very small and minor changes in assumptions can affect the results.

Our results highlight the importance of reinforcing and developing other sources of income in the retirement for workers in the new forms of employment, especially for those with lower earnings. Governments, pension market and citizens would benefit with this development.

The structure of the thesis is as follows: in the section 2 we describe new forms employment and how they challenge the core features of standard employment arrangement as well as the principles, economic concepts and the impact of new forms of employment on pension schemes and present the Portuguese pension system; in the section 3 we present the methodology used to measure the pension wealth provided by different pension schemes design for new forms of employment as well as an additional retirement saving plan; in the section 4 we analyze and discuss the results obtained and in the section 5 we show the conclusions, limitations and recommendation for future studies about the pension schemes´ design for new forms of employment in Portugal.

2. LITERATURE REVIEW

2.1. CLASSIFICATION AND CATEGORIZATION OF NEW FORMS OF EMPLOYMENT

Digitalization, globalization, and demographic and climate change are major trends that are transforming the labour markets, resulting in new opportunities as well as new challenges (OECD, 2019). In particular, the growth of the flexibility in the world of work and in enterprise strategies or the widespread use of more sophisticated information and communication technology (ICT), may originate new forms of employment (Eurofound, 2020) across Europe (Eurofound, 2015).

According to OECD (2019), workers performing new forms of employment are included in non-standard employment. Non-standard work had been suffering a slightly transformation, with the "emergence and expansion of new forms of non-standard work, in particular jobs relying on new technologies" over the last 20 years (OECD, 2019). The legal classification of non-standard work still does not exist (International Labour Office, 2016). However, there is a definition of relevant consensus at the international level, as a result of the February 2015 ILO Meeting of Experts on non-standard forms of employment (NSE) (International Labour Office, 2016), which will be considered in this dissertation.

According to International Labour Office (2016), normally NSE comprehends work not included in full-time open-ended, sub-ordinate, for only single employer contracts and, in some circumstances, which take place at an agreed location outside the home, known as "standard employment relationship" (International Labour Office, 2016). Platform work, very short-term contracts (Known as zero-hours contracts), and, as a whole, other types of own-account work are designated as "new" forms of work (OECD, 2019). It matters to refer that non-standard forms of employment can have common features among each other's(International Labour Office, 2016). In that sense, the distinction between NSE is not always clear (International Labour Office, 2016). Therefore, several dimensions of NSE may be found in the same work arrangement (International Labour Office, 2016).

There are situations where workers can have more than one non-standard work (OECD, 2019). Overall, non-standard work accounts for more than 33% of global work in OECD nations (OECD, 2019). Non-standard employment is more verified among older workers, namely self-employment and part-time work, as well as among women, namely part-time work(OECD, 2019). People that work in non-standard employment have, on average, lower income than those in standard contracts (OECD, 2019). More particularly, despite new forms of non-standard work representing only 0.5-3% of total work in developed countries, it has bigger relevance for younger generations than older people(OECD, 2019).

In 2015, Eurofound published a report mapping new forms of employment across the European Union (EU), the United Kingdom (UK), and Norway since about the year 2000 (Eurofound, 2020). The goal of this report was to point out for each nation the types of works that were new or of growing importance since about the year of 2000 (Eurofound, 2020). In 2020, an update of that report was carried out with the purpose to analyze the evolution of the previously named forms of employment, regardless of their newness (Eurofound, 2020). Based on Eurofound (2015), there is not a common consensus about the definition of new forms of employment, since the newness may depend on the country being analyzed.

Nevertheless, new forms of employment can be described as taking place in a non-conventional workplace (such as own-office, "anywhere") supported by Information and Communication Technology (ICT) (for example mobile phone, tablet) where the employment relationship can assume 3 categories (one employer to many employees; many employers to one employee; many employers to many employees); employment patterns are discontinuous, intermittent and non-conventional fixed-term; and networking among self-employed is taken further than traditional level, regardless of the work regulation type(legal basis, collective agreement and type of contract); and of the sector and occupation (Eurofound, 2020).

These features presented by new forms of employment have impact on the organization and dynamic of the pension systems and they affect differentially pension schemes incorporating defined benefit and pension schemes including defined contribution (Schoukens & Barrio, 2017). This part is developed in more detail later in the subchapter 2.3., which is about pension schemes.

According to Eurofound (2015) and Eurofound (2020), nine categories of new forms of employment were identified and they can either be clustered in a new model of employment relationship or new work patterns. Namely, seven of the nine categories exist in Portugal, even if on only a marginal scale.

Based on Eurofound (2020), no other trends in the forms of employment have been identified since 2015 across EU, UK and Norway. Three of nine new forms of work categories, namely ICT-based mobile work, platform work and collaborative employment, are verified in the majority of the countries analyzed (Eurofound, 2020).

2.1.1. ICT-based mobile work

This new form of employment can be characterized as the work conducted by an employee or self-employee from anywhere at any time apart from the company office regularly using ICT for online connection, enabled by advanced technologies for instance as smartphones and tablets and laptop computers (Eurofound, 2015, 2020). Traditional teleworking is different from this new form of employment due to the limited way in which the work is conducted, being frequently made in another fixed location (Eurofound, 2015, 2020).

Based on Eurofound (2020), ICT-based mobile can be occasional (employees related) – with lower location flexibility-, highly mobile (employees related) – with higher location flexibility - or self-employed – made in at least two places. European Working Conditions Survey 2015 concludes that about 16% of workers in the European Union nations were ICT-based mobile workers (53% of them occasional; 29% of them, highly mobile and 19% of them, self-employed), bearing in mind that its incidence is very different across countries (Eurofound, 2020).

According to Eurofound (2020), ICT-based mobile work has been growing, namely for the self-employed, and in the medium to long run, it is expected to continue to be a growing dynamic in the European labour market. Regarding the sector of activity, sectors´ of ICT, professional and scientific activities, real estate, and financial services are the ones where ICT-based mobile work is more predominant (Eurofound, 2020). In the majority of the countries analyzed, it is possible to identify two patterns regarding gender and age: on one hand, highly mobile workers are characterized by having a

gross share of men workers and performed by more people having more than 35 years old (latter also include self-employed) and, on the other hand, occasional workers are proportional in both genders and young workers represent the majority (Eurofound, 2020). Despite non-existing EU-level regulation about ICT-based mobile work, in particular, it can be found several legal frameworks that are very relevant for this form of work (Eurofound, 2020). Based on Eurofound (2020), at the national labour code level, regulations more focused on telework might also apply to ICT-based mobile work, despite sometimes it is not clarified in which way the more flexible feature of ICT-based mobile work is covered.

2.1.2. Platform work

This new form of employment consists in the use of an online platform to enable sustainably and efficiently interactions between producers and consumers to provide goods (physical or virtual) or services (standardized or non-standardized) in exchange for payment (Choudary, 2015; Eurofound, 2020). The platform work needs three parties involvement – the online platform, the client and the worker – in which the online platform serves as an intermediary to organize the paid work (Eurofound, 2020), setting the governance conditions (Parker et al., 2017).

The main enabler of value creation and exchange on platforms is the interaction between producers and consumers (Choudary, 2015). Platform work can be mediated online but conducted on-location or can be both mediated and conducted online (Eurofound, 2020). According to Parker et al. (2017), the rise of the platform as a business and organizational model is one of the most relevant economic and social developments that emerged from the depths of the 2000 recession.

Parker et al. (2017) through their Platform Revolution (2017)´s book try to give the first cohesive, complete and reliable guide to the fast growth of the platform model. They have worked with more than a hundred enterprises across several sectors on the developing and implementing their platform business models. Based on Parker et al. (2017), the reason for the success of this new form of employment is the force of the platform model– a new business model that uses ICT to globally connected producers and consumers interactively in an environment in which an efficient value creation and exchange can be accomplished.

Traditionally, the system structure/model employed by most businesses is known as pipeline, in which a step-by-step process of flowing in a straight line from producers to consumers is made for the creation and transference of value (Parker et al., 2017). Oppositely, in a platform model, the connections enabled by the platform itself create a cycle of complex arrangements in which the three parties involved engage in many group of relationships, originating a complex value matrix (Parker et al., 2017).

In different degrees, the platform business has been increasing in scale in all geographics (Parker et al., 2017). Based on previous authors, the biggest platforms for businesses creating value are in North America, followed by Asia, Europe, Africa and Latin America, in that order, respectively. According to Eurofound (2020), the majority of the research available indicates that 1-2% of platform workers do this form of employment as a core job and around 10% doing it once in a while in EU, UK

and Norway. In these three regions, the number of platforms operating in an country can vary from 5 to 100 for nations that have that information available (Eurofound, 2020).

Regarding the sectors of activities, there is a diversity of platform business that can be found in almost every industry, such as Agriculture, Communication and Networking, Consumer Goods, Education, Energy and Heavy Industry, Finance, Health Care, Gaming, Labor and Professional Services, Local Services, Logistics and Delivery, Media, Operating Systems, Retail, Transportation, and Travel (Parker et al., 2017).

Likely, the best-known and most widespread examples of platform business models are in the transportation industry, in particular car services and food delivery, which is mediated online but conducted on-location (Eurofound, 2020). Due to COVID-19 pandemic, in the first semester of 2020, delivery services had a growth and oppositely, demand for car service and household services decreased during lockdown imposed by government restrictions (Eurofound, 2020).

According to Eurofound (2020), platform work is done more often by men than women, the largest percentage of workers are under 35 years old and in general, platform workers are highly educated. The rapid rise of platforms markets is bringing regulatory issues such as tax policy, affordable housing, public safety, economic fairness, data privacy, labor rights and the negative impact of platform business on the traditional industries to the public discussion and policy debate more frequently since the financial crisis of 2008-09 (Parker et al., 2017).

Regarding regulation on platform work, there is a relevant tension between the heavy hand of regulation, who may discourage the innovation and the relatively laissez-faire approach, who may promote innovation and economic development (Parker et al., 2017).

As stated by Parker et al. (2017), some of the policy battles concerning platforms business indicate, in some degree, an attempt by the traditional industries to use policy framework as protection against the competitive models that platform structures introduce. This situation portrait one of the most known mechanics of regulatory failure, named by economist Nobel Prize winner and member of Chicago School of Economics George Stigler as "regulatory capture" – the core assumption is that the industry players will manipulate the regulation taking into accounting their own goals, jeopardizing even more the respective industry (Parker et al., 2017).

The doubt is specifically how platform work should be covered by regulatory regimes, despite the existence of regulatory capture phenomenon, using some intermediate level of government regulation thought oversight agencies, judicial redesign or a bit interconnection of the two (Parker et al., 2017). In years close to 2020, a set of policy initiatives at EU level and national level that are significant for platform work have arisen, despite the majority of them focus on general issues that also emerged in platform work and not in this employment form itself (Eurofound, 2020). The majority of policy initiatives that explicit target platform work are newly made, small in scale and with lack of evaluations, therefore the real impact of such measures is still unknown (Eurofound, 2020).

Collective agreements with individual platforms (example of negotiation of working condition), provision of insurance and social protection possible offered by a specific platform (special packages agreed with insurance enterprises) or by third parties such as trade unions and taxation may include a

particular regimes or procedures for platform workers are examples of measures to address the emerging issues on the platform work (Eurofound, 2020).

2.2. LABOR REGULATION OF NEW FORMS OF EMPLOYMENT

In most countries, the full-time open-ended employment relationship (known as standard work) is used as the main model for work regulation and thus it has the greatest labor and social security protection, while non-standard work receives less protection (Schoukens & Barrio, 2017). Therefore, the regulation of work, in particular social security, has grown dependent on specific features of standard work (Schoukens & Barrio, 2017). In the EU28, 58% of people in employment work under the standard full-time permanent employment arrangement (Schoukens & Barrio, 2017). However, the weakening of the characteristics of the standard model due to the growth of flexibilization of the labor world and the increasing both in importance and diversity of the non-standard work is putting in check the core building elements of social security systems, namely benefit levels related with old-age pensions (Schoukens & Barrio, 2017). Taking into consideration the definition of the standard employment relationship, a worker under this type of employment satisfies the usual requirements to be considered an employee (Schoukens & Barrio, 2017).

2.2.1. Main features of standard employment arrangement

Employment relationship

Defining if a person in an employment relationship is considered an "employee" has become very difficult because of the increasing number of work arrangements that do not fall neither in employment or self-employment notion (Schoukens & Barrio, 2017). Based on the 95th session of the International Labor Conference that took place in 2006 and on the work of authors such as Freedland, we will discuss in more detail the key features of standard employment arrangements (Schoukens & Barrio, 2017).

The primary elements of a standard employment relationship are personal subordination, bilateral character, mutuality of obligations, salary, economic dependency, and work normally performed on the employer´s premises. The personal subordination of the employee towards the employer is traditionally understood as the control and direction of the worker by the employer, which may vary significantly depending on the type of work (Schoukens & Barrio, 2017).

Based on Schoukens & Barrio (2017), factors such as technological advancements and greater specialization have made it more difficult for employers to closely supervise the performance of work. Besides that, the integration or not of the employee in the company organizational structure and the provision or not of the work tools by the employer may dictate the way the subordination is perceived (Schoukens & Barrio, 2017). The feature of mutuality of obligations has been largely understood as the duties of the employee to be ready to work, and of the company to provide work (Schoukens & Barrio, 2017). According to Schoukens & Barrio (2017), salary is paid by the employer to the employee in exchange of the work provided by the latter, resulting in the fifth feature of what makes a standard employment relationship, the economic dependency of the employee regarding the employer, since the employment arrangement is the main source of income of the employee. The sixth characteristic of the employment relationship is the fact that the work is normally done on the employer´s premises

(Schoukens & Barrio, 2017). This feature is controversial since in some nations (such as France and Belgian) having the work done in a different location than the employer´s premises does not impact the employment status by itself (Schoukens & Barrio, 2017).

Labour stability

The standard employment relationship enabled labour stability because the employment relationship has an open-ended duration, which implies that it may only be cessed under specific conditions or reasons , and the work is performed full-time and within a known timetable (known as "standardised working time", which also has attached mandatory holidays and leave provisions) (Schoukens & Barrio, 2017). Based on Schoukens & Barrio (2017), due to the reasons referred to before, labour stability is a key component of the social function of the standard employment relationship.

Income security

According to Schoukens & Barrio (2017), in the standard employment arrangements, the income security is due to labour stability. Income security encompasses receiving a salary that is enough to guarantee livelihood and the expectation of an appropriate level of social insurance (Schoukens & Barrio, 2017). As another key feature of the social function of the standard employment relationship, income security allows people to consume and plan for the long term and has given governments a livelong income through taxes, helping in the construction and maintenance of the welfare state (Schoukens & Barrio, 2017).

Protected by labor legislation, and collective agreements

An employment relationship that encompasses the aforementioned features will be fully covered by statutory law and collective agreements (Schoukens & Barrio, 2017). Therefore, standard workers will have comprehensive protection in social security and have been traditionally used as the base for social insurance schemes for work in western social security systems (Schoukens & Barrio, 2017).

2.2.2. Challenges of standard employment arrangement

There have been both internal and external challenges to the core features of the standard employment arrangement (Schoukens & Barrio, 2017).

The internal challenges have affected most of the standard employment relationship elements (Schoukens & Barrio, 2017). Subordination as a command has been more difficult to do by the employers due to the technological advancements and greater specialization, as referred before (Schoukens & Barrio, 2017). Besides that, according to Schoukens & Barrio (2017) the schedules of work are becoming more flexible adding more difficult to make a distinction between traditional full-time work and unusual part-time work relationships. Based on Schoukens & Barrio (2017), the bilateral character of the employment relationship is being challenged with the emerging of new forms of labor relations. Deviating from the established one-to-one employment arrangement are labor relations involving multiple parts, in particular multiple employers for each employee, one employer for multiple employees, or even multiple employers–multiple employee relationships (Eurofound, 2015). Labor stability and income security are the elements where the changes were more visible due to the large decrease in work protection law in Europe (Schoukens & Barrio, 2017).

Regarding the external challenges, fifty percent of new jobs created since the 1990s have been in temporary work, part-time work, or self-employment in OECD nations (Schoukens & Barrio, 2017). Simultaneously, the work arrangements that deviate from the standard employment relationship lack at a certain level the main features of permanent employment and they fulfill others (Schoukens & Barrio, 2017).

Lack of direct employment relationship

Lack of (or lesser) personal subordination in employment relationship difficult the classification of work relationships without (or lesser) of this feature but that at the same time have other characteristics of labor relations such as the traditional one-to-one employment arrangement (Schoukens & Barrio, 2017). Employment relationships that fall under that modality are for example economically dependent self-employed, freelancers, and owner-managers of incorporated enterprises (Schoukens & Barrio, 2017). Freelancers face income insecurity as a result of the intermittent nature of income accrual and overall low levels of income earned in one working day (Schoukens & Barrio, 2017). In several situations, income insecurity provokes situations of non-insurance, since the take-home pay values do not reach the minimum thresholds imposed by the social security system (Schoukens & Barrio, 2017). Freelance employment has been emerging more frequently through platform work (Schoukens & Barrio, 2017). The employment status of individuals carrying work through these platforms has been highly debated, since platforms normally treat them as self-employed, while they often defend they are in fact employees (Schoukens & Barrio, 2017).

Lack of a bilateral employment relationship

The labor relations involving more than two parties have emerged since the late 1960s and early 1970s, being agency work, in particular voucher-based work well Known triangular work relationships (Schoukens & Barrio, 2017). In years since about 2010s, the identification of the employer has been a challenge in platform work because several parties are playing the different functions of the employer (Schoukens & Barrio, 2017).

Lack of labor and income stability

Lack of (or lesser) labor and income stability is due to the lack of (or lesser) permanent employment and lack of full-time employment (Schoukens & Barrio, 2017).

Lack of permanent employment

Fixed-term work (whether part-time or full-time) represent more than 25% of the workforce in Portugal, being this rate stable from around the 2000s until 2017 (Schoukens & Barrio, 2017). Regardless of the modality, workers performing temporary work have more difficulty accessing social security benefits (such as a full pension) (Schoukens & Barrio, 2017). It is more complex due to their work fragmentation to reach the needed minimum period of insurance and the earning instability and lower and slower-growing wages may impact the level of their benefit (particularly related with pensions) since it is correlated contributions (Schoukens & Barrio, 2017).

Taking into account the points displayed above, the non-standard work challenges the social security systems because it is difficult to define the notion of "work", to identify the employer, and to

operate with the labour instability common in almost non-standard forms of work (Schoukens & Barrio, 2017).

Determining what is considered "work" is essential since the traditional social security systems, particularly concerning old-age pension, are work-related schemes in which employee and employer contributions are withheld (Schoukens & Barrio, 2017).

The employer is responsible for paying contributions (financing), which is one of the reasons for the identification of the (main) employer being an important aspect of social security (Schoukens & Barrio, 2017). In several non-standard forms of work, it is not clear who is the employer (Schoukens & Barrio, 2017). For example, in platform work, the debate is whether the workers are employed by the users of the platform or by the platform itself (Schoukens & Barrio, 2017). In forms of work with high flexibility, such as platform work, it is common for a worker to be registered in several platforms at the same time even though the person can work actively only in some of them and these platforms can be based on several nations, which make very complicated to identify the employer and to keep a record of work performed (Schoukens & Barrio, 2017).

The fragmentation of careers (labor instability) issue is more evident in the case of the requirement of holding paid contributions for a specific length during a certain timeframe (Schoukens & Barrio, 2017). As a result, people performing non-standard work are left out of the social security schemes when several work assignments are very small to be considered for social insurance purposes and may also have their employment history not tracked (Schoukens & Barrio, 2017).

2.3. PENSION SCHEMES

The main purpose of a pension scheme is to generate an income after the retirement event takes place by providing an old-age pension benefit (Almeida, 2021). Pension schemes play other objectives such as consumption smoothing, increasing national savings, macroeconomic stability, income redistribution, and promoting intergenerationally fair arrangements (Barr & Diamond, 2008; Bravo, 2012a, 2012b, 2015, 2016, 2019; Bravo et al., 2013, 2014).

On the literature review, Bismarck and Beveridge's models are the two main systems used as reference models by the majority of countries on the design of their social protection systems (Almeida, 2021). Pay-as-you-go (PAYG) financed pension systems are base of most welfare states and it can be structured into two basic philosophies: Bismarckian systems (continental) and Beveridgean systems (Anglo-Saxon) (Kolmar, 2007). In terms of funding, PAYG schemes imply that current workers´ contributions are used to pay the old-age pension of the current retirees whereas in funded plans contributions are withheld in a fund and used after the workers who made the contribution retire (Social Protection Committee (SPC) & European Commission (DG EMPL), 2018b).

German Chancellor Otto von Bismarck created the Bismarck model and fomented a structured social insurance system by introducing statutory health insurance (1883) in Germany (Ochel, 2008). Bismarckian systems are characterized by benefits closely connected to contributions paid graduated and based on wages or salaries during the working lifetime, which implies that the insured individuals are gainfully employed (Ochel, 2008; Schoukens & Barrio, 2017). The purpose of the Bismarckian model is to assure a sufficient old age pension for all workers (Ochel, 2008; Schoukens & Barrio, 2017).

In the nations, in the middle of the European continent, the prevalent model is the Bismarck (Ochel, 2008).

William Henry Beveridge presented in 1942 a complete report to the British Parliament on social policy and the proposals on that report were the pilar for the post-war (1945) British social insurance scheme, being the Beveridge system named after him (Ochel, 2008). Beveridge systems are characterized by universal basic flat-rate benefits mainly financed from the state budget (Ochel, 2008; Schoukens & Barrio, 2017). The purpose of the Beveridge model is to ensure a minimum pension for subsistence hence in most countries associated with this system philosophy, the Beveridge model is complemented by occupational and private schemes and they used are more widespread (Conde-Ruiz & González, 2016; Ochel, 2008; Schoukens & Barrio, 2017). The northern European nations have a strong affiliation to the Beveridge model (Ochel, 2008).

In its original format, the Bismarck system has no redistribution between different income levels while redistribution is verified in a Beveridge system (Kolmar, 2007; Ochel, 2008). However, no nation follows neither of the two models in their original form, which imply that even in Bismarckian systems different levels of intragenerational redistribution exist and the separation about which EU country use which model have progressively become weaker, which imply that sometimes it is difficult to assign one of these systems to an EU country (Conde-Ruiz & González, 2016; Ochel, 2008).

The non-standard forms of work, which include new forms of employment, can be considered a challenge both for Bismarck and Beveridge systems (Schoukens & Barrio, 2017). On one hand, the several career-break spells and lower incomes, features of most non-standard forms of employment, result in low access (and low benefits) in the Bismarckian model because benefits are closely tight to contribution paid. On the other hand, non-standard workers may not sometimes qualify for the occupational and private pension systems that complemented the Beveridgean model; the attempts to settle residence requirements or other limits in several Beveridgean models result in restricted access to social security benefits for migrant workers and the diminution of interest in the Leveridge system if the standard workers support almost entirely the (co-) finance of the basic universal schemes (Schoukens & Barrio, 2017).

The World Bank´s (1994) "Averting the Old Age Crisis: Policies to Protect the Old and Promote Growth" is an important policy research report that settled main principles and concepts about old age security arrangements, being the first complete and global examination of these matters (World Bank, 1994, 2008). This research project recommends governments to develop three systems or "pillars" of old age security: a compulsory tax-financed publicly managed system to mitigate poverty in later ages; a compulsory fully funded privately managed savings systems and optional savings because spreading the insurance goal across all three layers offers bigger income security in later ages than dependence on any single layer and because the share of payroll tax to support the public pillar can be kept relatively small (World Bank, 1994). Further World Bank development on refining pension system designs have allocated all public pension programs to the first pillar; added the concept of "zero pillar", which is non-contributory social assistance financed by the government depends upon the budgetary resources and added a "fourth pillar", which includes the informal support (such as family), others formal assistance programs (such as health care or housing) and other individual assets (such as homeownership and equity release schemes) (OECD, 2005; World Bank, 2008; Holzmann et al., 2019). These advancements culminate in World Bank´s Five Pillar Framework (World Bank, 2008).

In 2000, Nicholas Barr, through his working paper "Reforming Pensions: Myths, Truths, and Policy Choices" categorizes pension in three tiers. In this categorization, the second tier can be publicly or privately managed, funded, or PAYG and it may or may not be included in the first tier (Barr, 2000).

Since 2005, OECD publish a biennial report on pension systems across OECD and G20 countries – "Pensions at a Glance". Each edition has a comprehensive comparison of pension policies of OECD and G20 nations and recent reforms. Besides that, there is at least one thematic chapter and a set of indicators encompassing pension estimation for current workers (OECD iLibrary, 2021).

The OECD developed a taxonomy of the different types of retirement-income programs found around the world. This taxonomy consists of two mandatory "tiers": the first tier – the redistributive component – generates old age pension regardless of past earning level and is designed to ensure that pensioners achieve a minimum standard of living; the second tier – the insurance component – includes earnings-related components and is designed to achieve a standard of living in some degree more close to the one before retirement (OECD, 2005, 2019). The third tier includes the private provision of pensions (personal or occupational) (OECD, 2005, 2019). This involves several accumulation vehicles (e.g., retirement saving schemes) and decumulation products (life annuities, lump sum payments, longevity-linked annuities, programmed withdrawals, tontines) (see, e.g., Bravo & Freitas, 2018; Bravo, 2019, 2021; Freitas & Bravo, 2021).

According to the OECD framework, the first tier is publicly managed and there are four types of programs: residence-based basic, targeted, contribution-based basic and minimum, for which past earnings are not relevant in the computation of retirement income (OECD, 2019). For these programs, institutional set-up, eligibility conditions, and incomes have been taken into account (pensions, other sources or/and assets) when defining the value of the benefit is different (OECD, 2005, 2019). Similarly, the taxation of pensions varies across different pension schemes and countries (see, e.g., Holzmann & Piggott, 2018; Bravo, 2016, 2018).

All pension schemes designed in the OECD nations include the first tier, where almost half of these countries provide a minimum pension benefit as part of their contributory scheme (OECD, 2019). Regarding the second tier, it can be public, having four types of schemes – defined benefit (DB), points (P), notional defined contribution (NDC), and funded defined contribution (FDC) – or it can be private, having two types of schemes – defined benefit and funded defined contribution. About the third tier, the schemes are private and they can be also DB or FDC.

Defined Benefit plans (DB plans)

The most common form of second-tier retirement-income provision in OECD countries is the public DB plan, namely the public pay-as-you-go (PAYG) schemes (17 countries) (OECD, 2005, 2019). In DB schemes, there is a guarantee by the government or pension agency that the benefit amount received by a pensioner, which depends on the number of years of contributions, accrual rates, and individual pensionable earnings, will be paid (OECD, 2019; World Bank, 1994).

Defined Contribution plans (DC plans)

The next most found kind of second-tier retirement-income provision in OECD nations is the defined contribution plan (OECD, 2005). In this type of plan, a periodic contribution is settled, and the benefit depends on the contribution plus the investment return (World Bank, 1994). DC plans can be

funded or notional (OECD, 2019). In FDC schemes each worker has an individual account in which contributions are saved and invested (OECD, 2005). NDC schemes are based on PAYGO financing since the funds obtained from payroll taxes are used to finance pension benefits to those currently retired with unfunded or virtual individual accounts that apply a notional rate of return to contribution done (Williamson & Williams, 2003). NDC schemes are a comparatively new approach (OECD, 2019). Funded defined contribution (FDC) plans are mandatory in nine OECD countries and there are notional defined contribution (NDC) plans in five OECD nations (OECD, 2019). In both FDC and NDC, the accumulated capital is normally converted into a monthly pension at retirement (OECD, 2019).

Points Schemes

The Points schemes can be found in five OECD countries: four of them with public schemes and one of them (French) with occupational plans managed by social partners under public supervision (OECD, 2019). In these schemes, workers obtained pension points accordingly with their income level and, at retirement, the total amount of pension points is multiplied by a pension-point value to transform them into a common pension payment (OECD, 2019).

The improvement of financial sustainability due to the issue presented by the population ageing results in pension rules changing in all OECD countries since about 1970 (OECD, 2019). The long-term trends in pension reforms include the change from defined benefits to defined contributions, tightening the link between earnings and benefits, automatic adjustment mechanisms such as linking benefits to life expectancy in defined benefit schemes and linking the retirement age to life expectancy, and changes in pension replacement rates (OECD, 2019).

Approaching or entering retirement, it is important to have a good strategy and timing for the decumulation of financial and non-financial wealth. The decumulation phase may include a unique decision took at the time of retirement or a set of schedule and logical decisions made throughout the entire retirement period (Freitas & Bravo, 2021). The most appropriate decumulation strategy must consider individual circumstances and preferences and the financial and fiscal environment (Bravo, 2016; Bravo & Herce, 2020; Freitas et al., 2011; Freitas & Martins, 2014). According to Freitas & Bravo (2021), annuitization strategies including longevity-linked life annuities and hybrid solutions offer higher expected lifetime utility.

2.4. THE PORTUGUESE PENSION SYSTEM

The pension system in Portugal consists of a public pension pillar (first pillar) complemented by voluntary occupational pension schemes (second pillar) and personal pension schemes (third pillar)(Bravo & Herce, 2020; Social Protection Committee (SPC) & European Commission (DG EMPL), 2018a). According to the same authors, the public pension pillar - which is a mandatory and earnings-related defined benefit (DB) scheme - is composed by two distinct but convergent schemes: general social security scheme – RGSS (covering private- and public-workers registered after 2005) and CGA - *Caixa Geral de Aposentações* subsystem (covering civil servants who had started working in the public sector before December 2005). Based on Bravo & Herce (2020) and Social Protection Committee (SPC) & European Commission (DG EMPL) (2018b) the public pension pillar includes also the non-contributory regime accordingly to the length of contributory career, subject to means-testing, fully

funded by general taxes. In Table 1, we report the minimum pension level according with the length of the contribution period.

Table 1 - Minimum pension according with the length of the contribution period

Contribution period	Current (2021) monthly minimum pension amount
Less than 15 years	€ 275.30
From 15 to 20 years	€ 288.79
From 21 to 30 years	€ 318.67
More than 31 years	€ 398.34

Source: Author´s preparation according to Centro Nacional de Pensões (2021)

The mandatory public pension schemes, which includes old-age, earlier retirement, disability and survivors´ pensions, are financed on a pay-as-you-go basis by contributions paid by both employer (23.75%) and employee (11%) summing up a total contribution of 34.75 percent of gross earnings of which 26.94 percent is allocated for pensions (namely 20.21 percent for old-age benefit), complemented by a small proportion of the value added tax ('social' VAT) (Bravo & Herce, 2020; Social Protection Committee (SPC) & European Commission (DG EMPL), 2018a; Social Security, 2022). Based on the same authors, regarding the self-employed, the global rate of contribution ranges between 29.6% and 34.75%. In 2020, approximately 80 percent of the pensioners received old-age pension from the RGSS and the old-age pensions accounted for 70 percent of the total social security pensions – see Figure 1 (Caixa Geral de Aposentações, 2020; Social Security, 2022).

Figure 1 – Percentage of public pension pillar subsystems and percentage of general social security (RGSS) pensions, by type
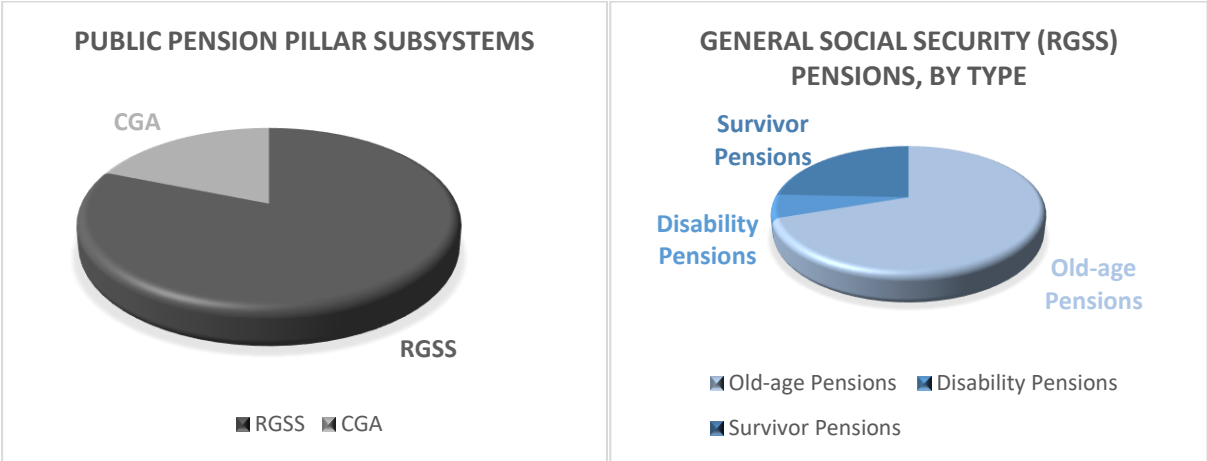
Source: Author´s preparation based on Caixa Geral de Aposentações (2020) and Social Security (2022)
Notes: RGSS - general social security scheme subsystem; CGA - *Caixa Geral de Aposentações* subsystem

The coverage of the occupational pension schemes in Portugal is low being occupational pension market composed by a few private funded schemes (Bravo & Herce, 2020; Social Protection Committee (SPC) & European Commission (DG EMPL), 2018a). According to Bravo & Herce (2020), as of 2019, only 2.5% of Portugal´s workforce is covered by occupational schemes.

The third pillar encompasses funded personal individual retirement plans and also do not cover many individuals in Portugal (Social Protection Committee (SPC) & European Commission (DG EMPL), 2018a).

The reform trends, namely parametric pension reforms, have mainly tried to address sustainability of the Portuguese pension system, including the introduction of a sustainability factor in the pension formula under certain special condition – it implementation can reduce the pension amount by 15.5% (in 2021) (sustainability factor is not applied to pensions obtained at normal retirement age); an increase in the statutory retirement age which, from 2015 onwards, is automatically adjusted yearly according to life expectancy evolution; shift from best years to lifetime average earnings; the introduction of incentives for late retirement and penalties (reduction of 0.5% for each month anticipated compared to the normal retirement age) for earlier retirement; suspension of earlier retirement variant between 2012 and 2015; means-testing for non-contributory schemes and convergence rules between RGSS and CGA subsystems (Bravo & Herce, 2020; Centro Nacional de Pensões, 2021; Social Protection Committee (SPC) & European Commission (DG EMPL), 2018a). As of 2021, the normal retirement age was 66 years and 6 months, with the possibility of being less when individuals present contributory career exceeding 40 years under certain conditions.

3. METHODOLOGY

The purpose of this section is to describe the materials and methods used to achieve our academic research goal – estimate the pension wealth for a different design of retirement income systems for new forms of employment in Portugal. To achieve this goal, first, we forecasted the cohort life expectancy at the mandatory retirement age for the male Portuguese population. Next, we describe a case study method considered in the simulation study, as well as the assumptions used. Then, we compute the gross pension wealth of an individual in a new form of employment for the benchmark current (2021) defined benefit (DB) Portuguese pension model. This will serve later to analyze the impact of different pension models on pension wealth for new forms of employment. Finally, we estimate the pension wealth for the other four pension models' design. From now on the gross pension wealth will be referred to as pension wealth, for simplification purposes. The other four schemes of pension for which we will estimate the pension wealth are defined contribution (DC), points , notional DC supplemented by funded DC and complemented by DC. We selected these five models since they represent most of the design of pension systems found worldwide. Additionally, we will assess the impact of an extra retirement saving plan on the current (2021) defined benefit (DB) Portuguese pension model.

3.1. STOCHASTIC MORTALITY MODEL AND CALIBRATION

To compute the pension wealth for each pension model considered in our study we project the mortality of the Portuguese male population using the stochastic mortality model log bilinear Poisson Lee Carter. We selected a variant of Lee and Carter (1992) (LC) model due to its appropriability for the Portuguese population demonstrated in other studies, such as (Bravo & Herce, 2020; Reis, 2018), and it is used as the reference model at Statistical Offices worldwide, including Statistics Portugal (Bravo & Herce, 2020; Reis, 2018).[1]

Developed by Brouhns et al. (2002), the log bilinear Poisson Lee-Carter model assumes that the number of deaths verified at age x during the year t (D_{xt}), among those exposed-to-risk $(E_x(t))$, follows a Poisson distribution:

$$D_{xt} \sim Poisson\big(E_x(t)u_x(t)\big) \; with \; u_x(t) = exp(\alpha_x + \beta_x k_t) \qquad (1)$$

being that $u_x(t)$ represents the force of mortality at age x during year t; α_x represents the average level of mortality rates over time for each age, regardless of factor time t; k_t denotes the mortality´s time trend (if k_t decrease, mortality decrease, and vice versa); β_x represents the mortality trend at age x as a result to a change in parameter k_t. Poisson Lee-Carter model assumes that the force of mortality is constant within age and calendar year's interval:

$$u_{x+\varepsilon}(t + \tau) = u_x(t), \varepsilon \geq 0, \tau \leq 1 \,. \qquad (2)$$

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[1] See Bravo & Nunes (2021), Bravo et al. (2020) and Bravo & Ayuso (2020, 2021) for an overview of the literature on single-population and multiple-population discrete-time and continuous-time stochastic mortality models, including novel Bayesian Model Ensemble techniques.

With this variant of LC model, Brouhns et al. (2002) imply that the residual terms of the model are heteroscedastic (the variance of the residual terms are not constant) whereas in original LC model they are homoscedastic, which was one of the disadvantages of original LC model (see, for example, Reis, 2018).

The parameters of this variant of LC model are under the same restrictions as the parameters of the original LC model including the following two constrains to avoid the identification issue by allowing the model to have one single solution:

$$\sum_{x=0}^{X} \beta_x = 1; \sum_{t=0}^{T} k_t = 0. \tag{3}$$

To estimate the mortality rates, we first set up the Lee-Carter (LC) model to the male Portuguese population using data from 1980 until 2013 and for ages 60-95 for estimation. We use the data available in the Human Mortality Database web page (University of California Berkeley (USA) & Max Planck Institute for Demographic Research (Germany), 2021) about deaths and exposures. Then we followed the steps described in (Bravo & Herce, 2020) - namely in chapter 3.3 – Stochastic mortality modelling and calibration - and a practical example of coding in R of curricular unit Banking and Insurance Operations to compute in the R software the crude death probabilities and complete cohort life expectancies at retirement age using model log bilinear Poisson LC (see Bravo & Herce, 2020) for methodological details). Please note that in our study we do not use the Jarque Bera normality test.

In our study, we reach the same conclusion as (Bravo & Herce, 2020) about the best ARIMA model to forecast k_t: an ARIMA(1,1,0) with drift. Bravo & Herce (2020) assume in their study that vectors α_x and β_x are kept the same over time and that the future values of k_t are estimated using the ARIMA (p, d, q) model. We also use this approach to forecast the parameters to the next 130 years, namely from 2013 until 2143, by replacing in the model the time parameter (k_t) by the forecasted values and the remaining parameters (age parameters α_x and β_x) by the estimated values. Considering that our study is about old-age benefit pension design, we focused our mortality projection on the later ages.

3.2. SIMULATION DESIGN APPROACH

The calculation of pension entitlements required several inputs, such as salary track, which cannot be public access in Portugal, and the information available through other sources are not enough and new form of employment history may not be tracked (Bravo & Herce, 2020; Schoukens & Barrio, 2017). Therefore, based on the literature review made, we defined one case study based on the new forms of employment. The case study has been used on several occasions to evaluate public policies (Bravo & Herce, 2020). We assume our case study to be a childless male worker in a new form of employment (which represent his main job) with lower location flexibility entering the Portuguese labour´s market at age 22 in 2010 – this profile is used in all pension model.

We also defined five earnings profiles for a new form of employment worker, defined as a multiple of average wage (AW): 0.5AW, 0.75AW, 1AW, 2.5AW, 6AW which were considered as pensionable salary. To bear on mind that 0.5AW is like the minimum wage amount. This set of pensionable salaries

aimed to reflect the high volatility in new forms of employment income. The source of the average wage was Statistics Portugal. As referred to in the literature review, the new forms of employment are characterized by employment patterns being discontinuous, intermittent, and non-conventional fixed term. Therefore, we also assume our case study male worker had multiple short and fragmented unemployment periods of different durations: 3, 6, and 9 months every year during all contributory careers. The concept of unemployment spell considered in our study encompasses the total number of months not worked in a civil year, regardless of them being occurred all at once or with employment periods between them. Since workers in new forms of employment have more difficulty achieving the minimum requirement to be covered by the social security unemployment program, we assume that there are no pension credits due to the unemployment spells in our study.

The future entitlements were calculated under current (2021) parameters and rules of pension models considered. For the calculation of pension entitlements, we used as the benchmark the current (2021) defined benefit (DB), Portuguese pension model, considering the above-described case study. Then, we compute the pension entitlement based on the other four models considered in our study for the same case study and analyze the impact of the change of pension model on the pension wealth. In the literature review, it is widely referred to that the pension entitlement is bigger for standard workers than for the non-standard workers, which the new forms of employment belong to (see, for example, Almeida, 2021; Bravo & Herce, 2020; Schoukens & Barrio, 2017) due to several elements already mentioned. For this reason, in our study we will focus on calculating the old-age pension for a worker in a new form of employment for several pension schemes without calculating the correspondent pension entitlement for a worker in a standard form of employment. Also aiming to compare the results obtained, in our study we consider the most of pension model considered in (Almeida, 2021).

Additionally, the following assumptions were used in the simulation of pension entitlements:

<u>Economic assumptions:</u>

Considering that the inflation rate estimated for the current (2021) year is highly influenced by the Covid-19 pandemic, in our study we consider the inflation rate to use as an average of the inflation rate verified in the last 10 years in Portugal. i.e., 1% p.a. The figure 1% was calculated using inflation rate p.a. available at PORDATA online portal information regarding the total inflation rate for Portugal between 2011 and 2020. Our study used as assumptions a real salary growth of 2% p.a. and pension growth of 1% p.a. The discount rate is assumed to be 2.75%. The inflation rate, real salary growth, pension growth, and discount rate are assumed uniform, which implies that every year these figures are the same.

For simplification purposes, the study considers that all contributions were made and refunded by the same pensioner individual hence the old-age benefit was not sponsored by an active member of the pension model implying no investment return.

Above mentioned assumptions and others used in calculation briefly summarized below:

Economic assumptions:

Inflaction rate (p.a):	1%
Real salary increase (p.a):	2%
Pension increase (p.a):	1.00%
Discount rate (p.a):	2.75%
Notional Interest rate (p.a.):	2%
Assumed rate of return	3.00%
Contribution rate:	17.21%
Contribution rate NDC	14.88%
Contribution rate DC	2.33%
Contribution rate DB+DC model-DB part:	5.93%
Contribution rate DB+DC model-DC part:	11.28%

Demographic assumptions:

The study assumes, for simplification purposes, that the only source of income during retirement is the pension entitlement provided by the pension model and that the worker retires at the current (2021) legal retirement age of 66 years and 6 months hence no penalties are applied in the pension entitlement. The study assumes that the average annual wage is 18.396€ (2020). The average annual wage for 2021 was not available yet at the time of the computation of pension entitlements and for reference purposes, the current (2021) minimum annual wage is 9.310€ (2021). To compute the pension wealth, we used the forecasted male Portuguese future mortality using Poisson Lee Carter stochastic mortality model and used it to estimate complete cohort life expectancies at the retirement age.

Plan rules

The plan rules for the selected pension models and respective parameters meaning of the models are explained detailed in the next subchapter.

Measures to validate the results and mathematical equations

To measure the impact of the pension model on the pension entitlement we considered two indicators: pension wealth expressed as multiple of gross annual individual earnings (PW as multiple of AE) at retirement age and actuarial fairness. Pension wealth is the actuarial present value of projected benefit at retirement age x. In our study, we choose pension wealth as a measure of pension entitlements rather than the commonly known replacement rate because pension wealth is a more comprehensive indicator (OECD, 2019). According to OECD (2019), pension wealth takes into account factors such as life expectancy, normal retirement age, and indexation of pension benefits that impact the length of pension benefit payments and its evolution over time, providing a full picture while replacement rates do not have these features.

We compute pension wealth expressed as multiple of gross annual individual earnings at retirement age using the following formula:

$$PW \ as \ multiple \ of \ AE = \frac{Pension \ wealth}{Gross \ Annual \ individual \ earnings \ at \ retirement \ age}. \qquad (4)$$

To simplify, now forward gross annual individual earnings will be referred to as annual individual earnings.

The concept of actuarial fairness used in this study follows the definition of Queisser & Whitehouse (2006), which states that actuarial fairness requires that the present value of working life contribution equals the present value of all pension benefit received. Following this definition, we compute actuarial fairness as:

$$Actuarial \ Fairness = \frac{Pension \ Wealth}{Accumulated \ comtribution \ at \ retirement \ age}. \qquad (5)$$

Please be aware that both measures will be analyzed with estimated values rather than actual values, that is, ex-ante.

3.3. PENSION SCHEMES DESIGN

As referred above, we considered five pension schemes to estimate the pension entitlements. For all five models considered in our study, we implemented in our computation a minimum old-age pension regardless of past earning level and depending only on the number of years of contributory career designed to ensure that pensioners achieve a minimum standard of living as defined in subchapter 3.2. Besides that, the pension benefit computed here are annual (monthly pension payable 14 times per year) and at retirement age. Below we will display in more detail the formulas used to do the calculation of the five pension schemes and of the additional retirement saving plan:

Portuguese defined benefit scheme

The Portuguese pension system was introduced in detail in subchapter 2.4.

Since the individual in our study started to work and signed into social security in 2010, the pension benefit (P) is calculated as follows:

$$P = RE \times A \text{ with } RE = TR/(n \times 14), \qquad (6)$$

where RE is the reference earnings; A is the accrual rate; TR is the total declared labour earnings during the entire contribution career, with a limit of 40 years and n is the number of contribution years (minimum of 15 years and maximum of 40 years).

The pension benefit P in Equation (6) assumes different formats depending on number of years worked (n).

If $n \leq 20, P = RE \times 2\% \times n$. Otherwise, that is, n>20, pension benefit P in Equation (6) is written according to Table 2:

Table 2 – Portuguese old-age pension formula for 21 or more years of contributions

Reference earnings (RE)	Pension benefit (P)
RE<=1.1IAS	RR×2,3%×n
1.1IAS<RE<=2	(1,1IAS×2,3%×n) + [(RR– 1,1IAS)×2,25%×n]
2<RE<=4	(1,1IAS×2,3%×n) + (0,9IAS×2,25%×n) + [RR–2 IAS)×2,2%×n]
4<RE<=8	(1,1IAS×2,3%×n) + (0,9IAS×2,25%×n) + (2IAS×2,2%×n) + [(RR–4 IAS)×2,1%×n]
RE>8	(1,1IAS×2,3%×n) + (0,9IAS×2,25%×n) + (2IAS×2,2%×n) + (4IAS×2,1%×n) + [(RR–8 IAS)×2%×n]

Source: Autor´s preparation based on Portuguese Social Security Institute, P.I. (ISS – *Instituto da Segurança Social*, I.P.) (2021) pratical guide[2] Notes: RE - reference earnings; n - number of contribution years (minimum of 15 years and maximum of 40 years) and IAS - *Indexante dos Apoios Sociais* (Social Support Index).

Since we assume that in our study, the individual retired at statutory retirement age, the sustainability factor is not applied in this situation.

Defined contribution scheme based on the Venezuelan model

To build up the defined contribution plan used in our study, we considered some of the features of the Venezuelan model for the old-age pension benefits according to Social Security Administration (2018c), according to which Venezuelan old-age pension scheme consists in a combination of basic amount benefit combined with a defined contribution plan covering the public and private sector workers and financed, at different level, by both employer and workers. For our study, we adapted the defined contribution plan to be in line with our demographic and economic assumptions resulting in the pension benefit (P) being calculated as follows:

$$P = \frac{AC_{ret}}{\ddot{a}_x^{d,p}} = \frac{\sum_{i=0}^{n} cw_i(1 + s_i)^{n-i}}{\sum_{t=0}^{\omega-x} \left(\frac{1+p}{1+d}\right)^t \times {}_t p_x}, \tag{7}$$

$$where \quad {}_t p_x = \prod_{j=0}^{t-1}(1 - q_{x+j,t+j}) \tag{8}$$

where AC_{ret} stands for accumulated contribution at retirement age; $\ddot{a}_x^{d,p}$ stands for life annuity due factor estimated using the cohort expected survival probabilities $({}_t p_x)$, the discount rate (d) mentioned in the subchapter 3.2 and pension increase rate (p) also mentioned above in the subchapter 3.2 considering the life table maximum age (ω); c stands for contribution rate; w_i stands for individual salary in year i and s_i stands for assumed return rate as defined in the subchapter 3.2.

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[2] See Centro Nacional de Pensões (2021).

Points scheme based on the German model

To develop the points scheme used in our study, we considered some of the features of this type of plan applied in the Germany´s mandatory public earnings related PAYG system financed by both employer and workers. According to *Pensions At A Glance 2019: Country Profiles - Germany* (2019) and Social Security Administration (2018a), in the German pension system, the pension benefit is obtained by multiplying pension points accumulated at retirement by a pension-point value. One pension point corresponds to a year´s contribution at the average earnings and its value can be less or more depending on lower or higher year´s contribution made, respectively. In the German pension system, the pension points are obtained by dividing earnings by the pension-point cost whereas in other countries the pension points are obtained by dividing contributions by the pension-point cost. German pension system has a maximum pay used to calculate contributions (ceiling wage). For our study, we adapted the points plan to be in line with our demographic and economic assumptions resulting in the pension benefit (P) being calculated as follows:

$$P = v_n \times Accumalated\ Points = v_n \times \sum_{i=0}^{n} \frac{w_i}{k_i}, \tag{9}$$

where v_n stands for the "pension-point value" at retirement age; w_i has the same meaning as above; k_i stands for the value of the pension-point in year i. To simplify, we assume that a year´s contribution at the average earnings (average earnings in current (2021) is €18,396) earns one "pension point" and that the starting "pension-point value" corresponds to 1% of the average earnings in current (2021). We use these references to obtain the pension point and "pension-point value" for our earning profiles, already including the breaks periods on employment. We also considered a ceiling wage to calculate the contributions in this plan. Namely, the ceiling wage corresponds to 2 times the average earnings in current (2021).

Notional DC supplemented by Funded DC based on the Swedish model

To create the notional DC supplemented by funded DC plan used in our study, we considered some of the features of the Swedish pension system, which encompasses a PAYG notional accounts (NDC) system and a statutory funded defined contribution (FDC) pension and a defined benefit (DB) means-tested (*Pensions At A Glance 2019: Country Profiles - Sweden*, 2019). The DB means-tested is a basic "guarantee pension" for individuals with low benefit amount from notional accounts and its coverage encompasses individuals with at least three years´ residency in Sweden. NDC and FDC coverage employed and self-employed individuals (Social Security Administration, 2018b). For our study, we include the NDC and FDC systems and adapted them to be in line with our demographic and economic assumptions resulting in the pension benefit (P) being calculated as follows:

$$P = P_{NDC} + P_{FDC}, \tag{10}$$

with

$$P_{NDC} = \frac{Accumulated\ Notional\ Balance}{\ddot{a}_x^{d,p}} = \frac{\sum_{i=0}^{n} cw_i \times (1 + r_i)^{n-i}}{\ddot{a}_x^{d,p}} \tag{11}$$

and

$$P_{FDC} = \frac{AC_{ret}}{\ddot{a}_x^{d,p}} = \frac{\sum_{i=0}^{n} cw_i(1 + s_i)^{n-i}}{\ddot{a}_x^{d,p}}, \tag{12}$$

.

where P_{NDC} is the pension benefit provided by NDC plan; P_{FDC} is the pension benefit provided by FDC plan; r_i is the notional interest rate in year i as defined in subchapter 3.2 and c, w_i, $\ddot{a}_x^{d,p}$ and s_i has the same meaning as in previous models.

In this plan, the contribution c to finance the pension benefit is 2.33% for FDC and 14.88% for NDC, summing up 17.21% of the contribution used for non-standard workers. In the Swedish pension model, the contributions for NDC and FDC are also 14.88% and 2.33%, respectively. Therefore, the NDC is the primary model and FDC is the secondary model.

Defined Benefit plus defined contribution based on the Indonesian and Ghanian models

To develop the defined benefit plus defined contribution scheme used in our study, we considered some features of the Indonesian pension system and Ghanian pension system. Both countries have a pension system that encompass hybrid defined benefit and defined contribution scheme (Guven, 2019; *Pensions At A Glance 2019: Country Profiles - Indonesia*, 2019). Indonesian pension system encompasses both an earnings-related social insurance scheme (defined benefit) and a defined contribution plan covering employees in private and public sectors (*Pensions At A Glance 2019: Country Profiles - Indonesia*, 2019). Besides that, it is not required retirement to receive the pension amount, that is, individuals may continue to work and receive pension benefit(*Pensions At A Glance 2019: Country Profiles - Indonesia*, 2019). Ghanian pension system encompasses a mandatory defined benefit public pension scheme and mandatory defined contribution occupational scheme privately managed both of them covering the public and private employees (*IOPS Member country or territory pension system profile: Ghana*, 2011). Both Indonesian and Ghanian pension systems have a maximum earnings amount used to calculate contributions - ceiling wage (Social Security Administration, 2019a; 2019b). For our study, we adapted the hybrid "DB+DC" plan to be in line with our demographic and economic assumptions resulting in the pension benefit (P) being calculated as follows:

$$P = P_{DB} + P_{DC}, \tag{13}$$

<u>with</u>

$$P_{DB} = 1\% * n * AE \tag{14}$$

and

$$P_{DC} = \frac{AC_{ret}}{\ddot{a}_x^{d,p}} = \frac{\sum_{i=0}^{m} c * \min(w_i, ceiling\ wage) * (1 + s_i)^{m-i}}{\ddot{a}_x^{d,p}}, \tag{15}$$

where P_{DB} is the pension benefit provided by DB plan; P_{DC} is the pension benefit provided by DC plan; n is the number of contribution years (minimum of 15 years and maximum of 40 years; AE is the

average declared labour earnings during the entire contribution career, with a limit of 40 years; AC_{ret} is the accumulated contribution at retirement age; $\ddot{a}_x^{d,p}$ is the life annuity due factor estimated as in previous models; c is the contribution rate; w_i is the individual salary in year i; ceiling wage is the maximum earnings amount used to calculate contributions; s_i is the assumed return rate as defined in the subchapter 3.2. In this hybrid plan, the contribution c to finance the pension benefit is 5.93% for DB and 11.28% for DC, summing up 17.21% of the contribution used for non-standard workers. The ceiling wage corresponds to 4 times the average earnings in current (2021) of €18,396.

To compute the pension wealth (PW) at retirement age x, we then multiply the pension benefit (P) at retirement age x estimated for each pension model by a life annuity due factor $\ddot{a}_x^{d,p}$, estimated using the discount rate (d)and pension increase rate (p) both mentioned above in this subchapter. To note that life annuity due factor $\ddot{a}_x^{d,p}$ is calculated as in the Equation 7 and Equation 8.

$$PW^x = P^x \times \ddot{a}_x^{d,p}. \tag{16}$$

The annuity factor estimated for our case study is 19.18.

When not mentioned, the contribution rate considered to calculate the contribution amount is 17.21% as defined in subchapter 3.2.

To simplify, when needed, now forward we will refer to the schemes without referring the countries used as reference to develop them.

Retirement saving plan (RSP)

This hypothetical retirement saving plan would be implemented by the government and it would be voluntary. According with its evolution, it may become progressively statutory. The members of this retirement saving plan would contribute 1%, 2% or 4% of yearly declared labour earnings during the entire contributory career, with a limit of 40 years and a minimum of 15 years, depending on if they are low (0.5AW and 0.75AW), average(1AW) or high (2.5AW and 6AW) earners, respectively. For members not able to use the proportion of the pay as contribution, it is also contemplated that the plan can be financed with credits acquired throughout the participation in several programmes (e.g., volunteering at hospitals and schools) within certain limit. By enrolling in this retirement saving plan, the participants would have the possibility of: (i) retiring earlier at 60 years and 6 months without penalty or (ii) retiring at normal retirement age (NRA) of 66 years and 6 months with 0.05%, 0.03% or 0.01% of the total contribution paid for the plan depending on if they are low (0.5AW and 0.75AW), average(1AW) or high (2.5AW and 6AW) earners, respectively. Note that when applying this additional product the income during retirement would include also the benefit provide by the RSP (in case of choose of that option) and pension entitlement provided by the pension model.

4. RESULTS AND DISCUSSION

In this section, we analyze the pension entitlements computed for each of five pension schemes considered in our study for a worker in a new form of employment focusing on one criteria each time: pension wealth (PW); pension wealth as multiple of annual individual earnings (PW as multiple of AE) and actuarial fairness. Besides that, we analyze the impact of the results of a retirement saving plan on the defined benefit (DB) pension scheme.

Pension wealth

In Figure 2, we display the pension wealth (PW) estimated for five pension schemes computed for a male worker in a new form of employment entering the labor market at age 22 in 2010 in Portugal for low (0.5AW and 0.75AW), average (AW) and high (2.5AW and 6AW) earnings profiles considering three different unemployment spells: 3-, 6- and 9-months for each year of the contributory career.

Figure 2 – Pension wealth (PW) for different pension schemes design and earnings profiles, by unemployment spells
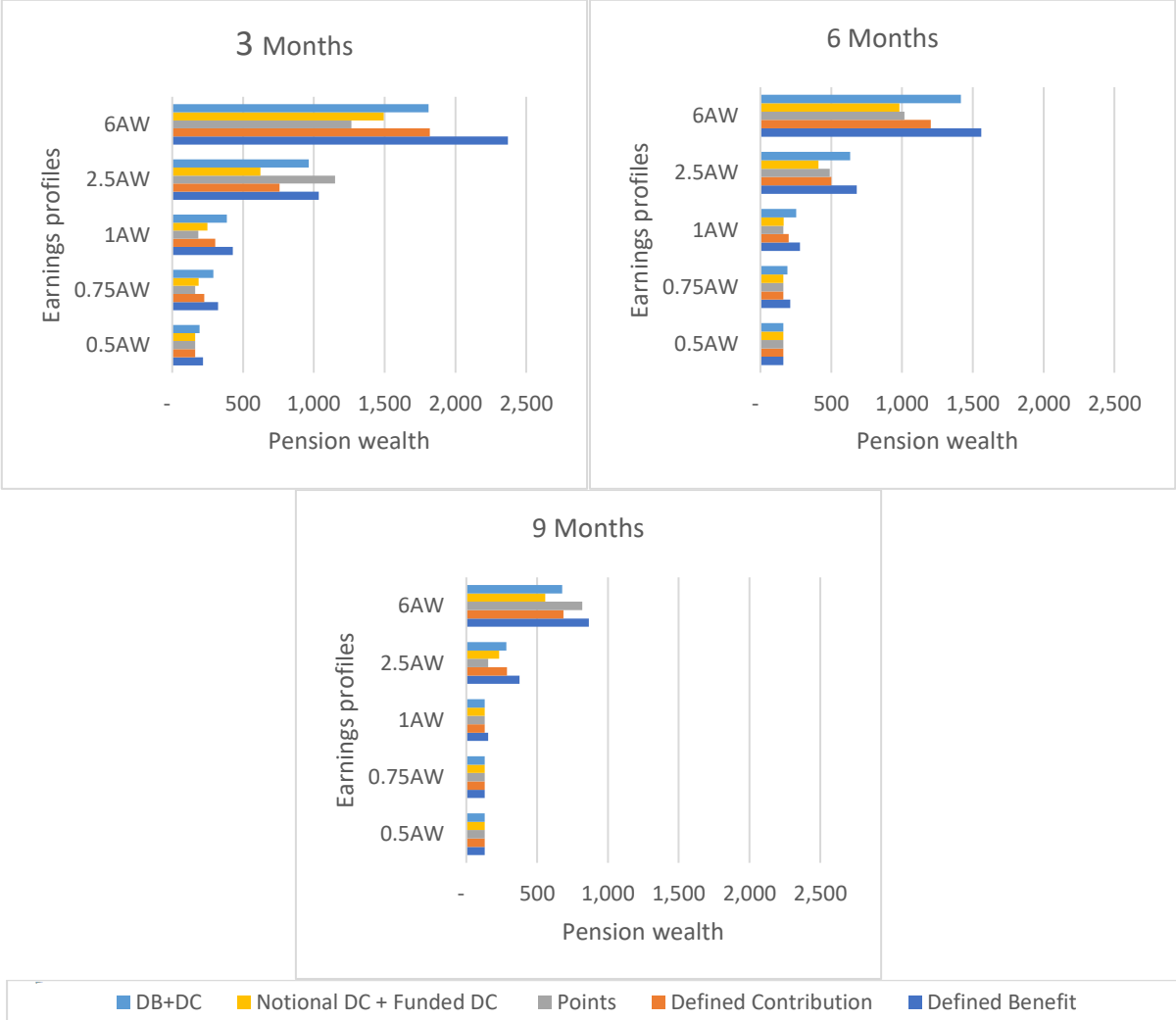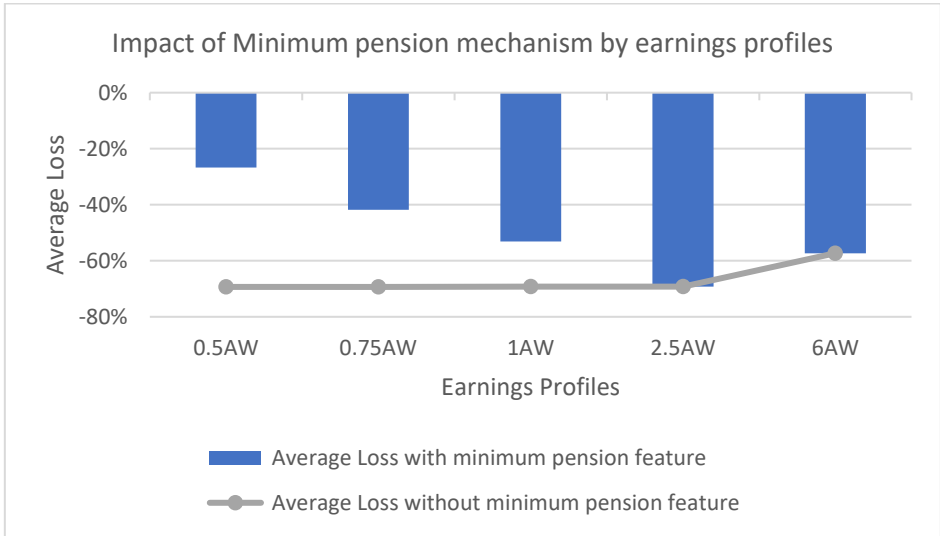

Source: Autor´s preparation

Notes: Pension wealth (PW) in EUR1,000; AW – average wage; DC – Defined Contribution; DB – Defined Benefit.

As expected, for all five pension schemes, the longer the unemployment spells´ duration, the smaller the pension entitlement estimated, regardless of the earning profile. This trend is verified due to the strong link between the level of benefit, contribution paid and years of contribution in every pension schemes considered in our study. For example, the pension entitlement of an average (AW) earner would decrease, on average, 53% if unemployment spell changes from 3- to 9-months per year. The negative correlation between pension entitlement and unemployment spell shown by our results is equal to the conclusion reached in previous studies (Bravo & Herce (2020); Almeida (2021)).

Such as in Bravo & Herce (2020), our results show that the impact of unemployment spells in the pension entitlements is smaller for the low and average earnings profiles than for high earnings profiles. The smaller impact of unemployment spells in the old-age pension benefit verified on the low and average earnings profiles is due to the implementation of a minimum pension in all five pension schemes regardless of the past earning level, known as the redistributive component of OCDE taxonomy of retirement-income programs or "zero pillar" concept of World Bank´s old age security. As shown in the figure above, for 0.5AW, 0.75AW and AW earnings profiles, in all three scenarios of unemployment spells, the pension wealth is below 500 thousand EURs but for 2.5AW and 6AW earnings profiles, the pension wealth decreases from around 2,500 thousand EURs on the 3 months unemployment spells per year to around 1,000 thousand EURs on the 9 months unemployment spells per year. Namely, for low and average earnings profiles, as the unemployment spells´ duration increases, the pension entitlement tends to the minimum pension culminating in the average earner – with 9 months unemployment spells per year - having the minimum pension for all pension schemes (except for defined benefit) of 129 thousand EURs.

To further enhance on the conclusion above, the graphic in the Figure 3 presents the average loss on the pension entitlements between 3- and 9-months unemployment spells per year for the five pension schemes with (assumption used in our study) and without minimum pension mechanism by earnings profiles.

Figure 3 – Pension wealth average losses between 3- and 9-months unemployment spells per year for all pension schemes with and without minimum pension mechanism, by earnings profiles

Source: Autor´s preparation
Notes: AW – average wage

As expected, the implementation of minimum pension mechanism significantly decreases the losses on the old-age benefit for low and average earns. More precisely, having minimum pension feature prevents lower earns (0.5AW) of losing on average 43% of their pension entitlements when unemployment spells´ duration increases from 3- to 9-months per year whereas the same feature has a null impact in a high earner since the loss with and without minimum pension feature is the same. According to Bravo & Herce (2020), the mitigating effects of redistributive component (such as minimum pension mechanism) of the Portuguese public PAYG schemes (defined benefit system) for low earnings profiles are neutralized by redistributive effect of heterogeneity in longevity.

To conclude, our results evidence that not only the defined benefit scheme is not well equipped for new forms of employment workers but also that other pension schemes here analyzed have the same fragility when confronted with earning instability, short and fragmented unemployment periods characteristic of new forms of employment workers similarly to previous studies results.

Pension wealth as multiple of annual individual earnings

In our study, the pension adequacy is measured by the indicator pension wealth as multiple of annual individual earnings (PW as multiple of AE). By pension adequacy we mean the capacity of the pension´s systems provide an old-age pension to a reasonable level. Due to positive correlation between replacement ratio and pension wealth relative to individual earnings, we assume that higher the PW as multiple of AE, better the adequacy of the pension scheme.

In Table 3, we report pension wealth relative to individual earnings for all five pension schemes and earnings profiles considering 3-, 6- and 9- months unemployment spells per year. The results in Table 3 evidence that pension wealth at individual earnings equal to average wage (AW) is highest for defined benefit at 15.4-, 17.1- and 18.9-times annual individual earnings for 3-, 6- and 9-months unemployment spells per year, respectively. Still considering the average wage, the lowest pension wealth for 3- and 6-months unemployment spells per year is found in points systems and for 9 months unemployment spells per year in all pension models (except defined benefit) at 6.6, 9.9 and 15.8, respectively. The lowest pension at 6.6 and 9.9 is due to low replacement rates. Like OECD (2019), the pension models incorporating defined benefit plan (in our study they are defined benefit and DB+DC) models present higher pension wealth relative to individual earnings, apart from some deviations on 9 months unemployment spells scenario.

Such as in OECD (2019), the results in Table 3 also show that pension wealth relative to individual earnings on average is higher for low earners (0.5AW) than for average earners (1AW). In our study, this trend is noticed for all pension schemes, being that the gap between the two values increases as the unemployment´s spells per year increase. This detail is because of higher individual replacement rates for low earners than for average earners due to the minimum pension mechanism and due to progressive benefit formula in case of DB scheme too. For example, for a worker having 3 months unemployment spells per year with low earn (0.5AW), pension wealth is 12.9 times his annual earning on average, compared with 11.1 times for a worker in same situation but now with average earn (AW) whereas for a worker having 9 months unemployment´s spells per year with low earn (0.5AW), pension wealth is 31.6 times his annual earning on average, compared with 16.4 times for a worker in same situation but now with average earn (1AW).

Table 3 – Pension wealth as multiple of annual earnings for different pension schemes design and earnings profiles, by unemployment spells

3 Months					
Model	**0.5AW**	**0.75AW**	**1AW**	**2.5AW**	**6AW**
Defined Benefit	15.6	15.5	15.4	14.9	14.2
Defined Contribution	11.6	10.9	10.9	10.9	10.9
Points	11.6	7.8	6.6	16.5	7.6
Notional DC + Funded DC	11.6	8.9	8.9	8.9	8.9
DB+DC	13.87	13.87	13.87	13.9	10.8
6 Months					
Model	**0.5AW**	**0.75AW**	**1AW**	**2.5AW**	**6AW**
Defined Benefit	19.9	17.2	17.1	16.7	16.0
Defined Contribution	19.9	13.2	12.3	12.3	12.3
Points	19.9	13.2	9.9	12.0	10.4
Notional DC + Funded DC	19.9	13.2	10.1	10.1	10.1
DB+DC	19.9	15.6	15.6	15.6	14.5
9 Months					
Model	**0.5AW**	**0.75AW**	**1AW**	**2.5AW**	**6AW**
Defined Benefit	31.6	21.1	18.9	18.4	17.6
Defined Contribution	31.6	21.1	15.8	14.0	14.0
Points	31.6	21.1	15.8	7.5	16.7
Notional DC + Funded DC	31.6	21.1	15.8	11.3	11.3
DB+DC	31.6	21.1	15.8	13.8	13.8

Source: Autor´s calculations

Notes: AW – average wage; DC – Defined Contribution; DB – Defined Benefit.

Like the results obtained by Almeida (2021), for the pension models with a ceiling amount for higher earnings profiles– which in our study are points system and DB+DC model – the PW as multiple of AE for higher earners (6AW) is smaller or equal to the previous earn profile (2.5AW), except in the 9 months unemployment spells per year for points system.

Comparing our results with the ones obtained by OECD (2019), pension wealth relative to individual earnings tends to be higher in our study than in OECD (2019). This fact is mostly explained by the fact that in our calculations we assume shorter and fragmented unemployment spells over the course of the contributory career without coverage by the unemployment program whereas OCDE calculations assume a full career with mechanism in place to protect the pension entitlements for periods spent out of paid work including unemployment.

In summary, considering the pension adequacy, pension schemes incorporating defined benefit plan seem to produce higher old-age pension and therefore being more adequate within all five pension schemes even with the fragilities mentioned on the previous section. Will our next indicator support this conclusion?

Actuarial fairness

In our study, the pension schemes´ financial sustainability is measured by the indicator actuarial fairness, which represents the equilibrium between the old-age pension received during the length of retirement – until death for all five plans – and the contribution made during the working lifetime. Considering the mathematical equation used in our study to calculate this indicator (Equation 5), the closer the actuarial fairness is to value 1, better the financial sustainability of the pension schemes.

In Figure 4, we represent the actuarial fairness estimated for all five pension schemes and earnings profiles considering 3-, 6- and 9 months unemployment spells per year. As illustrated in the figure below, defined contribution scheme presents better equilibrium between benefit received and contribution paid. Despite notional DC + funded DC scheme having actuarial fairness equal to one for higher earn level as defined contribution plan, for lower earn levels the actuarial fairness tends to be further away from 1 than for defined contribution plan, trend that become more evident as the unemployment´s spells increase. These results are explained by the fact that in DC plans the workers bear the heavy part of the risk and that under NDC plans the paid contributions are not capitalized. Contrarily, defined benefit plan presents consistently higher actuarial fairness. Namely, actuarial fairness being 1.5 for DB model on average implies that the old-age pension received during the length of retirement is higher than the contribution made during the working lifetime putting on check, in the long run, the financial sustainability of the defined benefit scheme. The worst equilibrium between benefit received and contribution paid in DB plans results mostly from the fact that they have progressive benefit formulas embedded in their pension benefit calculations. Similar conclusions were obtained by Almeida (2021).

By combining DB and DC plans (DB+DC model), the DC component of the model helps to become the scheme more actuarial fair, keeping a similar pension adequacy compared to the DB model except for 9 months unemployment spell per year scenario for higher earners (as shown in Table 3). For example, as plot in the figure below for 6 months unemployment spell per year scenario, the DB and DB+DC models have similar actuarial fairness for lower (0.5AW) and high (2.5AW) earnings profiles, but in-between DB+DC model presents a better actuarial fairness, that is, closer to 1.

Such in Almeida (2021), our plots also evidence lower equilibrium for lower earning profile (actuarial fairness farthest from 1) and a higher equilibrium for higher earning profile (actuarial fairness closest from 1) (except for points system), element that become more accentuate as the unemployment´ spells increase. This detail is due to the redistributive features of the models. The difference between the actuarial fairness for lower and higher earner is smaller for models with DB plan (DB and DB+DC) than for models with DC component (DC and NDC+FDC) implying considerable smaller redistribution in defined benefits plans. For example, for 6 months unemployment spell per year scenario, this gap is -20% for DB model and -49% for Notional DC + Funded DC model. Besides that, new forms of employment workers - characterized by shorter, fragmented, and lower pay - have more difficulties to reach the minimum pension threshold, even for average earning profile, than a non-standard worker as the unemployment´ spells increase. For example, for 9 months unemployment spells per year scenario, the average earner does not reach the minimum threshold in four of the five pension schemes (as shown in Table 3) implying that the redistributive mechanism affects the actuarial fairness for an average worker as well.

The points system stands out on the plots in the figure below by presenting trends different from the other models. The lower equilibrium for higher earnings profiles is due to the ceiling amount used on the model and higher equilibrium for the average earner than the other earnings profiles is because of the average earner is less or not affected by the redistributive mechanism or the celling amount. For example, for 6 months unemployment spell per year scenario, the actuarial fairness is 0.9 for average earner and the actuarial fairness is 1.7 and 1.8 for lower and higher earner, respectively.

Figure 4 – Actuarial Fairness for different pension schemes design and earnings profiles, by unemployment spells
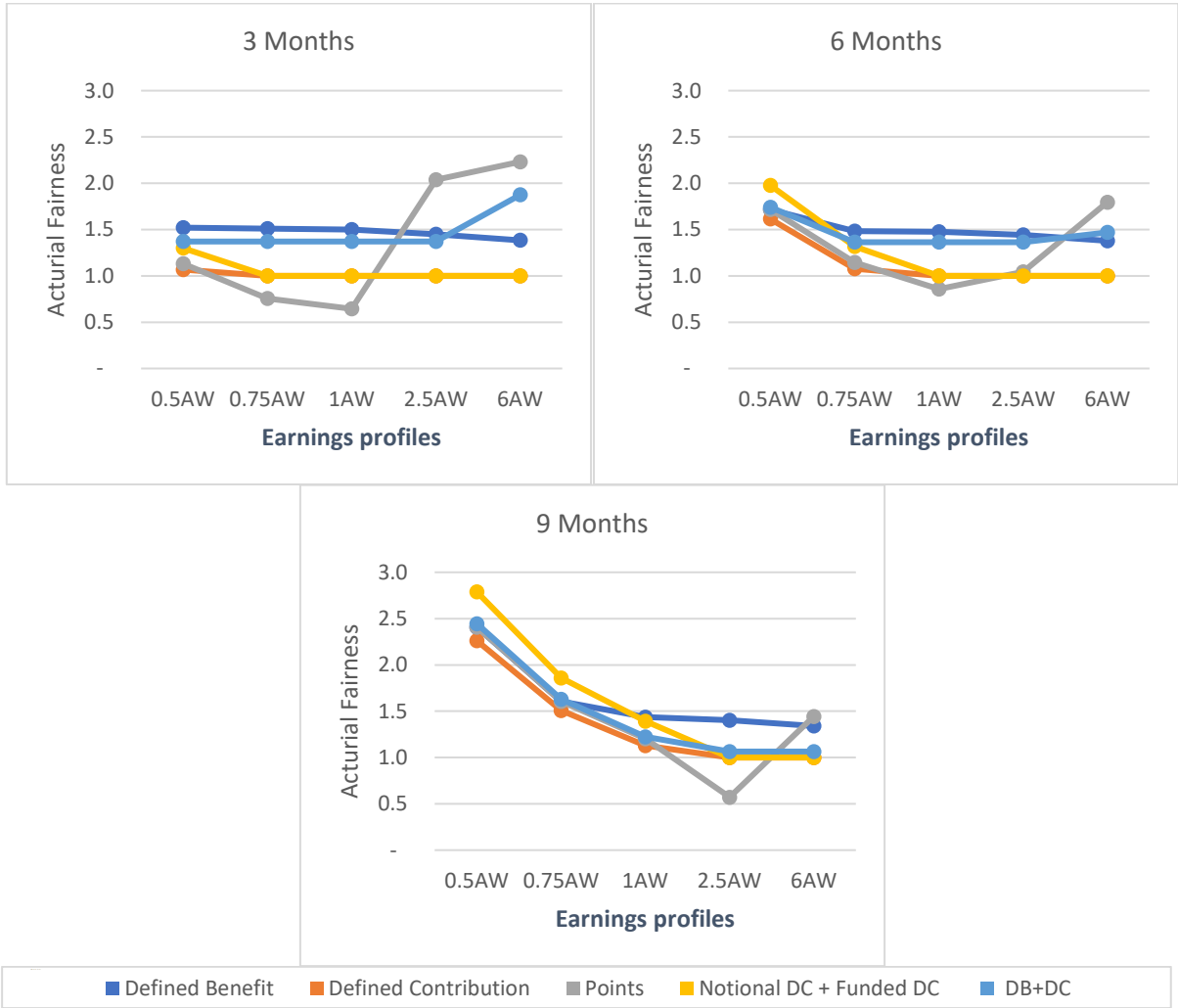
Source: Autor´s preparation

Notes: AW – average wage; DC – Defined Contribution; DB – Defined Benefit.

In summary, the results show that DC model is the one with better financial sustainability and DB model is the one with worst financial sustainability. Therefore, actuarial fairness indicator highlighted the bigger issues with DB models –notable unfair balance between contributions paid and benefits paid and low level of redistribution – hence this indicator do not reinforce the conclusion on the previous section.

Retirement saving plan

To tackle the major issues of defined benefit (DB) models mentioned above, we create and apply a retirement saving plan. We apply this retirement saving plan to our case study model, which implies that the individual retired at retirement age and had an extra pension benefit amount. In Table 4, we report the actuarial fairness of the DB plan with and without the impact of the results of the retirement saving plan considering that the worker chooses to retire at normal retirement age for all earnings profiles and for all three unemployment spells´ scenario.

As shown in the table below, the implementation of the proposal retirement saving plan contribute to improve the financial sustainability of the DB scheme due to the approximation of the actuarial fairness indicator to 1, evidencing a better equilibrium between the contribution paid and benefit received. For example, in the 6 months unemployment spells scenario, the actuarial fairness change from 1.4 to 1.1 for higher earner (6AW) due to the application of the retirement saving plan. This detail is due to the increase in the contribution paid as an opportunity to retire earlier or to retire at normal retirement age with an extra amount of benefit.

Besides that, the implementation of the retirement saving plan contributes to increase the level of redistribution of the defined benefit model since the difference between the actuarial fairness for lower and higher earner become higher. For example, in the 3 months unemployment spells scenario, without the retirement saving plan, the actuarial fairness is very similar to both lower (0.5AW) earner as for higher earner (6AW) (1.5 and 1.4 respectively) whereas with the implementation of retirement saving plan the actuarial fairness for lower (0.5AW) and higher (6AW) earner differ more (1.4 and 1.1 respectively).

Table 4 – Actuarial Fairness of defined benefit plan with and without retirement saving plan for all earnings profiles, by unemployment spells

3 Months					
	0.5AW	**0.75AW**	**1AW**	**2.5AW**	**6AW**
Actuarial Fairness with RSP	1.4	1.4	1.3	1.2	1.1
Actuarial Fairness without RSP	1.5	1.5	1.5	1.4	1.4
6 Months					
	0.5AW	**0.75AW**	**1AW**	**2.5AW**	**6AW**
Actuarial Fairness with RSP	1.6	1.4	1.3	1.2	1.1
Actuarial Fairness without RSP	1.7	1.5	1.5	1.4	1.4
9 Months					
	0.5AW	**0.75AW**	**1AW**	**2.5AW**	**6AW**
Actuarial Fairness with RSP	2.3	1.5	1.3	1.1	1.1
Actuarial Fairness without RSP	2.4	1.6	1.4	1.4	1.3

Source: Author´s calculation

Notes: RSP – retirement saving plan; AW – average wage.

Additionally, to contemplate the possibility of the individual choosing to retire earlier at 60 years and 6 months without penalty, we simulate that scenario and the actuarial fairness indicator for

the defined benefit scheme is very similar to the ones provide in the table above despite those results not being displayed in this document. By participating in the retirement saving plan and retire earlier the worker would not lose 36% of the pension benefit due to the reduction of 0.5% for each month anticipated compared to the normal retirement age (in this case would be an anticipation of 72 months) or at least 15.5% of the pension benefit due to application of the sustainability factor.

In summary, the implementation of the proposal retirement saving plan would contribute not only for improving the financial sustainability of the defined benefit plan but also to prevent loss of income at retirement.

5. CONCLUSIONS

In this study, the goal is to evaluate the pension wealth provided by a different pension schemes design for new forms of employment in Portugal. To achieve this goal, we project the future mortality rates and derive cohort life expectancy for the male Portuguese population using Poisson Lee-Carter stochastic mortality model and then compute the pension wealth for five design of pension schemes.

We compare the results of pension wealth for defined benefit (DB), defined contribution (DC), points, notional DC supplemented by funded DC and DB complemented by DC using the criteria pension wealth as multiple of annual individual earnings (PW as multiple of AE) to analyze the pension adequacy and actuarial fairness to evaluate the financial sustainability.

We find that not only the defined benefit but also the others four pension schemes design are not well designed to address the earning instability, short and fragmented unemployment periods characteristic of new forms of employment workers. PW as multiple of AE indicates that pension schemes incorporating defined benefit plan seem to produce higher old-age pension and therefore being the more adequate within all five pension schemes. However, actuarial fairness indicates that DC model is the one with better financial sustainability and DB model is the one with worst financial sustainability. A well-designed pension scheme needs a fair balance between the pension adequacy and financial sustainability of the scheme with a holistic approach, but our results do not support this theory. Despite that, the pension scheme design where this equilibrium seems to be more evident is the DB complemented by DC model even though the actuarial fairness still tends to be high, except in the more extreme unemployment spell duration for high earners.

Additionally, the application of a retirement saving plan in the defined benefit scheme shows not only the improvement of the financial sustainability of the defined benefit plan but also the prevention of loss of income at retirement hence being advantages for government as well for the participants. However, the proposal retirement saving plan is merely hypothetical and small change in its assumptions may alter the results or its initial purpose hence careful and a good financial literacy are very important factors to have into consideration in a future implementation of this product. Besides that, this product is voluntary so its successful is also related with the level of subscriptions. In line with literature review, our results evidence the importance of reinforcing and developing alternatives sources of income in retirement for workers in the new forms of employment, namely for those with lower earnings. Not only the governments/pension market but also the citizens would take advantages from this development.

The main limitations of this study are related with being a case study for only a male worker (hence no gender impact is analyzed and the sample is very small) and the fact that changes in the limited range of assumptions (financial and demographic) used can affect the results obtained. Besides that, a pension scheme design should fit both standard and non-standard workers and a change in the parametric of the pension models can also impact the results obtained. Regarding recommendations about future works, a future line of work could be understanding gender impact by including in the sample both female and male new forms of employment workers. It would be also interesting to perform market research to access the viability of implementation of the additional product presented in this study on the workers perspective. Another study would be to apply the proposal retirement saving plan in another pension schemes design. Note that R scripts will be provided upon request.

6. BIBLIOGRAPHIC REFERENCES

Almeida, P. M. S. S. (2021). *Future of Work and Pension Design: Portuguese Pension System* [Nova University of Lisbon - NOVA Information Management School (NIMS)]. http://hdl.handle.net/10362/114352

Barr, N. (2000). *Reforming Pensions: Myths, Truths, and Policy Choices*. https://www.imf.org/external/pubs/ft/wp/2000/wp00139.pdf

Barr, N., & Diamond, P. (2008). *Reforming Pensions: Principles and Policy Choices*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195311303.001.0001

Bravo, J. M. (2012a). Sistemas de Segurança Social em Portugal: Arquitectura de um Novo Modelo Social e Contributos para o Debate sobre a Reforma do Regime de Pensões. *Associação Portuguesa de Estudos Sobre Aforro, Investimento e Pensões de Reforma*, *Dezembro*. http://www.apfipp.pt/backoffice/box/userfiles/file/Relatório_APFIPP_Part2_Final.pdf

Bravo, J. M. (2012b). Sustentabilidade Financeira dos Sistemas Públicos de Segurança Social em Portugal: Situação Actual e Análise Prospectiva. *Associação Portuguesa de Estudos Sobre Aforro, Investimento e Pensões de Reforma*, *Dezembro*. http://www.apfipp.pt/backoffice/box/userfiles/file/Relatório_APFIPP_Part1_Final.pdf

Bravo, J. M. (2015). Reforma Estrutural dos Sistemas de Pensões. In S. M. Viriato & P. T. Pereira (Eds.), *Afirmar o Futuro: Políticas Públicas para Portugal, Volume I - Estado, Instituições e Políticas Sociais* (pp. 264–329). Fundação Calouste Gulbenkian. https://bibliografia.bnportugal.gov.pt/bnp/bnp.exe/registo?1910940

Bravo, J. M. (2016). Taxation of Pensions in Portugal: A Semi-Dual Income Tax System. *CESifo DICE Report*, *14*(1), 14–23. https://www.ifo.de/en/node/28275

Bravo, J. M. (2018). Taxation of Pensions in Portugal: Is There a Rationale for a Semidual Income Tax System? In R. Holzmann & J. Piggott (Eds.), *The Taxation of Pensions* (pp. 135–166). The MIT Press. https://doi.org/10.7551/mitpress/11593.003.0010

Bravo, J. M. (2019). Funding for longer lives: Retirement wallet and risk-sharing annuities. *Ekonomiaz. Basque Economic Review*, *96*(2), 268–291. http://hdl.handle.net/10362/92271

Bravo, J. M. (2021). Pricing participating longevity-linked life annuities: a Bayesian Model Ensemble approach. *European Actuarial Journal*, 1–35. https://doi.org/10.1007/s13385-021-00279-w

Bravo, J. M., Afonso, L., & Guerreiro, G. (2013). *Avaliação Actuarial do Regime de Pensões da Caixa Geral de Aposentações: Formulação Actual e Impacto das Medidas Legislativas*. https://novaresearch.unl.pt/en/publications/avaliação-actuarial-do-regime-de-pensões-da-caixa-geral-de-aposen

Bravo, J. M., & Ayuso, M. (2020). Previsões de mortalidade e de esperança de vida mediante combinação Bayesiana de modelos: Uma aplicação à população portuguesa. *RISTI: Revista Ibérica de Sistemas e Tecnologias de Informação*, *40*, 128–143. https://doi.org/10.17013/risti.40.128-145

Bravo, J. M., & Ayuso, M. (2021). Forecasting the Retirement Age: A Bayesian Model Ensemble Approach. In Á. Rocha, H. Adeli, G. Dzemyda, F. Moreira, & A. M. R. Correia (Eds.), *Trends and Applications in Information Systems and Technologies: Vol. 1365 AIST* (pp. 123–135). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-030-72657-7_12

Bravo, J. M., Ayuso, M., Holzmann, R., & Palmer, E. (2020). Addressing the Life Expectancy Gap in Pension Policy. *Insurance: Mathematics and Economics*, *99*, 200–221. https://doi.org/10.1016/j.insmatheco.2021.03.025

Bravo, J. M., & Freitas, N. E. M. D. (2018). Valuation of longevity-linked life annuities. *Insurance: Mathematics and Economics*, *78*, 212–229. https://doi.org/10.1016/j.insmatheco.2017.09.009

Bravo, J. M., Guerreiro, G., & Afonso, L. (2014). *Avaliação Actuarial do Sistema Previdencial da Segurança Social e Prestação Única da Segurança Social*. https://www.cidadaniasocial.pt/wp-content/uploads/2017/07/Avaliação-Actuarial-Sistema-Previdencial-Segurança-Social-GEP-MESS-Junho-2015.pdf

Bravo, J. M., & Herce, J. A. (2020). Career breaks, broken pensions? Long-run effects of early and late-career unemployment spells on pension entitlements. *Journal of Pension Economics and Finance*, 1–27. https://doi.org/10.1017/S1474747220000189

Bravo, J. M., & Nunes, J. P. V. (2021). Pricing longevity derivatives via Fourier transforms. *Insurance: Mathematics and Economics*, *96*(January), 81–97. https://doi.org/10.1016/j.insmatheco.2020.10.008

Brouhns, N., Denuit, M., & Vermunt, J. K. (2002). A Poisson Log-Bilinear Regression Approach to the Construction of Projected Life Tables. *Insurance: Mathematics and Economics*, *31*, 373–393. https://doi.org/10.1016/S0167-6687(02)00185-3

Caixa Geral de Aposentações. (2020). *Relatório e Contas da Caixa Geral de Aposentações – 2020*. https://www.cga.pt/relatoriocontas.asp

Centro Nacional de Pensões. (2021). *Guia Prático – Pensão de Velhice (7001 – v4. 56)*. www.seg-social.pt,

Choudary, S. P. (2015). *Platform Scale: How an emerging business model helps startups build large empires with minimum investment*. Platform Thinking Labs Pte. Ltd. https://www.pdfdrive.com/platform-scale-how-an-emerging-business-model-helps-startups-build-large-empires-with-minimum-investment-e196426028.html

Conde-Ruiz, J. I., & González, C. I. (2016). From Bismarck to Beveridge: the other pension reform in Spain. *SERIEs: Journal of the Spanish Economic Association*, *7*(4), 461–490. https://doi.org/10.1007/s13209-016-0148-3

Eurofound. (2015). *New forms of employment*. https://doi.org/10.2806/688041

Eurofound. (2020). *New forms of employment: 2020 update*. https://doi.org/10.2806/177981

Freitas, N. E. M. D., & Bravo, J. M. (2021). Drawing Down Retirement Financial Savings: A Welfare Analysis using French data. In *2021 The 5th International Conference on E-Commerce, E-Business and E-Government (ICEEG '21)* (pp. 152–158). Association for Computing Machinery (ACM). https://doi.org/10.1145/3466029.3466041

Freitas, N. E. M. D., Duc, C., Briard, K., Mage, S., & Legendre, B. (2011). Career interruptions: How do they impact pension rights. *Geneva Papers on Risk and Insurance: Issues and Practice*, *36*(3), 440–457. https://doi.org/10.1057/gpp.2011.12

Freitas, N. E. M. D., & Martins, J. O. (2014). Health, pension benefits and longevity: How they affect household savings? *Journal of the Economics of Ageing*, *3*, 21–28. https://doi.org/10.1016/j.jeoa.2014.03.001

Guven, M. (2019). *Extending Pension Coverage to the Informal Sector in Africa* (Issue 1933). https://doi.org/10.1596/32179

Holzmann, R., Ayuso, M., & Bravo, J. M. (2019). *Making use of Home Equity: The Potential of Housing Wealth to Enhance Retirement Security* (No. 12656; IZA Discussion Papers). https://ideas.repec.org/p/iza/izadps/dp12656.html

Holzmann, R., & Piggott, J. (2018). *The Taxation of Pensions*. The MIT Press. https://doi.org/10.7551/MITPRESS/11593.001.0001

International Labour Office. (2016). *Non-standard employment around the world: Understanding challenges, shaping prospects*. www.ifrro.org

IOPS Member country or territory pension system profile: Ghana, (2011). http://www.iopsweb.org/resources/49669146.pdf

Kolmar, M. (2007). Beveridge versus Bismarck public-pension systems in integrated markets. *Regional Science and Urban Economics*, *37*(6), 649–669. https://doi.org/10.1016/j.regsciurbeco.2007.01.003

Ochel, W. (2008). Bismarck versus Beveridge: a comparison of social insurance systems in Europe. *CESifo DICE Report - Journal for Institutional Comparisons*, *6*(4), 69–71. https://www.ifo.de/en/node/29191

OECD. (2005). *Pensions at a Glance: public policies across OECD countries*. https://doi.org/10.1787/pension_glance-2005-en

OECD. (2019). *Pensions at a Glance 2019: OECD and G20 Indicators*. https://doi.org/10.1787/b6d3dcfc-en

OECD iLibrary. (2021). *OECD Pensions at a Glance*. https://www.oecd-ilibrary.org/finance-and-investment/oecd-pensions-at-a-glance_19991363

Parker, G. G., Alstyne, M. W. V., & Choudary, S. P. (2017). *Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You*. WW Norton & Co. https://www.pdfdrive.com/platform-revolution-how-networked-markets-are-transforming-the-economy-and-how-to-make-them-work-for-you-e195137657.html

Pensions At A Glance 2019: Country Profiles - Germany, (2019). https://www.oecd.org/els/public-pensions/PAG2019-country-profile-Germany.pdf

Pensions At A Glance 2019: Country Profiles - Indonesia, (2019). https://www.oecd.org/els/public-pensions/PAG2019-country-profile-Indonesia.pdf

Pensions At A Glance 2019: Country Profiles - Sweden, (2019). https://www.oecd.org/els/public-pensions/PAG2019-country-profile-Sweden.pdf

Queisser, M., & Whitehouse, E. (2006). *Neutral or Fair? Actuarial Concepts and Pension-System Design* (No. 40; OECD Social, Employment and Migration Working Papers). https://doi.org/10.1787/351382456457

Reis, L. P. S. D. (2018). *Projeção da Mortalidade Portuguesa por meio dos Modelos Generalizados de Idade-Período-Coorte* [Nova University of Lisbon - NOVA Information Management School (NIMS)]. http://hdl.handle.net/10362/62523

Schoukens, P., & Barrio, A. (2017). The changing concept of work: When does typical work become atypical? *European Labour Law Journal*, *8*(4), 306–332. https://doi.org/10.1177/2031952517743871

Social Protection Committee (SPC), & European Commission (DG EMPL). (2018a). *The 2018 Pension Adequacy Report: current and future income adequacy in old age in the EU* (Vol. 2). https://doi.org/10.2767/653851

Social Protection Committee (SPC), & European Commission (DG EMPL). (2018b). *The 2018 Pension Adequacy Report: current and future income adequacy in old age in the EU* (Vol. 1). https://doi.org/10.2767/406275

Social Security. (2022). *Estatísticas*. https://www.seg-social.pt/estatisticas-detalhe/-/asset_publisher/GzVIhCL9jqf9/content/pensoes-de-velhice

Social Security Administration. (2018a). *Social Security Programs Throughout the World: Europe, 2018 - Germany*. https://www.ssa.gov/policy/docs/progdesc/ssptw/2018-2019/europe/germany.html

Social Security Administration. (2018b). *Social Security Programs Throughout the World: Europe, 2018 - Sweden*. https://www.ssa.gov/policy/docs/progdesc/ssptw/2018-2019/europe/sweden.html

Social Security Administration. (2018c). *Social Security Programs Throughout the World: The Americas, 2017 - Venezuela*. https://www.ssa.gov/policy/docs/progdesc/ssptw/2016-2017/americas/venezuela.html

Social Security Administration. (2019a). *Social Security Programs Throughout the World: Africa, 2019 - Ghana*. https://www.ssa.gov/policy/docs/progdesc/ssptw/2018-2019/africa/ghana.html

Social Security Administration. (2019b). *Social Security Programs Throughout the World: Asia and the Pacific, 2018 - Indonesia*. https://www.ssa.gov/policy/docs/progdesc/ssptw/2018-2019/asia/indonesia.html

University of California Berkeley (USA), & Max Planck Institute for Demographic Research (Germany). (2021). *Human Mortality Database*. https://www.mortality.org/

Williamson, J. B., & Williams, M. (2003). *The Notional Defined Contribution Model: An Assessment of the Strengths and Limitations of a New Approach to the Provision of Old Age Security* (No. 18; World Paper 2003). https://crr.bc.edu/working-papers/the-notional-defined-contribution-model-an-assessment-of-the-strengths-and-limitations-of-a-new-approach-to-provision-of-old-age-security/

World Bank. (1994). *Averting the old age crisis: policies to protect the old and promote growth*. https://doi.org/10.1596/0-8213-2970-7

World Bank. (2008). *The World Bank Pension Conceptual Framework*. http://hdl.handle.net/10986/11139