ARC Centre of Excellence in Population Ageing Research

Working Paper 2016/21

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THE EFFECT OF LABOUR TRANSITIONS IN PUBLIC PENSION FINANCING: A CASE STUDY FOR SPAIN

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ABSTRACT

The recent global financial crisis has intensified the public debate on the sustainability of pay-as-you-go pension schemes. The economic risk is expanding the effects of the already existent demographic risk in most European countries. Our objective is to analyse the effect of the alarming unemployment and inactivity patterns in Spain observed in the period 2008 to 2016 on the income from contributions and pension expenditures with respect to the GDP by using the Aggregate Accounting framework. We analyse the pension expenditures for the current pattern as well as for full employment and conclude that while the economic risk outweighs the demographic risk until 2040, the main driver of expenditures lies in the ratio of pensioners to working age population in the long run. Our results raise the need to tackle the current labour market situation and confirm that the most recent reforms made in Spain don't suffice to attain sustainability in the long run.

Keywords: Labour market, Labour Force Survey, Aggregate Accounting, Sustainability, Pay-as-you-go, Public pension

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1. Introduction

Public pension schemes in most European countries, including Spain, are pay-as-you-go financed, that is, the income from contributions is used to finance the pension expenditures, and have a defined benefit formula. However, the increase in life expectancy combined with a decrease in fertility rates is compromising their fiscal sustainability (Celentani *et al*., 2007, OECD, 2015). Recent studies from national and international government bodies show that Spain will face a substantial increase in pension expenditures which won't be compensated by a proportional increase in the income from contributions (Kingdom of Spain, 2014, 2016). For instance, the 2015 Ageing Report from the European Commission estimates that the pension expenditures as a percentage of the GDP will reach the level of 12,5 percent by 2045.

The recent financial crisis has intensified the public debate on the sustainability of both pay-as-you-go and funding public pension schemes, as seen in Rosado and Alonso (2015), because the economic risk is expanding the effects of the already present demographic risk. Spain has experienced a dramatic decrease of births per woman since 1960 attaining a record low of 1.23 birth per woman in 2000 and is among the European countries with the highest life expectancy (Eurostat, 2015). This leads to a decreasing ratio of employed to retirees as less individuals enter the system and they do it at later ages. In particular, the combination of ageing and decrease in economic growth with an increase in unemployment, public debt and market volatility is challenging the payment of pension entitlements in Spain as well as other European countries (Guillén, M. *et al.*, 2010).

The literature on the impact of ageing on the pay-as-you-go expenditures in Spain has been extensive in the last decade (some good examples can be read in Alonso & Herce, 2003; Comité de Política Económica, 2006; Balmaseda *et al*., 2006, or Conde Ruiz & Alonso, 2006). This literature makes usage of the Aggregate Accounting method, extensively used in the analysis of fiscal sustainability (Roseveare *et al*., 1996; Boldrin *et al*., 1999; Dang *et al.,* 2004, or Jimeno *et al*., 2008). It consists of studying the pension expenditures as a proportion of the GDP by analysing three different ratios: the pensioners to working age population, the inactivity rate, which represents the inverse to the activity rate, and the benefit ratio which relates the mean pension to the mean wage. All these studies conclude that ageing will increase the ratio of pension expenditures to the GDP to unsustainable levels. The main driver for this aggravation lies in the strong growth of the old-age dependency ratio as the other ratios will remain stable.

When analysing the impact of economic risk in public pension schemes, a closer look to labour participation is needed. Spain has experienced a great increase in the unemployment rate as a consequence of the global financial crisis. The unemployment rate increased from 13.30 percent in 2007 to 26.30 percent in 2013, stabilizing to 21 percent by 2016 (Labour Force Survey (2016), LFC). This trend has decreased the income from contributions by 7.1

percent between 2008 and 2015 while expenditures increased by 36.5 percent, setting the liquidity ratio[2] to 86.9 percent in 2015 (Ministry of Employment and Social Security, 2016).

The Spanish labour market has been widely studied by making usage of the longitudinal database Working Life Continuous Sample (Muestra Continua de Vidas Laborales) in the last decade. The seminal work of Toharia (1998), started this strand of literature in Spain by analyzing the driving factors of the Spanish labour market. Others studied the costs of hiring and dismissals (Malo and Toharia, 1999a, 1999b) effects of reforms in the labour market (Kugler et al., 2002, or Malo and Toharia, 2009), or the drivers and trends related to the entries to labour market (Cebrián et al., 2009, and Llorente et al., 2009). Few have studied the effects of labour market transitions in the public pension scheme, and some (as seen in Rosado et al., 2015) studied the internal rate of return of the system for individuals with heterogeneous careers.

The objective of this paper is to analyse the effect of the levels of unemployment and inactivity after the global financial crisis in Spain on the income from contributions and pension expenditures as a percentage of the GDP by using the Aggregate Accounting framework abovementioned. The framework studied considers the latest pension reforms that have been put in place in Spain in 2011 and 2013. The analysis is performed by considering the transition probabilities between two contributory states (employment and unemployment) and one non-contributory state (inactivity), as calibrated from the cross-sectional data stemming from the Labour Force Survey (LFC) for the post-crisis period 2008 to 2016 . By taking these transitions into account in our endogenous model, the cash flows related to the income and expenditures will become more realistic, producing more insightful estimates of the future pension expenditures burden. This innovative approach is a novelty in pension economics to the best of the authors' knowledge.

The remainder of the paper is structured as follows. First, the Spanish pension system and the most recent reforms will be briefly described. Then we will explain the Aggregate Accounting methodology, the LFC database as well as the multinomial logit used to calibrate our multi-state model. The hypothesis taken and the numerical results follow and the conclusions and appendix conclude.

2. The Spanish pension system

The Spanish public pension scheme is a pay-as-you-go financed, defined benefit scheme. Despite of the fact that individuals don't have individual accounts which are funded with their own contributions, like in funded pension schemes, the pension received is a function of the level of contributions made during their whole career. The accumulation of pension entitlements for both contributors and retirees creates an implicit debt which has to be

[2] The liquidity ratio is defined as the ratio between the income from contributions and pension expenditures, in the line of the works of Haberman and Zimbidis (2002), Gannon *et al*. (2014), Godínez-Olivares *et al*. (2016) and Alonso-Garcia and Devolder (2016).

financed (Holzmann et al., 2004). One of the main drivers of the pension liabilities is the demographic evolution in the past few decades (Alho et al., 2006). Moreover, one of the highest life expectancies combined with one of the lowest fertility rates in Europe (Eurostat, 2015) have been placed at risk the sustainability of the system. The effect of this demographic transition has been aggravated by the recent global financial crisis, which lead to an unsustainable increase in the liabilities.

As a consequence of this demographic and economic situation, various parametric reforms have been put in place in order to reduce the liabilities. From all those reforms, there are three which have had the most impact[3]. In 2011 and 2013 two reforms were made in order to increase the working life of individuals and to promote active ageing. The third reform introduced a *Sustainability Factor* and a liquidity-linked formula which affects the indexation on pensions called *Pension Revalorization Index*. These reforms will increase the sustainability of the system at the expense of the pension adequacy (Rosado and Domínguez, 2014). In practice, the indexation on pension will be lower than the consumer price index (CPI) which will affect the individuals living longer than average (as read in Conde, 2013a; Herce, 2013; Meneu *et al*., 2013; Devesa *et al*., 2013a, 2013b, 2013c; Devesa *et al*., 2014; Hoyo, 2014; Sánchez, 2014; or Rosado & Alonso, 2015). The decrease in adequacy goes against some recommendations (for instance, Queisser & Whitehouse, 2006, or more recently, the European Commission in The White Paper on Pensions, 2012), where they state that "*pensions should not only be sustainable, but also adequate and sufficient*".

One of the novelties introduced in the Bill 27/2011 was the *Sustainability Factor (SF)* which was supposed to be in force from 2027[4]. The SF links the first pension paid to the difference between the life expectancy when an individual aged 67 retires and the life expectancy observed in 2027 for an individual of the same age. For instance, this is in line with what is done in Finland since 2010 (Lindell, 2004, and OECD, 2015). In practice we can state that at least 12 European countries link the indexation of pensions to life expectancy or some similar type of indicator (OECD, 2012, and Turner, 2007, 2009). However, the dramatic decrease in the income from contributions due to the increase in the unemployment rate between 2008 and 2014 has accelerated its implementation to 2016 (Ministry of Employment and Social Security, 2016).

The other novelty of the pension reform was the adjustment of the *Pension Revalorization Index (PRI)*, which affects the indexation on pensions. This index is linked to

[3] The first two reforms on active ageing are named "Bill 27/2011 August 1st on the Update of Adequacy and Modernization of the Social Security System" and "Royal Act – Bil l5/2013, March 15th". The parametric reform on the indexation and sustainability factor is known as "Bill 23/2013, December 23rd".

[4] According to Guerrero (2014), the Sustainability factor will guarantee sustainability only by means of pension reduction. Ideally, the Bill 27/2011 on Modernization of the Social Security System should have also increased the income from contributions by increasing the contribution base, by tackling the informal workforce and by complementing the pensions in order to obtain adequate pensions in the line of the White Paper on Pensions from the European Commission (2012).

the income from contributions, pension expenditures and CPI. The subsequent application of the PRI is deemed to reduce the pension adequacy substantially. It is estimated that the purchasing power of an individual retiring in 2014 and surviving 21 years would decrease between 2 percent and 28,6 percent in the baseline economic scenario (Devesa *et al.,* 2014).

The impact of both the FS and PRI has been quantified in a report by the Ministry of Employment and Social Security, made in 2014. The authors state that the implementation of the PRI will save up to 33.000€ million compared to a scenario without reform. This would guarantee the sustainability of the pension scheme by adjusting the average pension paid (Díaz-Giménez and Díaz-Saavedra, 2011, and Sánchez, 2014). However, the pension scheme will still face a deficit after recovering economically due to the population ageing (Conde, 2013). Even though the introduction of these two factors, FS and PRI, will negatively affect the pension adequacy, they will guarantee long term sustainability to a certain extent in the line of recent European parametric reforms (Börsch-Supan *et al*., 2003; De las Heras, 2011; Devesa *et al*., 2012; and Bosch *et al*., 2013).

The papers abovementioned analysed the effect of the reforms put in place in 2011 and 2013 and focused mainly on the demographic risk. These studies do not consider explicitly the economic risk caused by the recent increase in unemployment rates. The methodology proposed in the following section does take into account reversible labour market transitions and provides a framework to study the impact of unemployment in the pension scheme.

3. Methodology

This section describes the Aggregate Accounting framework used to analyse the pension system, the database used, as well as the methodology used to estimate the transition probabilities between employment, unemployment and inactivity. This section highlights as well that by considering reversible state transitions we are able to analyse the effect of the current labour market situation in Spain and its impact on the future pension expenditures.

3.1. Aggregate accounting Method.

Jimeno *et al*. (2008) states that the Aggregate Accounting framework is one of the most widely used methods by public administrations and statistical bodies in order to analyse the financial soundness of the Social Security. The analysis makes use or demographic scenarios which account for fertility, life expectancy and migration fluxes, as well as macroeconomic scenarios which affect the labour market such as the employment rate. Assumptions on the mean pension as well as wages' increase are also made in order to calculate the income from contributions and the pension expenditures.

Otherwise, Doménech and Melguizo (2008) argue that the main advantage of this framework is that sound projections can be obtained in a simple way while considering a great degree of heterogeneity within and between cohorts, as stated in Table 1. This table summarizes the main characteristics of the most common accounting frameworks for analysing the solvency of pension schemes. One of their shortcomings is that actuarial cohort analyses are less straightforward.

The pension expenditures as a percentage of the GDP are then calculated as the product of three factors. The first factor accounts for the demographics and is represented by the ratio between the retired population and the working age population. This factor, contrary to the old-age dependency ratio, only considers the retired population who receive pension payments instead of the whole old-age population. The second factor accounts for the labour market and is represented by the ratio between the working age population and the employed population. The last factor is commonly known as economic factor and represents the ratio between the mean pension and the mean wage.

TABLE 1. MAIN MODELLING FRAMEWORKS USED FOR THE ANALYSIS OF PENSION SYSTEM'S SOLVENCY

Framework	Data needed	Advantages	Shortcomings
Aggregated Accounting	Data on demographic, labour market and economic variables.	Projections are based on few variables	Actuarial equilibrium and fairness are not straightforward to derive.
General equilibrium	Data on demographic, macroeconomic and institutional variables.	Variables are endogenous	Complex data manipulation and high sensitivity to hypothesis made on the dynamics.
Individual life cycle	Administrative data	It's possible to make disaggregated analysis of individual's working life profiles.	Complexity
Indirect	Data on income from contributions and pension expenditure.	Quantifying the equilibrium between income and expenditures can be done accurately.	Not possible to determine the representative individual's characteristics.

Source: the authors, Based on Jimeno *et al*. (2006) and Comité de Política Económica (2007).

Several authors have made use of this framework in order to analyse the sustainability of the Spanish pension scheme prior to the most recent reforms. Alonso and Herce (2003) made long-term projections of the Spanish pension system by accounting explicitly for immigration and concluded that immigration alone won't be able to re-establish the solvency of the system. Balmaseda *et al*. (2006) considered the Spanish National Statistical

Institute (SNSI) demographic projections for the period 2007-2059 and concluded that the scheme will not be sustainable. More recently, Moral-Arce *et al*. (2008) added another layer of complexity by considering heterogeneous wage profiles taken from the Working Life Continuous Sample database from the SNSI. However, all these studies make simple assumption in regards to the labour market by assuming an employment rate equal among all ages and without transitions.

The remainder of this subsection presents the Aggregate Accounting method, based on the frameworks shown in Boldrin *et al*. (1999) and Jimeno *et al*. (2006, 2008). As abovementioned, this paper will focus the study on the pension expenditures, more specifically on the expenditures with respect to the GDP. This is done, among other things, to increase the tractability and interpretability of our results, as well as to highlight where our unemployment framework will have an impact. Furthermore, this is usual practice when studying the fiscal implications of labour and demographic dynamics on pension spending (Roesevaere *et al*., 1996, and Dang *et al*., 2004). The pension expenditures at time t, denoted by PE_t, scaled to the GDP_t, at time t, are then expressed as follows:

$$\frac{PE_t}{GDP_t} = \frac{RP_t}{EP_t} \cdot \frac{\overline{P}}{\overline{W}} = \underbrace{\frac{RP_t}{WAP_t}}_{\substack{\text{Dependency} \\ \text{Ratio}}} \cdot \underbrace{\frac{WAP_t}{EP_t}}_{\substack{\text{Inverse} \\ \text{employment} \\ \text{rate}}} \underbrace{\frac{\overline{P}}{\overline{W}}}_{\substack{\text{Economic} \\ \text{Factor}}} \tag{1}$$

Where RP_t, EP_t and WAP_t represent the retired, employed and working age population respectively, and $\bar{P}$ and $\bar{W}$ represent the average pension per retiree and average labour productivity respectively. Our setting enhances the classical aggregate accounting framework by considering a multi-state Markov model with three states: employment, unemployment and inactivity. Our transition probabilities will have an impact in at least three factors:

- The employment population EP_t will depend not only on those who were employed in the previous period and remained employed, but also on those who were inactive and unemployed in the previous period and have transitioned to employment as well as those who were employed in the previous period and no longer are in the current period.

- The average pension per retiree $\bar{P}$ will be affected by the transitions from contributory periods (such as employment and unemployment) to non-contributory periods (such as inactivity) because it will affect the accrued rights of the individuals.

- Finally, the number of retirees RP_t will be impacted as well because only those who have been contributing during a minimum period of time will be eligible to receive a pension.

3.2. Database from the Labour Force Survey

The database from the Labour Force Survey (LFC) provides an estimate on the total individuals which are employed, unemployed and inactive as well as the transitions between these three states on a trimestral basis. The values are based on a representative sample drawn from households residing in Spain and aims at characterizing the individuals in the different states and consequently the labour market. The households randomly chosen are linked to a permanent address and are not itinerant. Collective homes such as hospitals, residential care facilities or barracks, as well as holiday houses are therefore not considered as households. However, individuals living in collective homes are considered in the sample whenever they belong to a family based externally.

This survey has been done by the SNSI since 1964 and considers 65.000 households per trimester. In practice, only around 60.000 households are effectively interviewed which accounts for 180.000 individuals. The definitions of employment, unemployment and inactivity are in line with the International Labour Organisation (ILO) allowing for straightforward comparisons. The remainder of this subsection will describe the definitions of the states according to the LFC:

1. **Economically active population:** population aged 16 years old or over who supply labour or are actively seeking employment during the interviewing week. This group includes both employed and unemployed.
    a. **Employed population:** population aged 16 years old or over who have supplied labour or have been self-employed. This considers full, partial and casual employment and accounts for individuals who were in sick or annual leave during the interviewing week.
    b. **Unemployed population:** population aged 16 or over who is unemployed and seeking employment or made themselves explicitly available to be employed. They are divided between unemployed seeking a first employment and those who were employed in the past.
2. **Economically inactive population:** population 16 years old or over who don't fall under the "employed" and "unemployed" definitions provided above during the interviewing week. It comprises homemakers, students, retirees and pre-retirees. It includes as well those who are not able to work and receive a public or private disability pension.

3.3. Multi-state model description and estimation

Labour market transitions have been widely studied in the literature. As Marston *et al*. (1976) stated in their seminal work researchers should "*not only consider flows into and* *out of unemployment but into and out of the labour force as well"*. Various studies have considered not only unemployment but inactivity or out-of-the-labour force, as read in Clark et al., 1979; Flinn & Heckman, 1982; Gonul, 1992; Jones & Riddell, 1999; or Kingdon & Knight, 2006. The various works of Nobel Prize winner James Heckman and his co-authors have attempted to estimate labour market transitions using various probit-like models which account for state duration, unobserved heterogeneity and time dependent explanatory variables (Heckman and Willis, 1977; Heckman, 1981; or Heckman & Borjas, 1980). More recently, other researchers have used the probit model to model low income transitions (Capellari and Jenkins, 2004), unemployment state dependence (Plum and Ayllon, 2015) and the interrelated dynamics of unemployment and low-wage employment (Stewart, 2007). But in the last years, the literature has moved towards the consideration of multinomial logit models in order to estimate labour market transitions like we do in this research (Caliendo and Uhlendorff, 2008; Haan, 2010; Jones & Riddell, 1999; Kingdon & Knight, 2006, and Uhlendorff, 2006).

We consider a three-state Markov process based on the data provided by the LFC database described in Section 3.2. The states considered will be denoted as follows: "E" (employed), "U" (unemployed), "I" (inactive). Note that all states are transient, meaning that individuals can either transit out or in the state during the studied periods, and that we don't have an absorbing state[5.]

The states considered in our analysis differ slightly from the ones defined in the LFC database described in Section 3.2. We define as "unemployed" those who are not employed and receive an unemployment benefit as these individuals contribute to the Social security. Those unemployed who don't receive an unemployment benefit are considered "inactive". The split between "contributory" and "non-contributory unemployed" is made according to data from the National Employment Service Body (NESB).

We adopt a time-discrete stochastic process $\{Y_t, t = 0,1,2,3, \dots\}$ which represents the state where the individuals are at the time studied. We assume as well that Y_t is a Markov process, which implies that the probability of an individual i aged x being in state j_t by time t, only depends on the most recent information available at the last period and is independent of its path before. Mathematically, this is represented as follows:

$$\Pr(Y_{it}^{x} = j_t \big| Y_{i0}^{x-t} = j_0, Y_{i1}^{x-t+1} = j_1, \dots, Y_{it-1}^{x-1} = j_{t-1}) = \Pr\left(Y_{it}^{x} = j_t \big| Y_{it-1}^{x-1} = j_{t-1}\right) = P_{j_{t-1}j_t}^{i,x}, \quad (2)$$

[5]Multi-state models are commonly used in other domains such as Actuarial Science in order to price long term care, or disability insurance. The models commonly used have usually an absorbing state which doesn't allow for recovery, such as death, which is mathematically more appealing (see Haberman and Pitacco (1998), and Denuit and Robert (2007) for more information).

TABLE 2. AGE DEPENDENT PROBABILITY OF TRANSITION BETWEEN EMPLOYMENT, UNEMPLOYMENT AND INACTIVITY (2008-2016)

Age	Initial situation (1ºT 2008)	Final situation (2ºT 2016)			
		Employed	Unemployed	Inactive	Total
16-24	**Employed**	85.22%	13.13%	1.66%	100,00%
	Unemployed	28.59%	32.37%	39.05%	100,00%
	Inactive	0.95%	7.90%	91.15%	100,00%
25-34	**Employed**	88.36%	9.93%	1.71%	100,00%
	Unemployed	31.41%	25.94%	42.66%	100,00%
	Inactive	0.98%	5.92%	93.11%	100,00%
35-44	**Employed**	90.81%	7.44%	1.75%	100,00%
	Unemployed	33.86%	20,.0%	45.74%	100,00%
	Inactive	1.00%	4.41%	94.59%	100,00%
45-54	**Employed**	92.69%	5.54%	1.77%	100,00%
	Unemployed	35.94%	15.79%	48.27%	100,00%
	Inactive	1.01%	3.27%	95.71%	100,00%
55-64	**Employed**	94.11%	4.11%	1.79%	100,00%
	Unemployed	37.65%	12.07%	50.28%	100,00%
	Inactive	1.03%	2.42%	96.55%	100,00%
65+	**Employed**	95.17%	3.03%	1.80%	100,00%
	Unemployed	39.03%	9.13%	51.84%	100,00%
	Inactive	1.04%	1.79%	97.17%	100,00%

Source: own calculation based on the LFC database (2008-2016)

where $P^{i,x}_{j_{t-1}j_t}$ represents the probability of transition between state j_{t-1} and j_t for an individual i aged x by time t. The following transition matrix $T^{i,x}$ shows the different transition probabilities between states j and k for an individual i aged x, which are denoted as $P^{i,x}_{j_k}$ for a given studied period:

$$T^{i,x} = \begin{pmatrix} P^{i,x}_{EE} & P^{i,x}_{EU} & P^{i,x}_{EI} \\ P^{i,x}_{UE} & P^{i,x}_{UU} & P^{i,x}_{UI} \\ P^{i,x}_{IE} & P^{i,x}_{IU} & P^{i,x}_{II} \end{pmatrix} \quad (3)$$

The different components of the transition matrix T represent the transition probabilities between the different labour market states. The probabilities $P^{i,x}_{jj}, for\ j = \{E, U, I\}$, where E represents employment, U unemployment and I inactivity, represent the sojourn probabilities, that is, the probability that an individual stays in state j during the period studied, while $P^{i,x}_{jk}, for\ j \neq k$ where $j, k = \{E, U, I\}$ represent the probability of making a transition from state j to state k during the period studied (Marston et al., 1976). We would like to note that the probabilities of transition are time-inhomogeneous to the extent that they differ for individuals belonging to different age groups, even though they are assumed fixed for different periods of time (Shao *et al.*, 2015). Finally, we assume that there is only one transition during the period of estimation, meaning that $E \rightarrow U \rightarrow I \rightarrow E$ is equivalent to us to sojourning in state E during the whole period.

We estimate the age-dependent transition probabilities by means of a standard multinomial logit model given by the following expression (Cameron and Trivedi, 2005):

$$P_{jk}^{i,x} = Pr\left(Y_{it}^{x} = k \middle| Y_{it-1}^{x-1} = j\right) = \frac{\exp\left(\beta_j Z_{ij}\right)}{\sum_l \exp(\beta_l Z_{ij})}, j, k = E, U, I. \tag{4}$$

Where subscript i denotes the individual and Z_{ij} represents the characteristics of this individual which includes their current state j. Table 2 summarizes the trimestral probabilities of transition between employment, unemployment and inactivity based on the LFC database.

The superscript denoting the individual i will be dropped from now on as the probabilities of transition are fully determined by the age x. The total employed, unemployed and inactive population is denoted as follows:

$$\boldsymbol{EP_t} = \sum_{x=x_0}^{x_r-1} {}_{E}\boldsymbol{N_t^x}, \tag{5}$$

$$\boldsymbol{UP_t} = \sum_{x=x_0}^{x_r-1} {}_{U}\boldsymbol{N_t^x}, \tag{6}$$

$$\boldsymbol{IP_t} = \sum_{x=x_0}^{x_r-1} {}_{I}\boldsymbol{N_t^x}, \tag{7}$$

where x_0 and x_r represent the entrance to the labour force and retirement age respectively and ${}_{E}N_t^x$, ${}_{U}N_t^x$ and ${}_{I}N_t^x$ represent the population aged x at time t which is employed, unemployed and inactive respectively.

Finally, the number of employed individuals ${}_{E}N_t^x$ aged x at the trimester $t \in \{2016T1, 2016T2, \dots, 2060T4\}$ is represented as follows:

$$\begin{aligned} {}_{E}\boldsymbol{N_t^x} &= {}_{E}\boldsymbol{N_{t-1}^{x-1}P_{EE}^x} + {}_{U}\boldsymbol{N_{t-1}^{x-1}P_{UE}^x} + {}_{I}\boldsymbol{N_{t-1}^{x-1}P_{IE}^x} \\ &\underbrace{=}_{\boldsymbol{P_{EE}^x = 1 - P_{EU}^x - P_{EI}^x}} {}_{E}\boldsymbol{N_{t-1}^{x-1}} + \underbrace{{}_{U}\boldsymbol{N_{t-1}^{x-1}P_{UE}^x} + {}_{I}\boldsymbol{N_{t-1}^{x-1}P_{IE}^x}}_{\boldsymbol{Entries}} - \underbrace{{}_{E}\boldsymbol{N_{t-1}^{x-1}P_{EU}^x} + {}_{E}\boldsymbol{N_{t-1}^{x-1}P_{EI}^x}}_{\boldsymbol{Exits}}, \end{aligned} \tag{8}$$

where ${}_{j}N_{t-1}^{x-1}$ represents the population in state j aged $x-1$ at $t-1$ and P_{ij}^{x} represents the probability of transition between state i and j for an individual aged x at time t, and this for $i,j \in \{E,U,I\}$ where E represents employment, U unemployment and I inactivity. A similar expression applies to the unemployed individuals ${}_{U}N_{t}^{x}$ and inactive individuals ${}_{I}N_{t}^{x}$.

4. Empirical Analysis

This section will present the various hypotheses and assumptions made in order to perform an empirical analysis of the pension expenditures with respect to the GDP for the Spanish case based on the methodology presented in the previous section.

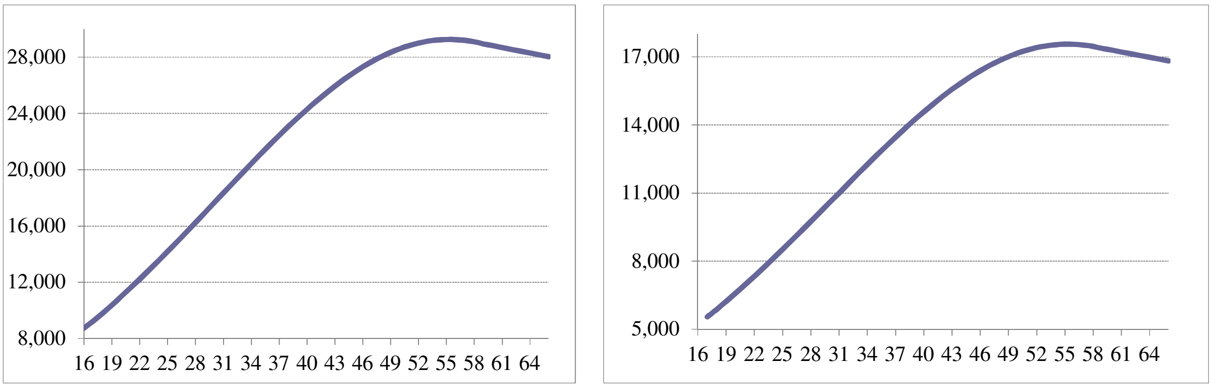
4.1. Hypotheses on the working and retired population

- The age-dependent employed, unemployed and inactive population in 2016 as defined in Section 3.2. is based on the values provided by the LFC database for the post-crisis period 2008-2016.
- In order to obtain the total unemployed population who receive an unemployment benefit, we multiply the total unemployed population from the LFC database by the proportion of unemployed contributors versus non-contributors taken from the National Employment Service Body (NESB) from the Ministry of Employment and Social Security.
- The employed, unemployed and inactive population from 2016 to 2060 is calculated by means of the formula presented in (8), that is, the future employed population depends on the employed population who didn't make a transition and the unemployed and inactive population in the previous trimester who transitioned to employment.
- Individuals enter the labour force at age 16 and leave the labour force at 67. The new entries are based on the population forecast from the SNIS from 2016 to 2060. In order to disaggregate the total population aged 16 by status, we multiply the population aged 16 by the current observed proportion of individuals in each status as of 2016. For instance, the total unemployed individuals aged 16 in 2020 is equal to the SNIS forecast of individuals aged 16 times the proportion of unemployed individuals aged 16 in 2016, which is equal to 4,17 percent.
- Survival probabilities are based on the most recent life table of the SNIS in 2014.
- Immigration is not taken into account[6].
- The age-dependent retired population as well as their corresponding pensions in 2016 is taken from the Statistical Reports from the Ministry of Employment and Social Security[7].

[6] Migration is often not taken into account when studying pension schemes from a theoretical viewpoint, as shown in Settergren and Mikula (2005), OECD (2016) or Alonso-Garcia & Devolder (2016). However, migration plays a big role in the population dynamics of most developed countries in practice (Eurostat, 2011 and 2012).

[7] Please note that even though the number of pensioners and their pensions is observed for 2016, we obtain similar results when using our framework to calculate these values.

FIGURE 1. ANNUAL AGE-DEPENDENT EARNINGS IN 2016



Employed Unemployed

Source: the authors based on the Wage Structure Survey from SNSI

- The future retiring population is based on the amount of individuals in the cohort that have acquired the right to receive pension payments due to having contributed for a minimum period of time in line with Bill 27/2011. Once retired they are no longer affected by the labour transitions but only by the survival probabilities aforementioned.

4.2. Hypotheses on the contribution bases

- The annual contribution bases are based on the age-dependent mean annual earnings for the employed and unemployed from the Wage Structure Survey from the SNSI in 2013. These values have been put in 2016 euros by indexing the contribution base by the Wage Increase Index for the employed and by the Consumer Price Index for the contributory unemployed. Figure 1 provides an overview of the age-dependent hump shaped contribution base for the employed and unemployed. Please note that the inactive individuals don't contribute to the system and therefore their contribution base is equal to zero.
- The historical contribution bases for the employed (resp. unemployed) population are based on the contribution bases at 2016 adjusted by the historical Wage Increase Index (resp. Consumer Price Index) from the SNIS.
- The contribution bases are modified such that they are at least equal to the minimum contribution base and no higher than the maximum contribution base.
- The minimum and maximum evolve according to the forecasted wages increase from the European Commission[8].

4.3. Hypotheses on the pension calculation

- The pension for a retiring individual aged 67 is calculated according to the most recent pension reform (Bill 27/2011)[9].

[8] Year 2015 data for the employed, and according to the forecasted CPI from the European Commission, year 2016 data for the unemployed.

- The defined benefit formula is based on the contributions made to the system during the last 25 years of the working career. All contributions except those relating to the last two contributing years are indexed until time of retirement by means of the CPI index. The sum of these indexed contributions is divided by 29,67 according to the Bill 27/2011.
- The value obtained in the previous point is multiplied by the Sustainability Factor calculated by the Ministry of Employment and Social Security as indicated in the Bill 23/2013 discussed in Section 2.
- The indexation of pensions is set to the minimum revalorization level 0.25 percent based on the forecasted Pension Revalorization Index from various sources (Ministry of Employment and Social Security, 2016; Herce, 2013; Conde, 2013; Meneu *et al*., 2013; Sánchez, 2014; Hoyo, 2014; Rosado & Domínguez, 2014; Devesa *et al*., 2013,,2013b,2013c; and Devesa *et al*., 2014).
- The pensions are modified in such a way that they are at least equal to the minimum pension and no higher than the maximum pension set by the Ministry of Employment and Social Security.

4.4. Results on the impact of unemployment and inactivity in the income from contribution and pension expenditures

This section shows the results of the empirical analysis for the Spanish case when a multi-state reversible model is incorporated in the model affecting the employed, unemployed and inactive population as well as the income from contributions and pension expenditures. The percentage of pension expenditures with respect to the GDP have been studied for the period spanning from 2016 to 2060 according to the latest pension reforms put in place in 2011 and 2013.

This section analyses two different scenarios: the *Baseline Scenario* accounts for the transition probabilities to employment, unemployment and inactivity estimated by means of a standard multinomial logit which makes usage of the LFC database as presented in Table 2.

The second scenario, denoted as *Full Employment Scenario*, assumes full employment. The aim of this scenario is to contrast the forecasts made by assuming the current labour market situation with a "best" scenario where no unemployment and inactivity periods are taken into account.

Table 3 and Figure 2 provide an overview of the forecasted pension expenditures as a percentage of the GDP for the 2016-2060 period for the two scenarios considered. The values indicate that in both scenarios the percentage will increase exponentially until 2040,

[9] Please note that we don't take the transitory period in regards of the retirement age into account and supposing that everyone retires at 67.

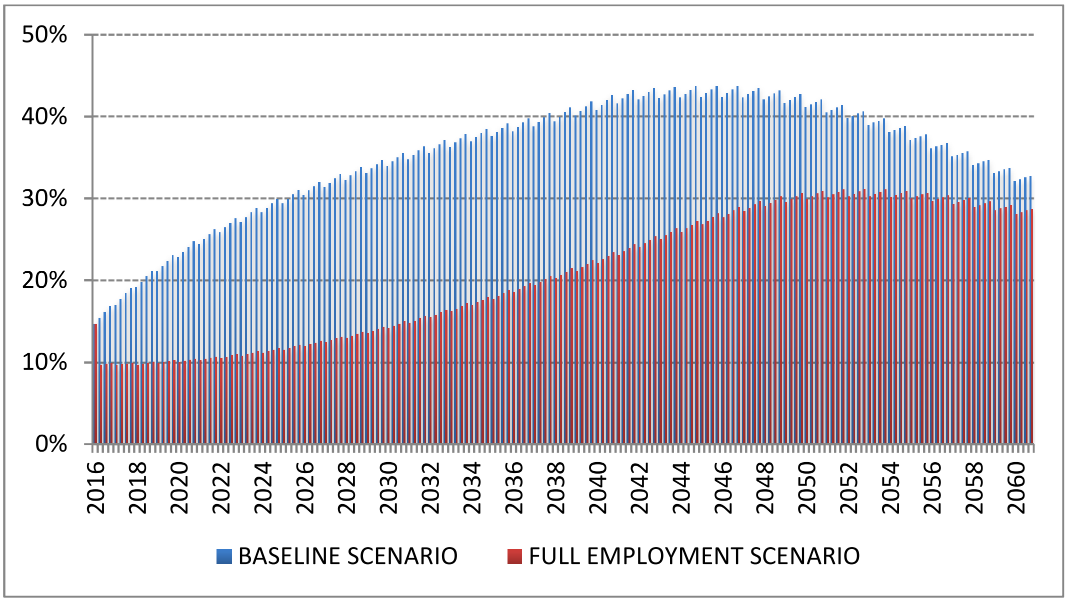
reducing thereafter and attaining similar levels by 2060. The disaggregated factors as presented in the Aggregate Accounting formula (1) in Section 3.1 are shown in Figure 3, Figure 4 and Figure 5 in the Appendix.

TABLE 3. PUBLIC PENSION EXPENDITURE PROJECTION (2016-2060).

	Pension Expenditures/GDP	**Pension Expenditures/GDP**
Year	Base Line Scenario	Full Employment Scenario
2016	14.67%	14.67%
2030	33.95%	14.13%
2040	40.81%	22.13%
2050	41.15%	29.92%
2060	32.12%	28.12%

Source: the authors.

FIGURE 2. PENSION EXPENDITURES AS A PERCENTAGE OF THE GDP.



Source: the authors.

However, for the Baseline Scenario the percentage increases from 14,67 percent in 2016 to 40.81 percent in 2040 decreasing to 32.12 percent by 2060, while for the Full Employment Scenario the maximum of 29.92 percent is attained in 2050 decreasing to 28.12 percent by 2060. The analysis shows that the total income from contributions is drastically reduced if the transition probabilities remain in their current levels and immigration is not taken into account, even when considering the three deficit reducing mechanisms (increase of the retirement age, sustainability factor and liquidity-linked pension indexation) introduced in the most recent pension reforms in 2011 and 2013.

The Full Employment Scenario provides values which are substantially lower than the Baseline Scenario throughout the forecasting period. However, in 2060 the values are quite similar due to the demographic factor. The life expectancy increased combined with the reduced entries in the system have a big effect in the pensions paid and the future sustainability. Furthermore, everyone in the Full Employment Scenario receives a pension because they all have complete working careers, leading to a substantial increase in the number of pensioners and amounts received.

The remainder of the section analyses the forecast of the different factors in the Aggregate accounting formula (1) is presented in Table 4.

TABLE 4. DISAGGREGATED PUBLIC PENSION EXPENDITURE PROJECTION (2016-2060).

Year	Pensions/Workers			Employment rate	Dependency ratio
	Pensioners to WAP	Inactivity rate	Economic factor		
Baseline Scenario					
2016	16.66%	33.35%	58.69%	58.23%	28.61%
2030	24.82%	63.74%	49.60%	30.06%	39.63%
2040	36.67%	63.95%	40.12%	29.88%	54.92%
2050	40.44%	64.00%	36.63%	29.73%	68.51%
2060	29.88%	64.06%	38.64%	29.63%	64.65%
Full Employment Scenario					
2016	16.66%	33.35%	58.69%	58.23%	28.61%
2030	30.28%	0.34%	46.49%	99.65%	39.63%
2040	45.39%	0.30%	48.61%	99.68%	54.92%
2050	59.95%	0.34%	49.41%	99.64%	68.51%
2060	57.79%	0.38%	48.47%	99.60%	64.65%

Source: the authors.

a) The ratio between the *Pensioners to the Working Age Population* increases with time in both scenarios, even though this increase is much higher in the Full Employment Scenario where it goes from 16.66 percent in 2016 to 57.79 percent by 2060. This increase is the main driver of the increase in the pension expenditures with respect to the GDP.
b) The dependency ratio increases from 28.61 percent in 2016 to 64.65 percent by 2060 in both Baseline and Full Employment Scenario. This is due to the fact that this ratio doesn't consider the labour status for the working population and whether the old-age population is retired or not.

c) The second factor, *Inactivity rate,* increases from 33.35 percent in 2016 to 64.06 percent by 2060 corresponding to a decrease in the *Employment rate* from 58.23 percent to 29.63 percent. This result highlights the effect of considering the current labour market situation as permanent during the forecasted period. In contract, the *Employment rate* for the Full Employment Scenario is close to 99.60 percent by 2060.
d) The third factor, *Economic factor*, indicates the degree of generosity of the pensions paid. This factor decreases from 58.69 percent in 2016 to 40.12 percent by 2040 and further decreases to 38.64 percent by 2060 because the inclusion of unemployment and inactivity decreases the contribution bases. Furthermore, the consideration of the Sustainability Factor reduces the first pension and the Pension Revalorization Index reduces the subsequent real pension as the forecasted index is far lower than the forecasted wages' increase. However, for the Full Employment Scenario this factor stays relatively stable from 58.69 percent in 2016 to 48.47 percent by 2060.

The results obtained in our forecast differ substantially from those made by the European Commission (2015). They estimate that the pension expenditures with respect to the GDP will increase from 11.8 percent to 12.5 percent by 2045 and then stabilize at 11 percent by 2060. The difference observed can be explained by the inclusion of unemployment and inactivity in our analysis, and exclusion of immigration. In fact, their labour and population hypotheses are far more optimistic than the ones used in our framework. For instance they assume that there will be around half a million individuals immigrating to Spain between 2013 and 2060.

The *employment rate* in 2016 of 58.23 percent is very similar in both studies. However, in our study the inclusion of the labour states decreases this rate to 29.63 percent by 2060 while the European Commission considers that it will increase to 73 percent by the same year. In the same lines, they assume that the unemployment rate will decrease from 21 percent to 7.5 percent by 2060.

The *Economic Factor* obtained by the European Commission has a value of 59.7 percent in 2016 and decreases to 39.8 percent which is similar to our results. In the same line, the *Dependency ratio* increases in their study from 27 percent to 53 percent in 2060 which resembles the values obtained in our framework as shown in Table 4.

5. Conclusion

The main objective of this research was to analyse the future sustainability of the Spanish pension system in a multi-state framework when the three deficit reducing mechanism of the 2011 and 2013 pension reforms are taken into account. The transition probabilities were estimated from the Labour Force Survey database for the period 2008-2016 following the global financial crisis and the sustainability was studied in terms of the pension expenditures with respect to the GDP by means of the Aggregated Accounting framework. One of the major contributions of this paper is that we have incorporated economic and labour risk endogenously by considering multiple labour states within the Aggregated Accounting framework. In particular, the future retired population and their pensions depend directly on their contributory and non-contributory periods.

The consideration of the current labour market situation as permanent in our forecast increases the pension expenditures with respect to the GDP exponentially, attaining a maximum of 41.15 percent by 2050 (Baseline Scenario), which is 12 percent more than whenever full employment is considered. The two main drivers for the increase in the pension expenditures are the increasing dependency ratio as well as the consideration of labour transitions between the different states. However, this difference between the two studied scenarios is reduced by the end of the forecasting exercise. The labour transitions have a lesser effect because the pensions paid and the number of pensioners is far lower than in the beginning of the forecasting exercise due to the high periods of unemployment and inactivity. In fact the main driver in the last 20 years of forecasting is the increasing ratio between pensioners to the working age population.

Even though the Ministry of Employment and Social Security reported in 2013 that the reforms put in place in 2011 and 2013 were sufficient to guarantee the sustainability of the pension system, we observed that whenever unemployment and inactivity is included their conclusion no longer holds. The results obtained in this paper raise the need to reform the labour market and the pension system further such that the employment rate increases to a sustainable level which doesn’t affect the individual’s decision on retirement.

The framework presented in this paper abstracts from immigration and future life expectancy increases, as it considers a static life table. In practice, migration plays a big role in the population dynamics of most developed countries, according with Eurostat. Furthermore, the percentages obtained may be higher if we would have considered an increasing life expectancy with a forecasted life table. In fact, we believe that the results would be comparable if the relative increase in the survival probabilities is the same for all ages. Whenever old-age population experience higher survival relative to the working age population we expect our pension expenditures in respect to the GDP to be higher. Accounting for migration, dynamic life tables and more heterogeneity are factors which will be included in our future research.

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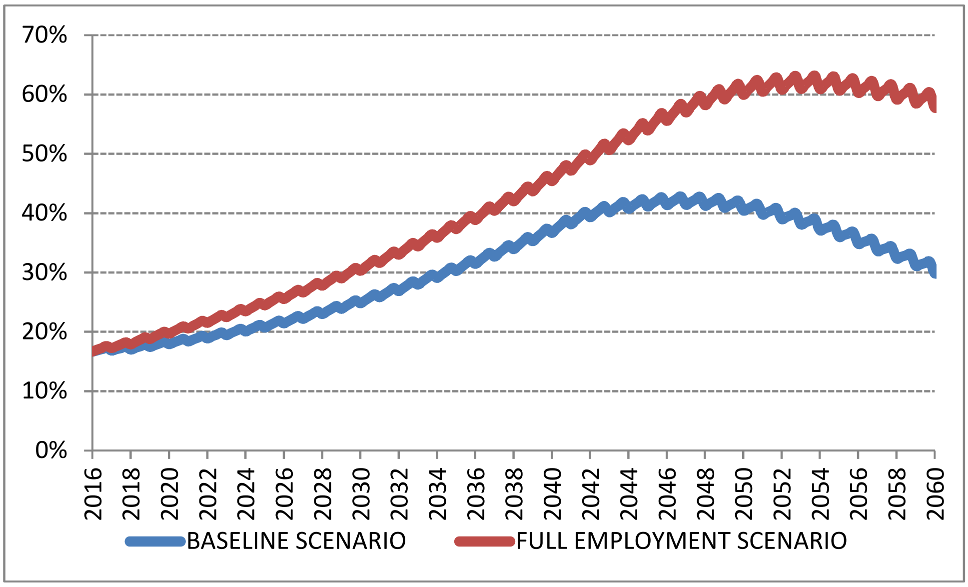
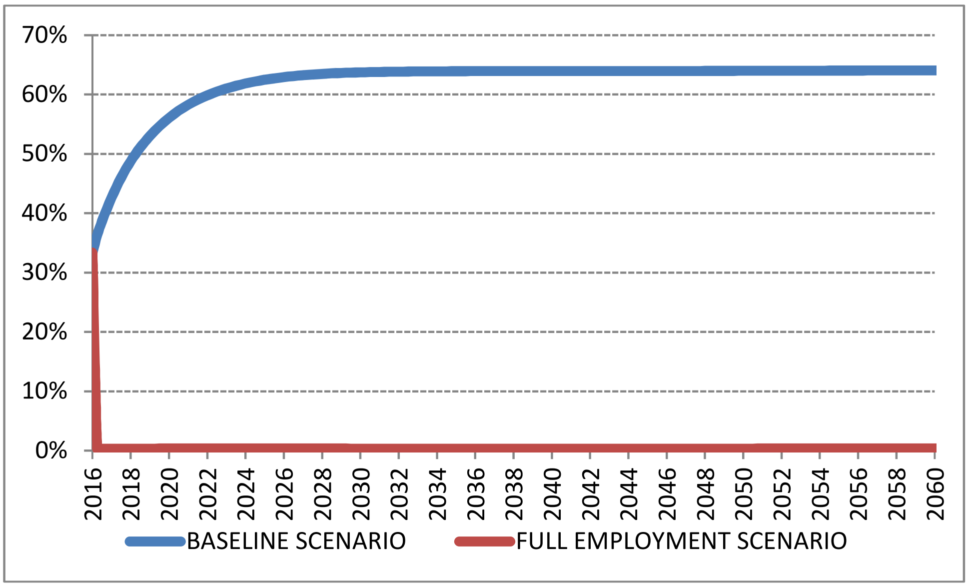
Appendix

FIGURE 3. PENSIONERS TO WORKING AGE POPULATION.



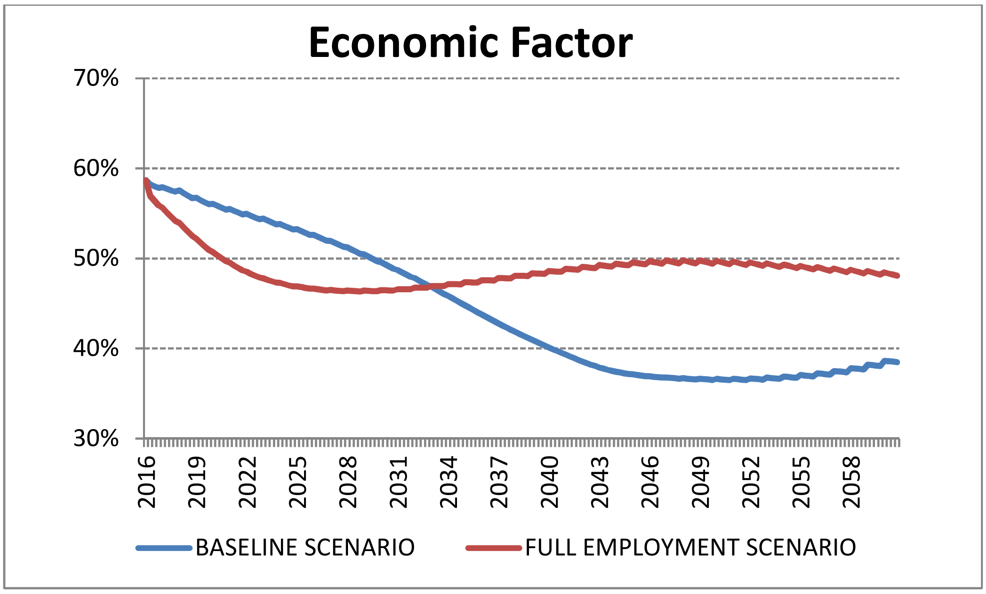
Source: the authors.

FIGURE 4. INACTIVITY RATE.



Source: the authors.

Figure 5. Economic factor.



Source: the authors.