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Sustainability and adequacy of the Spanish pension system after the 2013 reform: a microsimulation analysis

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Abstract

Concerns about the consequences of demographic ageing on the sustainability of the pension system has led to the adoption of reforms reducing pension expenditure. However, the impact of these reforms on pension adequacy is now coming under increasing scrutiny. Taking recent Spanish reform as an example, this paper analyses the extent to which fostering pension sustainability threatens pension adequacy. Using an extension of the DyPeS behavioural microsimulation model, results show that the introduction of mechanisms linking retirement pensions to the evolution of the social security budget balance has strong and negative effects on adequacy. The gains in sustainability are mainly driven by the significant fall in the benefit ratio (average pension to average wage), worsening the relative economic position of pensioners throughout forthcoming decades, reversing the past trend.

1. Introduction

The sustainability of welfare state programs, and specifically that of public pension systems, has been a matter of constant concern in recent decades. The marked ageing process that Europe is beginning to experience threatens a welfare system organized mainly on a pay-as-you-go basis, where the increasing ratio between the working-age (typically ages 16-64) and the economic dependent populations (ages 0-15 and 65+) is proving to be critical.

This marked ageing process has been exacerbated by the deep economic crisis that began in 2008 and which has left governments between a rock and a hard place. Public deficits started to rise dramatically and Social Security systems in a number of countries, including Spain, entered the red much sooner than predicted by demographic projections. In this context, many countries have introduced reforms to their pension systems in an attempt at controlling expenditure. One of the most noteworthy measures, in this regard, has been the adoption of mechanisms linking retirement pensions to the evolution of the social security budget balance, thus making explicit the dependence of the latter on demographic and economic factors.

However, changes to pension systems cannot be solely evaluated in terms of sustainability. They also need to be assessed in terms of adequacy, i.e., the extent to which they guarantee a minimum level of income for the elderly. By 'adequate', the World Bank understands that "all people regardless of their level or form of economic activity" have access to benefits "that are sufficient to prevent old-age poverty on a country-specific absolute level in addition to providing a reliable means to smooth lifetime consumption" (Holzmann and Hinz, 2005). As such, an 'adequate' system seeks to improve the position of the worst off, being compatible with any distribution of income between groups and, particularly, with any level of income inequality. Other distribution measures have also been considered by international organizations and the academic literature for the measurement of adequacy. These include various measures of the relative position of the elderly with respect to other groups as well as indicators of income inequality within the elderly.

The Ageing Report of the Economic Policy Committee (European Commission, 2015a) argues that pension systems, and in particular public pension schemes, have continued to ensure that most old people in the majority of EU countries are protected against the risk of poverty and deprivation and can enjoy living standards in line with the rest of the population. In general, the elderly (aged 65+) are not at any greater risk of poverty than other age groups. Indeed, in most countries, the elderly seem to have been better protected against the social impact of the recession and the public finance crisis than have other age groups. The relative income position of the elderly has generally improved in recent years. The relative median income ratio – median income of people aged 65+ as a share of people aged 0-64 – increased between 2005 and 2013 in 20 out of 28 Member States, with an increase of more than 15 percentage points in Luxembourg, Portugal, Cyprus, Ireland, Spain and Greece. Overall, it is clear that the income of older people has been relatively well protected during the crisis. This has been observed both in past crises (Holzmann and Hinz, 2005) and in the current crisis (European Commission, 2015b). In this respect, when measuring the relative position of the older population (by median income ratios, for example), Spain is one of the best situated, with ratios close to 100% in 2013 (European Commission, 2015b). Nevertheless, Spain has been hit particularly hard by the crisis, and many pensioner households may also suffer a deterioration of their financial situation as a result of sharing their resources with the younger generations in the family.

The definition of adequacy and its measurement are themselves an unresolved issue in the literature. Several papers and reports discuss existing indicators and propose new ones (Borella and Fornero, 2009; European Commission, 2015b; Chybalski, 2012). Brady (2010) develops a replacement rate that accounts for savings, taxes, and owner-occupied housing. Binswanger and Schunk (2012) address adequacy with a randomized survey design, individually tailored to each respondent's financial situation, and conducted in both the U.S. and the Netherlands. They find that the majority of individuals aim to achieve a spending profile in which retirement spending exceeds 80% of working life spending. The minimum desired replacement rates range between 95% for the lowest income quintile and 45% for the highest. For the Netherlands, these rates fall between 75 and 60%.

Several other studies seek to measure pension adequacy in a specific country. Knoef et al. (2016) measure the pension adequacy of the Dutch system, taking into account the total resources that people really accumulate. Using a large administrative data set, Chia and Tsui (2003) assess the adequacy of Singapore's publicly managed central provident fund system and find that it is inadequate to meet the future consumption needs of the female elderly. Others take a comparative perspective. For example, Holzmann (2013) reviews key recent and ongoing changes that are triggering reforms, outlines the main reform trends across pension pillars over the last two decades, and presents key policy areas on which the pension reform community needs to focus to make a difference.

As for methodology, microsimulation techniques have been introduced to complement more macro-oriented simulation models of pension systems, especially as regards attempts to simultaneously address sustainability and adequacy concerns. Microsimulation models can be used to draw a finer-grained picture of the evolution of old-age poverty in the future. Indeed, their use in policy evaluation and, particularly, in pension reforms has become fairly widespread (see, e.g., Borella and Coda Moscarola, 2010; van Sonsbeek, 2010; Buddelmeyer et al., 2006; Stensnes and Stolen, 2007). This is mainly thanks to the availability of an increasing number and quality of databases and computing tools. In the specific context in which we are working, these simulation tools need to be able to provide both a macro and a micro perspective: the former being essential for undertaking a consistent analysis of the sustainability of pensions or any other welfare state transfer; the latter being critical for a consideration of the adequacy of the benefit or of income redistribution, in general.

This paper analyses the impact on the sustainability and adequacy of the Spanish pension reform enacted in 2013 (Law 23/2013).[1] This reform introduced two adjustment factors to foster sustainability. On the one hand de so-called "sustainability factor", linking the amount of the new retirement pensions to the evolution of life expectancy. On the other hand, the "annual revaluation index", which is linked to the evolution of the Social Security balance and affects all public pensions. To do so, we use an extended version of DyPeS, a microsimulation model of the Spanish retirement pension system, incorporating the sustainability factors enacted in 2013. DyPeS is a dynamic, time-based, behavioural model, employing administrative data provided by the Social Security. In conjunction with the sustainability factors, we also implement a set of adequacy indicators in order to assess the role of pensions in preventing old-age poverty, as well as to determine their distributional effects. In short, we seek to address the following three questions: a) Is the pension system sustainable in the long-run? b) Are pensions sufficient to prevent old-age poverty? c) Are they equitable between generations?

The rest of the paper is organized as follows. Section 2 briefly describes the retirement pension system in Spain. Section 3 presents the microsimulation model used in the analysis and Section 4 describes the data and hypotheses adopted. Section 5 presents the results regarding the impact of the sustainability factors introduced in the 2013 reform in terms of both the sustainability and adequacy of the retirement pension system. Finally, Section 6 summarizes the main conclusions.

2. Institutional Framework: The Spanish contributory pension system

The Spanish contributory pension system, managed by the Social Security, is the most important program of social protection in Spain, in terms of both the

[1] See Conde-Ruiz and González (2013) who analyze the impact of the 2011 reform. The authors develop an accounting model with heterogeneous agents, introducing virtual working careers by means of a Montecarlo simulation. See Patxot et al. (2015) for an analysis of the impact of the 2011 reform on sustainability using a case base version of the DyPes model.

size of the population protected and the share of expenditure. In 2014, the Social Security dedicated 10.5% of GDP to contributory pensions. The contributory pension system is organized on a pay-as-you-go basis under a defined benefit scheme. Pensioners and workers are classified into different regimes (i.e., the General Regime and five Special Regimes) covering retirement, permanent disability and survivor pensions. The retirement pension is by far the most important program: in December 2014, it accounted for almost 60% of total contributory pensions, representing 65% of total Social Security expenditure (corresponding to 7.4% of GDP).

The present system was introduced in 1967 when the General Social Security Law was enacted. Since then, many partial reforms have been introduced, impacting different aspects of the system. The contributory (or *Bismarckian*) nature of the retirement pension system relies basically on the fact that the initial pension benefit is dependent, to some degree, on the worker's past contributions, although the worker must have completed a minimum period of contributions. Specifically, the initial pension (IP) is determined by applying the percentage [$p(n)$] (which depends on the contribution period) to the regulatory base [RB] (defined as the average contribution base over the last years). Moreover, various correction coefficients (c) may also apply in certain circumstances (such as delayed or early retirement):

$$IP = RB \cdot p(n) \cdot (1\text{-}c) \qquad [1]$$

The *Bismarckian* nature of these parameters has been increased as a result of subsequent reforms (see Appendix 1 for a summary), although a fully contributory system has yet to be achieved. Additionally, retirement pensions (and also contributions) are subject to lower and upper limits in pursuit of equity, which also mitigate their contributory nature.

In 2011 a major reform of the system was implemented, impacting such key characteristics as the general retirement age (for details, see Appendix 1). Moreover, it was announced that a "sustainability factor" was to be introduced in the pension system by 2027, aimed at taking into account the increase in life expectancy. However, this factor was announced in very vague terms and without specifying the exact formula. Two years later, and following the publication of a report entrusted to an Expert Committee created for that exact purpose, Law 23/2013 described how this "sustainability factor" was to work. Specifically, it comprised two distinct elements, referred to as the "pension revaluation index" (that is, an annual pension update index, henceforth UI) and the "sustainability factor" (SF). The UI replaced the consumer price index as the reference for updating benefits each year. As such, it affects all pensions in the system (not only new entries). The UI is calculated each year (t+1) using the following formula:

$$UI_{t+1} = \bar{g}_{I,t+1} - \bar{g}_{p,t+1} - \bar{g}_{s,t+1} + \alpha \left[\frac{I^*_{t+1} - G^*_{t+1}}{G^*_{t+1}} \right] \qquad [2]$$

where $\bar{g}$ is a moving arithmetic average, estimated for eleven years (the corresponding year, five periods before and five periods later), of the variation rate in Social Security revenues (sub-index *I*), the Social Security expenditure in contributory pensions (sub-index *p*) and the substitution effect (sub-index *s*);[2] *I* and *G* represent the moving geometric average of annual Social Security revenues and expenditures, respectively, estimated also for eleven years; finally, α is a parameter taking a value between 0.25 and 0.33, and revised every five years. In this way, the *UI* seeks to take into account Social Security (im)balances (both in past and future predictions) when obtaining the pension benefits. However, it is worth noting that there are legally established minimum (0.25%) and maximum (consumer price index plus 0.5%) values for the *UI*, independently of the value obtained using the formula. In fact, *UI* was first adopted in updating pensions in 2014, and since then the lower limit (0.25) has been applied because the value obtained from Equation [2] was lower than this value.

The sustainability factor (*SF*) only affects new pensioners joining the system in 2019 onwards (the date established for its launch). From that date, new pensions are to be calculated by correcting downwards (or eventually upwards) the result of the standard formula (Eq. 1) by the predicted increase (decrease) in life expectancy at the age of 67, as follows:

$$SF_t = SF_{t-1} \cdot e^*_{67} \qquad [3]$$

where *t* is the first year in which the *SF* is applied (for 2018, the value of *SF* will be 1), and e^*_{67} is the growth rate in life expectancy at age 67 over the previous five years. The parameter e^*_{67} will be estimated every five years.

Several countries have similarly used life expectancy as a reference point for introducing a sustainability factor in their pension systems. However, the majority have automatically linked increases in life expectancy to pensionable ages (Italy, Greece, Denmark and Netherlands) and/or the number of contribution years (France and Italy). Spain is one of the few countries (together with Portugal and Finland) to link benefit levels to life expectancy. Some institutions, including the European Commission, have pointed out that the first option is the best way to incentivize people to work longer and, hence, to neutralize the costs of structural longevity growth. In contrast, linking benefit

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[2] The *substitution effect* refers to the increase in the average pension system due to the difference in the benefits of new entries (new retirees with higher pensions) and system withdrawals (typically old people with lower pensions). In this way, after 35 years of contributions, individuals reached 100% of the *RB*, as they had before, but with a different distribution in favour of longer (as opposed to shorter) working careers.

levels to life expectancy is seen as "far less transparent", with the implication that it "can pose a threat to adequacy over time as people fail to react to financial incentives to delay pension take-up" (European Commission, 2015b p.189). To the extent that the model we are employing in our analysis, described in the next Section, is a behavioural model – allowing individuals to react to changes in pension system incentives – we should be able to test this, as well as other effects of the 2013 reform.

3. The model

This section describes the microsimulation model used in this exercise, that is, DyPeS. It was developed to analyse the Spanish contributory pension system and has been used in previous studies to measure the impact of the 2011 reform of the Spanish pension system (Patxot et al., 2015) and the corresponding behavioural reaction. DyPeS is a dynamic micro-based model – meaning that it simulates micro units over time. It was developed using ModGen, a generic dynamic microsimulation programming language designed and maintained by Statistics Canada and widely used in social science dynamic microsimulation.[3] This programming language allows the building of two parallel versions of the model: the time-based and the case-based versions. The former simulates successive cross-sections while the latter simulates each case from birth to death before the simulation of the next case begins. In this paper, the time-based version is used, due to the nature of the problem we seek to analyse. As we need information on Social Security budgets to calculate the annual revaluation index (*UI*), successive periods (years) need to be simulated in order to obtain this information. For the same reason, the model is open, in the sense that new agents are introduced, apart from those in the initial sample; and population-based, as opposed to cohort-based, as all the population – contemporaneous workers and pensioners – needs to be simulated every year.

DyPeS runs the simulation starting from the population contained in the Continuous Sample of Working Careers (*Muestra Continua de Vidas Laborales* or MCVL in its Spanish abbreviation). The next section explains this database in more detail. It is programmed in continuous time, though some of the events happen only once a year. With respect to previous versions of the model (Fernández-Díaz et al., 2013; Patxot et al., 2015), here one of the main improvements introduced is the calculation and projection of the two adjustment factors enacted by the 2013 reform. The implementation of the sustainability factor (*SF*) shown in Equation [3] is quite straightforward, but this is not the

[3] ModGen supports the creation, maintenance and documentation of most dynamic microsimulation model types, including both continuous and discrete time, case and time-based models as well as interacting and non-interacting populations. It is freely available at the Statistics Canada website.

case of the pension revaluation index (*UI* in Equation [2]). The *UI* and the projection of Social Security budgets must be simultaneously determined, causing obvious problems of recursivity. These problems are solved in DyPeS by running the simulation following an iteration process. As shown below, the non-limited values of the *UI* obtained from DyPeS for the first two years of application (-1.9% both years) are similar to those obtained by the Ministry and AIREF (AIREF, 2014; Roch et al., 2015) (-1.28% in 2015 and between -0.69 and -3.28% for 2016, depending on the scenario). The model also projects that the pension revaluation index will be stuck in the lower band during the following decades. This is due mainly to the negative impact of the 2008 economic crisis on the Social Security budget, but also to the expected negative demographic impact (baby-boomers starting to retire from 2020 on).

It is worth mentioning that one of the main advantages of DyPeS is that it introduces behaviour into the retirement decision, meaning that it accounts for behavioural reactions to financial incentives when individuals opt for retirement. This enables us to disentangle the effects of the reform that are related to the individuals' reactions to changes in the regulations (see O'Donoghue, 2001 and Li and O'Donoghue, 2013 for a definition of behavioural vs. statistical simulation). Microsimulation models that include behaviour in the retirement decision are scarce and heterogeneous in their modelling approach. Such models are preferably endowed with simple – non-behavioural – rules for retirement, assuming, for example, that individuals retire as soon as they become eligible (Borella and Coda Moscarola, 2010) or aligning the transitions to observed patterns (Dekkers et al., 2008; Richiardi and Leombruni, 2006). However, by integrating an econometric analysis with lifecycle theory, the literature on retirement behaviour can account for the role played by the financial incentives embedded in the pension rule. For example, Stock and Wise (1990) and Coile and Gruber (2000) for the United States; Baker et al. (2003) for Canada; Blundell et al. (2002) for the United Kingdom; and García-Pérez et al., (2013) and Vegas-Sánchez et al. (2013) for Spain, all find that individuals' retirement choices respond to some extent to the financial incentives of the pension system.

To date, there have been a few attempts to introduce behavioural reactions to pension rules into microsimulation models. Van Sonsbeek (2010) models the retirement decision by adopting the option value approach first suggested by Stock and Wise (1990). The author combines individual data on wages, state pension and private pension entitlements with individually varied option value parameters (time preference, leisure preference and risk aversion). Bianchi et al. (2003) also employ an individual reaction function, based on the Stock and Wise option value model, in which the worker calculates the expected value of the utility of retiring today and in the future, using available information. Borella and Coda Moscarola (2010) specifically compare the results of a behavioural model with a scenario without behaviour in which people retire as soon as possible. The retirement decision is modelled estimating a probit model and the main money's worth measures used in these estimates are the present value of pension benefits (PVB) and the peak value (PV), defined as the maximum forecasted accrual at each age.[4]

In DyPeS, the retirement module determines whether an eligible individual actually retires according to a proportional hazard model.[5] The data used to estimate the parameters governing the retirement decision consist of a monthly panel data set covering the period 2005-2010, extracted from the MCVL. It includes all individuals eligible for retirement during this period, excluding those who retired due to collective agreements or who were forced to do so by regulation (unemployed reaching the minimum retirement age). Covariates of the model include personal characteristics and financial incentives (improvements in expected future pensions). The model is estimated using a piecewise constant exponential function approach in which the hazard is assumed to be constant within pre-specified survival time intervals, but the constants may differ for different intervals. Those older than 58 compute their retirement hazards monthly and the covariates that determine the retirement decision are also updated monthly. The details of the retirement decision model are presented in Appendix 2.

All other events are modelled using information from the official statistics (demographics) or using the transition rates obtained from the MCVL. The following are the main events experienced by agents: they, first, experience birth and, second, entry in the labour market, then labour market transitions from employment to unemployment occur until the agents decide to retire and eventually die.

Wages and labour market transitions are conditioned by level of education, which is assigned as follows. For future contributors, the final education level attained determines how they enter the labour market (contribution group, entry age and wage), as shown below. Initial wages (for those working or contributing in 2007) take the value observed in the fiscal module of the MCVL in 2007. In case this value is missing, the contribution basis is used. This information is then used to impute future entry wages, while the error term observed in each cell is used to ensure the variability of the initial wage. Changes in the level of qualification and unemployment events are also derived from the transitions observed in the data set. Wages grow according to an econometric model – a version of the traditional Mincer model – estimated outside the microsimulation model. Next, contribution basis are updated taking into account the minimum and maximum thresholds (annually adjusted according to inflation). Appendix 2 contains a detailed explanation of the wage growth mechanism.

[4] See Patxot et al. (2015) for a more detailed discussion of behavioural models.

[5] The model parameters are estimated using Stata 11 and are introduced in DyPeS programming or directly in the input tables created for that purpose.

Once agents reach the eligible age for retirement (fixed from 59 to 75[6]), they start computing their expected pensions in each of the available pathways depending on their labour market status and, eventually, retire according to the survival times estimated by our retirement model. To capture the impact of labour market conditions on the probability of retirement, potential pensions are weighted by the probability of being unemployed in future years. A model of unemployment probabilities for people older than 58 is estimated outside the microsimulation model. We explain this probability using variables found mainly in the literature, seeking to capture differences in personal characteristics, productivity and contextual factors: sex, age, migrant status, educational level, contribution group, experience and unemployment rate.

Finally, agents die according to exogenous age and gender-specific mortality rates evolving in line with those used in the standard population projections. The projection routine of the model starts in 2008. Hence, for events occurring before – affecting agents alive in 2007, the observed data are taken from the data set.

4. Data and assumptions

DyPeS starts from the 2007 wave of the MCVL, excluding self-employed workers as there is no enough information to simulate their future wages. [7] The year 2007 is chosen as the base year and the reference point for most data. In this way, the data employed for transitions are not permanently distorted by the effects of the crisis. Nevertheless, other waves of the MCVL are used to estimate in more detail labour market transitions, the wage model and the retirement model (full details are provided in Appendix 2).

The MCVL extracts 4% of the population registered with the Social Security at that point in time. Then, all past information about their working careers and contributions is added. This information is reliable from 1980 onwards for their working conditions and from 1990 onwards with regard to their pensions. The sample includes both pensioners and contributors born between 1907 and 1991. Hence, in order to project future expenditure and revenue, new entries in the labour market from 2008 onwards and new births after 1991 need to be added to the model. To add the new-borns, we compare the number of people in the 2007 population and in the 2007 MCVL wave and take into account official population projections (Spanish National Institute of Statistics, INE, 2014). Once entered in the sample, agents experience several events. The data

[6] The minimum age of retirement considering all the possible pathways is 60, but agents start computing their expected pensions one year before.

[7] For a detailed description of the MCVL see MTAS (2006). Pérez-Salamero et al., (2017) undertook an evaluation of the representativeness of the MCVL.

employed to simulate each of the events are described below. The first step is to assign a level of education, but while the MCVL contains information about individuals' education, this variable is collected from a different data set that is not updated very frequently. As a result, the level of education is frequently missing or underestimated. For individuals registered in the MCVL, we retain the value as reported and correct it upwards in cases where there is an inconsistency between the value of education and the contribution group.[8] For "future" individuals, born from 1991 onwards, the final level of education is assigned randomly so as to reproduce the educational distribution reported for the Spanish population by MEC (2010)[9]. According to this publication, the level of education has risen substantially in recent decades.

In a second step, once the main characteristics of the individuals are assigned and they reach the age of 16, they are exposed to the probability of entering the labour market by age, gender, education and initial qualification level. This probability is obtained from the observation of the entry path of the last cohort, which has completed its incorporation into the labour market – those aged 36-40 in 2007.

In a third step, having entered the labour market, individuals are exposed to labour market transitions. The hazards observed are extracted from the 2007 wave of the MCVL. Specifically, transitions between qualification levels within employment and transitions between employment and unemployment are obtained by age, gender and qualification level when necessary. To this effect, the 13 contribution groups in the general regime of the Spanish Social Security are classed in just five groups – that is, those subject to the same contribution limits (thresholds). As the transition hazards among the different qualification levels are quite stable during the observed period (2002-2007), the value of the last transition observed before the economic crisis (2006 to 2007) is taken, and it is held constant for the future, except for the fact that they are temporarily adjusted to reproduce the crisis period (see Appendix 3 for details about the how the crisis period is considered in our simulation).[10]

The demographic and macroeconomic assumptions employed in our simulation are summarized in Table 1 and compared to those used by the Ageing Working Group of the European Commission in the last long-term projections of pension expenditure in the EU (European Commission, 2015a), hereafter AWG15. The

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[8] This can only be done for the first contribution group (University level).

[9] https://www.educacion.gob.es/educabase/menu.do?type=pcaxis&path=/Formacionyml/EPA2015/NivFor&file=pcaxis&l=s0

[10] Specifically, the unemployment and reemployment hazards are adjusted using observed trends as reported in FEDEA (Observatorio Laboral de la Crisis). It is beyond the scope of the present paper to report a detailed analysis of the impact of the crisis on the unemployment transitions. See Bentolila et al. (2017) for an analysis of changes in long-term unemployment during the crisis.

differences in the projection mechanisms employed in both cases are also detailed.

Table 1 Demographic and macroeconomic assumptions

	AWG15	**DyPeS**
Demographic assumptions	**EUROSTAT (EUROPOP 2013):** **Fertility (children per women)**: Starts at 1.3 and increases gradually to 1.55 in 2060. **Life expectancy at birth (2060):** 90.0 Female 85.5 Male **Migration:** - 311.000 net immigrants in 2013 +275.000 net immigrants in 2060	**INE (2014-2064):** **Fertility (children per women)**: Starts at 1.27 and remains practically constant (1.22 by 2060) **Life expectancy at birth (2060)**: 90.8 Female 86.9 Male **Migration:** No future migration explicitly modelled
Wage and productivity growth	**Productivity growth:** Starting from observed values it declines to 0.7 in 2020 and tends to 1.5 after 2030.	**Productivity growth:** Observed values for 2008-2015. ut ure values from the AW 15. **Wages:** A wage model estimates real wage as a share of average wage for each age, gender and education level, controlling for several variables.
Inflation	2013-2017: reaching 2% in 2018 from initial value 2018-2060: 2%	2008-2016: observed values (INE) 2017-2020: 1.4 * 2021-2055: 2.0 * * Taken from Hernández de Cos et al. (2017)
Labor market	Projection of participation and employment rates by age, gender and year elaborated on purpose (values in Table 1b)	Observed pre-crisis employment and reemployment hazards by age, gender and qualification group are kept constant, except for the adjustment during the crisis (see Appendix A.2). The resulting values are shown in Table 2.

The first row focuses on demographics. Our simulation starts from the demographic projections developed by INE (2014-2064), though we deviate from these to some extent. First, as mentioned above, the number of future new-borns introduced in the model is obtained from INE's population projections, adapting it to the size of the sample according to its representativeness. Hence, population age structure should be similar in both models, despite the fact that we do not model the entries and exits of migrants separately. Fertility assumptions are also in line with those of the INE (2014-2064). Second, the age and gender specific mortality rates employed in the model are those assumed by INE. Regarding migration, the assumptions taken in AWG15 indicate the difficulties in obtaining reliable assumptions about its future evolution. The crisis dramatically changed migration trends, especially in Spain where migration started late but ended quite abruptly. Hence, in this exercise we choose to avoid an explicit analysis of migration. We discuss the impact of this omission in the results section.

The second row presents the productivity growth assumptions and how they are translated into wage growth in the microsimulation model. The AWG15 assumes a productivity growth rate starting from the observed values and tending to an annual 1.5% from 2030 onwards. The inflation assumption tends to 2% as shown in the third row. In our case, we borrow the inflation assumption from Hernández de Cos et al. (2017). Starting from the observed values – some of which are negative – it increases to 1.4% for the period 2017-20 and 2% from 2021 onwards.

Finally, in the case of the labour market, while the AWG15 uses a projection designed for that purpose, in DyPeS it is more a result of the model. Specifically, as explained above, the initial transition rates observed for unemployment and reemployment are kept constant, except during the crisis period. Table 2 compares the participation rates by gender obtained in both cases, which prove to be quite similar.

Table 2 Labour market evolution: average participation rates (16-64)

		2013	2020	2030	2040	2050	2060
Female	AWG15	68.4	73.5	77.2	79.3	78.9	78.4
	DyPeS	64.1	74.6	73.3	72.8	73.7	72.9
Male	AWG15	79.9	79.5	79.2	79.9	80.1	79.3
	DyPeS	73.0	78.0	75.5	73.0	74.6	74.8

5. Results: The effects of the 2013 reform on pension sustainability and adequacy

This section presents and discusses the effects of the reform of the Spanish retirement pension system enacted in 2013. Those effects are captured via the extension of the DyPeS microsimulation model. Different scenarios are defined in the simulation. First, the baseline is defined as the pre-reform situation, taking into account the leading measures introduced in the past, including the reform measures introduced in 2011 (see Appendix 1 for details). Second, the reform scenario considers the legal configuration of the adjustment factors enacted in

2013, both the pension revaluation index, *UI,* introduced in 2014 and the sustainability factor, *SF,* linking the entry pension to eventual increases in life expectancy which was to be applied from 2019 onwards. It is important to note that our simulations only refer to retirement pensions, leaving aside the rest of contributory pensions (disability and survivor pensions), which are also affected by the *UI*. In addition, no other financing sources than contributions are considered when estimating the *UI* in the simulations. Hence, our results might be overestimating to some extent the adjustment needed.

Finally, an alternative scenario is considered by eliminating the upper and lower thresholds legally imposed on the application of the *UI*. The following subsections show, first, the evolution of the sustainability indicators, compared to those reported in the Ageing Report for 2015 (Subsection 5.1) and, second, the evolution of the adequacy measures in different scenarios (Subsection 5.2).

5.1. The impact on sustainability

We start by analysing the overall performance of the microsimulation model in demographic and macroeconomic terms. The benchmarks for comparison are the values obtained from official data for the period 2008-2015 (the model starts its projections in 2008) and the results of the 2015 Ageing Report by the AWG (European Commission, 2015a) for the future. [11] A well-known and widely used decomposition of total pension expenditure to *GDP* expresses this as the product of four elements: 1) The *old dependency rate* (ratio between the population aged 65 and over to the population aged 16-64); 2) The *coverage rate* (the number of retirement pensioners in relation to the population over the age of 65); 3) The *replacement rate* (defined as the ratio of the average pension to average productivity); and, finally, 4) The labour market performance (defined as the inverse of the *employment rate*, that is, the working age population divided by the number of workers). By so doing, increases in the first three factors contribute to raising the ratio of pension expenditure to *GDP*, while higher employment rates reduce this ratio. Following the same logic as that employed in the aforementioned decomposition, here we obtain a slightly different decomposition that is adapted to the characteristics of our microsimulation exercise. As our model does not project *GDP*, we decompose the ratio of total pension expenditure to the total wage bill, also into four components, where the first two (the old dependency rate and the coverage rate) are the same as 1) and 2) above. However, instead of the replacement rate defined above, we obtain the ratio between the average pension and the average wage, which we refer to as the *benefit ratio*. Finally, the inverse of the employment rate is measured here by dividing the working age population by the number of contributors (our proxy of the number of workers).

[11] Demographic data and pension information are obtained from the National Institute of Statistics (INE) and the Spanish Social Security, respectively.

Table 3 summarizes the projected values obtained for these four elements, which, in turn, determine the sustainability of the system. To the extent that our model explicitly models labour market income and its effect on the initial retirement pension at the micro level, it is a useful instrument for relating labour market performance to the ageing process, while at the same time allowing us to analyse adequacy. This analysis is of particular interest because the *UI* formula introduced by the 2013 reform relates retirement benefits to the Social Security balance, which implicitly means linking pension levels to wage growth, the main source of social security revenues.

Table 3 Demographic and macroeconomic indicators. Projections obtained from simulations.

	(1) Old depend. Ratio	(2) Coverage ratio (Baseline)	(2') Coverage ratio (Reform)	(3) Benefit ratio (Baseline)	(3') Benefit ratio (Reform)	(4) Labour market factor	(5) Pension expend. / wage bill (Baseline)	(5') Pension expend. / wage bill (Reform)
2013	23.1%	65.0%	66.6%	55.2%	55.5%	138%	11.50%	11.84%
2020	20.9%	68.2%	70.5%	64.0%	60.7%	125%	11.42%	11.19%
2030	26.2%	73.0%	75.0%	60.5%	50.5%	124%	14.37%	12.33%
2040	44.7%	91.2%	90.1%	55.1%	42.2%	129%	29.02%	21.95%
2050	66.9%	90.8%	87.9%	53.9%	37.2%	124%	40.63%	27.15%
2060	61.9%	88.4%	87.7%	50.3%	34.6%	124%	33.97%	23.21%

Notes: (i) The old-age of reference used for calculations (old-dependency rate, coverage ratio and labour market factor) is 65. (ii) After the initial period, the denominator in the coverage ratio only considers people aged 65+ who participated in labour market. (iii) The labour market factor is the inverse of the employment rate (population aged 16-64 / contributors). (iv) Average wages used for computing the benefit ratio are average annual wages per full-time equivalent employee. (v) As explained in the text 5 = 1·2·3·4 (or 5'=1·2'·3'·4).
Source: Authors' calculations

Column 1 shows the evolution of the old dependency rate, which presents a similar evolution, albeit with a more pronounced increase, to that outlined in the 2015 Ageing Report. Our model reports a value of 66.9% by 2050, compared to 62% in the Ageing Report, reflecting primarily a lower fertility rate and different migration assumptions (see Section 4). The evolution of this ratio is coherent with that of demographic projections, i.e., with the first wave of baby boomers reaching the age of 65 in 2022.

The coverage ratio of retirement pensions, shown in Column 2, increases in the first years of the projection. This is due primarily to the fact that baby boomer females retire with greater pension entitlements than those from the preceding cohorts, given their higher participation rates. The initial value for 2013 (c. 66%) is coherent with that obtained when merging data on population and pensions from official sources.[12] In this case, the values are not readily comparable with those reported in the Ageing Report, including public pensions of all kinds and all ages (not only retirement pensions). Using the reported number of pensioners aged 65 and more, the coverage ratio for this age group can be derived. Specifically, it rises from 84.4% in 2013 to reach 90.4% in 2060. Nevertheless, this figure is not yet fully comparable to our estimation as it includes all kind of pensions for those older than 65 (a significant share being widower pensions). In our case, the increase of the coverage ratio for only retirement pensions is higher (from 66.6 to 87.7%). The increase is overstated because the denominator only considers people aged 65+ who participated in labour market. The non-participants are not present in the initial MCVL sample, although they are added to reproduce the initial dependency ratio. However, along the simulation we cannot keep track of their gradual evolution and hence, the denominator (population aged 65+) is understated. Our initial value for the benefit ratio in 2013 (55.2%) is coherent with that reported in official sources (52%).[13] The 2015 Ageing Report projects a decrease in the benefit ratio (for all pensions) of around 20 percentage points, similar to our projections (20.9 percentage points). Insofar as our microsimulation model projects future pensions in relation to the past evolution of wages, it should capture better all the factors that might affect the future evolution of the benefit ratio. As we see below (see comments to Figure 6), the interplay between the past evolution of wages and pensions in Spain has non-trivial implications for sustainability.

Finally, the initial value for the labour market factor obtained in our simulation is similar to that stated by the 2015 Ageing Report, which assumes employment rates close to 78%. The future evolution is also very similar, reaching values of 85 (2015 Ageing Report) and 81% (our projections). Overall, therefore, we can conclude that our model is able to replicate long-run trends in terms of both demographic and labour market conditions.

Our results are also in line with those obtained in other analysis, although they are not fully comparable because of the different methodologies employed. Hernández de Cos et al. (2017) undertake an illustrative exercise deriving alternative future scenarios of the main components of the pension expenditure shown in Table 3. Their simulations extrapolate past trends, considering also future foreseeable changes as the increase in old-age dependency. Sánchez-Martín (2014 and 2017) and Díaz-Giménez and Díaz-Saavedra (2017) employ a general equilibrium overlapping generations model (OLG) with endogenous retirement age. Leaving aside demographic evolution, which is taken as given by all the studies, differences remain in the other factors. The OLG models do

[12] For example, in 2013, the population older than 64 stood at 8.34 million (National Institute of Statistics, INE), and the number of pensioners at 5.52 million (Spanish Social Security), giving a coverage ratio of 66% (INE).

[13] The Spanish National Institute of Statistics (INE) reports a yearly average wage of 22,698 euros, and the Social Security reports an average pension of 11,861 euros.

not permit to grasp the evolution of the labour market factor easily. In fact, they both obtain a *UI* above the minimum threshold for several years before the retirement of the baby boomers, probably due to the fact that they cannot capture the effect of the current crisis. Nevertheless, the *UI* has actually been in the minimum threshold since 2014. More recently, De la Fuente et al. (2018) refine the calibration of the crisis period and obtain *UI* below the minimum threshold. Interestingly, on the one hand, Sánchez (2014) found a negligible impact on the employment rate and a very small one in the pension coverage rate. On the other hand, Hernández de Cos et al. (2017) show a scenario including an implicit increase in the coverage ratio.[14] Overall, all of them obtain that the main effect of the 2013 reform will be a reduction in the benefit ratio. For example, Díaz-Giménez and Díaz-Saavedra (2017) report a decrease around 60% (54% in our case).

To better understand the projections obtained in our simulation, the evolution of the different variables affecting pension expenditure is described below in detail. First, Figure 1 shows that the changes in the number of entry pensions associated with the 2013 reform. Panel a) reports the evolution of the number of entry pensions, showing the effects of the retirement of baby boomers. The effect of the reform can be seen in Panel b) showing changes in new entries regarding the baseline in the different scenarios. As observed, the effect of the reform is significant along the first part of the projection period. It is, in fact, related entirely to the introduction of the sustainability factor (*SF*) described in Equation [3] – while the *UI* (Equation [2]) does not affect entry pensions. The introduction of the *SF* could induce workers to retire earlier to avoid further cuts in their pensions due to their higher life expectancy, although some workers might seek to extend their labour participation to obtain pension improvements from the application of the *Bismarckian* pension formula. It should be stressed at this point that the 2013 reform did not seek to delay retirement, primarily because a reform with this exact objective was promulgated two years earlier in 2011.

Figure 1 here

These results seem to confirm the findings of the 2015 Adequacy Report (European Commission, 2015b), namely, that people fail to react to financial incentives to delay pension take-up in line with developments in life expectancy. And this is not (solely) because people's behaviour is not entirely rational when opting to retire. The behavioural model embedded in DyPeS supposes that individuals do behave rationally. However, in a future context in which pensions are set to grow at a permanently low rate (the expectation is that the *UI* will be

[14] This study does not provide explicitly the coverage rate, but the product of the dependency and the coverage ratios. However, it is possible to estimate it using the dependency ratios provided by the Ageing Working Group. This way, given the dependency ratio for 2016 (28.8%) the coverage rate is 107%; for 2050 the dependency is 62%, implying a coverage of 117%.

fixed in the lower band), the mechanism for updating pensions remains neutral to the decision of when to retire.

Figure 2 here

Figure 2 shows the evolution of the average retirement pension level. First, it is interesting to examine the impact of the *SF* (without the *UI*), which has a sizeable impact. Second, we observe that the total cut in pensions introduced by the 2013 reform (reaching almost 35% in nominal terms) is quite substantial; yet, it is much less than the reduction that would have resulted from a scenario with a non-limited *UI*. As explained above, Law 23/2013 of 23 December regulating the sustainability factor and the annual revaluation index of Social Security pensions established that, regardless of the result of applying the formula (Eq. 2) to obtain the *UI*, the revaluation of Social Security contributory pensions should not be less than a minimum annual percentage (0.25%) nor exceed a maximum rate (evolution of the Consumer Price Index in the previous year + 0.50%). Notoriously, the results of our simulation for the scenario in which the 2013 reform is fully implemented with thresholds indicate that the *UI* will be fixed in the lower band of 0.25% during the whole period of analysis (2015-2055). The scenario that considers the implementation of the *UI* without thresholds, produces *UI* values close to -2% for 2015 and 2016, which is coherent with other estimations (AIREF, 2014).

Figure 3 here

Finally, Figure 3 summarizes the overall effect of the reform by showing the evolution of the ratio between pension expenditure and the wage bill. The model predicts a decrease of almost 15 percentage points of this ratio following the introduction of the 2013 reform. And this decrease is magnified once again by the scenario with no limits. This ratio is not fully comparable to that between pension expenditure and GDP calculated in the Ageing Report (2015), but it is sufficiently informative of the extent of the effects.

In short, it can be concluded that the main objective of the reform – a reduction in future public expenditure on pensions – is achieved, at least to quite a considerable degree. The next section analyses whether the adequacy effects of the reform allow for an equally positive interpretation.

5.2 The impact on adequacy

There is no broad consensus in the academic literature and within policymaking circles as to what constitutes the best measure of pension adequacy. Moreover, a review of recent reports, including the Adequacy Report of the European

Commission (European Commission, 2015b), suggests that the concept of adequacy is in fact a compilation of various objectives: that is, not only securing a minimum standard of living for the elderly (the "strict" definition of adequacy), but also achieving distributional and equity objectives (in both inter- and intra-generational terms). It should be stressed, however, that protecting the elderly from the risk of poverty and depravation is compatible with an income distribution that improves the position of those that are worst off. Consequently, no single measure appears to offer a clear indication of the extent to which the reforms impact on the achievement of these pension system goals.

To analyse the intergenerational equity effects of the reform enacted in 2013, in line with the aforementioned report (European Commission, 2015b), we focus primarily on the relative distribution between workers and pensioners, paying specific attention to two dimensions of analysis. First, we investigate the relative position of the elderly with respect to the working-age population (simultaneous comparison of two cohorts). Second, the projection model allows us to monitor the future evolution of their relative positions, providing a complementary picture of intergenerational equity insofar as it reflects the position of future generations at the time of retirement (comparison of two cohorts at different times). Specifically, we compute two indicators of intergenerational equity: the benefit ratio and the relative median income ratio. The former can be computed in aggregate accounting models based on representative age cohorts, while the latter – and more detailed measures of income redistribution – can only be obtained in the framework of microsimulation.

As stated above, the benefit ratio is defined as the average pension benefit relative to the average wage. It provides an estimate of the overall generosity of a pension system, measuring its income replacement capacity. At the same time, it also provides information about the relative economic position of workers and pensioners. In this sense, the benefit ratio represents the broadest of measures, since it compares all (public) pension payments with economy-wide incomes, whereas other indicators are narrower in their approach. For example, the aggregate replacement ratio, used in the Adequacy Report (European Commission, 2015b), only compares the pension income of those aged 65-74 with the earnings of people aged 50-59.

Figure 4 presents the benefit ratio obtained under the three alternative scenarios (the baseline without the reform; the reform implemented in 2013; and, a hypothetical scenario applying the *UI* without thresholds). Interestingly, the application of the 2013 reform causes the benefit ratio to decrease substantially. The baseline scenario initially presents an increase followed by a decrease after 2025, reflecting the gradual effects of the reform implemented in 2011. It is worth mentioning that the scenario in which the thresholds of the revaluation index are eliminated (in particular, the minimum threshold) leads to a significantly greater reduction in the benefit ratio, highlighting the huge potential impact of this reform in terms of adequacy.

Figure 4 here

Figure 5 shows the relative median income of pensioners regarding workers. The relative median income ratio is calculated as the median income of people aged 65 (the median pension) as a share of the median income of people aged 16-64 (median wage).[15] The expected evolution of this ratio is quite similar to that obtained for the benefit ratio. An increase is observed during the initial projection period (in all scenarios) that might reflect the fact that workers are subject to labour market instability (attributable to the economic crisis), while pensioners are no longer subject to these effects. This situation is best captured by the median income ratio, which has greater explanatory power in terms of inequality. Note, however that this ratio does not fall in the baseline scenario, as it does in the case of the benefit ratio.

Figure 5 here

Overall, both indicators – the benefit ratio and the median income ratio – present similar patterns. The impact on adequacy – as on sustainability – of the sustainability factor and the pension revaluation index introduced in the 2013 reform are significant, while a hypothetical elimination of the minimum threshold for the revaluation index would be devastating. Figure 6 gives interesting insights in this respect. It shows the past evolution of wages and pensions, together with the future expected trends under the different scenarios. Note that the effects of the economic crisis, which initiated in 2008, caused a fall in pension growth, but above all in wage growth. From 2012 onwards (the worst year in terms of unemployment rates and other macro indicators), the progressive economic recovery saw wage growth recover positive values, while pension growth was restricted by the reform.

Figure 6 here

Figure 6 shows that over recent decades, the average retirement pension in Spain has grown significantly more than wages (benefit ratio increases), but this trend is set to be reversed in the future. Even in a hypothetical baseline scenario without the 2013 reform, average wage growth would surpass that of pensions after 2025. The reform stops radically the increase in the benefit ratio and reduces it bellow pre-crisis level. Finally, the hypothetical application of the UI

[15] The 2015 Adequacy Report constructs this ratio by comparing the median equivalised disposable income of people aged 65 and more and those aged 0-64, including all sources of income, not only pensions and wages.

without thresholds (which is negative for most of the period) reinforces this process producing a more than 50% cut in the benefit ratio. Wages grow far above pensions. First, productivity growth is not translated fully into pensions growth (it only affects entry pensions). Second, pensions do not grow with inflation any more, since the introduction of UI in the 2013 reform. As a result, the benefit ratio deteriorates dramatically. This trend depends on productivity growth as shown in the sensitivity scenarios (Appendix 4)

In other words, by conditioning retirement benefits to the social security balance, the reform links pension levels to wage growth (that is, to the main source of social security revenues). Thus, the relationship between pensions and wage growth is implicitly "sustainable" (a sustainable benefit ratio): increasing gains in retirement benefits due to higher wages are only maintained when the growth in pensions does not compromise the social security budget.

To complete the analysis of intergenerational equity, the expected evolution of the risk of poverty among pensioners is plotted in Figure 8. The risk of poverty is defined as the situation in which a pensioner receives a pension below that of the median income of the economy (plotted in Figure 7).[16] The implementation of the 2013 reform is set to increase the risk of poverty among pensioners in the future, since it results in lower pension growth and, consequently, worsens the relative position of pensioners with regard to workers. Overall, the share of pensioners with income below that of the median will increase up to around 15 percentage points from 2013 onwards. This picture deteriorates markedly in the scenario in which the *UI* is applied without thresholds. In this case, the share of pensioners with an income below the median would be significantly higher, even approaching 100% throughout the decade of the 2030s.

Figure 7 here

Figure 8 here

The microsimulation nature of our model also allows us to analyse equity from an intragenerational perspective. Figure 9 shows the expected evolution of the S80/S20 pensions ratio under the different scenarios. The S80/S20 indicator is a widely used indicator for measuring inequality and is included in the Joint Assessment Framework (JAF), as well as in the Social EMU scoreboard on key social and employment indicators. It is obtained as the ratio between the total income received by the 20% of the population with the highest income (the top

[16] In our microsimulation exercise, the median income is computed with the distribution of wages and pensions, as other income sources are not included in the model.

quintile) and that received by the 20% of the population with the lowest (the bottom quintile). In our exercise, we compute the S80/S20 for retirement pensions, that is, we obtain an indicator of distribution among pensioners based solely on pension income. Interestingly, Figure 9 shows that, in the medium term, the 2013 reform increases inequality among pensioners, while this effect is eliminated in the long-term (from the late 2030s onwards). In contrast, in the hypothetical scenario in which the *UI* is applied without thresholds, equality would increase among pensioners. The explanation is quite simple: inequality would improve at the expense of a general decrease in pensions (as shown previously in Figure 6), which means pensioners would be more equal, but poorer. [17]

Figure 9 here

6. Conclusions

Concerns about the consequences of demographic ageing on the sustainability of the pension system have led to the adoption of reforms to reduce pension expenditure. However, the impact of these reforms on pension adequacy has frequently been overlooked. In this paper, we have used an extended version of the DyPeS microsimulation model to assess the impact of the last major reform of the Spanish retirement pension system, implemented in 2013, introducing a new revaluation index to update pensions linked to the budget balance of the Social Security, and a sustainability factor adjusting the initial pension according to changes in life expectancy. The model is designed to facilitate analysis of the effects both on pension sustainability and adequacy, providing indicators of both inter and intragenerational distribution.

In line with previous studies, our results show that the reform implemented in 2013 represents a major step towards sustainability, although it has yet to be fully achieved. Our simulations project a significant reduction in total expenditure on retirement pensions thanks to the reform. The ratio between total expenditure (on retirement pensions) and the total wage bill is projected as being reduced by around 14 percentage points by 2050; even though it would still double the current figure (29.5 vs. 14.6%). An examination of the four factors that this ratio can be broken down into presents the expected trends. The coverage rate and, specially, the old dependency rate are set to increase significantly. While the latter is mainly driven by demographic assumptions, the increase in the coverage rate basically responds to the gradually progressive access of women to retirement pensions. In contrast, the expected evolution of the other two factors, that is, the benefit ratio and the employment rate, presents a reduction in the ration between pension expenditure and the wage bill,

[17] See ppendix 5 for additional results on redistribution.

although it will be insufficient to offset the increase created by the coverage and the old dependency ratios. It is worth stressing that the benefit ratio is the factor most strongly affected by the reform. Interestingly, the introduction of the sustainability factor and the annual revaluation index both stops and reverses the trend observed over the last two decades during which pensions have grown at a faster rate than wages. By 2050, the average pension will represent below 40% of the average wage, as opposed to the current value of 55%, while in a hypothetical scenario without reform, it would stand at around 54%.

At the same time, the introduction of the sustainability factor and the annual revaluation index in the Spanish pension system is set to have important effects in terms of adequacy, which are also worthy of our attention. The gains in sustainability are mainly driven by the significant fall in the benefit ratio (average pension to average wage), which implies that the relative economic position of pensioners will deteriorate continuously throughout forthcoming decades, in contrast to the situation experienced in past decades. As a result, our simulations show that from 2030 onwards the percentage of pensioners receiving earnings below the median income will be close to 80%, while this figure is less than 65% in the scenario without reform. This trend would be strengthened in a hypothetical scenario in which the *UI* was applied without thresholds, so that the benefit ratio would fall even more dramatically and the percentage share of pensioners with an income below the median would be close to 100%. Interestingly, if we examine the intragenerational redistribution among pensioners, the effects are far from straightforward. The S80/S20 ratio, comparing the pensions received by the highest and the lowest quintiles in the distribution, increases slightly up to 2030, indicating that equity among pensioners deteriorates with the introduction of the sustainability factor and the pension revaluation index. However, the results in the hypothetical scenario in which the *UI* is applied without thresholds show a clear improvement of the intragenerational distribution across the whole projection. In this latter case, as the average pension would fall significantly, equity would improve at the expense of poverty: pensioners would be more equal but markedly poorer.

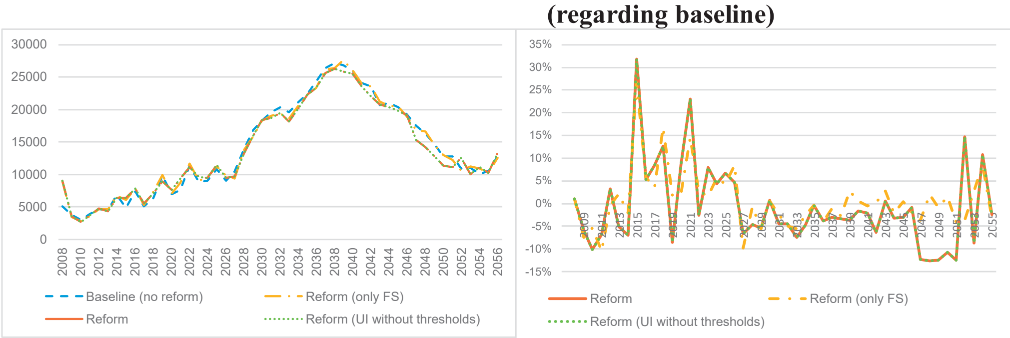
In short, our results indicate that although pension reforms are designed primarily to foster sustainability, they also have significant effects on adequacy, an impact that deserves closer scrutiny. Indeed, the design of the distributive effects of pension systems clearly requires further investigation. Besides the preference for redistributive (*Beveridgean*) or non-redistributive (*Bismarckian*) pensions, the life-cycle nature of pension insurance and the need to cope with demographic ageing complicate the picture further insofar as they potentially have unpredicted redistributive effects. Overall, further research is required in order to investigate the redistributive effects of pensions from a lifetime perspective and in relation to other social programs.

Figures

Figure 1 Evolution of entry pensions

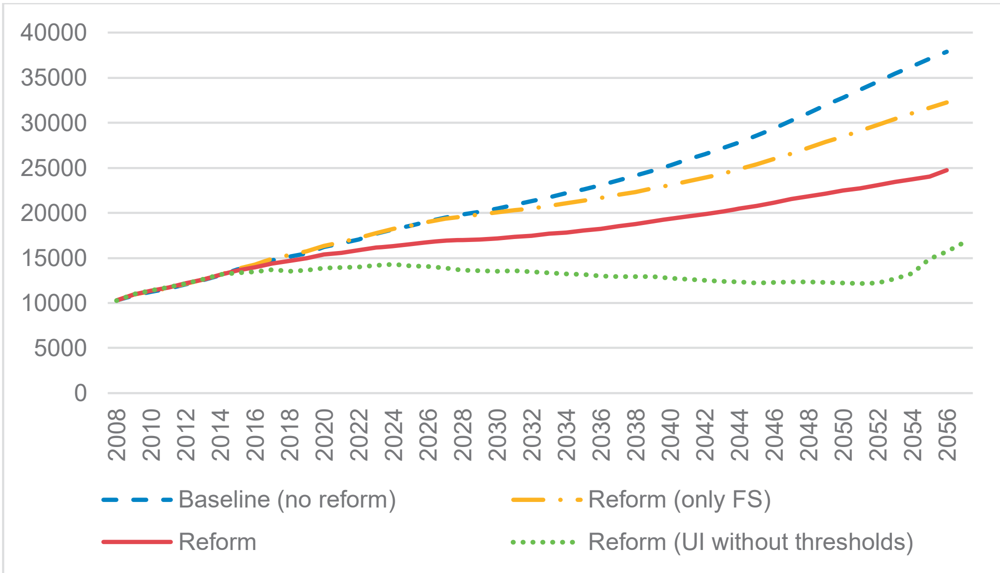
a) Number of new pensioners (*)

b) Changes in the number of new pensioners (regarding baseline)



(*) Results refer to the size of the MCVL, representing around a 4% of the reference population
Source: Authors' calculations

Figure 2 Average retirement pension level (nominal euros per year)

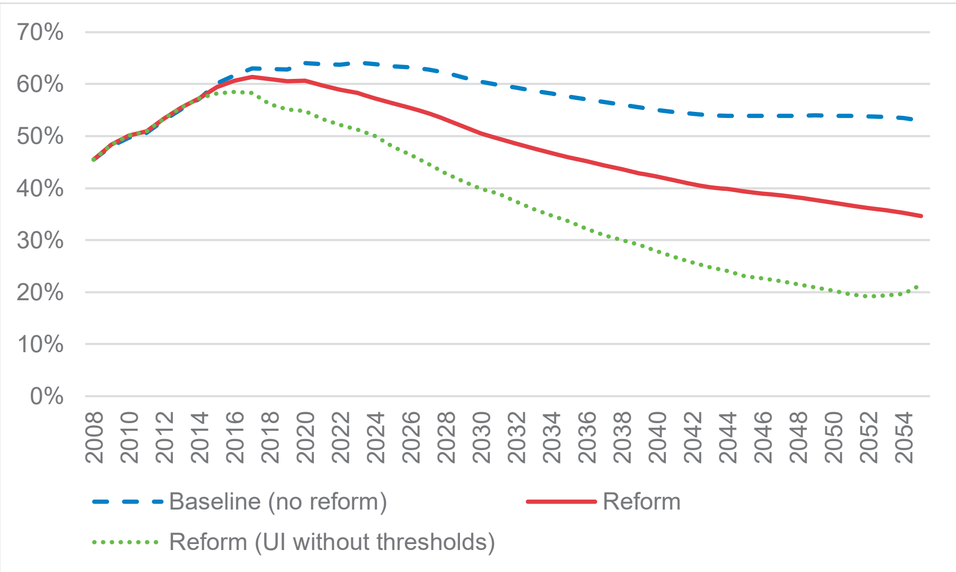


Note: Calculations refer to the average retirement pension of all the Social Security regimes excluding self-employed.
Source: Authors' calculations

Figure 3 Retirement pension expenditure to total wage bill

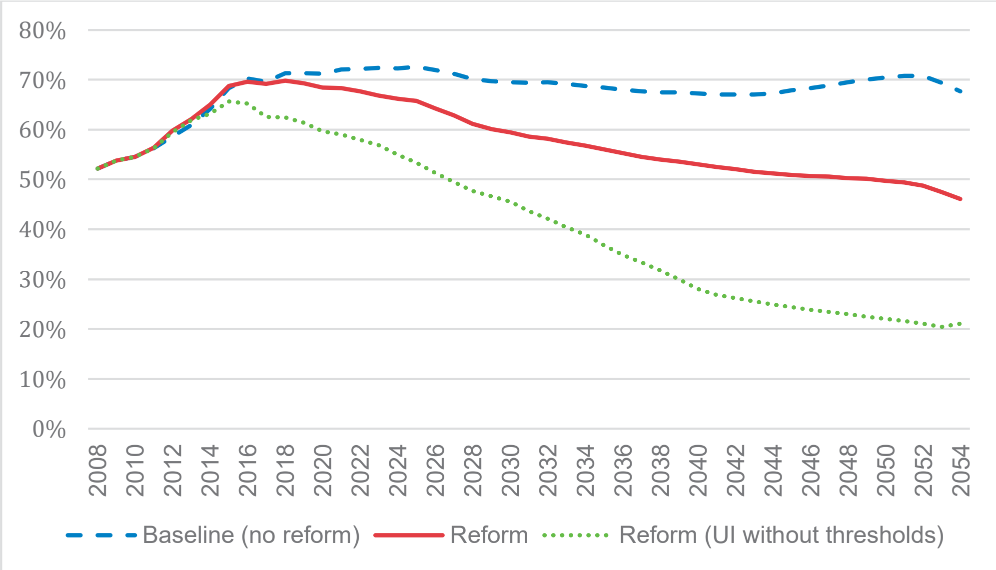
Source: Authors' calculations

Figure 4 Benefit ratio (average retirement pension to average wage)



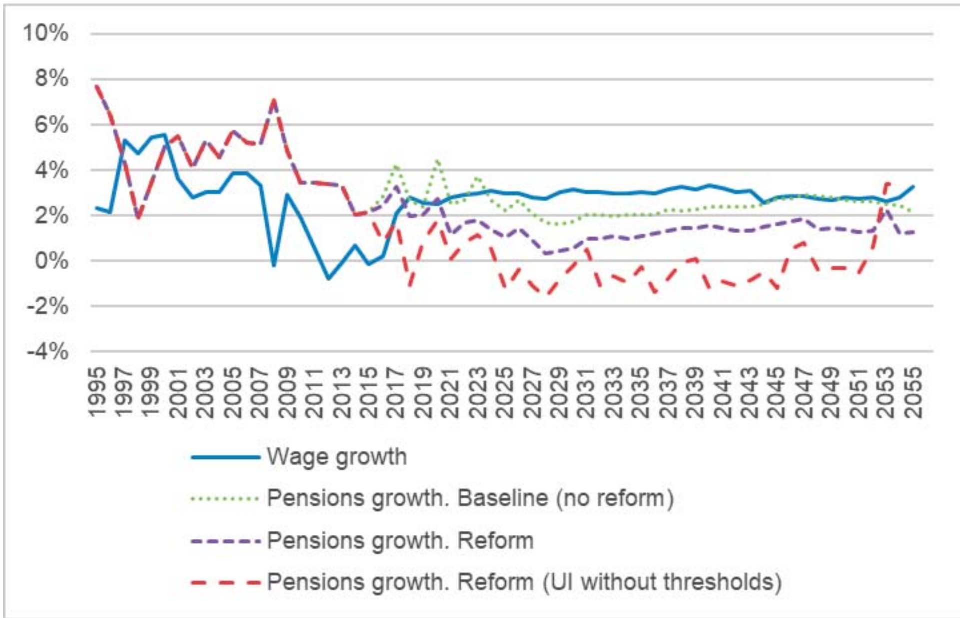
Source: Authors' calculations

Figure 5 Median income of pensioners (aged 65 or older) as a share of the median wage of people aged 16-64.



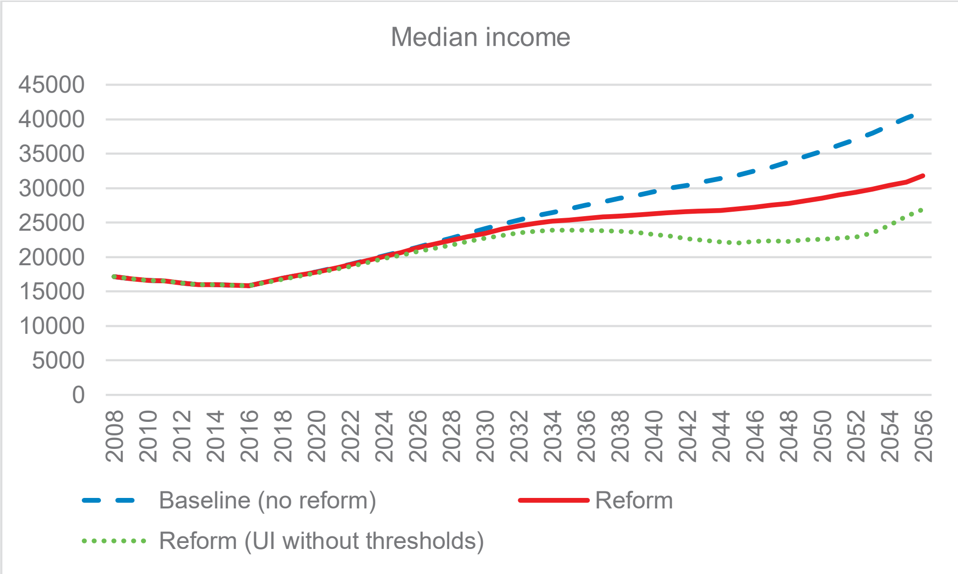
Source: Authors' calculations

Figure 6 Annual average growth of wages and pensions, 1995-2055



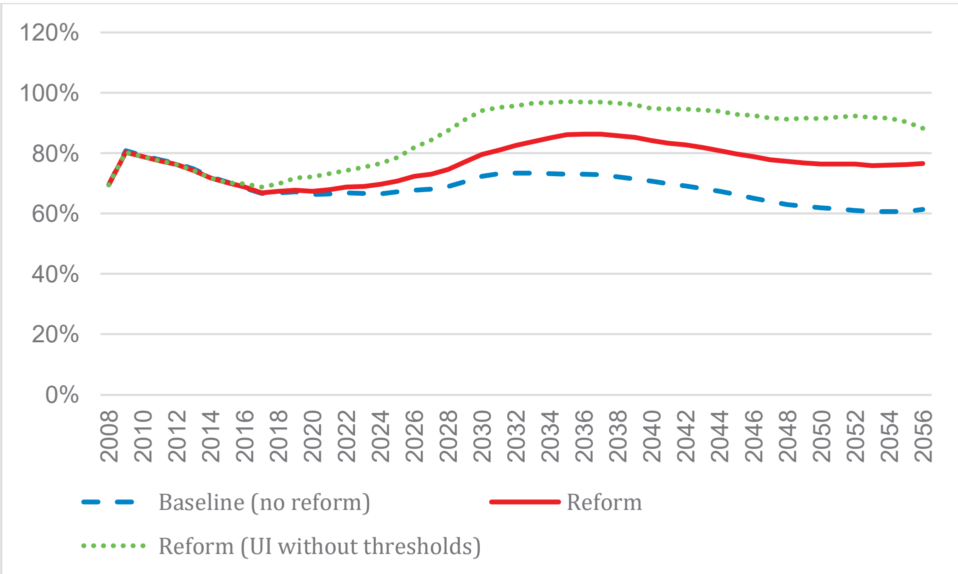
Note: Nominal growth rates.
Source: Observed data from 1995 to 2015 (Annual Economic Data Base of the European Commission and Spanish Social Security). Data from 2016 onwards are projected by the authors.

Figure 7 Median income (nominal euros per year)



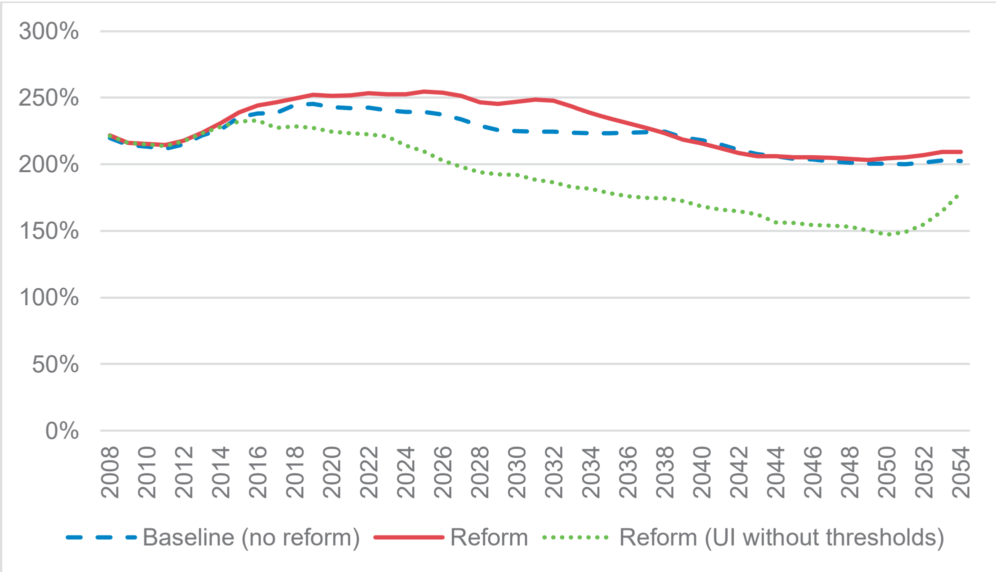
Source: Authors' calculations

Figure 8 Percentage of pensioners in risk of poverty (below median income)



Source: Authors' calculations

Figure 9 S80/S20 pensions ratio



Source: Authors' calculations

Appendix 1. A summary of the main reforms of the contributory retirement pensions system prior to 2013

Without seeking to be exhaustive, we present a chronological summary of the main reforms affecting retirement pensions in Spain's Social Security system. The present system was introduced in 1967 with the enactment of the General Social Security Law. The system is contributory, insofar as the retirement pension relies on the fact that the initial pension benefit is dependent, to some degree, on the worker's past contributions, although the worker must have completed a minimum period of contributions. Specifically, the initial pension (*IP*) is determined by applying a percentage (*p)* which, in turn, depends on the contribution period *(n)* to the regulatory base [*RB*] (defined as the average contribution base in the past). Moreover, various correction coefficients (*c*) may also apply in certain circumstances (such as delayed or early retirement):

$$IP = RB \cdot p(n) \cdot (1\text{-}c)$$

The first major reform of the Social Security was made in 1985, when the minimum period of contributions for receiving a pension was increased from 10 to 15 years, and the period for calculating the *RB* was also increased from 2 to 8 years. Both measures sought to reduce expenditure by limiting access and by reducing benefits through the extension of the period to calculate the regulatory base. Moreover, an explicit actualization mechanism (annual) for existing pensions was introduced, taking into account the predicted rate of inflation for the next year.

In 1995, all political parties signed the Toledo Pact, following the setting up of a special Parliamentary commission whose remit was to analyse the pension system and make recommendations about possible reforms. The Pact identified the need to reinforce the contributory nature of the system, separate the financing of the non-contributory pensions from that of the Social Security, promote delayed (voluntary) retirement, guarantee the purchasing power of pensions over time and create a reserve fund with eventual surpluses to be used in the future. Some of these recommendations were implemented in the 1997 reform. In order to strengthen its contributory nature, the components of the formula for calculating the *IP* were again modified. Specifically, the years for computing the *RB* were increased from 8 to 15 and the percentages was modified as follows: the first 15 years of contribution gave the right to 50% of the *RB* (60% before the reform) as initial pension benefit. Each additional year up to 25 increased the pension by 3 percentage points, and each additional year between 26 and 35 increased the pension by 2 percentage points (prior to the reform, each additional year between 16 and 35 years increased the pension by 2 percentage points). In this way, after 35 years of contributions individuals reach 100% of the *RB* as before, but with a different distribution in favour of longer working careers. Any improvement in the contributory nature of the system was, however, modest. The 1997 Reform also introduced (albeit in a somewhat vague fashion) the creation of a Social Security reserve fund with eventual surpluses, and the possibility of measures to promote delayed retirement. In 2002, a new Law enacted more specific measures to encourage delayed retirement and to discourage partial retirement.

In 2007, changes were once again made in retirement pensions. The conditions for accessing partial retirement were further tightened, while the premium coefficient (c) applied to delayed retirement was increased. The next major Social Security reform in Spain was implemented by means of Law 27/2011. In the middle of a deep economic crisis, the government decided to undertake far-reaching reforms in order to reduce expenditure and avoid short-term financial deficits caused by the dramatic fall in contributions. Among the measures introduced, mention should be made of the extension of the ordinary retirement age from 65 to 67 (although it remained at 65 for individuals with long working careers, accrediting 38.5 or more years of contribution). To strengthen the contributory nature, both components of the formula for calculating the initial pension were again modified – the period of past contributions considered in obtaining the RB was increased from 15 to 25 years, while the percentage to apply to the RB was also modified for individuals with more than 15 years of contributions (being extended from 35 to 37 years and being made more proportional). The possibility of early retirement was also modified by introducing two paths of access (voluntary and involuntary) for those with long contribution histories. A lengthy period of transition (2013-2027) was established before all these measures were fully adopted.

Appendix 2. Modelling wages and the retirement decision

The DyPeS model enables us to project the effects of the labour market on the pension system, because productivity growth at the macro level is linked to individual wage growth and, hence, to the entry pension level, affecting in turn the retirement decision. It achieves this by means of two principal mechanisms: the wage growth model and the retirement decision model.

The wage model is based on the traditional Mincer equation, and is estimated separately by gender and education group:

For period t

$$w_{it} \quad \bar{w}_t\left(\frac{\beta_0}{\bar{w}_t} + \frac{\beta_1}{\bar{w}_t} w_{i,t-1}, \frac{\alpha}{\bar{w}_t} X_{it}\right) \qquad [A2.1]$$

where w_{it} is the yearly wage of individual i, $\bar{w}_t$ is the average wage of the economy and β_0, β_1 and α are the parameters of interest that we wish to estimate. The set of explanatory variables, X_i includes, apart from the previous wage (w_{it-1}), age, age squared and business cycle indicators – unemployment rate.

Thus, using the following coefficients:

[A2.2]

and applying the productivity growth rate assumed in each scenario to the average wage of the economy (w_{it-1}), we obtain the future individual wage for the projected periods ($t+1$ and the following periods) as:

$$w_{it+1} \quad \bar{w}_{t+1}\left(\beta_0^* + \beta_1^* w_{i,t}, \alpha^* X_{it+1}\right) \qquad [A2.3]$$

To estimate the model (Equation [A2.1]), we use a panel data set covering the period 2005-2014, which has been drawn up using information from the MCVL and from the macroeconomic indicators (Spanish National Institute of Statistics, INE). During the simulation, earnings (and contribution bases) are updated on a continuous basis. To do so, both a current value and an accumulated value are maintained and updated in the following cases. First, earnings are updated at the beginning of the year, in accordance with Equation [A2.3]. At the same time, contribution bases are also updated. Second, whenever a labour status transition occurs – both among contribution groups within employment status, and between unemployment and employment statuses, a change in wages is applied depending on gender and the original and final states. For this purpose, the average change in wage observed is used. Finally, every time one of the aforementioned changes occurs, total earnings (and contribution bases) functions are updated. This also happens at the end of the year, so that the annual flow of earnings and contribution bases can be recovered and stored.

The estimation results of the wage growth model are shown in Table A2.1. As expected, wages increase with age, but non-linearly. In the case of men, the positive impact of age on wages is more than twice the impact recorded on women. As expected, higher unemployment rates result in a reduction in wage growth, and this effect is most marked among men with high levels of education.

Table A2.1 The wage growth model: Results

	Coef.	Std. Err.	t			Coef.	Std. Err.	t	
Male less than secondary					Female less than secondary				
Past wage	0.0023	0.0001	26.92	**	Past wage	0.0060	0.0002	33.07	**
Age Sq.	0.0406	0.0007	57.56	**	Age Sq.	0.0012	0.0007	1.83	*
Age Sq.	-0.0004	0.0000	-68.08	**	Age Sq.	-0.0001	0.0000	-12.37	**
Unemployment rate	-0.0391	0.0001	-266.5	**	Unemployment rate	-0.0210	0.0001	-158.93	**
Constant	0.1436	0.0204	7.03	**	Constant	0.7583	0.0189	40.09	**
Male secondary					Female secondary				
Past wage	0.0010	0.0000	22.82	**	Past wage	0.0003	0.0000	8.88	**
Age Sq.	0.1116	0.0008	140.1	**	Age Sq.	0.0570	0.0005	108.19	**
Age Sq.	-0.0013	0.0000	-169.9	**	Age Sq.	-0.0007	0.0000	-139.47	**
Unemployment rate	-0.0484	0.0002	-268.3	**	Unemployment rate	-0.0322	0.0001	-274.71	**
Constant	-0.8239	0.0202	-40.72	**	Constant	-0.0445	0.0130	-3.42	**
Male university					Female university				
Past wage	0.0073	0.0002	31.28	**	Past wage	0.0030	0.0002	15.74	**
Age Sq.	0.2002	0.0034	58.11	**	Age Sq.	0.1020	0.0016	63.76	**
Age Sq.	-0.0024	0.0000	-70.76	**	Age Sq.	-0.0013	0.0000	-78.68	**
Unemployment rate	-0.0707	0.0007	-95.15	**	Unemployment rate	-0.0461	0.0003	-138.36	**
Constant	-1.7209	0.0861	-19.98	**	Constant	-0.3443	0.0368	-9.35	**

The retirement model seeks to capture the fact that individuals may change their behaviour in response to pension system reforms, modifying their retirement decision to optimize their benefits. Indeed, given that retirement choices reflect individuals having to weigh up options regarding their present and future income, as well as their leisure preferences and risk perceptions, such choices can be modelled within the theoretical framework of the life-cycle theory of consumption, based on utility maximization. This approach captures the impact of changes in the budget constraint on the retirement decision, given an individual's consumption and leisure preferences reflected in the utility function. A full structural estimation of this model requires the explicit modelling of all these factors, which in turn implies strong parametric assumptions about preferences. The approach has the advantage of affording a clear interpretation of results, but it poses major challenges of feasibility. In this regard, the seminal works of Miller (1984), Wolpin (1984), Pakes (1986) and Rust (1987), identified the conditions under which these dynamic discrete choice models were both feasible and relevant for solving key economic questions.

We model retirement behaviour by introducing financial incentives within a survival framework. In line with previous research for the US (Coile and Gruber, 2000; Baker et al., 2003; Gruber and Wise, 2005), survival estimates highlight the role played by the economic incentives for retirement implicit in the pension scheme. Specifically, in the reduced-form approach the retirement hazard is estimated as a function of individual characteristics (age, education, etc.) and retirement incentives. Indeed, reduced-form models, in the form of discrete response or hazard models, can be traced back to utility models, as shown by Stock and Wise (1990). Changes in income reflect changes in utility (thus avoiding the need to model consumption), while preferences for leisure can be captured by variables expressing impatience to retire. Including this reduced form retirement behavioural equation in our microsimulation model allows us to define an 'optimal time to retire' scenario coherent with current regulations.

To define the incentives to be included in our model, we take as our starting point recent studies for Spain that estimate the effects of Social Security incentives and use the same dataset as the one employed herein (i.e., the MCVL). Vegas-Sánchez et al. (2013) estimate Social Security Wealth (*SSW*), i.e., the present net value of net benefits received from the pension system; Social Security Accrual (*SSA*), i.e., the discounted change in *SSW* when postponing retirement by one year; and, the Peak Value (*PV*), which compares this year's *SSW* with the maximum *SSW* that can be attained in the future. The authors report that the coefficients of all three social security variables are statistically significant with the expected sign. However, several studies (based on a preliminary experimental version of MCVL) report the limited effect of retirement incentives on the retirement decision, suggesting that age is the main determinant (Boldrin et al., 2004; Jimenez-Martin, 2006). In this respect, it is well known (Gruber and Wise, 2004) that *SSW* might be endogenous and it may not be possible to separate the effects of financial incentives and the taste for work – both interacting with age. More recently, García-Pérez et al. (2013) show that, when incentives are properly defined and problems such as individual heterogeneity are taken into account, incentives have a strong impact on labour market decisions, especially on retirement decisions. We estimated a similar model to the one used in Vegas-Sánchez et al. (2013) and found that the *PV* has no impact on the probability of retirement. Thus, in our microsimulation model, we opted to include a set of incentives that are closer to those use in García-Pérez et al. (2013). The latter authors specify a model that only considers the current pension benefits of retirees and changes in their pension rights. We take a similar approach by considering pension rights and the difference between the expected pension at its highest possible value and the pension if the worker retires in the current year. The influence of minimum pensions on low-wage workers is also tracked. We also include the replacement rate (initial pension to last individual's wage) and current labour income as a financial incentive, which takes the form of wages, for employees, or unemployment benefit, for the unemployed.

The individual replacement rate and the maximum expected pension are clearly related to an individual's wage trajectory and, also, to the average productivity of the economy, in line with the model presented above. These mechanisms cause productivity growth to have an impact on both the level and adequacy of pensions and, hence, on the average retirement age. On the one hand, more optimistic productivity growth scenarios would lead to higher individual growth rates and, consequently, worsen the relative position of the elderly with respect to the working population (decreasing median income ratios, for example). On the other hand, higher wages mean higher future entry pensions, given that the formula calculating initial pensions links them directly to the contributions made over the preceding years (15 in 2015 increasing gradually to 25 from 2023 according to the 2011 reform). Finally, higher wages would lead to a decrease in replacement rates, making it more attractive for workers to remain in the labour market. This, in turn, would also have a positive impact on initial pensions. Consequently, projecting different productivity growth rate scenarios (see Appendix 4) can provide interesting information for policy evaluation as regards the impact of changes in the retirement age and their interaction with labour market performance. Note that the results in this respect are not easily predictable without a complete model that links, to some extent, the micro and macro levels.

The other variables included in our model (apart from retirement incentives) are: level of education, labour status (employed/unemployed), an indicator as to whether the individual is a recipient of unemployment benefit, waiting time (and age) to obtain the maximum pension, replacement rate, and a time counter that seeks to capture impatience. We also include a proxy for the state of the business cycle (unemployment rate). We expect financial incentives and variables related to taste for work and impatience to interact, as is commonly assumed by economic theory: people seek to maximize their income, but they prefer leisure to work. The time dimension operates discounting future gains in terms of both leisure time and money (people are assumed to be impatient). People aged over 58 and fulfilling the eligibility conditions compute their retirement hazards monthly, and the covariates that determine the retirement decision are also updated monthly.

We estimate a piecewise-constant exponential model in which the hazard is assumed constant within pre-specified survival time intervals but the constants may differ for different intervals. This kind of semi-parametric model is commonly used in a continuous time framework – the approach we adopt to exploit the richness of our dataset – to avoid assumptions about the shape of the hazard function implied by parametric models. Then, the exponential model can be defined by:

$$\theta(t, X_t) \quad \theta_0(t)\exp(\beta' X_t) \qquad \text{[A2.4]}$$

$$\theta(t, X_t) \quad \begin{cases} \bar{\theta}_1 \exp(\beta' X_1) & t \in (0, \tau_1] \\ \bar{\theta}_2 \exp(\beta' X_2) & t \in (\tau_1, \tau_2] \\ \vdots & \\ \bar{\theta}_k \exp(\beta' X_k) & t \in (\tau_{k-1}, \tau_k] \end{cases} \qquad \text{[A2.5]}$$

where the baseline hazard rate is constant within each of the k intervals but differs between intervals, X is a vector of variables (fixed or, if time-varying, constant within each interval) representing personal characteristics, working careers and macro-indicators that are relevant for our model, β is the vector of parameters we wish to estimate, and t represents time. We use a monthly panel dataset covering the period 2005–10, derived from the MCVL. It includes all individuals eligible for retirement during this period, excluding those that retired due to collective agreements or who were forced to do so by regulation (unemployed who reach the minimum retirement age).

Table A2.2 Estimations of the retirement decision. Behavioural model

	Men				***Women***			
	Haz. Ratio	*Std. Err.*	*z*		*Haz. Ratio*	*Std. Err.*	*z*	
Age	21.2169	12.1363	5.34	**	0.8289	0.0198	-7.87	**
Age S .	0.976	0.0043	-5.49	**	-			
Sec nda y studies[a]	0.9727	0.0551	-0.48		0.8574	0.0785	-1.68	
Uni e sity s dies	1.1521	0.0688	2.37	**	0.9322	0.1076	-0.61	
Fi s year eti ed	11.219	2.2717	11.94	**	7.2516	3.1661	4.54	**
Unemployed	0.6557	0.0444	-6.22	**	0.6919	0.0586	-4.35	**
Unemployment benefi	0.1557	0.0906	-3.19	**	0.2133	0.1248	-2.64	**
Wage (100 € change)	0.9952	0.0001	-13.48	**	0.9947	0.0006	-8.58	**
PV (difference max. pensi n, 100 € change)	0.9686	0.0001	-2.3	**	0.9014	0.0268	-3.49	**
Time max. ensi n	0.9947	0.0028	-1.83	*	1.0021	0.0110	0.20	
Age at max. pensi n	1.0001	0.0001	1.92	*	1.0000	0.0002	-0.17	
Replacement ate	1.0744	0.0263	2.93	**	1.1310	0.0560	2.49	**
Minim m pensi n	1.1235	0.0692	1.89	*	1.4381	0.1026	5.09	**
M nths since eligible(log)	1.3289	0.0358	10.55	**	1.4757	0.0650	8.83	**
Unemployment rate	1.0117	0.0040	2.92	**	1.0121	0.0062	1.97	*
C ns ant	5454	0.0000	-5.39	**	6453	10501	5.39	**

[a]base category: no s udies primary s udies
*signi icant at 5%
*signi icant at 10%

Table A2.2 shows the results of our behavioural model. As expected, the retirement hazard increases with age (at a decreasing rate), but the most powerful effect is that associated with the variable "first year of eligibility", which increases the hazard for both genders. This is consistent with the fact that between 55 and 60% of people (depending on the year considered) retire as soon as they can (via the "ordinary" retirement pathway). The unemployed and those receiving unemployment benefit tend to retire later. Individuals are forced to retire (via the "ordinary" pathway) if they are unemployed at the legal retirement age. In our estimation, we eliminated these enforced retirement events as they do not reflect real choices. Hence, the unemployed present in our sample are mostly people eligible for early retirement, observed before their ordinary retirement age. Variables related to financial incentives behave as expected (see explanation above) and the effects of the replacement rate (individual ratio of pension to last wage) and the minimum pension are especially strong. The effect of the PV proxy is also very strong in the case of women (we compute changes in one euro). These results are in line with those reported by García-Pérez et al. (2013), who show that greater accrued pension rights are, as expected, associated with lower re-entry rates and higher retirement rates. The effect of the economic crisis (measured in our estimation using the unemployment rate) is associated with delayed retirement for both genders.

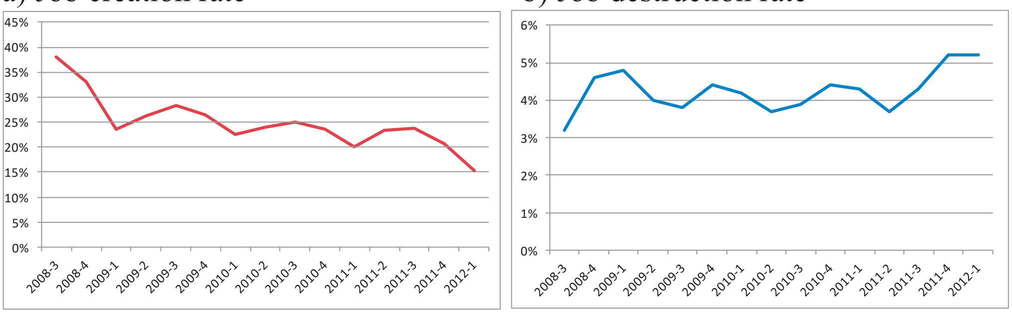
Men with higher education tend to remain less time in the labour market after becoming formally eligible for retirement (the same effect is observed for women but it is not significant). In contrast, the less educated are more likely to be affected by periods of unemployment and non-participation, especially during the crisis. This effect, combined with lower wages, may reduce their entry pension level, obliging them to work longer to achieve financial security. As explained, the retirement choice reflects heterogeneous tastes for work and leisure, and different budget constraints. Longer working careers may reflect work and leisure preferences more aligned to remaining in the labour market (associated with the more highly educated and those earning higher wages). However, retirement decisions also reflect budget constraints, supposedly more so for the less educated, and thus, they work in the opposite direction.

Appendix 3 The impact of the crisis

The year 2007 is chosen as the base year so as to ensure the projections are not permanently affected by features attributable to the crisis starting in 2008. However, at the same time, we do need to take into account the temporary effects of the crisis. Given that we seek to simulate the long-run trends in pension expenditure, we opted in our model for a stylized simulation of the crisis period. First, we consider an increase in the unemployment rate induced by a temporary increase (decrease) in the job destruction (creation) rates, in line with the evolution observed in the early years of the crisis (as shown in Figure A3.1). Second, a reduction in the growth rate of wages is also considered. Specifically, the observed falls in inflation and productivity growth are taken as given, and it is assumed that they will recover to the long-run values projected by the Ageing Working Group simulations (European Commission, 2015a) (see Table 1 in Section 4).

Figure A3.1 Evolution of job creation and destruction rates (quarterly values, 2008-2012)

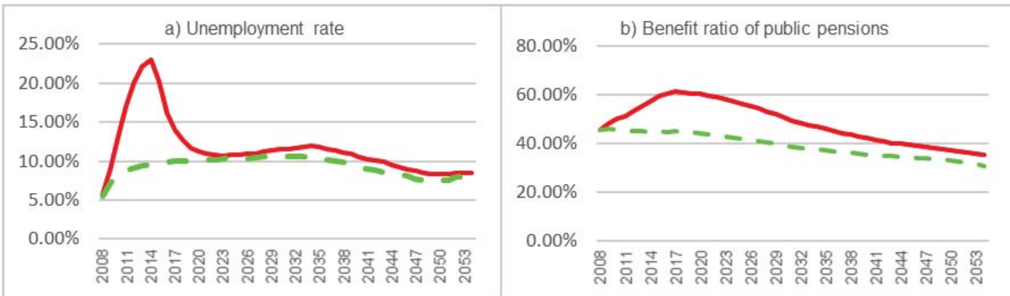
a) Job creation rate b) Job destruction rate



Note: The job creation rate = the share of unemployed that obtain employment in the next trimester. The job destruction rate = the share of workers who lose their job in the next trimester. Source: FEDEA, *Observatorio laboral de la crisis* (http://www.fedea.net/observatorios-fedea/empleo/)

In order to assess the impact of the economic crisis on our long-run projections, an alternative scenario without the effects of the crisis has been considered. To do so, constant values of productivity growth and inflation at 1.6 and 2%, respectively, are assumed across the whole simulation period. Figure A3.2 illustrates the results of this hypothetical scenario without the crisis compared to the results obtained when simulating the effects of the crisis (note that in both cases we consider the introduction of the sustainability factor and the pension revaluation index implemented in the reform of 2013). As shown in panel a), our simulation of the crisis causes the unemployment rate to almost triple the rate resulting from the hypothetical scenario without the crisis. [1] Second, the projected decrease in wage growth due to the crisis, results in a progressively lower growth in the average retirement pension. So that, in the short run, the crisis causes a significant increase in the benefit ratio, with wages falling sharply while pensions remain quite constant (panel b). However, this trend is reversed once the crisis terminates. The benefit ratio is always higher than the resulting from the scenario without the crisis.

Figure A3.2 Impact of the economic crisis on unemployment and pensions



Note: The solid lines correspond to the central scenario of our simulations, incorporating the reform implemented in 2013, while the dashed lines represent a hypothetical scenario with the reform but without the effects of the crisis.
Source: Authors' calculations

[1] Note that unemployment rate (panel a) in Figure A3.2 increases during the period corresponding to the retirement of baby boomers. This is the result of a composition effect due to the fact that unemployment rates are higher for older workers and might be offset in reality by the relative scarcity of labour supply.

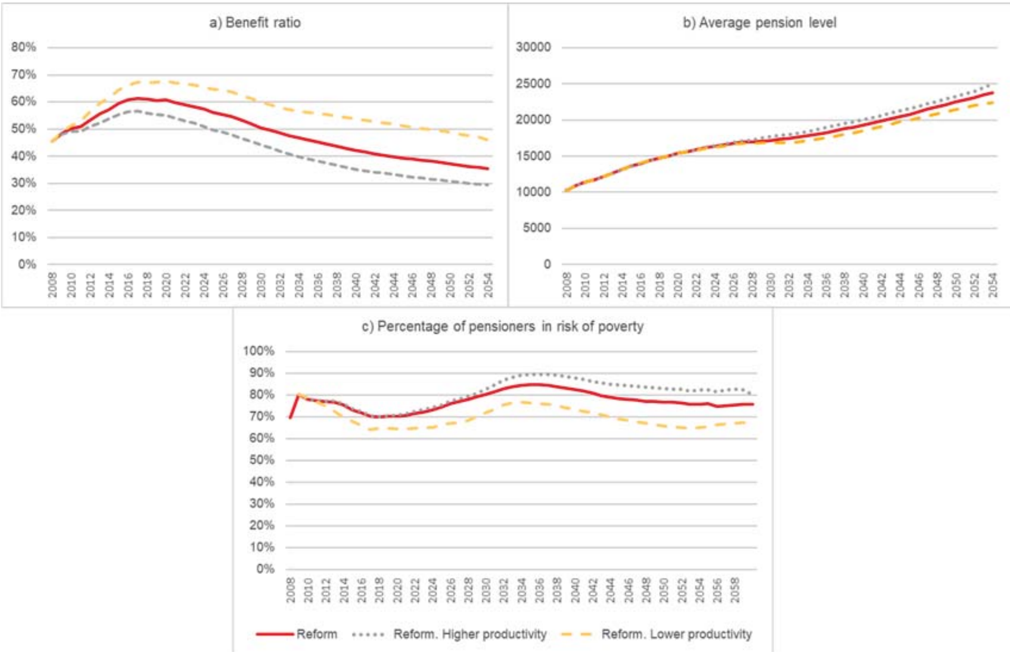
Appendix 4. Sensitivity analysis: changes in productivity rates

In this Appendix, we simulate two alternative scenarios of productivity: one in which productivity rates are 30% higher each year, and another in which these rates are 30% lower than those predicted in the central scenario of our simulations (and by previous studies, as discussed in the main text). The most obvious indicator to be affected by changes in productivity rates is the benefit ratio. The impact of productivity on this indicator has been discussed in previous studies. As Hernández de Cos et al. (2017) explain, a rebound in productivity growth leads to a further transitional reduction in the benefit ratio across the period in which cohorts experiencing lower productivity growth during their working lives enter retirement. However, given that contributory pensions are dependent on the workers' labour history (both the number of years worked and the average wage over the last 25 years), increases in productivity – insofar as they generate wage gains – are eventually transferred to pensions. Consequently, increases in productivity have a positive and significant transitory effect on the financial situation of the public pension system, which is compensated for as pensions increase albeit at a smaller magnitude (see, for example, Conde-Ruiz, 2017). In addition, both effects occur only as a result of a decrease in the benefit ratio. Given that all these effects are quite predictable (at least in terms of their direction), what remains more open to investigation is the impact of changes in productivity on pension levels and, more generally, on pension adequacy. Hernández de Cos et al. (2017) point out that higher rates of productivity growth might allow retirement pensions to be higher, even if their replacement rate were lower, so that the standard of living of retirees would improve, although their income relative to cohorts of the working-age population would decrease.

Our model allows us to disentangle the magnitude and direction of these effects and their consequences in terms of pension sustainability and adequacy. The fact that the model is based on micro data means we can capture changes in poverty indicators, while the fact that it includes behavioural reactions to changes in incentives for retirement means we can investigate the interaction of changes in the benefit ratio with other factors affecting sustainability, namely, coverage rate and labour market factors.

Figure A4 shows the effects of increasing (decreasing) productivity by 30% on four indicators: the benefit ratio, the pension expenditure to wage bill ratio, the average pension and the percentage of pensioners in risk of poverty (with a pension below the median income). These results seem to confirm the observations of the previous authors described above. Increasing productivity permits an increase in the average pension that is compatible with a worsening in relative measures, which comprise a reference to wage levels (risk of poverty and the benefit ratio). As expected, the sustainability of the pension system improves with increased productivity. The opposite is true for lower productivity, but the effect presents a higher magnitude, probably due to the asymmetric effect of maximum and minimum pension thresholds. Moreover, the same rationale can be used to explain the evolution of the benefit ratio in the case of the crisis: markedly lower wages (the scenario with lower rates of productivity terminates in 2060 with an average wage of 41,184€, that is, 13,000€ lower than that expected in the scenario with regular productivity projections) serve as a weak incentive to remain in the labour market, with consequent higher coverage rates and lower employment rates.

Figure A4 The impact of the productivity assumptions



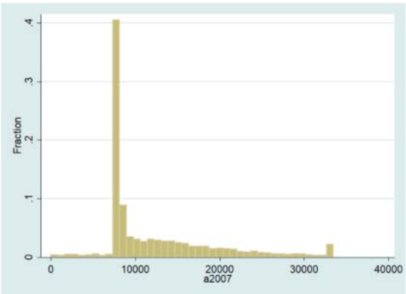
Note: the average pension level is expressed in nominal euros per year
Source: Authors' calculations

Appendix 5. Additional distributive analysis.

This appendix complements the redistributive results. Specifically histograms showing the distribution of pensioners by pension level at the beginning and at the end of the simulation period in the different simulated scenarios. To complement the picture, the corresponding value of the Gini index is also reported.

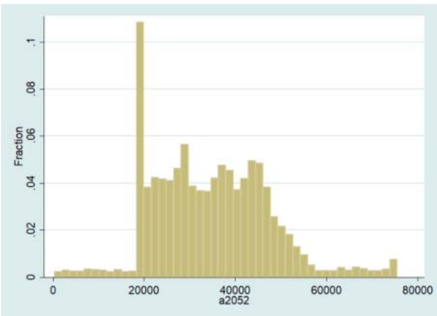
<u>YEAR 2007</u>

Baseline [Gini 28.1]

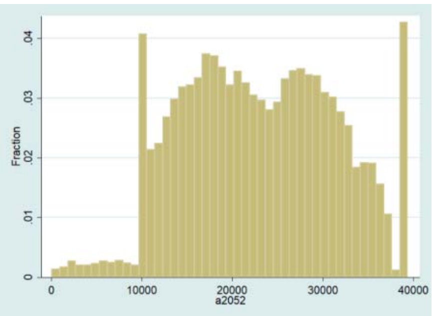


<u>YEAR 2052</u>

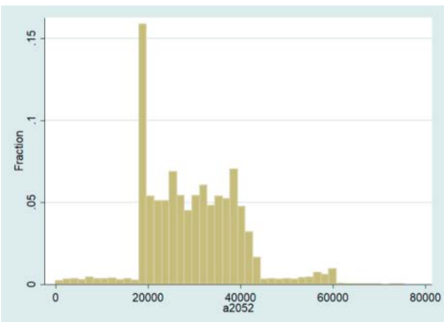
Baseline [Gini 20.8]



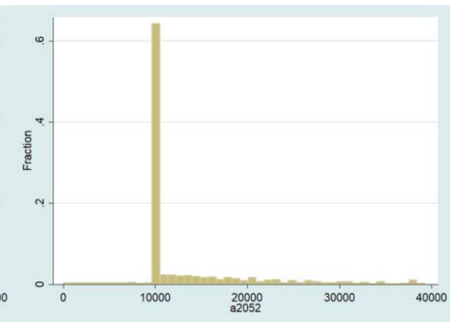
Reform [Gini 21.1]



Only SF [Gini 18.7]



UI without thresholds [Gini 21.6]



In the first Figure, showing the distribution before the simulation period (year

2007) in the baseline scenario, one can observe that a 40%[1] of pensioners receive the minimum pension. The share of pensioners is decreasing afterwards, except for a slight increase for those receiving the maximum pensions. Interestingly, the role of pension thresholds is crucial in explaining the evolution of redistribution. The maximum threshold reaches a value of almost 80.000€ in the baseline scenario and in the scenario modelling only the sustainability factor (Only *SF*), given that the pension thresholds are still updated to inflation. On the contrary, when the pension revaluation index with and without limits (*Reform* and *UI without thresholds* scenarios), the maximum pension values are reduced around a half. A similar variation occurs with the minimum pension.

According to the Gini index all the future scenarios imply a reduction in inequality with respect to the 2007 situation. Nevertheless, as shown in the corresponding histogram, substantial differences remain in the resulting distributions. Together with the cut in pensions produced by the sustainability factor (*SF*) and the pensions revaluation index (*UI*), the key factor explaining these differences is the evolution of the pension's thresholds. In the scenario applying only *SF*, with pension thresholds still growing with inflation, the share of pensioners receiving the minimum pensions is higher than the value obtained in the baseline (15% versus 11%); and the share of pensioners receiving the maximum level remains very low. When the reform is applied and hence the pension thresholds are also updated with *UI*, the share of minimum pensions is reduced to 4%, near the share of maximum pensions. Finally, in a hypothetical scenario in which the limits to the pension revaluation index (*UI*) where eliminated, redistribution improves (the Gini index attains the lower value) because most pensioners (more than 60%) are left with minimum pension.

[1] The value of 40% is higher than expected as the threshold is computed using the highest value of the minimum pension (people aged 65+ and with partner). In addition, it includes pensions below the minim not complemented because the pensioner has other income sources, including other pensions (widow's pensions, for example).

References

AIREF (2014). Opinión sobre la determinación del Índice Revalorización de las Pensiones 2015. Documento de Opinión, available at: http://www.airef.es/documents/42901/510390/2017+07+13+Opini%C3%B3n+IRP+2017.pdf/c2796533-c899-41a4-bbcf-4aa41c5d0bea

Baker, M., J. Gruber, J. and K. Milligan (2003). "The retirement incentive effects of Canada's income security programs". *Canadian Journal of Economics*, 36(2), 261-290.

Bentolila, S., I. García-Pérez and M. Jansen (2017). *Are the Spanish Long-Term Unemployed Unemployable?* FEDEA, Estudios sobre la Economía Española 2017/02.

Bianchi, C., M. Romanelli and P.A. Vagliasindi (2003). "Microsimulating the evolution of Italian pension benefits: the role of retirement choices and lowest pensions indexing". *Labour*, 17(s1), 139-173.

Blundell, R., C. Meghir and S. Smiths (2002). "Pensions incentives and the patterns of early retirement". *Economic Journal*, 112, 153-170.

Binswanger, J. and D. Schunk (2012). "What is an adequate standard of living during Retirement?". *Journal of Pension Economics and Finance*, 11(02), 203-222.

Boldrin, M., S. Jimenez-Martín and F. Peracchi (2004). "Micro-modeling of Retirement Behaviour in Spain", In Gruber, J. and D. A. Wise (Eds), *Social Security and Retirement around the World.* NBER, University of Chicago Press, 499-567.

Borella, M. and E. Fornero (2009). "Adequacy of Pension Systems in Europe: An Analysis Based on Comprehensive Replacement Rates". *ENEPRI Research Report,* No. 68. Available at SSRN: https://ssrn.com/abstract=2033652 or http://dx.doi.org/10.2139/ssrn.2033652

Borella, M., and F.C. Moscarola (2010). "Microsimulation of pension reforms: behavioural versus non behavioural approach". *Journal of Pension Economics and Finance*, 9(04), 583-607.

Brady, P.J. (2010) "Measuring retirement resource adequacy". *Journal of Pension Economics and Finance*, 9(2), 235-262.

Buddelmeyer, H., J.Freebairn and G. Kalb (2006). "Evaluation of policy options to encourage welfare to work". *Australian Economic Review,* 39 (3), 273–292.

Chia, N. C. and A.K. Tsui (2003). “Life annuities of compulsory savings and income adequacy of the elderly in Singapore”. *Journal of Pension Economics and Finance*, 2(01), 41-65.

Chybalski, F. (2012). *Measuring the multidimensional adequacy of pension systems in European countries*. The Pensions Institute Cass Business School City University London. Discussion paper PI-1204.

Coile, C. and J. Gruber (2000). *Social security incentives for retirement*. Working Paper 7651, National Bureau of Economic Research, Cambridge, MA.

Conde-Ruiz, J. I. (2017). *Medidas para restaurar (o no) la sostenibilidad financiera de las pensiones*. FEDEA, No. 2017-04.

Conde-Ruiz, J. I. and C.I. González (2013). “Reforma de pensiones 2011 en España”. *Hacienda Pública Española/Review of Public Economics*, 204(1), 9-44.

De la Fuente, A., Díaz, M. A. G., & Sánchez, A. R. (2018). La salud financiera del sistema público de pensiones español. Un análisis retrospectivo. FEDEA, Documento de trabajo 2018-05.

Dekkers, G., H. Buslei, M. Cozzolino, R. Desmet, J. Geyer, D. Hofmann, M. Raitano, V. Steiner, P. Tanda, S. Tedeschi and F.C. Verschueren (2008). *What are the consequences of the AWG-projections for the adequacy of social security pensions? An application of the dynamic micro simulation model MIDAS for Belgium, Italy and Germany*. Report of the Work Package 4 of The AIM project, Federal Planning Bureau report, September 2008.

Díaz-Giménez, J. and J. Díaz-Saavedra (2017). “The Future of Spanish Pensions”. *Journal of Pension Economics and Finance*, 16(02), 233-265.

European Commission (2014). *The 2015 Ageing Report: Underlying Assumption and Projection Methodologies*. European Economy, No. 8/2014. Available at:
http://ec.europa.eu/economy_finance/publications/european_economy/2014/ee8_en.htm

European Commission (2015a). *The 2015 Ageing Report: Economic and budgetary projections for the 28 EU Member States (2013-2060)*. European Economy 3/2015. Available at:
http://ec.europa.eu/economy_finance/publications/european_economy/2015/pdf/ee3_en.pdf

European Commission (2015b). *The 2015 Pension Adequacy Report: current and future income adequacy in old age in the EU*, Luxembourg, Publications Office of the EU.
http://ec.europa.eu/social/BlobServlet?docId=14529&langId=en

Fernández-Díaz, F.J., C. Patxot and G. Souto (2013). *DYPES: A Microsimulation model for the Spanish retirement pension system*. FEDEA, Documento de Trabajo 2013-06.

García-Pérez, J.I., S. Jiménez-Martín and A. R. Sánchez-Martín (2013). "Retirement incentives, individual heterogeneity and labor transitions of employed and unemployed workers". *Labour Economics*, 20, 106–120.

Gruber, J., & Wise, D. (2005). *Social security programs and retirement around the world: Fiscal implications, introduction and summary.* National Bureau of Economic Research No. w11290.

Hernández de Cos, P., J.F. Jimeno y R. Ramos (2017). *El sistema público de pensiones en España: Situación actual, retos y alternativas de reforma.* Documentos Ocasionales nº 1701, Banco de España.

Holzmann, R. (2013). "Global pension systems and their reform: Worldwide drivers, trends and challenges". *International Social Security Review*, 66(2), 1-29.

Holzmann, R. and R. Hinz (2005). *Old-Age Income Support in the Twenty-first Century: An International Perspective on Pension Systems and Reform*, Web Version of 18 February 2005, World Bank.

Jimenez-Martín, S. (2006). "Evaluating the Labor Supply effects of Alternative Reforms of the Spanish Pension System", *Moneda y Crédito*, 222, 271-307.

Jimeno, J.F. (2003). "La Equidad Intrageneracional de los Sistemas de Pensiones". *Revista de Economía Aplicada*, nº 31, pp. 5-32.

Knoef, M., J. Been, R. Alessie, K. Caminada, K. Goudswaard and A. Kalwij (2016). "Measuring retirement savings adequacy: developing a multi-pillar approach in the Netherlands". *Journal of Pension Economics and Finance*,15(01), 55-89.

Li, J., & O'Donoghue, C. (2013). "A survey of dynamic microsimulation models: uses, model structure and methodology". *International Journal of Microsimulation*, 6(2), 3-55.

Miller, R. A. (1984). "Job Matching and Occupational Choice*", Journal of Political Economy*, 92, 1086-1020.

Ministerio de Trabajo y Asuntos Sociales (MTAS) (2006). *La Muestra Continua de Vidas Laborales*. Colección Informes y Estudios. Serie Seguridad Social, vol 26. Ministerio de Trabajo y Asuntos Sociales, Madrid.

O'Donoghue, C. (2001). "Dynamic microsimulation: A methodological survey". *Brazilian Electronic Journal of Economics*, 4(2), 1-77.

Pakes, A. (1986). "Patents as Options: Some Estimates of the Value of Holding European Patent Stocks," *Econometrica*, 54, 755-784.

Patxot, C., M. Solé, G. Souto and M. Spielauer (2015). *Explaining retirement decisions for Spain: paper on life course factors affecting retirement decisions based on Spanish administrative data*, AGENTA Project Deliverable 3.2. http://www.agenta-project.eu/Jacomo/upload/publications/d-3.2-submitted.pdf

Pérez-Salamero J.M., M. Regúlez-Castillo and C. Vidal-Meliá (2017). "The continuous sample of working lives: improving its representativeness". *SERIEs*, (8), 43-95.

Richiardi, M. and R. Leombruni (2006). "LABORsim: an agent-based microsimulation of labour supply. An application to Italy". *Computational Economics*, 27(1), 63-88.

Roch, O., M. Bosch-Princep, I., Morillo, and D. Vilalta (2015). "A Revision of the Revaluation Index of Spanish Pensions). (January 9, 2015). Hacienda Pública Española,/review of Public Economics, 222-(3/2017): 109-134. Available at SSRN:
https://ssrn.com/abstract=2547808 or http://dx.doi.org/10.2139/ssrn.2547808

Rust, J. (1987). "Optimal Replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher," *Econometrica*, 55, 999-1033.

Sánchez-Martín, A.R. (2014). "The automatic adjustment of pension expenditures in Spain: an evaluation of the 2013 pension reform". *Documento de trabajo* 1420, Banco de España.

Sánchez-Martin A. R. (2017). *Proyecciones financieras y de bienestar del sistema español de pensiones: modelización en equilibrio general*. FEDEA Estudios sobre la Economía Española - 2017/03.

Stensnes, K. and N.M. Stølen (2007). *Pension reform in Norway: microsimulating effects on government expenditures, labour supply incentives and benefit distribution*. Discussion Papers No. 524, December 2007, Statistics Norway, Research Department.

Stock, J. H. and D. A. Wise (1990). "The pension inducement to retire: An option value analysis", in Wise, D.A. (Ed) *Issues in the Economics of Aging* (p. 205-230). University of Chicago Press, 1990.

Van Sonsbeek, J. M. (2010). "Micro simulations on the effects of ageing-related policy measures". *Economic Modelling*, 27(5), 968-979.

Vegas-Sánchez, R., I. Argimon, M. Botella and C.I. González (2013). "Old age pensions and retirement in Spain". *SERIEs*, 4 (3), 273–307.

Wolpin, K. (1984). "An Estimable Dynamic Stochastic Model of Fertility and Child Mortality," *Journal of Political Economy*, 92, 852-87.