Ageing Europe – An Application of National Transfer Accounts for Explaining and Projecting Trends in Public Finances

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Contents

Abstract

This paper analyses retirement decisions and their long-term effects in the sustainability of the pension system. We focus on the impact of changes in financial incentives caused by a reform of the pensions system and its interaction with life-course factors like education and work trajectories. To that propose, we use administrative data from Spain to run a model that accounts for individuals' reactions to changes in financial incentives to retire. In a second step, we develop a microsimulation model to observe the long-term effects such decisions in terms of sustainability. The 2011 Spanish reform was based on increasing contributiveness - by adding more years to the computation of the initial pension - combined with other measures, such as delaying legal retirement age. On the other hand, work trajectories may have been strongly affected by the current economic downturn. Our hypothesis is that, in a context of low (or even negative) wage growth rates, and considering that individuals will react to the new incentives, these measures may not fully reach the desired objectives. Our results, obtained using the "Dynamic Microsimulation Pensions Model for Spain", DyPeS, support this hypothesis. We find that the consideration of more contribution years in the computation of the initial pension amount, combined with the effect of the crisis on work trajectories, would have a positive impact on initial pension level. In line with other studies, we also find that those having a university degree are more prone to retire. This result holds in both non-behavioural and behavioural model, in which we control for labour income and financial incentives to retire.

Keywords

Dynamic microsimulation, pensions, behavioural model, pension reforms.

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1. Introduction

The majority of developed countries are facing a population aging process that may threaten the sustainability of their social protection programmes. Therefore, governments at several levels are concerned about maintaining their welfare states in a context of rising medical and long-term expenditure and an increasing pensions' bill. According to the European Commission (2012), the demographic old-age dependency ratio (people aged 65 or above relative to those aged 20-64) is projected to increase from 28% to 58% in the EU as a whole over the period 2010-2060. In this respect, Spain is an extreme example of an abrupt population ageing process, with an old-age dependency ratio rising from 27% to 61% and occurring a little later than in other European countries. Sustainability problems are worsened by the fact that the majority of welfare states - among them Spain - are based on a pay-as-you-go financing system, which implies that pensions will be sustained by a proportionally smaller generation of workers.

Therefore, the concern about the necessary reforms to make it sustainable in the long term is fully justified. Reform proposals vary from a complete restructuring of the system – like a switch to a true or to a notional capitalisation system[1] – to marginal adjustments of the legal parameters of the current system. Given the expected increase in the ratio of pensioners to contributors, all of the proposed reforms imply raising contributions and/or reducing pensions. Among them, some measures are aimed at increasing contributiveness, or proportionality between contributions and pensions, strengthening - when it exists - the *Bismarckian* nature of the system. Alternatively - or simultaneously - an increase in the retirement age is often proposed to offset the increasing life expectancy. Note that this might improve sustainability both on the expenditure and on the revenue side. Although the legal retirement age used to be 65 for most workers in most countries, the fact is that average retirement age is clearly lower, despite the increase in life expectancy. Governments in the EU, concerned about the importance of this phenomenon, are interested in incentivising workers to delay retirement.

[1] The possibility of switching to a funded system is limited by the so-called *transition problem*: the initial gift given to generations who did not contribute and received a pension now needs to be offset by a double burden on current workers, who need to maintain the old PAYGO system and contribute to the new one. Some countries have opted for introducing some kind of notional funding, which is somehow a sophisticated way of introducing a defined contribution system.

The design and evaluation of reform measures require the availability of analytical tools. Simulation models have been developed – especially in recent decades - thanks to the availability of an increasing amount and quality of databases and computing tools. In this respect, the use of microsimulation models in policy evaluation and, particularly, in pension reforms is becoming more widespread (see e.g. Borella and Coda Moscarola, 2010; van Sonsbeek, 2010; Buddelmeyer et al., 2006; Stensnes and Stolen, 2007). In the context we are dealing with, these simulation tools need to have both a macro and a micro perspective. The former is essential if one aims at analysing in a consistent way the sustainability of pensions or any other welfare state transfer. The latter is crucial when considering the adequacy of the benefit level in respect to income redistribution. The EU, in the joint report of the European Policy Committee (EPC) and the Social Policy Committee (SPC), has been recommending attending to both dimensions in order to maintain the welfare state, one of the main achievements of Europe in the past century.

On the other hand, previous literature also show that social, economic, and demographic factors play a central role in explaining retirement decisions. For example, the importance of education, health, occupation, marital status, and gender on labor market exit rates has been documented by Börsch-Supan et al. (2009); Buchholz et al. (2013); Glans (2008); Komp et al. (2010); Larsen and Pedersen (2013). These life-course factors for retirement decisions were as well as by Divenyi and Kezdi (2015) using retrospective life history data from 13 European countries (SHARELIFE). These authors investigate the extent to which differences in labor market history (unemployment spells), family history, and parenthood explain differences in retirement behavior, focusing (as we also do) in the effects of the economic crisis on work trajectories. An important result of their analysis is that the relationship of long-run factors and retirement timing shows no significant differences in the pre-recession years (2004 through 2008) and the recession years (2009 through 2013).

One conclusion arising from these previous works is that changing retirement age may be related to a variation in population composition over time, such as the changes in the share of population completed tertiary education. With respect to the role played by terciary education, Qi et al (2015.A) find that workers with university or higher degrees are more prone to retire than those who only attained secondary and primary education.

However, whether the changing educational composition matters for the cohort trend in old-age employment would also depend on changes in the employment differentials across educational groups. In this line of though, Qi et al (2015.B) find a positive relationship between the changes in education composition and old-age employment across cohorts, given the consistent high employment rate among the highly educated and the increasing share of the population with tertiary education across cohorts.

In this paper we present a simulation model of the contributory retirement pension system in Spain that we use to analyse the effects of the reform enacted in 2011. Our model also allows us to disentangle which part of these effects is related to individuals' reaction to changes in regulations which can then be subject to policy intervention. The main measures of this reform consisted of delaying legal retirement age and reinforcing the Bismarckian nature of the system by increasing contributiveness. We add to the literature on microsimulation by accounting for individuals' reactions to financial incentives when deciding to retire. Life-course variables as education and work trajectories (the last supposed to be affected by the current economic crisis) are taken into account.

The microsimulation models that introduce behaviour into the retirement decision are scarce and heterogeneous in the modelling approach. That is probably because there is an inevitable trade-off between explanatory power of the econometric analysis found in the retirement behaviour literature and feasibility of implementation in behavioural microsimulation models. On the one hand, microsimulation models are preferably endowed with very simple - non-behavioural - rules for retirement, for example assuming that individuals retire as soon as eligible (Borella and Coda Moscarola, 2010) or aligning the transitions to the observed patterns (Dekkers et al., 2009; Richiardi and Leombruni, 2006). On the other hand, the literature on retirement behaviour accounts for the role played by financial incentives embedded in the pension rule by integrating the empirical evidence with lifecycle theory. For example, Baker et al. (2003) for Canada, Blundell et al. (2002) for the United Kingdom, Coile and Gruber (2001) for the United States. For Spain, García-Pérez, Jiménez-Martín & Sánchez-Martín (2013) and Vegas et al. (2013) all find that individuals' retirement choices do respond to financial incentives of the pension system.

In relation to studies that specifically analyse changes in the pension rules, 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. 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. In van Sonsbeek (2010), the retirement decision is modelled by the option value approach first suggested by Stock and Wise (1990), combining the individual data on wages, state pension entitlements and private pension entitlements with individually varied option value parameters (time preference, leisure preference and risk aversion). In this model, the retirement decision is taken once and for all at age 60. This does not allow the agent to update changes observed in the final working period, which is crucial for us in order to simulate the effects of the crisis. Therefore, as we will see in more detail, our agents will update expected pensions. Bianchi, Romanelli and Vagliasindi (2003) use an individual reaction function based on the Stock and Wise option value (OV) model in which the worker calculates the expected value of the utility of retiring today and in the future, using the available information. The structural models allow for more sophisticated and explicit theoretical assumptions, but impose restrictions that sometimes reduce applicability. This kind of behavioural models takes into account utility maximisation along the life cycle and, hence, the whole set of contribution and pension receipts from the pension system. Nevertheless, due to constraints in availability of longitudinal data sets, it has become common to use reduced form estimations of retirement decision. For our purposes - mainly predicting long term behaviour -, feasibility is an obvious requirement. We thus opt for reduced form models - in which, of course, the variables included are also theoretically justified.

The results regarding the introduction of pension system reforms for different countries are not directly comparable, also because the pension systems themselves are difficult to compare. Nevertheless, some indications can be found in previous studies. Van Sonsbeek (2010) found that raising the retirement age from 65 to 67 (the same measure was decided for Spain and will be analysed here) will decrease state pension expenditure by 0.72% of Dutch GDP in 2040. Our results show a higher impact of delaying ordinary retirement age: state pensions costs will decrease by 5.7% due to this reform in 2040, although the reform effects are weaker for other periods. Regarding the effects of the crisis, our results are close to those found in Geyer and

Stainer (2010), who focus on cohort effects.[2] They also analyse the application of pension reforms considering a context of rising unemployment rates and changes in the labour market. In Geyer and Steiner (2010), simulations show that pension levels for East German men and women will fall dramatically among younger cohorts, not only because of policy reforms but due to higher cumulated unemployment. For West German men, the authors found that the small reduction in average pension levels among younger cohorts is mainly driven by the impact of pension reforms, while future pension levels of West German women are increasing or stable due to rising labour market participation of younger birth cohorts.

Additionally, as regards the Spanish case, to the best of our knowledge DyPeS is the first dynamic simulation model developed for studying the Spanish pension system.[3] This has been possible thanks to the availability of the Continuous Sample of Working Lives, known as the MCVL in Spanish (from "Muestra Continua de Vidas Laborales"), an administrative data set published by the Social Security Administration since 2004. The paper is organised as follows. Section 2 is devoted to the description of the Spanish pension system. Section 3 describes the model structure and the data employed, including the projection rules and the behavioural equations implemented in the model. Section 4 presents the results and Section 5 gives some final remarks.

2. The Spanish pension system

The pension system is one of the main components of the Spanish welfare state and the most important social expenditure programme. At present, it is composed of two different types of benefits: non-contributory (or *Beveridgean*) and contributory (or *Bismarckian*). The former can be considered a system of minimums, as it provides, under some conditions, a minimum income to those individuals who cannot access the contributory

[2] In this paper, the modelling strategy is quite different from ours. The evolution of the effective retirement age is obtained by extrapolating the distribution of the effective retirement age of people retiring in 2006 by a common factor that reflects the enacted long-term increase in the statutory retirement age from 65 to 67 years, but there is no behaviour in the retirement event.

[3] See Fernandez-Díaz, F.J., Patxot, C., Souto, G. "DYPES: A Microsimulation model for the Spanish retirement pension system. FEDEA (Fundación de Estudios de Economía Aplicada) Documento de Trabajo 2013-06 for an earlier version of the model without behaviour.

level. The latter is the main part of the system, in the sense that the pension received is mainly determined by the past contributions of the worker.[4] It is organised on a pay-as-you-go (PAYGO) basis and includes different kinds of pension benefits - retirement, disability and survival - for those individuals who meet the eligibility requirements regarding age and past contributions to the system[5].

In 2007, retirement pensions represented over 65% of all contributory pension expenditure, and over 5% of GDP in Spain[6]. Moreover, a huge increase in its size can be expected in the face of demographic ageing: retirement pension expenditure will be more than 79% of public pension expenditure and almost 11% of GDP in 2060 according to the last projection exercise of the Economic Policy Committee (2012).[7]

The initial retirement benefit is determined according to a formula depending on retirement age, the number of contribution years and the amount of past contributions. Since the reform enacted by the 24/97 Act, the computation is as follows. First, a basic amount (*BR*) is computed as a mean of the level of contributions made in the 15 years prior to retirement[8]. Second, a percentage depending on the number of years of contributions – *p(n)* – is applied to the *BR* in the following way: 50% for the first 15 years, an increase of 3% for each additional year between the 16th and the 25th, and an increase of 2% for each additional year from the 26th until it reaches 100%, at 35 years of contributions. Furthermore, when retirement age deviates from the legal retirement age a correction coefficient – *cc(n)* – is applied, also depending on the number of years of contribution. Thus, in general terms, the legal formula to calculate the initial retirement benefit (*IRB*) or entry pension is:

$$IRB = p(n)*BR*cc(n) \qquad (1)$$

[4] The civil servants have their own system.
[5] See Fernandez-Díaz, F.J., Patxot, C., Souto, G. "DYPES: A Microsimulation model for the Spanish retirement pension system. FEDEA (Fundación de Estudios de Economía Aplicada) Documento de Trabajo 2013-06 for a detailed description of the Spanish retirement pension system.
[6] Other contributory pensions are: disability pensions, survivor's pension, orphan's pension and pensions in favour of falmily members.
[7] European Commission. (2012). The 2012 Ageing Report, Economic and budgetary projections for the 27 EU Member States (2010-2060). European Economy. Economical and financial affairs. This projection is in line with previous projections and also with those undertaken in academic work.
[8] The legal name is *base reguladora*. In the computation, the contributions are updated from the third year according to the evolution of the consumer price index.

The coefficient *cc(n)* will be above (below) one for workers delaying (advancing) their retirement from age 65. In the first case, an additional 2% will be applied for each year of delay, or 3% if the worker has 40 or more years of contributions – this premium either acts on *p(n)*, increasing up to 100%, holding *cc(n)* equal to one, or increasing *cc(n)* above one if the worker already reached the 35 contribution years. In the second case, if the worker retires before age 65, an annual penalty between 6% and 8% is applied, depending on the years of contribution.[9]

There are several ways to access retirement in Spain, some of them depending on the labour status. The pension formula is the same for all of them, except for the value of *cc(n)*. Table 2.1 summarises all these different possibilities or retirement paths. The ordinary retirement age – 65 – was not compulsorily established by law, but it was agreed in most collective wage settlements. In any case, at the moment 65 is the reference age for retirement rules and incentives[10]. For the first time, the 2011 reform establishes a gradual increase to 67, as explained in Section 4.

As shown in table 2.2., the average retirement age for males has remained quite stable in Spain in recent years. Interestingly, at present females retire later, perhaps due to a joint retirement decision or to the need to complete their shorter contribution histories. This would also explain some of the differences observed between male and female retirement probabilities. Despite the stability of the average retirement age, the evolution of the share of new entries by age and sex has undergone substantial changes which seem to be driven by cyclical movements. In fact, changes in early and delayed retirement move in different directions. The share of those retiring after age 65 is only slightly affected by incentives to delay retirement initially introduced in the 35/2002 Act. One should bear in mind that most collective wage settlements deny workers the possibility of delaying retirement, so that incentives to work beyond age 65 might become inoperative.

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[9] In particular, the 8% affects those that only reach the minimum eligibility requirement of 15 contribution years. This penalty is reduced gradually for those crediting enough years to move to the next contribution years scale: 31-34 (7.5), 35-37 (7), 38-39 (6.5) and 40 plus (6).

[10] Apart from this general rule, there are also other possibilities to reduce the age of retirement: i) certain professional activities, ii) disabled workers, iii) special retirement at age 64 with no penalty and iv) partial and flexible retirement. In each of them, different correction coefficients are also applied.

Table 2.1 Retirement paths in Spain according to labour status

Labour Status	Retirement path	Eligibility requirements and rules determining benefits (2007)
Disabled	Disability*	At age 65 disability pensions are converted into retirement pensions, but keeping the same benefit level
Unemployed	Back to work (all)	
	Early retirement from age 60 (Old system)	Minimum *n* = 30 8% penalty per year until age 65 (gradually reduced to 6% if *n*≥*40*)**
	Early retirement from age 61 (New system)	Minimum *n* = 30 7.5% penalty per year until age 65 (gradually reduced to 6% if *n*≥*40*)**
	Regular retirement at 65	The same conditions as workers (detailed below)
Worker	Special retirement at age 64	No early retirement penalty Substitution contract in the same firm
	Early retirement from age 60 (Old system)	8% penalty per year until age 65
	Regular retirement from age 65 (includes delayed retirement)	<u><65:</u> Reduced age for special professional activities with no penalty <u>Age 65:</u> Minimum *n*=15 (2 in the last 15) <u>>65</u>: Increases beyond 100% of *RB* by 2% per year (3% if *n*≥40)
	Partial retirement**	From age 60 Minimum *n* =15 years Part-time work and proportional reduction of pension If age < 65 substituting contract No early retirement penalty

Retired	Flexible retirement	Part-time work and proportional reduction of pension

Notes: *n*= number of years of contribution; * Only disabled below age 65 might change status back to work; ** 7.5% (*n*=30-34), 7% (*n*=35-37), 6.5% (*n*=38,39), 6% $n \geq 40$; *** In 40/07 Act the minimum *n* was increased to 30 and 6 years of seniority in the same firm were required.

Table 2.2 Distribution of new entries by pathways (Spain 2002-2011)

Year / Retirement Pathway	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
From disability	**6.86%**	**5.84%**	**4.48%**	**2.33%**	**1.92%**	**0.60%**	**0.02%**	**0.02%**	**0.06**	**0.07**
Early retirement	**29.42%**	**33.79%**	**33.86%**	**24.02%**	**28.28%**	**26.77%**	**24.51%**	**24.34%**	**27.38%**	**30.25%**
• **Old system: from age 60 on**	25.44%	29.50%	27.95%	19.62%	22.57%	20.24%	20.33%	18.51%	19.97%	21.17%
• **From unemployment**	12.58%	14.10%	14.18%	10.18%	11.21%	10.76%	10.44%	9.97%	11.63%	12.54%
• **From employment**	12.86%	15.40%	13.77%	9.44%	11.36%	9.48%	9.25%	8.54%	8.34%	8.63%
• **New system: from age 61 and unemployment**	0.51%	0.92%	1.60%	1.47%	1.88%	2.32%	2.53%	3.46%	5.23%	7.57%
• **Special retirement at age 64**	2.35%	2.19%	3.40%	2.13%	2.57%	3.14%	2.29%	2.37%	2.18%	1.51%
• **Collective wage settlements**	0.00%	0.05%	0.06%	0.10%	0.23%	0.27%	0.27%	0.63%	0.38%	0.56%
• **Pre-retirement**	1.12%	1.13%	0.86%	0.70%	1.02%	0.81%	0.90%	0.48%	0.57%	0.48%
Partial retirement (from employment)	**3.45%**	**5.30%**	**8.10%**	**7.78%**	**11.80%**	**12.82%**	**12.94%**	**12.43%**	**9.17%**	**10.74%**
Flexible retirement (from retirement)	**0.24%**	**0.52%**	**0.30%**	**0.31%**	**0.31%**	**0.20%**	**0.17%**	**0.23%**	**0.21%**	**0.27%**

Ordinary retirement pensions (Including delayed)	**60.04%**	**54.55%**	**53.26%**	**65.56%**	**57.69%**	**59.60%**	**56.88%**	**56.23%**	**56.75%**	**50.67%**
<60	1.14%	1.11%	0.98%	0.81%	1.11%	1.25%	0.90%	1.05%	0.93%	0.94%
60	0.97%	0.49%	0.49%	0.40%	0.24%	0.20%	0.14%	0.13%	0.16%	0.25%
61-64	1.83%	1.07%	1.35%	1.09%	1.22%	1.05%	0.97%	0.98%	0.94%	0.81%
65	44.83%	39.84%	38.25%	43.36%	41.93%	45.43%	48.43%	48.13%	49.06%	42.40%
>65	11.26%	12.05%	12.19%	19.90%	13.19%	11.66%	6.45%	5.95%	5.66%	6.27%
Missing age	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Note: Pre-retirement includes only those which can be identified as receiving public subsidies.

Source: Authors' elaboration from the MCVL 2011.

3. The model

This section is devoted to the description of DyPeS, the microsimulation model developed to analyse the Spanish contributory pension system. Subsection a) outlines the model structure, Subsection b) details the data employed while Subsection c) is devoted to explaining the way in which retirement decision is modelled.

3.1 Model structure

As said in the introduction, DyPeS is a micro-based model, thanks to the availability of the MCVL. The construction of a microsimulation model involves several decisions, mainly affected by the question analysed and the data set on which the model is based (see Jinjing and O'Donoghue, 2012). In our case, the nature of the pension policy necessarily implies the use of a dynamic model – meaning that it simulates the micro units over time. Note that, in this setting, dynamic does not necessarily mean behavioural.[11] Nevertheless, in this paper we introduce behaviour into the retirement decision, given that retirement pensions are the main focus of our analysis. The rest of events are modelled in the simplest way given data availability. The following are the main events experienced by agents. Agents experience first birth and second entry in the labour market. Third, other labour market transitions, including changes in the qualification level and unemployment events, are derived based on 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 by the authors (see the estimation results in Appendix E). For that we employ a panel data set elaborated from the MCVL that includes information on wages, firm characteristics, and personal characteristics comprising the period 1997 to 2010.

[11] The term dynamic has been confused with the term behavioural for some time, especially in static microsimulation models. See Dekers et al., (2008) and Jinjing and O'Donoghue (2012) for a survey on dynamic microsimulation models.

Fourth, once agents attain the eligible retirement age (fixed from 59 to 75), 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 (see section c). 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.

Regarding the programming strategy, DyPeS is a case-based model – one case is simulated after another -, as opposed to time-based – where all cases are simulated in each period. It is an open model, in the sense that new agents are introduced, apart from those in the initial sample; and population-based, instead of cohort-based. It is programmed in continuous time, though some of the events happen only once a year. DyPeS has been developed using ModGen, a generic dynamic microsimulation programming language developed and maintained by Statistics Canada and widely used in social science dynamic microsimulation.[12]

3.2 Data employed

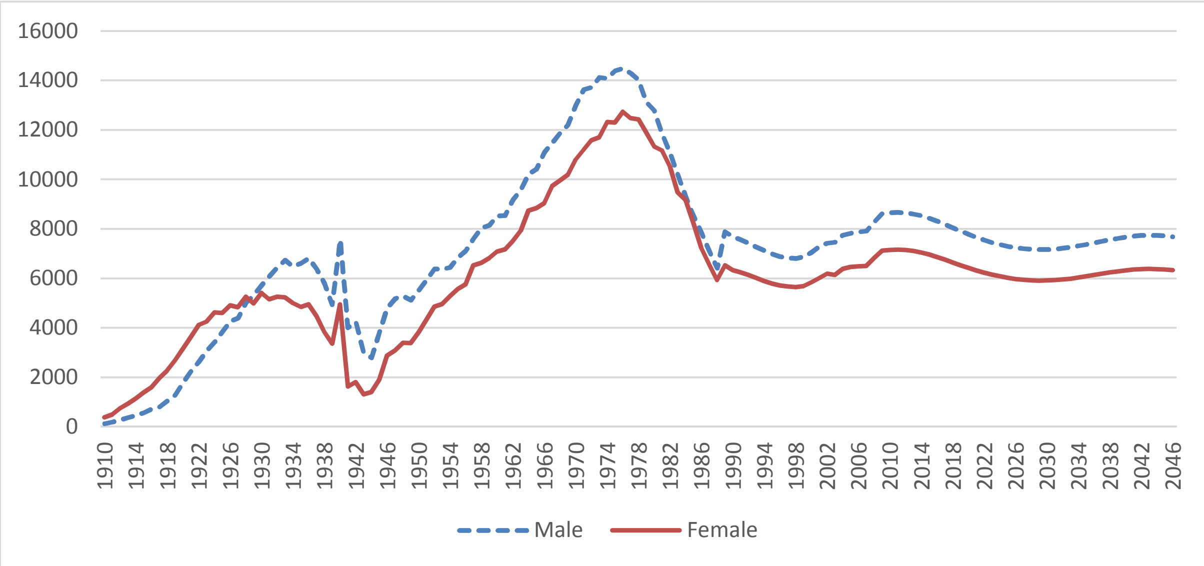
DyPeS starts from a subsample of individuals registered with the Social Security in 2007 extracted for the 2007 wave of the MCVL. The year 2007 is chosen as the base year and the reference point for most data. In this way the data employed for transitions are not distorted by the effects of the crisis. Certainly, future waves of the MCVL will improve perspectives to measure the effect of the crisis. For the moment, we start in 2007 and simulate the effect of the crisis in a stylised way, as described in Section 4.[13] At

[12] 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 web site.
[13] The last complete wave – including fiscal data - available at the moment is for year 2009.

this first stage we stick to information given in the MCVL and no alignments to external data are made, unless strictly necessary. Below, the main decisions taken regarding the MCVL data set and information used from external sources are summarised.

The MCVL extracts 4% of the population who have some relation with Social Security administration at that moment. Then, all past information on their working careers and contributions is added. Nevertheless, the quality of data worsens for the past (see Appendix A for details). The sample includes both pensioners and contributors born from 1907 to 1991. Hence, in order to project future expenditure and revenue, new entries in the labour market from 2008 on and new births from 1991 need to be added to the model. In order to add new-borns, we compare the number of people in the 2007 population and in the 2007 MCVL wave. Figure 3.1 below shows this relation for males and females.

Figure 3.1 Number of people in our sample by birth year. 2007



Source: Authors' elaboration

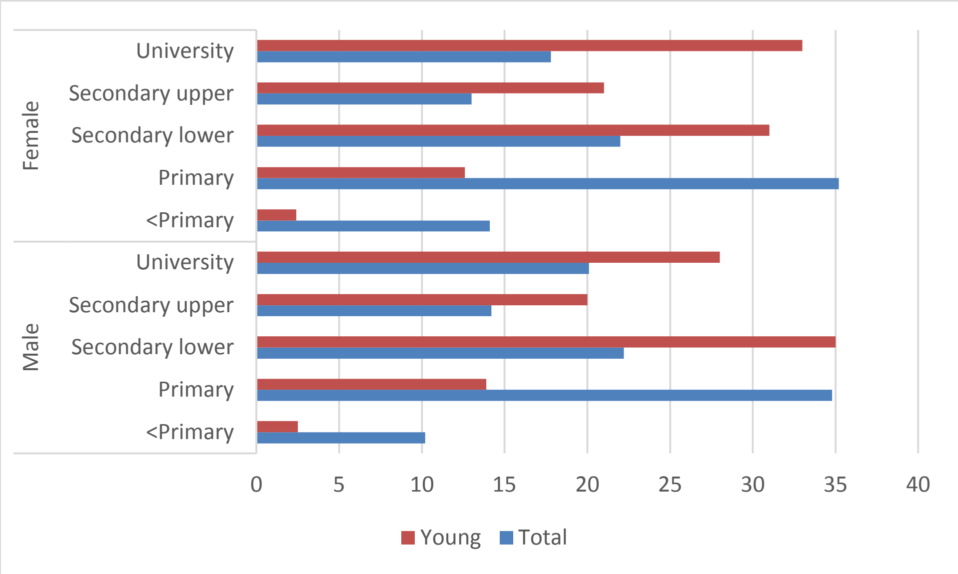
Females overtake males for cohorts born before 1930 due to the higher life expectancy of females. For the rest of cohorts, the pattern of both sexes is quite similar.

The data employed to simulate each of the events are described below. The first step is to assign an education level. Decisions on education level are minimised and simplified as much as possible. The MCVL contains information about the education level of the individuals. For individuals registered in the MCVL, we keep the value reported and correct it upwards in case there is an inconsistency between the value of education and the contribution group[14] (it can be done for the first contribution group, which requires a university degree). For "future" individuals, born from 1991 on, the final education level is assigned randomly so as to reproduce the educational distribution observed for the Spanish population by MEC (2010). According to this publication, the education level has grown substantially. In 1997 – Figure 3.2, panel a) - one can already observe that the young population was more educated than the total population. The improvement in the education level continues until 2008, as can be observed in panel b) in the same Figure: the education level increases for young males and females from 1997 to 2008. Interestingly, the education level is currently higher for young females that for males, inverting the initial situation. Note that we are assigning the final educational attainment without any attention to transitions from one education level to the next, given the data constraints and the focus of our analysis.

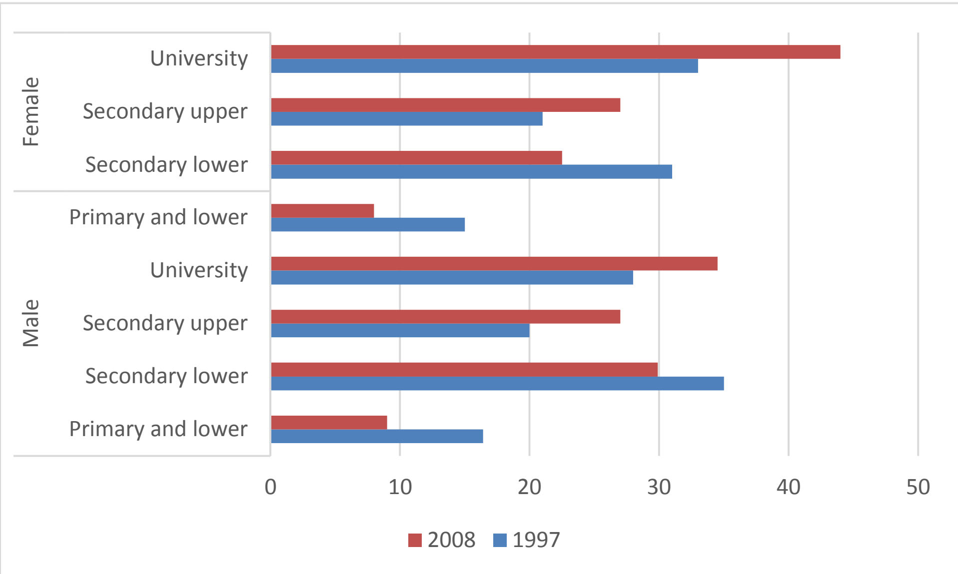
[14] Contribution groups are: 1.Engineers, University Graduates & Senior Management Personnel, 2. Engineering Technicians. Experts & Assistants with university degree, 3. Administrative and workshop managers, 4.Unskilled workers, 5. Part-time unskilled workers.

Figure 3.2 Education attainment by gender (%)

a) Young (25-34) and total working age population (25-64) in 1997



b) Young (25-34) in 1997 and 2008



Source: Authors' elaboration from MEC (2010).

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 (see Table 3.2.). As shown below, most entrances are in the 5th contribution group (composed of part-time workers) except for the most educated – more than ¼ of them enter once they obtain their degree. The pattern is similar for females, with slight differences.

Table 3.2 Entrance in the labour market by education and qualification level (CG)

	Initial qualification level (CG)					
	.Engineers, University Graduates & Senior Management	Engineering Technicians. Experts & Assistants with university degree	Administrative and workshop managers	Unskilled workers	Part-time unskilled workers	
Education level	Males					**Total**
Primary education or less	0.83%	0.37%	0.72%	10.10%	87.98%	**100%**
Secondary education	6.95%	4.21%	3.77%	31.08%	53.98%	**100%**
University education	25.17%	11.25%	9.98%	33.41%	20.19%	**100%**
	Females					
Primary education or less	1.28%	0.94%	0.65%	26.93%	70.19%	**100%**
Secondary education	7.32%	7.54%	1.98%	53.14%	30.02%	**100%**
University education	20.89%	15.53%	4.34%	43.72%	15.53%	**100%**

Source: Authors' elaboration

In a third step, once individuals enter the labour market, they are exposed to the labour market transitions. The hazards observed are extracted from the MCVL 2007. In particular, transitions between qualification levels within employment and transitions between employment and unemployment are obtained by age and gender and qualification level when necessary. To that effect, the 13 contribution groups in the general regime of the Spanish Social Security are grouped in five subgroups – those subject to the same contribution limits (thresholds). As the transition hazards among the different qualification levels are quite stable during the period observed (2002-2007), the value of the last transition observed before the economic crisis (2006 to 2007) is taken, and is held constant for the future (see Appendix B for details). In Section 4.a), an explanation is given of how these hazards are altered during the crisis.

Regarding earnings, some decisions need to be taken. On the one hand, the initial value of wages for future workers needs to be decided. On the other hand, it is necessary to decide how wages are to be projected to the future both for 2007 workers and for those entering the labour market afterwards. First, regarding initial wages, for those working or contributing in 2007, the initial value of wages in 2007 is taken from the fiscal module of the MCVL. In case this value is missing, the contribution basis is taken. For future contributors, the final education level attained determines their contribution group, entry age and wage, as shown above. The error term observed in each cell is used to ensure variability of initial wage.

Second, wages grow according to a model based on the traditional Mincer equation (see estimation results in Appendix E):

for the period t

$$w_{it} = \bar{w}_t \left(\frac{\beta_0^*}{\bar{w}_t} + \frac{\beta_1^*}{\bar{w}_t} w_{i,t-1}, \frac{\alpha^*}{\bar{w}_t} X_{it} \right)$$

then we obtain:

$$\beta_0^* = \frac{\beta_0}{w_t} \quad and \quad \beta_1^* = \frac{\beta_1}{w_t} w_{i,t-1}$$

For $t+1$ and the following periods:

$$w_{it+1} = \overline{w}_{t+1}\left(\beta_0^* + \beta_1^* w_{i,t}, \alpha^* X_{it+1}\right)$$

where w_{it} is the yearly wage of the individual i, $\overline{w}_t$ 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 previous wage (only one period is considered), personal characteristics - age, age squared and migrant status -, productivity indicators - education, qualification group and experience -, business cycle indicators - unemployment rate - and cohort effects that are supposed, for simplicity, to be linear (see detailed results in the appendix). We use a data set covering the period 1997-2010, which has been elaborated using information from the MCVL and information on macroeconomic indicators provided by the Spanish National Institute of Statistics (INE).

During the simulation, earnings (and contribution bases) are updated on a continuous time basis. For this purpose, 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, according to equations 2 and 4. At the same moment, contribution bases are also updated. Second, whenever a labour status transition occurs – both among contribution groups within employment status, and between unemployment and employment status –, a change in wage is applied depending on gender and the original and final states. For that purpose, the average change in wage observed is used. Finally, each time one of the abovementioned 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.

Agents start computing potential pensions when they reach 59 years old, considering all the available retirement paths and also weighting potential pensions 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 the traditional variables found in the literature, trying to capture differences in personal characteristics, productivity and contextual factors: sex, age, migrant status, educational level, contribution group, experience and unemployment rate (see appendix F). Once agents reach retirement age, the retirement module – detailed below – produces the retirement event. Finally, an exogenous age, gender and time-specific mortality rate, coherent with demographic projection, is applied.

3.3 The retirement decision

In this section, we describe in more detail the way the retirement decision is modelled. The retirement module determines whether an eligible individual actually retires according to two alternative criteria: considering financial incentives or not (behavioural versus non-behavioural model). First, individuals are assumed to claim their pension benefit according to a survival model which only includes personal characteristics and business cycle indicators, but not financial incentives: age, age squared, educational level, last wage, a dummy variable that takes value 1 during the first year that the person is eligible and 0 otherwise, and, finally, the unemployment rate. This set of variables tries to capture all the factors involved in any retirement decision and under any regulatory framework: age and, therefore, time of benefit from pension, productivity issues and individual's performance in the labour market, time preferences and business cycle considerations. To summarise, this non-behavioural criterion depicts the scenario not affected by changes in regulations (see results in appendix E).

Second, we model retirement behaviour by introducing financial incentives again using a survival framework. The survival estimates highlight the key role played by economic incentives to retirement implicit in the pension scheme, in line with previous research for the United States (Gruber and Wise, 2004; Coile and Gruber, 2000; Baker et al., 2003). Including this retirement behavioural equation in our microsimulation model allows us to define an ‘optimal time of retirement’ scenario coherent with current regulation to be compared with the ‘non-behavioural’ one.

To define the incentives to be included in our behavioural model, we take as starting point two recent studies that estimate the effects of Social Security incentives for Spain with the same data as ours (the MCVL). Vegas et al. (2013) estimate the Social Security Wealth (SSW), the present net value of net benefits received from the pension system, the Social Security Accrual (SSA), which measures the discounted change in SSW from postponing retirement one year, and the Peak Value (PV), which compares this year’s Social Security Wealth with the maximum social security wealth that could be attained in the future. The authors find that all the coefficients of these social security variables (SSW, SSA and PV) are statistically significant with the expected sign. However, the results regarding the effect of measures related to the SSW seem to be mixed for Spain. SSW might be endogenous and it might not be possible to separate the effect of financial incentives and the taste for work – both interacting with age. In this respect, different studies show a poor effect of retirement incentives on retirement decision, indicating that age was the main determinant (Boldrin et al. (2004) and Jimenez-Martin (2006).[15] These works were based on a preliminary experimental version of MCVL. Recently, García-Pérez et al. (2013) extended the analysis using the MCVL and the results show that, when incentives are properly defined and problems like individual heterogeneity are taken into account, incentives have a strong impact on labour market decisions and particularly on retirement decisions. We estimated a similar model to Vegas et al. (2013), obtaining the result that the Peak Value has no impact on the probability of retirement (see appendix D for more details). Accordingly to these previous considerations, we opted for including in our microsimulation model a set of incentives that are closer

[15] These authors mainly focused on employed individuals, while the alternative pathways to retirement - long-term unemployment benefits and disability - were included using exogenous age and gender-specific probabilities. The first study is the chapter devoted to Spain in an international comparative study edited by Gruber and Wise (2004). Although incentive measures turn out to be significant for most countries, results for Spain seemed to be an example of the identification problem. See also Argimón et al. (2007 and 2009). In the former, retirement incentives are not considered among the explanatory variables. In the latter, retirement incentives are included, but there is no clear way of controlling the alternative pathways to retirement.

to those found in García-Pérez et al. (2013). These authors specify a model that only considers current pension benefits of the retired and changes in 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 one retires this year. The influence of minimum pensions on low-wage workers is also tracked, as in García-Pérez et al. We also include current labour income as a financial incentive. It takes the form of either wages, for employees, or unemployment benefits, for the unemployed. García-Pérez et al. also include a proxy of life-cycle wealth as a determinant of the marginal utility of wealth and, consequently, of the relative value of income versus leisure.

Other variables of our model, apart from those already included in the non-behavioural model, are: qualification level (contribution group), labour status (employed/unemployed), an indicator for receiving unemployment benefits, time to obtain the maximum pension, age when reaching the maximum pension, replacement rate, and time counter that tries to capture simple impatience. We also include a proxy for the state of the business cycle (the unemployment rate).

As previously mentioned, there is an inevitable trade-off between complexity and feasibility when modelling retirement decision. We opted for using a model that, with a reasonable degree of complexity, predicts retirement behaviour quite accurately in terms of number, level of entry pensions and pensions' growth rate for the period 2008-2013, for which we observed patterns. Ideally, a behavioural model should take into account a simultaneous consideration of the decision both of the firm and the individual. This is rarely possible, given the lack of data on the position of the firm, and most studies focus on the perspective of the individual.

In both behavioural and non-behavioural models, we estimate a piece-wise constant exponential model. This kind of semi-parametric model is commonly used in a continuous time framework – the approach we take to benefit from the wealth of data - to avoid the strong assumptions about the shape of the hazard function implied by parametric models. The hazard is assumed constant within pre-specified survival time intervals. Then, the exponential model can be defined by:

$$h_i(t) = h_0\lambda_i \textit{ where } \lambda \equiv \exp(\beta' X_i) \tag{5}$$

or:

$$\log[h_i(t)] = \log(h_0) + \beta' X_i \tag{6}$$

where h_0 is the baseline hazard, X is a vector of variables representing personal characteristics, work trajectories and macro-indicators that are relevant for our model and β is the vector of parameters we wish to estimate. In this case, the baseline hazard $h_0(t) = h_0$ is a constant.

For both behavioural and non-behavioural estimations we use a monthly panel data set covering the period 2005-2010, elaborated from the MCVL. It includes all individuals eligible for retirement during this period, excluding those who retired due to collective agreements or forced by regulation (unemployed that reach the minimum retirement age).

Table 3.3 shows the results of estimating our behavioural model, including financial incentives. As expected, retirement hazard increases with age (at a decreasing rate). The more educated tend to retire earlier in the case of men, but the opposite is true for women. These results are coherent with those fund in Divenyi and Kezdi (2015), whereas the opposite effects were found in Qi et al (2015). The most powerful effect is that related to the variable "first year of being eligible", which increases the retirement hazard for both men and women. This is coherent with the fact that between 55% and 60% of people, depending on the year considered, retire as soon as they can (through the "ordinary" retirement pathway). Those unemployed and receiving unemployment benefit tend to retire later. As previously stated, people are forced to retire (trough ordinary retirement) if they are unemployed at the legal retirement age. We removed retirements forced by regulation because they do not reflect real choices.

Therefore, the unemployed in our sample are mostly people eligible for early retirement that we observe before ordinary retirement age. Variables related to financial incentives behave as expected, and the effects of the replacement rate (individual ratio of pensions to last wage) and the minimum pension are particularly strong. The effect of our Peak Value measure is also very strong in the case of women (we are computing changes in one euro). These results are coherent with García-Pérez et al. (2013), who show that larger accrued pension rights are associated with lower re-entry rates and higher retirement rates, as expected.

Table 3.3 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	**	0.8267	0.0181	-8.66	**
Age Sq.	0.9760	0.0043	-5.49	**	-			
Secondary studies	0.9727	0.0551	-0.48		0.8723	0.0794	-1.50	
University studies	1.1521	0.0688	2.37	*	0.9418	0.1082	-0.52	*
First year retired	11.2190	2.2717	11.94	**	7.0650	3.0741	4.49	**
Unemployed	0.6557	0.0444	-6.22	**	0.6886	0.0583	-4.40	**
Unemployment benefit	0.1557	0.0906	-3.19	**	0.2102	0.1229	-2.67	**
Wage	0.9999	0.0001	-13.48	**	0.9999	0.0006	-8.54	**
PV (difference max. pension) 1 € change	0.9996	0.0001	-2.30	**	0.9989	0.0003	-3.61	**
Time to max. pension	0.9947	0.0028	-1.83	*	-			
Age at max. pension	1.0000	0.0001	1.92	*	-			
Replacement rate	1.0744	0.0263	2.93	**	1.156	0.0558	3.09	**
Minimum pension	1.1235	0.0692	1.89	*	1.4313	0.1021	5.03	**
Months since eligible (log)	1.3289	0.0358	10.55	**	1.4678	0.0644	8.74	**
Unemployment rate	1.0117	0.0040	2.92	**	-			
Constant	5454.00	0.0000	-5.39	**	9130.48	13749.21	6.06	**

*base category: no studies or primary studies

**significant at 5% level

4. Results of the simulation model

This Section is devoted to showing the first results of DyPeS with behavioural reactions. First (Subsection a), the baseline situation is characterised, explaining how the effects of the crisis are simulated. Second (Subsection b), the impact of the reform of the Spanish pension system approved in 2011 is analysed.

4.1 The impact of the crisis on working careers and its long-term effect

Our baseline scenario incorporates both behaviour in the retirement decision and the effects of the 2011 reform. It tries to reproduce the "real" situation in the sense that the 2011 reform had already been undertaken when our projections were made, based on the behavioural model that we consider best replicates the retirement decision. In this respect, other scenarios - without behaviour, without reform - act as counterfactuals.

Figure 4.1 shows the evolution of wages and pensions during the last few decades and their projected growth rates. The average growth rate of wages during the period 1995-2008 was 3.49% and the projected future growth is 3.55%. Remarkably, pensions have grown above wages: 4.7% during the period 1995-2008. This is exactly the same average growth rate that we obtain from our projections for the period 2008-2060. The fact that, historically, pensions have grown at a higher rate than wages will have consequences in the projection.

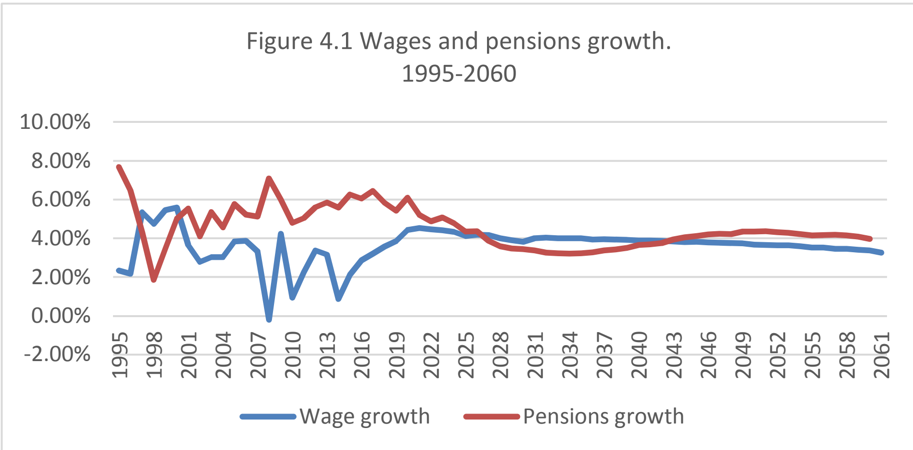


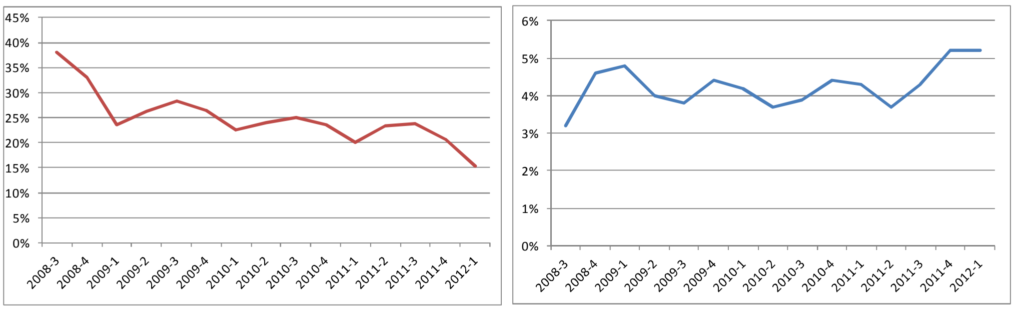
Figure 4.1 Wages and pensions growth. 1995-2060

Source (1995-2008): Annual Economic Database. European Commission and Spanish Social Security. Authors' elaboration (2008-2060).

As mentioned above, the year 2007 is chosen as the base year to prevent the projections from being permanently affected by features due to the current crisis. At the same time, it is necessary to take into account the effect of the crisis. Hence, we opt for a simplifying *ad hoc* simulation of a reduction in the growth rate of wages and a temporary increase (decrease) in the job destruction (creation) rate, in line with the evolution observed in the first years of the crisis, shown in Figure 4.1. Given the uncertainty of the duration of the current crisis, we assume a slow recovery ending in 2018. The change observed in job destruction and job creation rates during the crisis (Figure 4.2) is applied to the transition hazard rates observed in the MCVL (see Figures B.1-3 in Appendix B) from 2008 to 2018.

Figure 4.2 Evolution of the job creation and destruction rates (2008-2011)

a) Job creation rate b) Job destruction rate



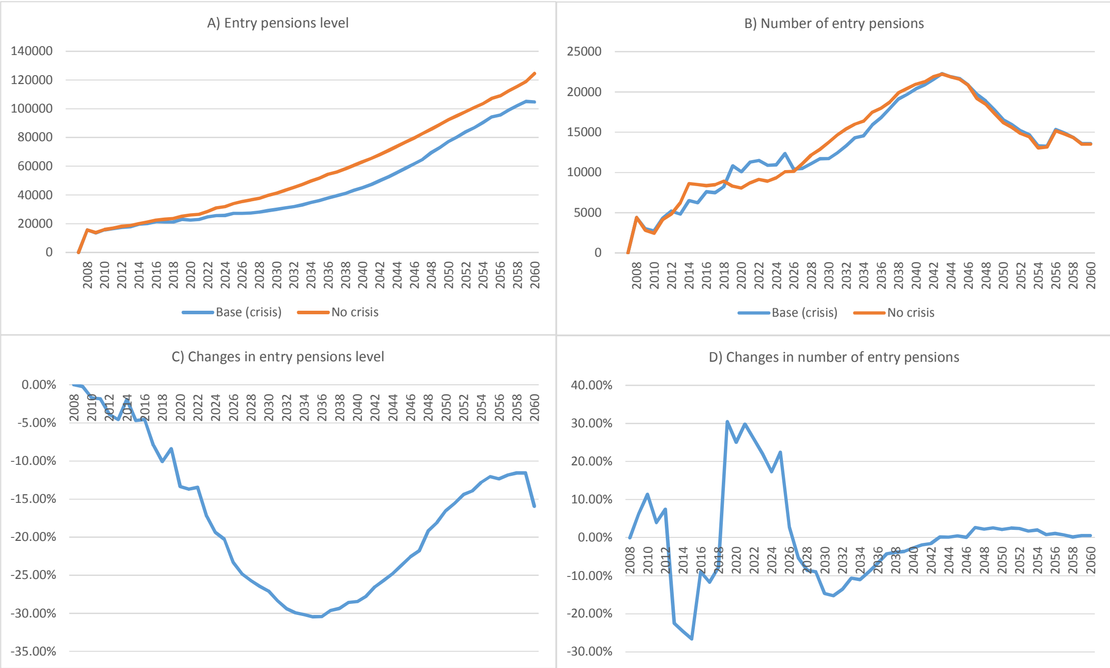
Note: Job creation rate: share of unemployed who obtain employment in the next trimester; Job destruction rate: share of workers who lose their job in the next trimester. Source: Observatorio laboral de la crisis, (www.fedea.es/observatorio)

As a result unemployment triples, as panel a) in Figure 4.4 illustrates.[16] This increase in unemployment probably understates the long-term impact of the current crisis, but is sufficient to take into account the effect of the crisis and illustrates the potentialities of the model. Figure 4.3 shows the effects of the

[16] Note that the unemployment rate (Figure 4.2 panel a) increases during the retirement of baby boomers. This is 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. A general equilibrium setting would be necessary to account for this.

current crisis on entry pensions (both number and level). The main driving force of the changes observed is the decrease in the pension level, due to poorer working careers. This effect is sizable, starting during the crisis and reaching 30% for the cohort retiring in 2036. The amount of past years' contributions considered to compute the basic pension amount – *BR* – being between 15 and 25, it is obvious that these cohorts are those most affected by the cut in wages and unemployment spells associated with the crisis. As a result, there is an impact on the time path of the number of entry pensions. The crisis produces a delay in retirement during the period 2013-2018, probably caused by the need to offset losses of potential pension associated with lower wages and less time worked. This delay in retirement during the crisis produces the opposite effect during the following years: from 2019 to 2026, we observe more retirements in the scenario with crisis than in the baseline one. All these results show that there is a reaction in retirement decisions due to the big movements in labour status that the current crisis produces. In a behavioural model such as the one considered here, agents can exit the labour market through early retirement, escaping penalties, and then avoid a higher reduction in entry pension level. As we will see in the next section it seems that, when behaviour is incorporated into the model, workers effectively tend to retire later, coping in this way with the effect of the crisis on their labour careers. As shown in panels c) and d) of figure 4.4., the total effect of the crisis in terms of increasing total expenditure and ratio of pensions to wage bill is huge, despite the sizable delay in entry pensions shown in figure 4.3. It is mostly the consequence of the dramatic fall in wages due to the crisis, which has permanent effects (see panel d) of figure 4.4.) This sensitivity analysis shows the strong impact of the crisis and illustrates the difficulties in designing the interplay between the micro and macro modules of the model.

Figure 4.3. Effect of the current crisis on pensions (level and number).



Source: Authors' elaboration

Figure 4.4 Effect of the current crisis. Other indicators

Source: Authors' elaboration.

4.2 The effects of the 2011 reform

The effects of the main reform measures approved in 2011 in Spain are simulated below. Table 4.1 gives an overview of the kind of measures approved (see Appendix C for further details). The first two measures aim at increasing contributiveness, or proportionality between contributions and pensions, strengthening the Bismarckian nature of the system. This motivation has been present in the Spanish reform agenda since it was explicitly expressed in the Toledo Agreement in 1995. Interestingly, these measures tend to decrease pension rights in different ways, as we will see later. They thus have a positive effect on sustainability, besides potential effects on redistribution. The first reform measure increases the amount of past years' contributions considered to compute the basic pension amount – BR – from 15 to 25. The second goes in the same direction by modifying the share of BR received as a pension – p(n) – to make it more linear. Nevertheless, it also increases the total number of years needed to obtain 100% of BR, implying a direct cut in pension rights. The last and most discussed measure modifies the reference retirement age from 65 to 67. It also changes the retirement penalty for early retirement and premium for delayed retirement - cc(n). All the measures are implemented gradually from 2013 to 2027. Below, we will present the simulation results and discuss the effects on pension expenditure sustainability and redistribution.

In order to interpret the results, one should bear in mind that the effects of the reforms might differ depending on a main issue: the extent to which reform affects either one pathway or all of them. The latter would imply that being able to choose the pathway does not make a difference and, hence, we will not observe changes in the number of pensions, but only in the level – especially when behavioural responses are not allowed. Most of the measures approved apply to all the pathways at the same time: changes in *BR* and *p(n)*. Only the change in *cc(n)* could have an impact on pathways, but this measure is implemented together with the change in the retirement age, which does, indeed, affect the number of pensions.

Given that our analysis incorporates more than one dimension, we will first briefly present the effects of introducing behaviour into the model on the most relevant indicators. This will allow us to test whether agents behave as expected. In a second step, the effects of the 2011 reform introduced in both scenarios - with and without behaviour - are compared. Finally, the effects of the different measures that comprise the 2011 reform are analysed separately for the behavioural scenario.

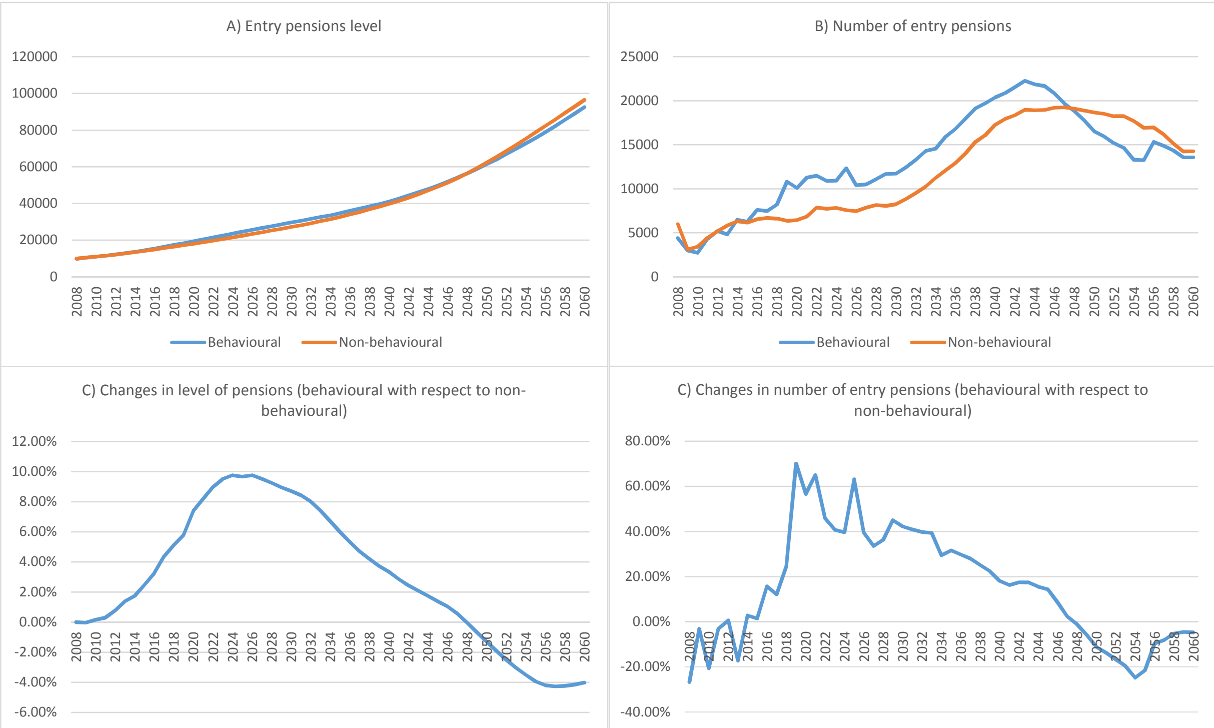
Table 4.1 Summary of the main reforms in retirement approved in 2011 (27/2011 Act)

	Previous Situation (since 40/2007 Act)	**Reform 2011** (27/2011 Act)
p(n)	*p(n)*= 100% ; *n*=35 Three levels for n - First 15 years: 50% - 16 to 25: 3% / year - 26 to 35: 2% / year	*p(n)*= 100% *n*=37 Three levels for n - First 15 years: 50% - next 248 months: 0.19 per month - next months: 0.18 per month (gradual implementation 2013-2027)
$BR[bc_{t-15},\ldots bc_{t-1}]$	*bc* from the last 15 years	*bc* from the last 25 years (gradual implementation 2013-2022)
Retirement age	General 65 Minimum 61 (except Old system)	General 67 (65 if n≥38.5) Minimum 63 (61 if involuntary unemployment)
	Retirement premium (*) - n<40: 2% / year - n≥40: 3% / year (*) There is a maximum limit. Early retirement	Delayed premium (*) - n<25: 2% / year - 25≤n≤37: 2.75% / year - n>37: 4% (*) Maximum limit maintained Early retirement relaxed (not yet simulated)

Source: Authors' elaboration

Figure 4.5 shows the pure effects of introducing behaviour into the retirement event. As expected, initial pensions are higher when individuals can react to financial incentives. In the same direction, Graph 4.5 b) indicates that, when behaviour is considered, individuals tend to retire when gains in entry pensions are higher, tending to delay retirement during the years of the crisis. This makes sense for several reasons. First, if we look at the variables involved in the simple model without behaviour we will see that most of the variables - and with powerful effects as shown in the estimations - impel individuals to retire early. Only the most sophisticated indicators related to financial incentives introduced in the behavioural model drive workers to consider the future benefits of waiting for a higher pension. Second, as seen in the previous section, the effect of the crisis in working careers must be sizable, indicating that the benefits of continuing to work after the crisis and adding years to the working career must be remarkable.

Figure 4.5. Behaviour versus non-behavioural model



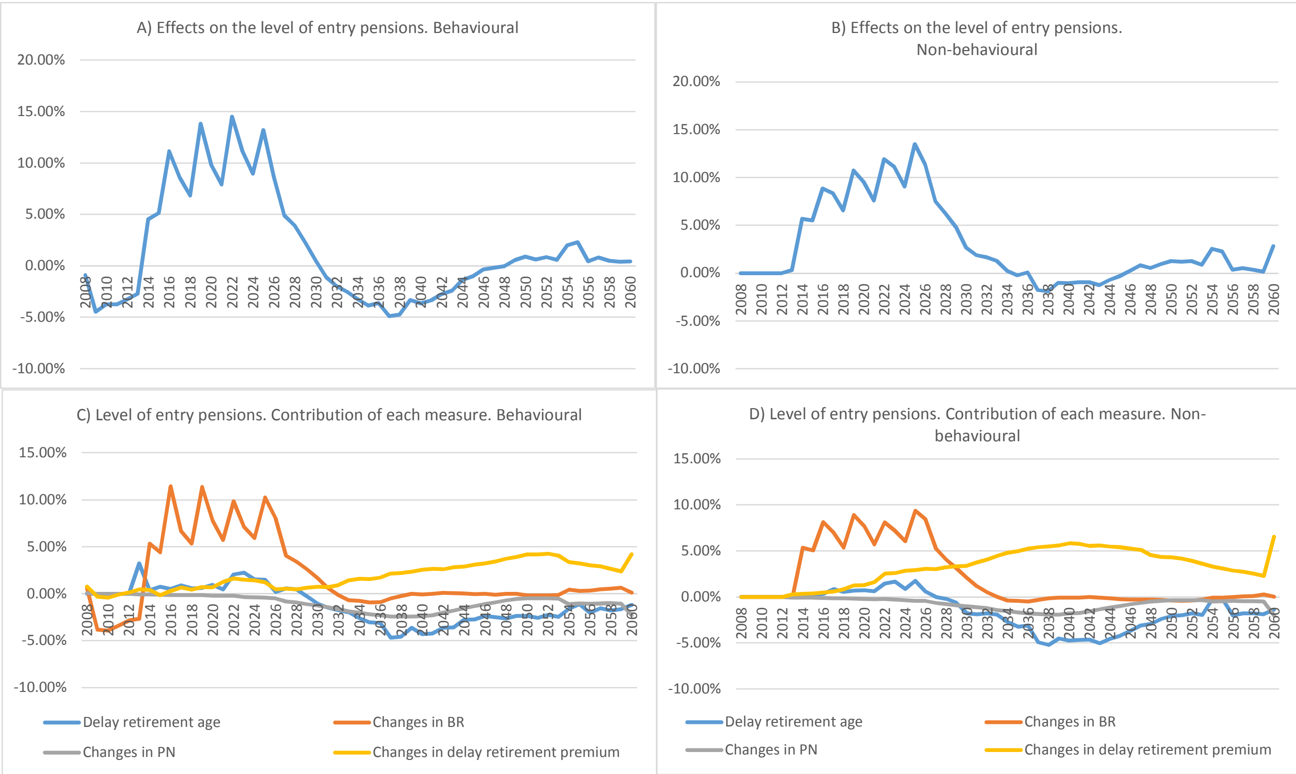
Source: Authors' elaboration

We describe the effects of the 2011 Reform in both scenarios considered - with and without behaviour - in figures 4.6 to 4.8. Figure 4.6 shows the effects of the reform on the level of entry pension. In both scenarios, the reform is associated with an increase in initial pensions until 2031 (or 2036 in the non-behavioural scenario). We then observe a lower decrease in entry pensions until approximately 2046. The increase in entry pension associated with the reform is higher in the behavioural model, which is coherent with the results shown in figure 4.4. Taking account of the measures that cause this trend in pension level, the changes in the number of years used to compute *BR* - increasing gradually from 15 to 25 -, seems to be behind the increase in pensions in both scenarios. This strong effect seems surprising at first glance. The expected effect of this measure depends on the shape of the lifetime real earnings profile.[17] If the real earnings profile is increasing, when *BR* takes more years in the past this implies a reduction in the level of wages considered and, hence, a cut in pension rights. Nevertheless, the earnings career does not always grow to the same extent during the life cycle. It is expected to grow more at the beginning, to stabilise around the 50s and then remain constant or possibly worsen, if the working career is interrupted because of unemployment events. Hence, the effect of this measure can be a small cut or even an increase in pension benefit if wages are not growing in real terms. The increase in pensions we observe during the years after the crisis is probably due to the fact that the increase from 15 to 25 years implies adding years of contributions not affected by the crisis.

The delay in legal retirement age does not cause a cut in entry pensions until approximately 2027. Before that date, its effect is not remarkable. The change in *p(n)* implies a decrease in the level of initial pensions, reaching almost 3% in the case of the non-behavioural and 2% in the behavioural model. This average negative effect probably conceals positive and negative effects for people with different working careers. In general, reforms of *p(n)* have potential effects on redistribution, as discussed in Appendix C. Nevertheless, in this particular case they are very small, due to the small scale of the current reform. Changes in the incentives for delayed retirement are associated with higher pensions in both scenarios.

[17] The relevant magnitude is real wages (and hence contributions), as the formula to compute BR updates wages to inflation two years prior to retirement.

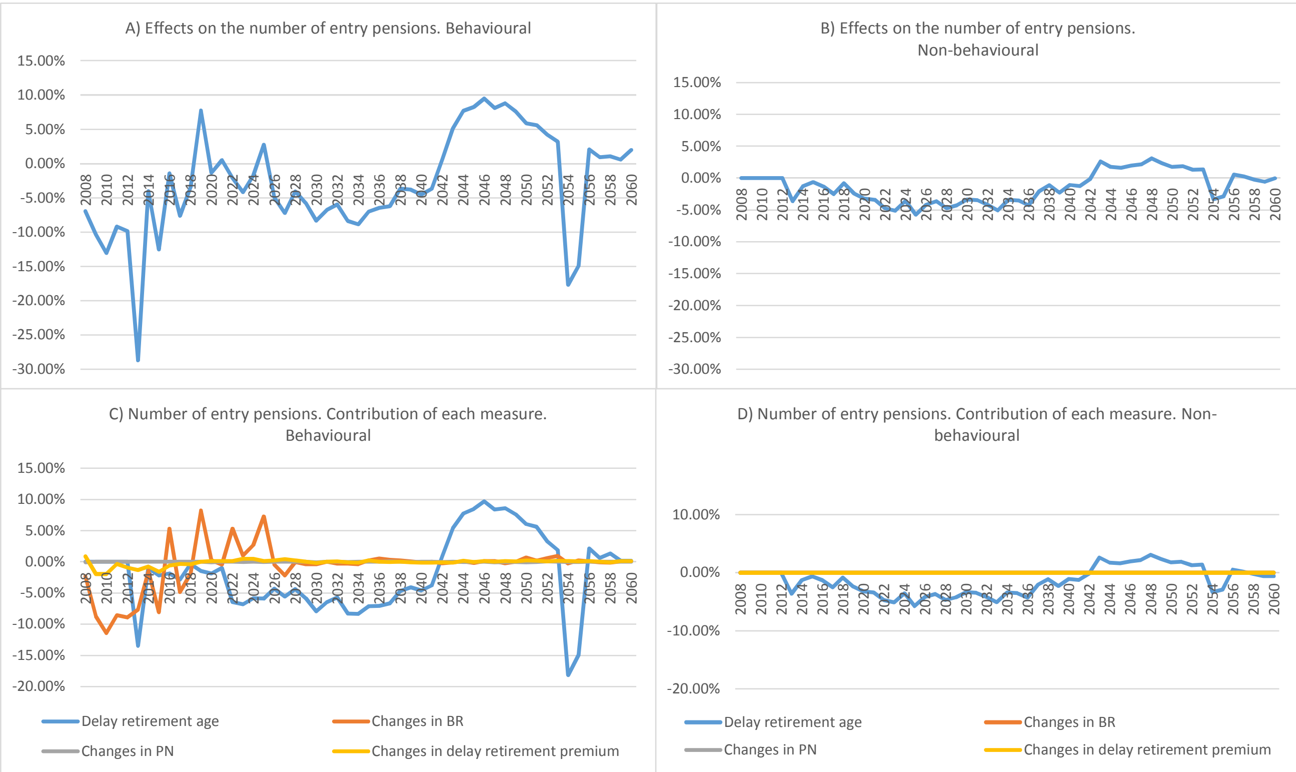
Figure 4.6. Effects of the 2011 Reform on the level of entry pensions



Source: Authors' elaboration

Figure 4.7 describes the results regarding the number of entry pensions. The 2011 reform produces an apparently erratic trend in number of entry pensions when the behavioural scenario is considered. The only measure that seems to incentivise people to retire earlier during the first years of the simulation is the change in the computation of the BR. This is coherent with the intuition explained above: if the past years of working history added to compute the average base are "better", the incentives to keep working (probably with relatively lower wages) are weaker. Delay in retirement age causes, as expected, fewer retirements during the first part of the simulation, this being offset during the period 2042-2053. Not surprisingly, the only measure that has an effect on time of retirement in the non-behavioural scenario is the "compulsory" one: delay in retirement age. In this scenario, agents are not allowed to use retirement time to react to the changes in financial incentives to retire. Consequently, other measures produce no changes.

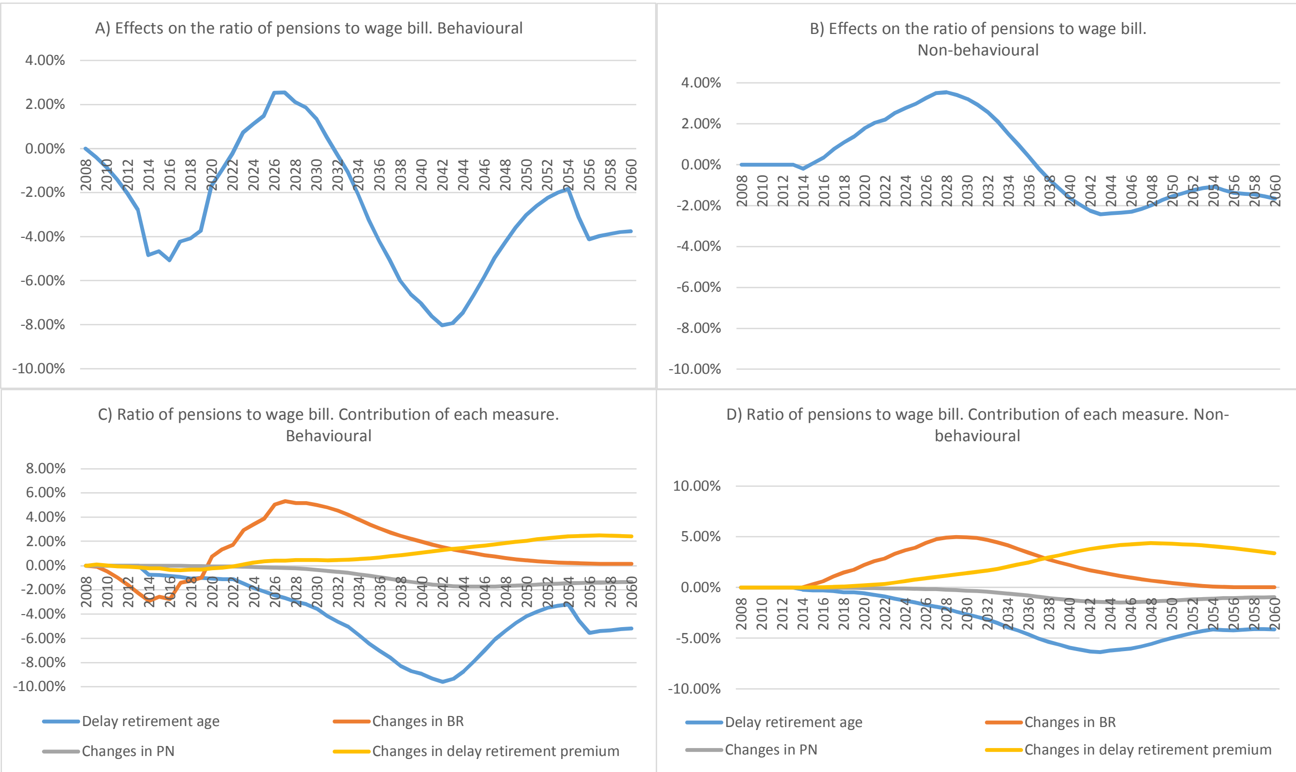
Figure 4.7. Effects of the 2011 Reform on the number of entry pensions.



Source: Authors' elaboration

The most general indicator, which summarises the effects of the reform in different dimensions, is the ratio of pensions to wage bill. Figure 4.8 shows the percentage changes in the ratio and the contribution of each measure. In the behavioural scenario, this ratio decreases due to the introduction of the reform over the whole period, except for the years 2022-2032. As expected, the change in the computation of the average base (BR) introduced by the reform is – except for the first years - associated with a higher ratio, as well as the change in retirement premium. Delay in legal retirement age, as expected, produces a cut in this ratio, being the only measure that significantly improves sustainability (changes in *pn* operate in the same direction, but their effects are weak).

Figure 4.8. Effects of the 2011 Reform on the ratio pensions to wage bill



Source: Authors' elaboration

Finally, table 4.2 summarises the total effects of the 2011 reform, as well as the contribution of the two most important measures: delay in retirement age and reform of the average base (BR) computation. The 2011 reform, considered as a whole, produces a decrease in both total pension expenditure and ratio of pensions to wage bill throughout the period 2010-2060, except for the year 2030. The level of entry pensions increases, mainly due to the effect of the reform of the regulatory base, BR, except for 2010 (crisis time) and 2040, in which year there is a small decrease in the average pension level. It can be said that the most effective measure in terms of improving sustainability is the delay in retirement age, which leads to a cut in pension expenditure of 7.5% and in the ratio of pensions to wage bill by almost 9% in 2040. The reform of the BR produces moderate increases in total expenditure and in the ratio of pensions to wage bill throughout almost the whole period considered.

TABLE 4.2.CHANGES IN DIFFERENT INDICATORS DUE TO THE 2011 REFORM						
(percentual change with respect to the baseline)						
	2010	2020	2030	2040	2050	2060
Total (public) pension expenditure	-0.84%	-1.53%	1.87%	-5.60%	-2.59%	-3.03%
Ratio pensions to wage bill	-0.85%	-1.70%	1.37%	-7.04%	-3.02%	-3.76%
Level of entry pension	-3.76%	9.86%	0.49%	-3.65%	0.88%	0.43%
Number of retirements	-13.04%	-1.34%	-8.33%	-4.52%	5.90%	1.99%
CONTRIBUTION OF THE MAIN MEASURES ON THE EFFECT OF THE 2011 REFORM						
A) DELAY IN LEGAL RETIREMENT AGE						
Total (public) pension expenditure	0.00%	-0.98%	-3.07%	-7.53%	-3.76%	-4.47%
Ratio pensions to wage bill	0.00%	-1.06%	-3.55%	-8.94%	-4.18%	-5.19%
Level of entry pension	0.00%	0.95%	-1.05%	-4.31%	-2.34%	-1.19%
Number of retirements	0.00%	-1.89%	-7.94%	-4.61%	6.04%	0.50%
B) REFORM OF THE REGULATORY BASE						
Total (public) pension expenditure	-0.48%	0.80%	5.00%	1.97%	0.43%	0.15%
Ratio pensions to wage bill	-0.49%	0.75%	5.01%	1.97%	0.43%	0.15%
Level of entry pension	-3.92%	7.78%	1.69%	-0.07%	-0.19%	0.12%
Number of retirements	-11.42%	0.23%	-0.38%	-0.09%	0.67%	0.06%

5. Final remarks

The reform of pension systems is one of the main topics on the EU policy agenda. The design and evaluation of reform measures require the availability of analytical tools suited to that purpose. This paper presents the results of DyPeS, the first dynamic microsimulation model of the retirement pension system applied to the Spanish case. The model is based on the MCVL - the administrative data set of the social security administration. It reproduces the main events occurring over the life cycle: birth, entrance into the labour market, unemployment events, retirement and death. In addition, DyPeS introduces behavioural reactions to account for retirement decisions. Regarding the programming strategy, it is a case-based, population-based model, and it was modelled in continuous time. DyPeS was implemented using ModGen, a programming language developed by Statistics Canada.

In order to show the potentialities of the model, first the effects of the crisis and second the effects of the reform approved in 2011 are simulated. Regarding the former, it is worth mentioning that the short and long-run effect of the crisis on wages turns out to be crucial for the future sustainability of the pension system. Different assumptions regarding wage growth rates imply remarkable differences in ratio of pensions to wage bill and, more generally, in the pension system's sustainability. Further research is needed to more precisely measure these effects. Regarding the latter, the results show that the reform would have an impact on pension expenditure, but it does not seem to be sufficient to ensure sustainability – especially when behavioural reactions are in place. In particular, once the effect of the current crisis is introduced, three main reforms are implemented: the increase in the number of years considered to compute the basic pension benefit (BR) from 15 to 25, the change in the share of BR received as a pension, p(n), – implying changing the weight given to the years of contribution - and the delay in retirement age.

The effects of the current economic downturn in working careers seem to be remarkable, and particularly the impact of the crisis on wages seems to have long-term effects on pensions level and retirement decisions

As expected, when individuals are allowed to react to financial incentives, initial pensions grow and the number of initial pensions decreases - suggesting that individuals delay retirement to obtain higher pensions. The simulation of the reform approved in 2011 shows that only the delay in retirement age (from 65 to 67) would have a significant effect on pension expenditure by reducing the number of entry pensions, while other measures changing the computation of the initial pension for new retirees have a limited impact. Paradoxically, it is found that the consideration of more contribution years in the computation of the initial pension amount, combined with the effect of the crisis on wages, has a positive impact on initial pension level. This result suggests that the link between redistribution and sustainability requires more research.

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Appendix A: The MCVL data set and the sample extraction[18]

The MCVL is a sample extracted from Social Security administrative data. Four per cent of all individuals registered with the Social Security administration – both contributors and recipients of benefits – over the sampling year are selected and their entire life history in the social security records is included in the data set.[19] Thus, although it is not a pure panel, the data set is rich in longitudinal data. This feature, however, complicates the structure of the information, as the registration unit varies substantially ranging from the person – in the personal data file – to the contract – in the affiliation file – or to the contract and year – in the contribution file. This structure also complicates the data selection. Furthermore, the quality of data is not homogenous, deteriorating the further back in time we go as more data are missing. The data collection itself was initiated at different points in time: data on pensions were first included around 1996; data on contributions around 1980, while some data on affiliation (contract registering) are available from as early as 1970. Clearly, all these factors condition our analysis. We provide details of the data employed below. We focus primarily on the pension file whose registration unit is defined by the individual, the benefit and the year, but we also recover contributory data for those individuals in our sample.

Among the difficulties of dealing with such a large administrative data set – the sample size reaches about a million people in 2005 – the most challenging are dealing with empty contribution bases and relating contribution, affiliation and benefit data from the same individual, all defined with different registration units. In particular, in order to extract reliable data regarding contributions in a specific time unit, it is necessary to follow up all the contracts in which an individual has been involved, computing

[18] See MTAS (2006b) for a detailed description of the *Muestra Continua de Vidas Laborales* (MCVL), available upon request at www.seg-social.es/Internet_1/Lanzadera/index.htm?URL=82.
[19] Both workers and pensioners are thus included and also individuals receiving unemployment benefits or benefits prior to early retirement. The latter can be identified by the type of relation they have with the Social Security.

time and contribution separately so as to avoid an erroneous correspondence between working time and contribution per unit of time. Below we describe in detail how we dealt with this.

The model presented in this paper draws mainly on administrative data, extracted from the Social Security administration – the MCVL. It seeks to examine the impact of certain reform measures on the probability of retiring. The MCVL allows for this kind of analysis because it contains data of the main factors included in the initial pension formula. Specifically, over the period covered by the database, we are able to recover the number of working years, the life-cycle contributions of the individual and the retirement age, thus determining any penalisations for early retirement. It is also possible to recover these variables – except the not yet observed retirement age – to analyse future pension rights for potential pensioners – i.e. all the individuals in the sample who can opt for retirement. For pensioners, the total number of lifetime working years considered on computing the initial pension is also registered in the MCVL. Nevertheless, it is also necessary to obtain the annual working time in order to fill the gaps in the contribution data, in line with Spanish legislation.[20] Hence, the annual contribution period or working time is obtained by recovering all the contracts signed by the individual for each year, taking into account part-time work as well as the possibility of contracts that ran simultaneously.

At the same time, the average hourly contribution is obtained. One of the main problems we faced was the existence of missing contribution data. This can occur either within a contract registered in the contribution file or due to a lack of correspondence between the affiliation data – starting long before 1980 – and contribution data – starting in 1980. For example, we might find, even after 1980, no

[20] When the individual presents a non-contributory period within the last 15 years considered for computing the *RB*, the minimum contribution threshold rather than zero is considered to compute the *RB*.

recorded contribution for one specific worker, while data regarding affiliation showed the worker to be actually contributing.[21]

Appendix B: Data employed for the labour market transitions.

This appendix details the data employed in the employment transitions. Abstracting from exits and re-entering the labour market, they have been simplified to changes among qualification level – being employed - and changes from employment to unemployment and vice versa. Figures B.1 to B.3 show the evolution of the transition hazards observed from 2002 to 2007. Figure B.1 shows the changes in qualification level for workers re-entering employment from unemployment, both for male (panel a) and female (panel b). In all cases the transition hazards remain quite stable during the period covered. Only slight changes – more pronounced in 2004-05 - can be appreciated for males entering from groups 2 and 3 and females entering from group 3 to group 4.

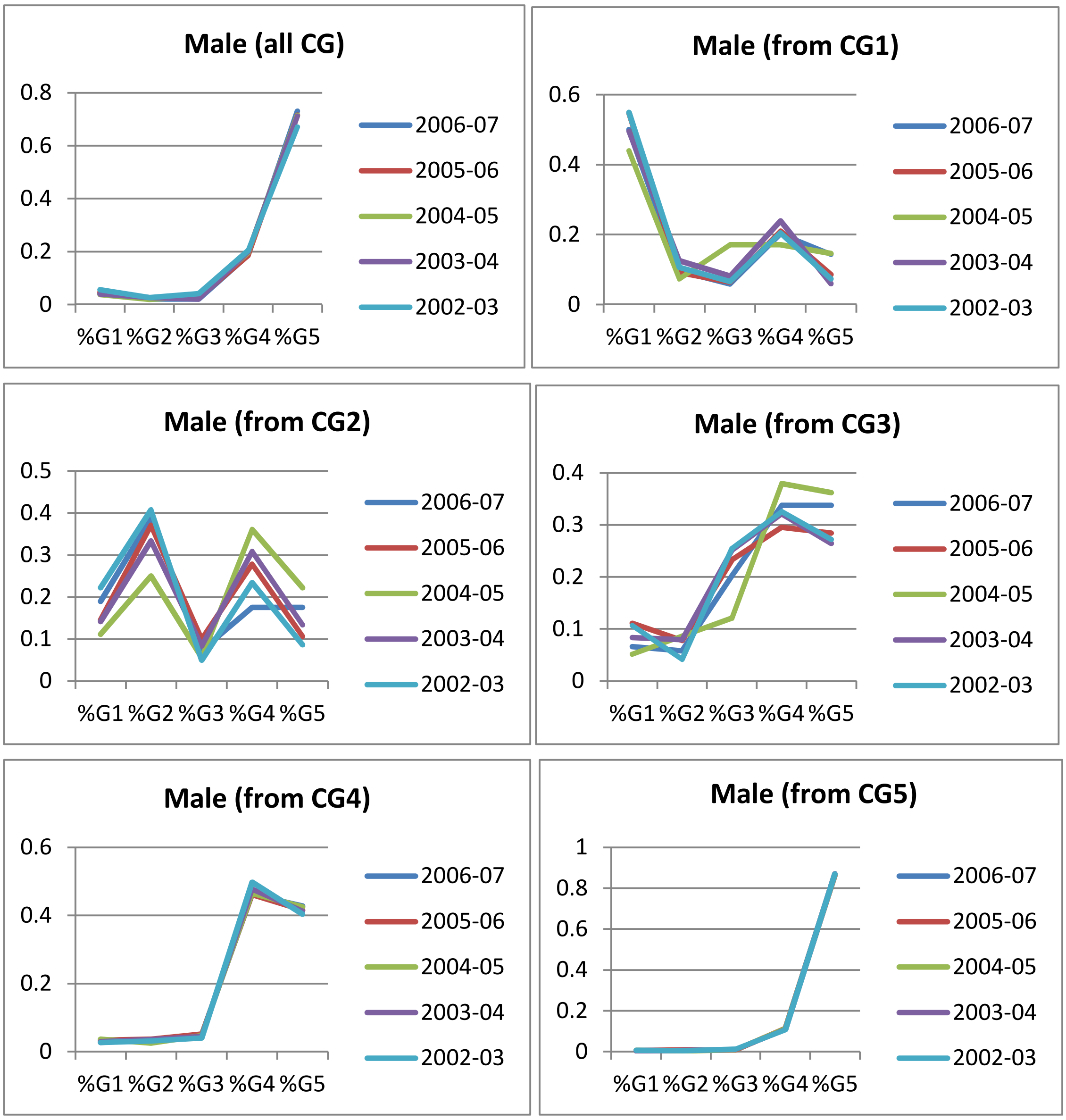
In Figure B.2, the transition hazards from employment to unemployment are shown. In this case, stronger differences can be appreciated among the different years, probably because the Figures show the detail by age. Nevertheless, the trend is also quite stable both for males and for females. Finally, in Figure B.3 hazard rates for transitions between different qualification levels (contribution groups) within employment can be observed. Again, no significant changes are appreciated for the different years analysed.

As the transition hazards among the different qualification levels are quite stable during the period observed, the value of the last transition observed before the economic crisis (2006 to 2007) is taken and is held constant for the future. In Section 4.a), an explanation is given of how these hazards are altered during the crisis.

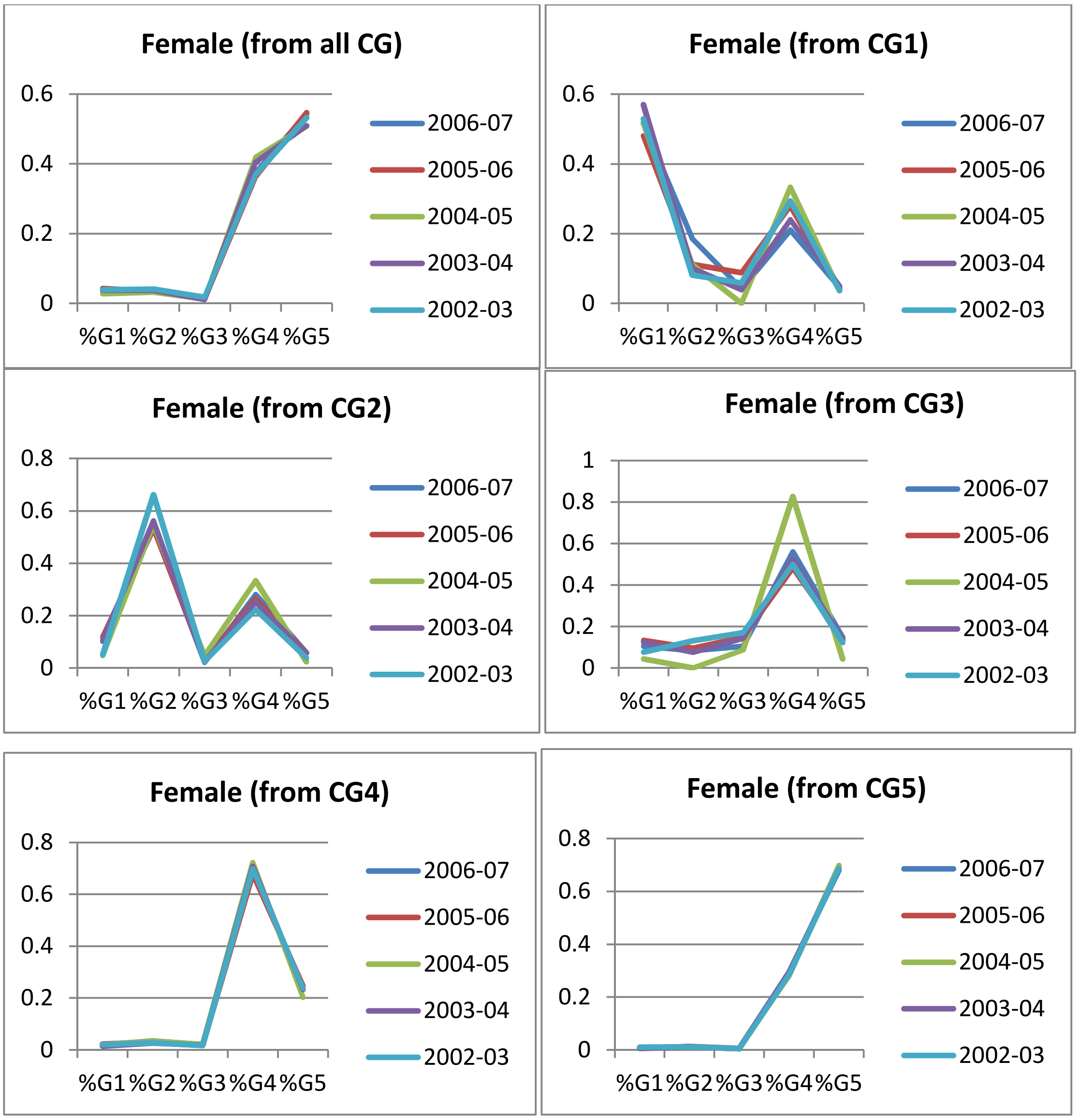
[21] Information regarding contributions was first gathered in 1980, but is more reliable after 2001. The providers of the sample found that the share of contracts with missing data fell from 78% in 1984 to 94% in 1992 and to 99% in 2003.

Figure B.1 Changes in qualification level from unemployment to employment

Panel a) Male

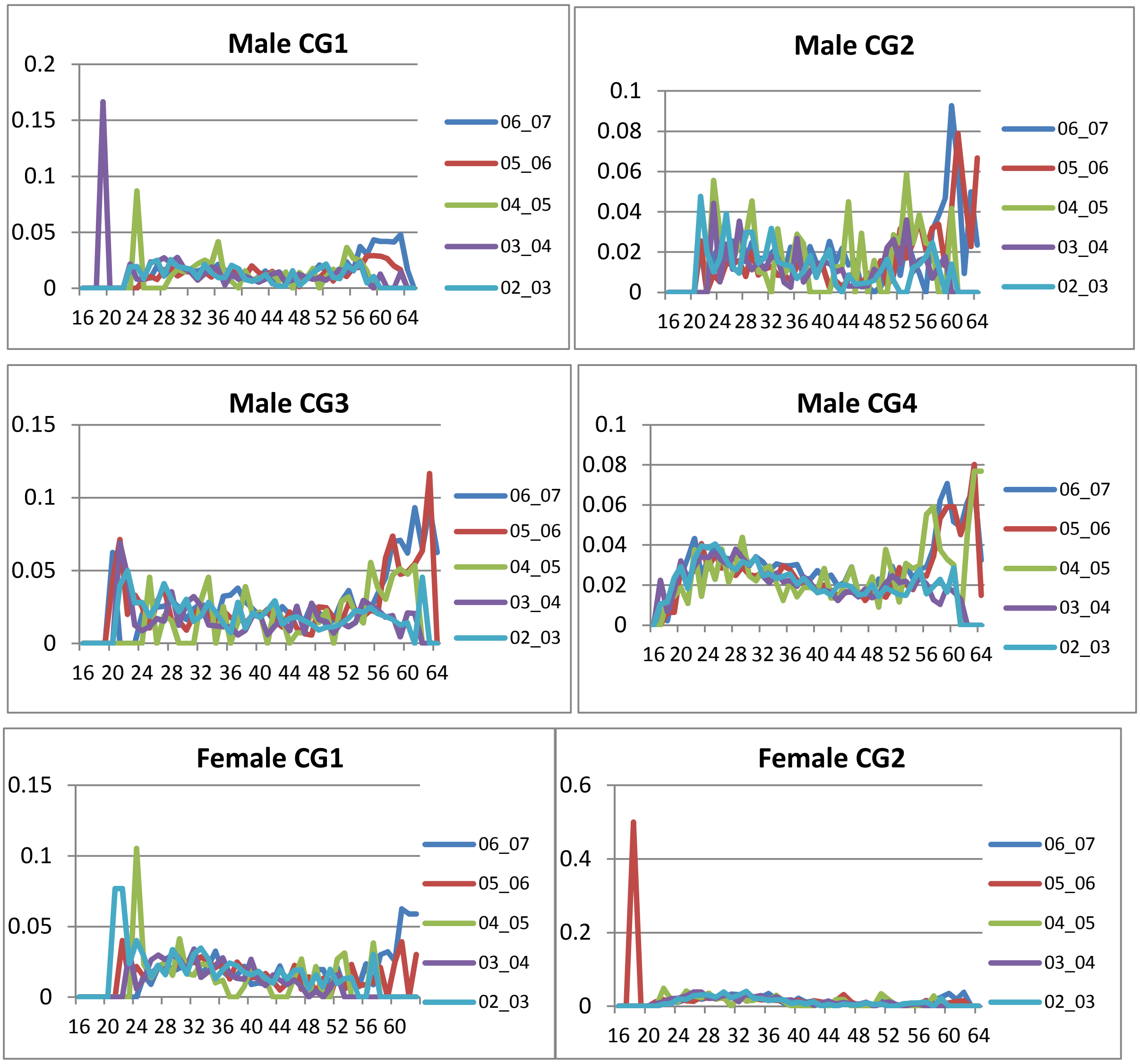


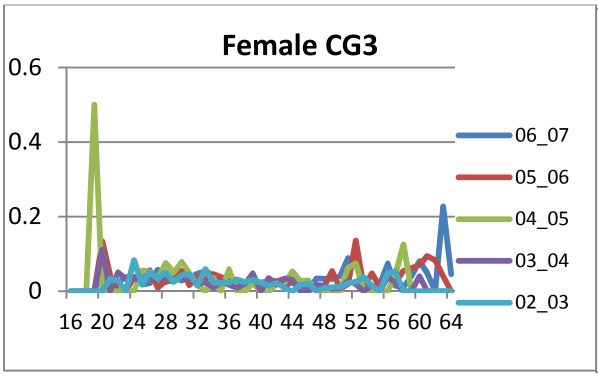
Panel b) Female

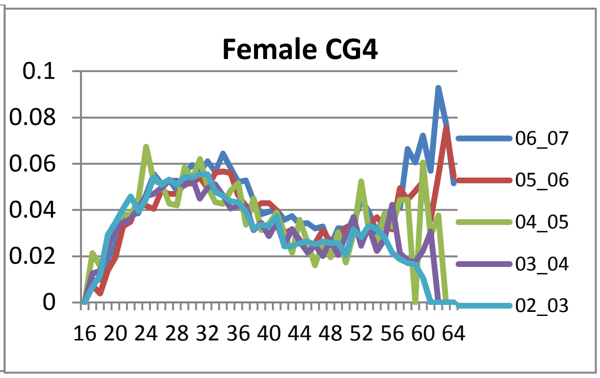


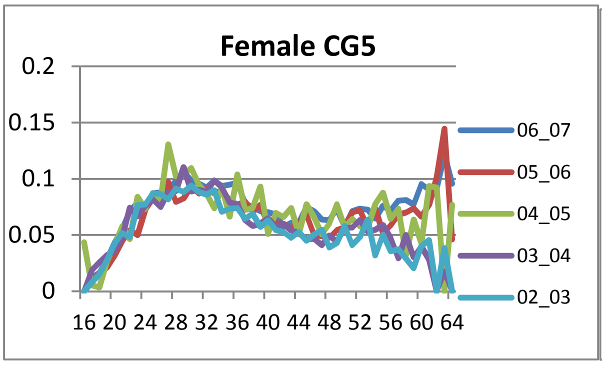
Source: Authors' elaboration

Figure B.2 Changes from employment to unemployment (observed hazards)




Female CG3
0.6
0.4
0.2
0
16 20 24 28 32 36 40 44 48 52 56 60 64
06_07
05_06
04_05
03_04
02_03


Female CG4
0.1
0.08
0.06
0.04
0.02
0
16 20 24 28 32 36 40 44 48 52 56 60 64
06_07
05_06
04_05
03_04
02_03


Female CG5
0.2
0.15
0.1
0.05
0
16 20 24 28 32 36 40 44 48 52 56 60 64
06_07
05_06
04_05
03_04
02_03

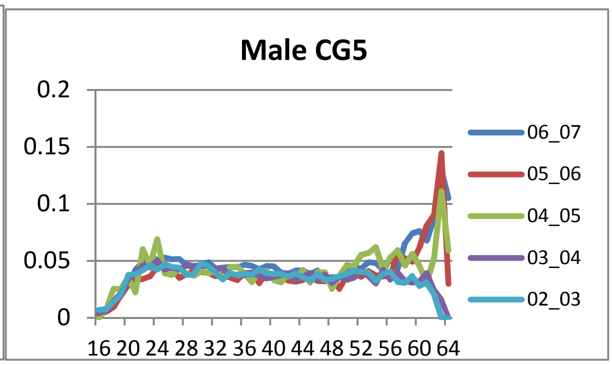
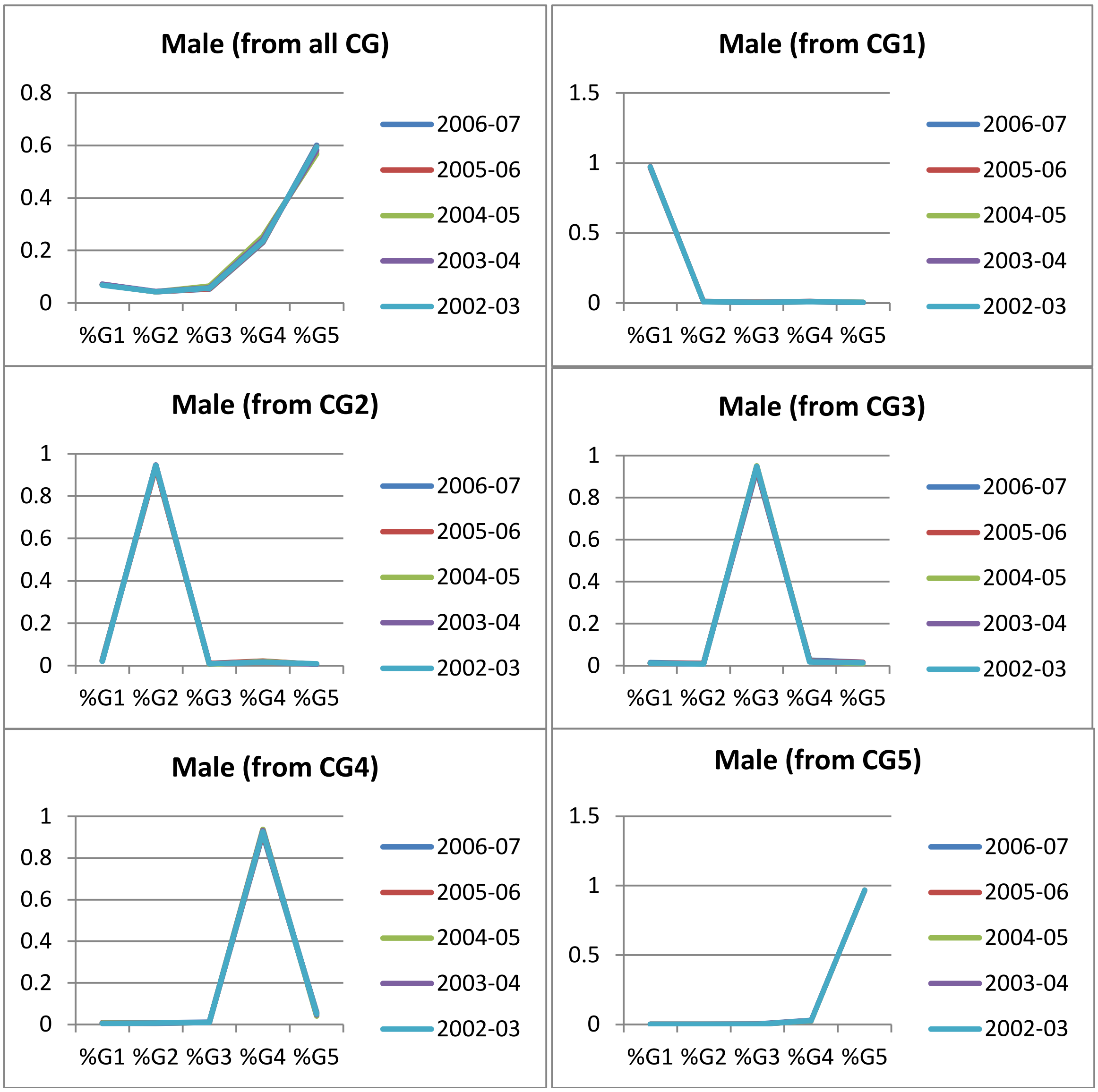
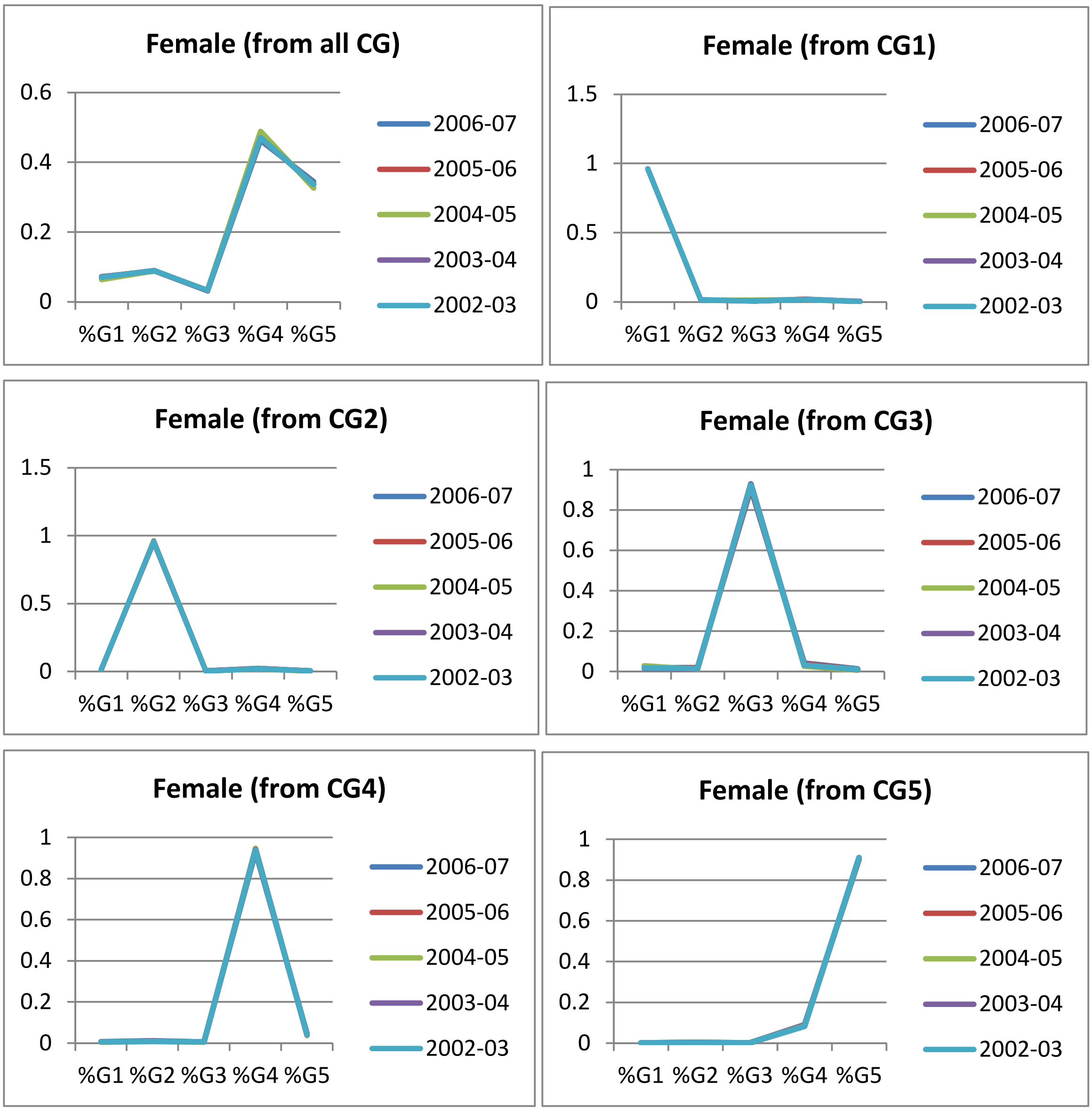

Male CG5
0.2
0.15
0.1
0.05
0
16 20 24 28 32 36 40 44 48 52 56 60 64
06_07
05_06
04_05
03_04
02_03

Figure B.3 Changes in qualification level within employment

Panel a) Male



Panel b) Female



Source: Authors' elaboration

Appendix C: Past and future reforms of the pension formula

This appendix summarises the main features of past and future reforms affecting the pension formula. Past reforms of the pension formula refer to each of the three factors in Equation [1] in the text. First, changes in RB basically relate to the number of past BC used to compute the BR. Only two years were considered when the system started. The number of years increased to 8 in 1985 (26/1985) and to 15 in 1997 (24/1997 Act). The current reform has increased it to 25, still below the recommendation of the Toledo agreement of taking into account the whole contribution history. Second, changes in the cc(n) have been varied and depend very much on the retirement path. Finally, changes affecting *p(n)*, i.e. the weight attached to the number of contribution years, so as to compute the share of the *RB* received as a pension. Table I.1 summarises the different legal changes undergone by this scale. According to the present one, fixed by the 24/1997 Act, *p(n)* is decreasing after the minimum, so that the weight attached to the first years is higher – which results in a redistributive effect. The former scale gave a lower weight to the initial years. The following columns show further reforms in line with the Toledo Agreement proposal, fostering the *Bismarckian* nature of the system: specifically, full proportionality considering the present maximum of 35 years – that is 2.86% a year - or a maximum of 40 years – that is 2.5% a year. As shown in Table I.1, for the various scales considered, the weight attached to one particular year oscillates between 5% in the first ten years prior to the 1997 reform, to 2% during the last years of the current legislation. The reform of p(n) approved in 2011 is in the same direction but has a small impact, while it complicates the computation now based on months instead of years.

Figure C.1 illustrates the potential effect of reforms on this legal parameter. On the one hand, the function *p(n)* is plotted for each of the legal scales considered. It is worth noting, first, that individuals who do not meet the minimum eligibility requirement would clearly benefit from a proportional rule. Second, it is clear that, for those crediting between 15 and 35 years, both the previous and the present rules (26/1985 and 24/1997 Acts, respectively) are more generous than the two proportional rules.

On the other hand, the cumulative distribution of new registrations with respect to the number of contribution years, in the 2004 MCVL wave, is also shown. This highlights the share of individuals affected by each legal scale and hence its specific effect. First, note that most individuals – 72% – credit up to 35 contribution years and, as such, are not affected either by the legal changes already enacted or by moving to a system of full proportionality with a maximum of 35 years. Second, we can see that the legal change introduced in 1997 only affected 6% of new pensions. Finally, it is interesting to note that an eventual change to full proportionality would affect almost 50% of individuals, which accounts for the highest effect obtained for this simulated legal change.

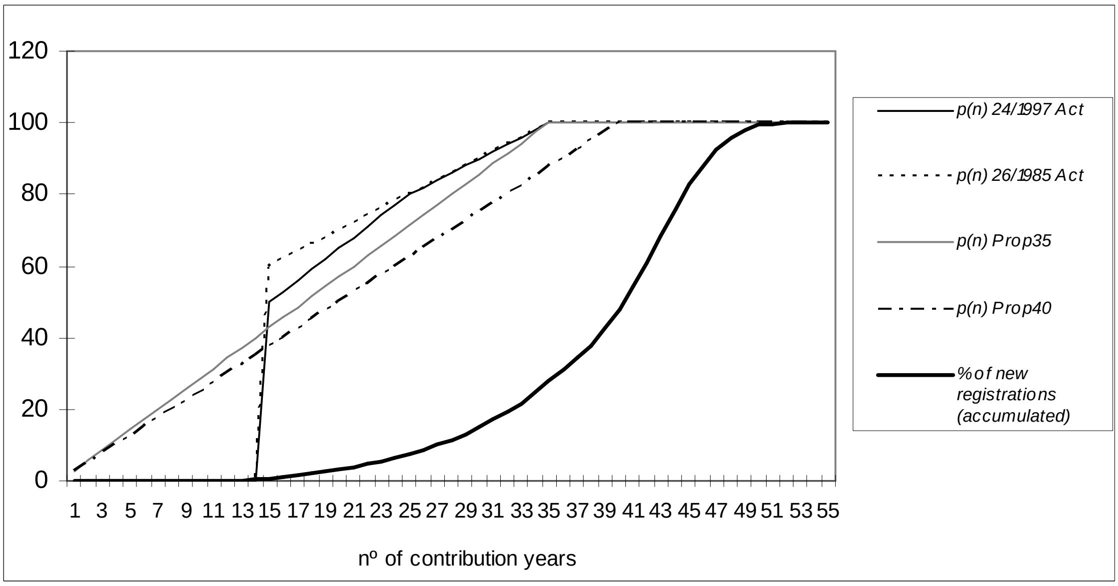
Table C.1. Weight attached to contribution years in the share of *BR* (several legal scenarios)

<table>
<tr><th></th><th>Prior to 1985</th><th>26/1985 Act</th><th>24/1997 Act</th><th>Total Proportionality</th></tr>
<tr><td>Minimum eligibility condition</td><td>10 years</td><td>15 years</td><td>15 years</td><td>–</td></tr>
<tr><td></td><td colspan="4"></td></tr>
<tr><td>Contribution years</td><td colspan="4">Total p(n)
(per year)</td></tr>
<tr><td>10</td><td>50% (5.0%)</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>15</td><td rowspan="3">(2.0%)</td><td>60% (*)
(5.0%)
(2.0%)</td><td>50%
(3.3%)</td><td rowspan="3">In 35 years
(2.86%)

In 40 years
(2.50%)</td></tr>
<tr><td>16-25</td><td rowspan="2">(2.0%)</td><td>(3.0%</td></tr>
<tr><td>26-35</td><td>(2.0%)</td></tr>
</table>

(*) 60%: according to the same previous scale, 50% from the first 10 years (5% a year) plus 10% from the next 5 years (2% a year).

Figure C.1. Average effect on pensions from fixing different functions of *p(n)*



Source: Source: Authors' calculations using MCVL data and legal parameters.

Table C.2. The 2011 reform in the pension formula

	Previous Situation (since 24/2007 Act)	**Reform 2011 (17/2011 Act)**
a) $p(n)$	*p(n)*= 100% ; *n*=35 Three levels for n - First 15 years: 50% - 16 to 25: 3% / year - 26 to 35: 2% / year	*p(n)*= 100% *n*=37 Three levels for n - First 15 years: 50% - next 248 months: 0.19 per month - next months: 0.18 per month (gradual implementation 2013-2027)
b) $BR(bc_{t-15},...,bc_{t-1})$	*bc* from the last 15 years	*bc* from the last 25 years (gradual implementation 2013-2022)

c) Retirement age	General 65 Minimum 61 (except Old system)	General 67 (65 if n≥38.5) Minimum 63 (61 if involuntary unemployment)
d) $cc(n)$	Delayed retirement(*) - n<40: 2% / year - n≥40: 3% / year (*) There is a maximum limit. Early retirement(**) -Old system annual 8% before 65 - Unemployed: annual 7.5% before 65 (or lower if n≥35) - special retirement at 64 with no reduction Partial retirement (25-75% reduction)	Delayed retirement(*) - n<25: 2% / year - 25≤n≤37: 2.75% / year - n>37: 4% (*) Maximum limit maintained Early retirement(**) -Old system annual 8% before 65 -*n*<38.5: an additional 1.875% quarterly before legal retirement age -*n*≥38.5: an additional 1.625% quarterly before legal retirement age - It disappears (**) New possibility if stop working voluntarily (age≥63) or involuntarily (≥61), considering time to retirement age as contributed. Partial retirement (25-75% reduction) - = conditions

	- From age 61 to retirement age need to substitute the worker (minimum contribution base 65% of the old contract).	(minimum contribution base 100% of the old contract)

Appendix D: Retirement decision estimations.

Table C.3. Hazard rate model for retirement with SSW incentives

	Men				**Women**			
	Haz. Ratio	Std. Err.	z		Haz. Ratio	Std. Err.	z	
Age	154.4777	47.8289	16.28	**	9.9089	4.2229	5.38	**
Age Sq.	0.9518	0.0022	-21.15	**	0.9714	0.003	-9.29	**
Secondary studies	0.9155	0.0282	-2.86	**	0.8899	0.0452	-2.3	**
University studies	0.9434	0.0322	-1.71	*	0.9658	0.0618	-0.54	
First year retired	4.1764	0.1636	36.49	**	3.8053	0.4091	12.43	**
Unemployed	0.6731	0.0256	-10.4	**	0.7264	0.0384	-6.04	**
Unemployed benefit	0.287	0.0688	-5.21	**	0.2221	0.0716	-4.67	**
Wage	0.9354	0.0000	-33.01	**	0.9434	0.0000	-15.52	**
SSW	0.9999	0.0000	-22.59	**	0.9999	0.0000	-10.93	**
PV (difference to max SSW)	1.0000	0.0000	-0.04		1.0000	0.0000	0.36	
Time to PV	0.8993	0.0152	-6.29	**	0.8919	0.0215	-4.74	**
Age at PV	1.0016	0.0003	6.22	**	1.0017	0.0004	4.67	**
Replacement rate	0.9716	0.0148	-1.89	*	1.1507	0.0366	4.41	*
Minimum pension	1.3912	0.0501	9.16	**	2.1308	0.101	15.96	**
Months since eligible (log)	1.9373	0.0307	41.71	**	1.5538	0.0374	18.31	**
BR	1.0000	0.0000	29.02	**	1	0	13.52	**
Unemployment rate	1.0094	0.0022	4.23	**	1.0178	0.0038	4.76	**
Constant	0.0000	0.0000	-21.31	**	0	0	-8.7	**
*base category: no studies or primary studies								
**significant at 5% level								

In this appendix we show the results of considering a model that includes the Social Security Wealth and the Peak Value as main financial incentives. These variables are commonly used in the literature and particularly in previous studies for Spain (Vegas et al. 2013). These authors use the Social Security Wealth, the Social Security Accrual and the Peak Value and find that all the coefficients of these social security variables are statistically significant with the expected sign. Increases in the total present value of the flow of pensions that a person will receive from the year she retires to the year she dies, i.e. a rise in SSW, increase the hazard. Increases in the difference of this amount derived from postponing the retirement (either one or more years) reduce the hazard, irrespectively of whether SSA or PV is used to capture the substitution effects.

By contrast, we find that the effects of the SSW and PV variables are very weak, being non-significant in the case of the PV. As far as we have to include these results - the coefficient values - in a microsimulation model that predicts future behaviour, we opted for discarding this model and used the one explained in section 3.3 to describe the social security incentives involved in the retirement decision. Two different kinds of reasons might explain why our results differ from those found in Vegas et al. (2013): some related to the data employed and others related to the model. First, there are differences in the subsamples employed. Vegas et al. (2013) use a subsample of people entitled to a pension benefit and aged from 60 to 70 in 2006, and our period of reference is longer (2005 to 2010) and includes people aged from 60 to 75. That is to say, we observe retirement transitions occurring between 2050 and 2010 and not only in 2006. In this respect, the inclusion of three years affected by the economic crisis may affect the retirement patterns observed. Second, the period discrete time-varying variable in Vegas et al. (2013) is defined in years, and ours is defined in months. Finally, models are not identical. For example, Vegas et al. (2013) use control variables – such as regional dummies - that we do not include in our model (as previously mentioned, we can only include in our model the variables that we will be able to reproduce for future periods in our microsimulation model).

Appendix E: Wage estimations.

Dependent variable: yearly wage (full-time equivalent)								
	Men				***Women***			
	Coef.	**Std. Err.**	***t***		**Coef.**	**Std. Err.**	***t***	
Past wage	0.5157	0.0002	2039.91	**	0.5596	0.0003	1779.91	**
Age	802.4182	1.7828	450.09	**	633.5351	2.1533	294.21	**
Age Sq.	-5.0966	0.0221	-230.63	**	-4.0222	0.0270	-148.93	**
Immigrant	-1846.8940	9.8040	-188.38	**	-976.6809	12.7950	-76.33	**
Secondary studies	1022.9080	5.0308	203.33	**	1059.1550	5.9456	178.14	**
University studies	1686.2680	8.5644	196.89	**	2366.8250	8.0633	293.53	**
Experience	0.0424	0.0001	368.00	**	0.0513	0.0001	357.65	**
Experience Sq.	-0.0002	0.0000	-125.16	**	-0.0001	0.0000	-133.56	**
Non-manual work	1503.3060	4.9434	304.10	**	1360.39	5.6977	238.76	**
Qualified work	3733.7810	11.2921	330.65	**	3905.67	12.3322	316.70	**
Year of birth	355.1204	0.3138	1131.55	**	279.1048	0.4010	695.96	**
Unemployment rate	27.1295	0.4591	59.09	**	45.0072	0.5482	82.09	**
Constant	-714479.50	629.3685	-1135.23	**	-563384.9	803.2160	-701.41	**
*base category: no studies or primary studies								
**significant at 5% level.								

All the variables behave as predicted by the theory. Variables related to productivity - education, experience - increase wages, and more qualified and non-manual jobs are better paid. Also, wage increases with age but at a decreasing rate and immigrants are worse paid that Spaniards. We introduced cohort effects - supposing a linear relation - through the variable "year of birth", whose impact on wages is strong and positive.

Appendix F: Retirement probabilities for people older than 58. (Non-behavioural. Logit model)

	Men				*Women*			
	Coef.	**Std. Err.**	**z**		**Coef.**	**Std. Err.**	**z**	
Age	3.0697	0.4719	6.51	**	0.6747	0.3858	1.75	*
Age Sq.	-0.0253	0.0038	-6.65	**	-0.0057	0.0031	-1.85	*
Secondary studies	-0.2794	0.0634	-4.41	**	-0.1462	0.0664	-2.2	**
University studies	-1.7038	0.3948	-4.32	*	-1.5157	0.4756	-3.19	**
Experience	0.0106	0.0057	1.86	*	-0.0182	0.0049	-3.68	**
Experience Sq.	-0.0002	0.0001	-1.82	*	0.0004	0.0001	3.8	**
Non-manual work	-0.5554	0.0640	-8.68	**	-0.2084	0.0498	-4.18	**
Qualified work	0.4393	0.3855	1.14		0.4367	0.4602	0.95	
Unemployment rate	0.0800	0.0040	20.17	**	0.0296	0.0038	7.85	**
Constant	-94.4544	14.5995	-6.47	**	-21.1534	12.0011	-1.76	*
base category: no studies or primary studies								
**significant at 5% level								
*significant at 10% level								