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Immigration and Social Security in Spain*

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Abstract

The objective of this paper is to understand the impact of immigration on the Spanish pension system during the next fifty years by building a quantitative-theoretical framework. In order to carry out the exercise of projection of revenues and expenditures in the Spanish pension system, we have developed an Overlapping Generation Model where individuals differ by age, gender, skill and nationality. The Cohort Component Population Projection Method is used for the demographic projections, and for the labor market scenario we have simulated the full labor history of all of our different workers for the period 2008-2050 taking into account the future evolution of the educational levels and five possible situations during their labor history (employed, self-employed, unemployed, disable and inactive).

In a first baseline scenario the system will be in deficit around year 2023 according to the last official estimations. The arrival of a large number of foreign workers is offering the Social Security System roughly five years of additional time to correct its important underlying unbalances. However after this period, the structural problems will come back and may be even magnified by the presence of an additional number of retired immigrants. Even if immigration reaches its total assimilation in the labor market it will not be sufficient to avoid that the pension system will be in deficit. However, immigration is allowing us to obtain very valuable additional time in order to carry out the necessary reforms.

JEL CODES: H55, J26

1 Introduction

The objective of this paper is try to understand the impact of immigration on the Spanish pension system both during the last ten years and, more importantly, during the future fifty years, by building a quantitative-theoretical framework. In other words, we look at the recent past in a tentative to predict the future. Because we are perfectly aware of the intrinsic impossibility of predicting future economic events at a longer horizon than a few days, we interpret our simulations and predictions with a very large of clinical judgement. It is not that we do not trust them: as far as we can tell, given the information available today, these are the best predictions we can think of. On the other hand, being quite aware of the dramatic limitations in the information available to us, we spend most of our time pointing out the multiple reasons why our predictions may turn out to be completely wrong. In this sense, all we are attempting here is to offer a frame of reference for an educated policy discussion, and for further, more powerful and deeper, economic research.

While the framework is, in principle, quantitative-theoretical we have made an intentional effort to minimize the relevance of theory. This is not because we have no respect for economic theory, quite the opposite.

The migration boom is indisputably one of the most important socio-economic changes in recent years, transforming Spain from an important emigration country to an important immigration country. In the last few years, Spain's population growth rates have been the highest of its recent history, reaching an unprecedented 1.5% growth rate per year between $2001 - 2005$, that is faster than in the post-war period and during the 1960s baby boom. In the period $2000 - 2007$, the population increased by over 4.6 million, i.e. by more than in the previous 20 years (3.4 millions). This population increase can be attributed to a dramatic rise in life expectancy (by 8 years in the last two decades) but, most notably, to a spectacular inflow of immigrants, with more than 3.8 million immigrants entering Spain between 2000 and 2007. Since the year 2000, migrant inflows have successively become more intense: in the year 2005 Spain was the country of destination for more than 10% of all immigrants to OECD countries, only below United States.

These data give an idea of the relevance of the phenomenon, which has inevitable implications not only at a demographic level but also for the labor market. First of all, immigration has contributed to the rejuvenation of the population given that the great majority of immigrants are between 20 and 40 years old. Secondly, 87% of immigrants are in age to work, between 16 and 64 years, which means that it is an immigration with fundamentally labor characteristics. In fact almost half of the new jobs created between 2001 and 2007 have been occupied by immigrants, mainly in those sectors

intensive in manual labor, i.e construction, agriculture or domestic service.

The paper is organized as follows, the model with the demographic and labor scenario is described in the second section; the key institutional elements of social security system in Spain are included in the third section; the fourth section presents the results of the revenue and expenditure projections for the baseline scenario and the fifth the results under an alternative scenario of gradual labor assimilation of the immigrants. Finally the last section concludes.

2 The Model

In order to carry out the exercise of projection of revenues and expenditures in the Spanish pension system, in the first step the demographic projections have been carried out up to year 2050 through the cohort component projection method, taking the year 2007 as the starting point of the demographic situation. In addition, with the purpose of being able to compare our results with other similar studies, we have chosen the same hypothesis of the scenario number 1 of the long term population projections elaborated by the INE.

The developed model is an Overlapping Generation Model in which individuals live for 17 periods. Every period corresponds to five years of calendar time. Individuals enter the economy at the age of 15 and live at most until age 100. The maximum potential working life of an individual is therefore of 10 periods, that is from 15 years old until 64 years old, as the legal retirement age is set at 65. Finally the maximum potential life in retirement (for individuals retiring at 65) is of 7 periods.

Individuals differ not only by age, but also by gender, skill (or educational attainment) and by country of origin. More precisely, the individual heterogeneity is characterized as follow:

- by nationality (country of origin) $c \in \{n, m\}$: n for '*natives*' and m for '*immigrants*'
- by gender $g \in \{m, f\}$: m for '*males*' and f for '*females*'
- by educational level $e \in \{c, h, d\}$: d for 'high school dropout ' (primary education), h for 'high school' (secondary education) and c for 'college graduate' (tertiary education).

- by age $j \in \{1, 17\}$, $j = 1$ for individuals between 15 and 19 years of age, and so on until $j = 17$ for individuals between 95 and 99 years of age.

We have 12 different groups of individuals, each one of which is, in turn, subdivided in 17 groups according to their age.

2.1 Demographic Scenario

In less than two decades, Spain has become the country in Europe with the largest inflow of foreign immigrants. After 2000, the inflow has reached an average of $600,000$ new arrivals per year and the number of immigrants has increased from 0.9 million (2.2 percent of the population) in year 2000 to 4.7 millions (10.5 percent of the total population) in year 2007. This five-fold increase in the span of seven years has no parallel in any other of OECD country during the recent decades. In fact, 10 percent of all the immigrants in OECD countries during the period $2000 - 2005$ have come to Spain. By far, the most important group of immigrants comes from Latin America, followed by other EU members and Northern Africa. This large and relatively sudden influx of immigrants has, in turn, meant that the population growth rate of Spain has been higher than at any point in time during the last hundred years (around 1.8% per year). The Spanish population increased more in the period $2000 - 2007$ (by 4.6 million) than in the previous two decades (3.4 million).

The immigration flow has rejuvenated the Spanish population: in 2007 more than 86% of immigrants were between 16 and 64 years of age, compared to 66% in the native stock. Absent immigration, the number of individuals aged between 16 and 24 would have decreased by as much as 1.5 million in the last seven years. In terms of median age, immigration has decreased it by two years from 40 to the current 38 years. In 1996, most international agencies were forecasting a bleak demographic outlook for Spain. The United Nations projected a population of 30 million people in Spain in 2050. The current projections from the INE (Spain's National Statistics Institute), which are subject to considerable uncertainty because of the new demographic situation, speak of a population of 53 million in 2050.

In this section we describe the effect of immigration on the Spanish demographic scenario. More specifically, taking the demographic situation of 2006 as our starting point[1] we try forecasting its evolution until 2050. The methodology used is the Cohort Component Population Projection Method. The cohort component technique uses the

[1] We fix the year 2006 as the starting point of our exercise to be consistent with the last available wave of the MCVL data.

components of demographic change to project population growth. The methodology takes each age-group of the population and projects it forward using estimated models of mortality, fertility and migration. To project the total population and the number of males and females by age group, we use the following identity

$$Pop_{t+n} = surviving\ population + births + net\ migrants \tag{1}$$

The total population of Spain in period t is decomposed as follows

$$Pop_t = \sum_{j=1}^{17} \sum_{g\in\{m,f\}} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} Pop_t\left(j,g,e,c\right) \tag{2}$$

where $Pop_t\left(j,g,e,c\right)$ is the number of individuals with age j , gender g, education level e, and nationality c living in Spain in period t. A few definitions will be useful in what follows.

- The probability of surviving from age j to age $j+1$ is $\psi_t\left(j,g\right)$ (one minus the mortality rate). We treat males and females differently, but not natives and immigrants.
- The (females) probability of reproduction is $k_t\left(j,e,c\right)$, which depends on age, education and country of origin.
- Net migration is $M_t = \sum_{j=1}^{17} \sum_{g\in\{m,f\}} \sum_{e\in\{c,h,d\}} m_t\left(j,g,e\right)$; where $m_t\left(j,g,e\right)$ is the net inflow of immigrants with age j , gender g and education level e in period t.

The law of motion of the population is:

$$\begin{aligned} Pop_{t+1} = M_{t+1} &+ \sum_{j=1}^{17} \sum_{g\in\{m,f\}} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} \psi_t\left(j,g\right) Pop_t\left(j,g,e,c\right) + \\ &+ \sum_{j=1}^{17} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} Pop_t\left(j,f,e,c\right) k_t\left(j,e,c\right) \end{aligned} \tag{3}$$

The benchmark demographic scenario is calibrated to match the 'long term scenario No 1' of INE. We adopted it this as our benchmark because it has been used in most of the papers analyzing the Spanish social security system. This requires taking directly

from INE the survival probabilities, the total number of births and the average net immigrant flow, which we have done.

Taking as starting point the INE's hypothesis for the total number of births and net immigrant flow, the main assumptions for our **baseline scenario** in the distribution by gender, age and nationality, therefore, are:

- **Births**: the total number of births (from INE scenario 1) is allocated: i) by gender (males 51% and females 49%); ii) by nationality, in proportion to the number of women between the age of 16 and 49. Moreover, we treat as immigrants the children of an immigrant females, even though they were born in Spain. This assumption allows us to measure the total impact of immigration on the demography in Spain. On the one hand, it is probable that many of these children ended up reaching the Spanish nationality, but on the other hand is sure that they would not be in Spain if their mothers had not be in the migration flow.
- **Net immigrant flow**: INE's forecast is allocated: i) by gender (males 51% and females 49%); ii) by age: between 0 and 40, using the proportions observed during the last two years, which are reported in Figure 2.

Figure 3, shows the two demographic pyramids - the one for natives and the one for immigrants - in year 2007. The process of aging of the population is inevitable by which the population pyramid will transform in the next decades reducing the base and at the time growing the size of cohorts of greater age. The fact that the most of the immigrants is between 20 and 40 years, they have rejuvenated substantially the Spanish population now. Nevertheless, it is important to emphasize that the largest cohorts of immigrants also coincides with the largest cohorts between the Spaniards, reason why Spanish and immigrant population will face a parallel processes of aging in the next decades.

The result for the total population obtained in our projections is in line with the results of the INE but with the richness of our research that allows us to difference between nationality and educational level. In table 1, we report, for our benchmark scenario, the projected Spanish population, as can be seen in the absence of legal assimilation, the share of immigrants in the total population will increase from 12.3% to 40.1% in 2050. It is important to stress that we include in the total of immigrant population the children of an immigrant females, even though they were born in Spain. As can be observed in the Figure 4, the total amount of children with immigrant parents in Spain could be the 36% of the immigrant population in 2050 (8.5 million people approximately). This point is very important to take into account, because, due to the inevitable aging process of the Spanish population, without the arrival of

these relevant immigration flows will suppose a reduction in the Spanish population in the next four decades.

In table 1, we report, for our benchmark scenario, the projected Spanish population, the old age dependency ratio (population older than 64 divided by population between 16 and 64), and the working age population (between 16 and 64), with and without immigrants. In the absence of immigration, the dependency ratio would be a 35% grater meanwhile the potential working force would be a 45% smaller. In reference to the population between working ages, that will condition future employment and activity rates, the proportion over the total population of natives between 16 and 64 would diminish considerably. If we pay attention to the rank of age between 30 and 45 years, that would be really the strong group of the labor force, we see that again in the case of natives they would diminish while the immigrant group would grow. We can say that the potential labor force would really be a 30% less if we did not consider immigration phenomenon.

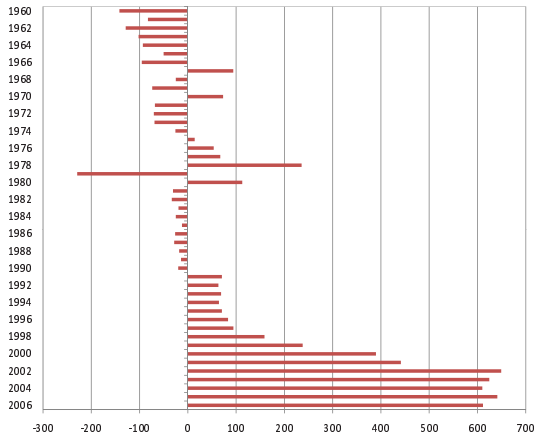
Table 1: Baseline Scenario

year	Total pop	Natives	Immigrants	
2008	45,476,172	39,881,691	5,594,481	(12.3%)
2010	46,371,684	39,975,928	6,395,755	(13.8%)
2020	50,559,876	39,910,397	10,649,479	(21.1%)
2030	53,609,035	38,773,867	14,835,169	(27.7%)
2040	56,286,736	37,240,222	19,046,514	(33.8%)
2050	58,463,150	35,027,510	23,435,640	(40.1%)

Old age projections

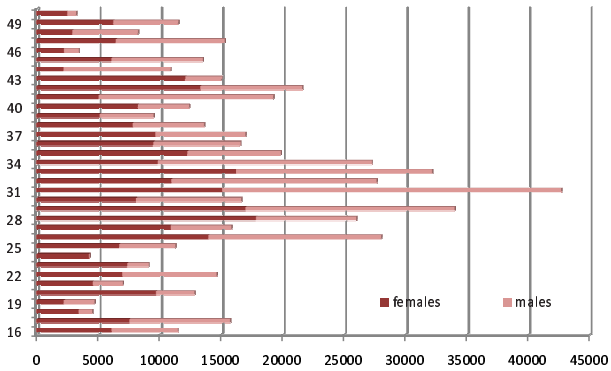
year	Population 16-64	Dependency rate (%)	Population 30-45
2008	30,789,296	24.3	12,337,980
2010	31,121,765	24.8	12,744,263
2020	32,586,236	27.8	12,409,768
2030	33,830,687	33.0	10,422,681
2040	33,830,041	41.2	10,910,023
2050	32,956,125	48.7	12,222,221

Figure 1: Net immigrant flows in Spain 1960-2007



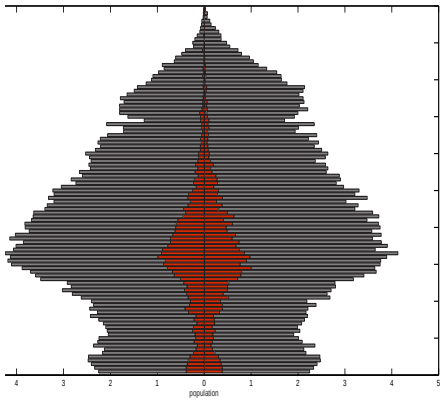
Source: Own elaboration with FBBVA data (thousands)

Figure 2: Net immigrant arrival 2005-2007



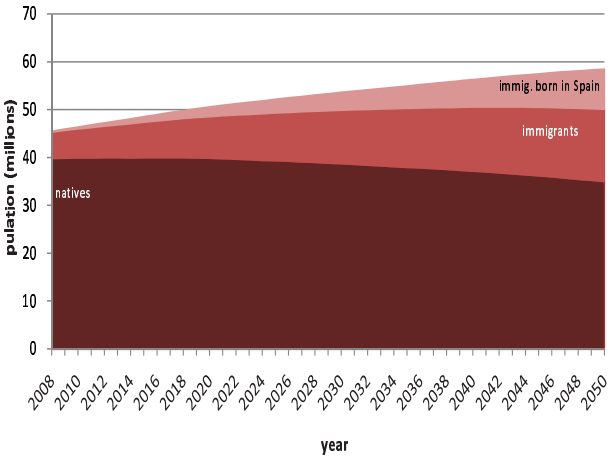
Source: Labor Force Survey (EPA)

Figure 3: Native and Immigrant Population pyramid - 2007



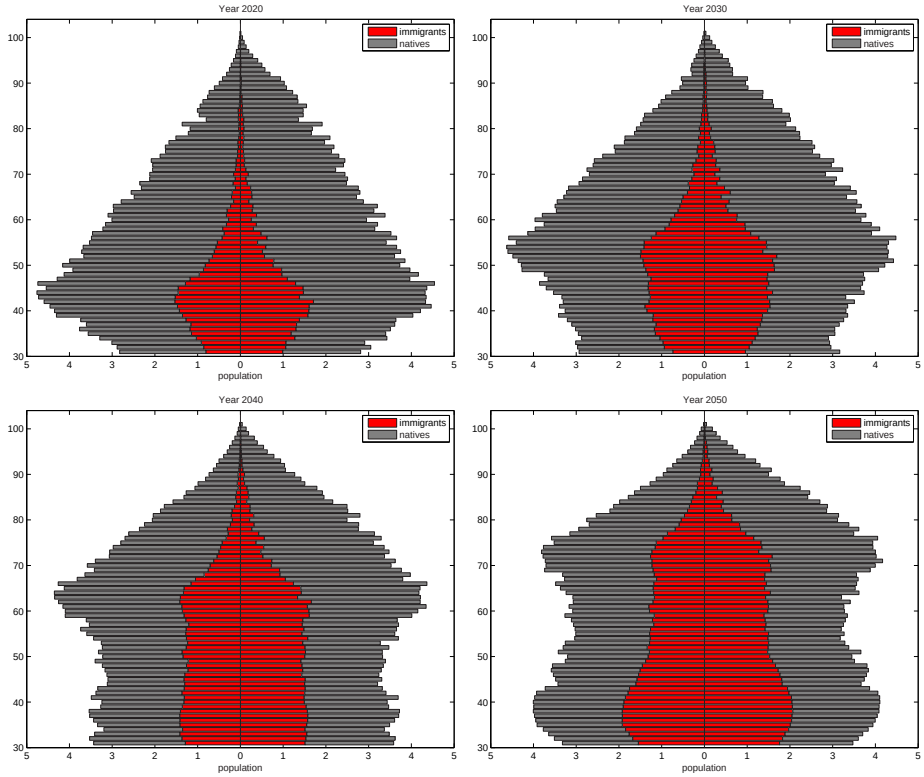
Source: Labor Force Survey (EPA-INE)

Figure 4: Population projection by nationality 2008-2050



Finally, figure 5 reproduce the predicted evolution of the demographic pyramids for natives and immigrants. In spite of the large immigration flow, the aging process of the Spanish population is predicted to continue.

Figure 5: Population pyramid 2050 own projections



2.2 Immigration and the Labor Market Scenario

In this section we examine the direct impact of immigration on the labor market. On the one hand, the participation rate of immigrants is much higher than that of natives, in all age groups. On the other hand, the unemployment rate is also higher among immigrants. As a result, the employment rate for immigrants is lower than that of natives for certain age groups. In spite of this, almost 50% of all the new jobs created during the period 2000-2007 have been taken by immigrants.

The arrival of a large number of immigrants has been accompanied, in the Spanish labor market, by two other major changes: a reduction in the unemployment rate of the natives, and a dramatic increase in the activity rate of women.

One of the most relevant aspects of this research is the analysis of the future evolution of the educational levels. Figures 6 and 7 report the distribution of the Spanish labor force in year 2007 according to education, age, gender, nationality and (educational) skills. Currently, with the information from the Labor Force Survey immigrants are more likely to have primary and secondary education and less likely to have tertiary levels of education. Moreover, between 28 and 40 years old, women have a more proportion of tertiary levels than men with the same ages.

Because the educational attainment of Spanish natives and immigrants have changed dramatically during the two last decade, we need to make some assumption about how they will evolve in the future. This is obviously arbitrary, as neither theory nor data can tell us much. Nevertheless, because something must be assumed, we assume that all the new cohorts will reach the same educational levels of the most educated cohort so far, which corresponds to the one born in 1975, i.e. to people that were 32 years old in 2007. The dynamic implications of this assumption are in Figure 8: the share of college educated people in the labor force moves from 26.5% to 39.5%, while the high school dropouts shrink to 33.5%, from the current level 49.2%.

Figure 6: Educational levels natives 2007

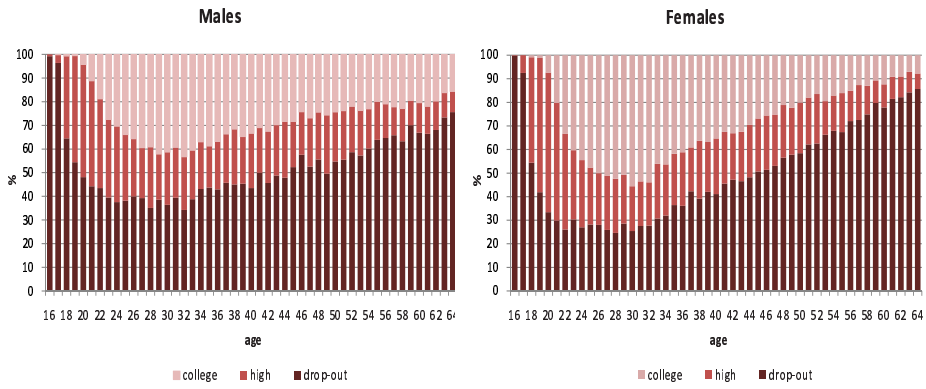


Figure 7: Educational levels immigrants 2007

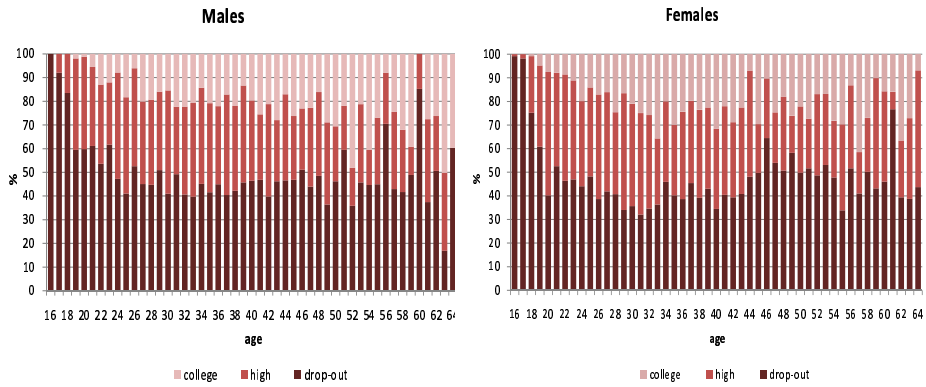
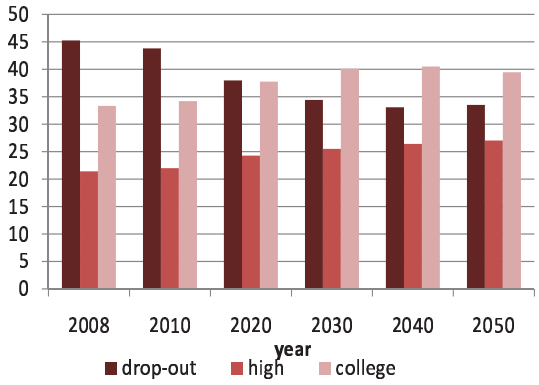


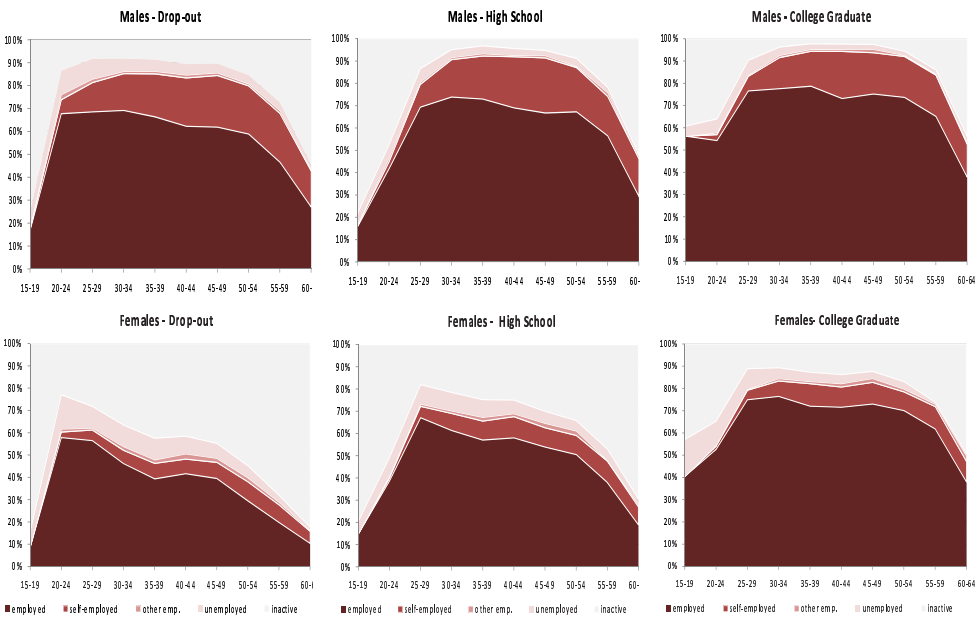
Figure 8: Evolution of the educational levels distribution



We begin with describing the evolution, along the individuals' life cycle, of their labor market condition. We use information from EPA to condition for individual heterogeneity. Between the ages 15 and 64 an individual can be employed (E), unemployed (U) or out of the labor force (I). The employed can be either self-employed (denoted by o_{cp}) or employees (denoted by o_{ca}). Those out of the labor force are either students (denoted by e), retired and receiving either an old age or a disability pension or inactive (denoted by d and i, respectively). Unemployed individuals are just unemployed, without further distinction. Between the ages of 65 and 99, individuals are assumed to be out of the labor force and either receiving or not receiving a pension, according to the rules described below.

We denote with $o_{ca,t}(j, g, e, c)$ the percentage of employees in the group with characteristics (j, g, e, c). Similarly, $o_{cp,t}(j, g, e, c)$ is the percentage of self-employed, $u_t(j, g, e, c)$ the percentage of unemployed, $d_t(j, g, e, c)$ the percentage of those with a permanent disability pension, and $i_t(j, g, e, c)$ the residual percentage of inactive people. Figure 9 shows the vast heterogeneity of conditions among the various groups. Among native residents, the inactivity rate is higher among females but the difference shrinks for younger age groups, while the activity rate increases with educational level, as to be expected. Among immigrants (see Figure A.1 in the Appendix) the activity rate is higher than among natives for all the relevant age groups.

Figure 9: Life cycle Natives by age and educational level - 2006



Next, using the data from EPA, we estimate the transition probabilities among the five groups (o_{ca}, o_{cp}, d, u and i) at different stages of the life cycle. The estimated process follows a finite state Markov chain that is, for a set of individual characteristics (j, g, e, c), homogeneous across workers and whose conditional transition probability matrix is:

$$p_{ss'} = \Pr(s_{t+1} = s' s_t = s \mid j, g, e, c) \text{ for all } s \text{ and } s' \in \{o_{ca}, o_{cp}, u, d, i\} \tag{4}$$

The transition probabilities so obtained (see figure 10) are consistent with the observed snapshot for year 2006, reported in Figure 9. Further, the estimated transition probabilities incorporate an aggregate evolution of the average employment rate from the 65.6% of 2006 to the 72.8% of 2050. Finally, we should stress that the lack of any reliable data about immigrants has forced us to an unpleasant choice in the estimation of the transition probabilities: we are assigning to immigrants the same transition probability matrix estimated for natives.

2.3 The Spanish Social Security System

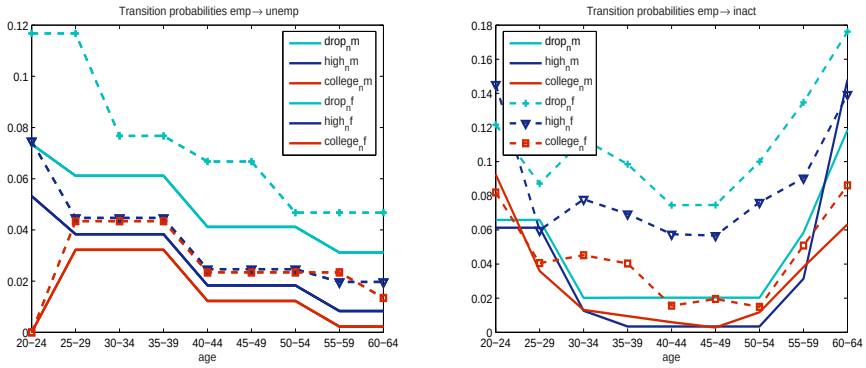
The Spanish Social Security System is composed by two major schemes – the general regime - RG- (Régimen General de la Seguridad Social), covering most private employees, and the special regimes (Regímenes Especiales de la Seguridad Social), covering mainly self-employed - RETA (Regimen Especial de Trabajadores Autonomos) - and workers in the agricultural, fishing and mining sectors. At 31*st* of December 2007, 76.7% of the workers in the private sector were enrolled in the Régimen General, 16.5% in the RETA and 6.8% in the other special regimes. Furthermore, some public employees were covered by the Régimen de Clases Pasivas that, in 2007, paid out almost 6% of all pension benefits, financed by general revenues rather than by standard social security contributions.

The public schemes provide four types of benefits: old-age pensions, disability pensions, survivors' pensions and family benefits. In 2006, old-age pensions amounted to almost 58.8% of the total number of pensions, but to almost 64.6% of total pension expenditure, followed by survivors' pensions, which amounted to 26.9% of total number of pensions and 19.4% of the expenditure. Finally, disability pensions represent 10.7% of total pensions and 11.8% of the expenditure.

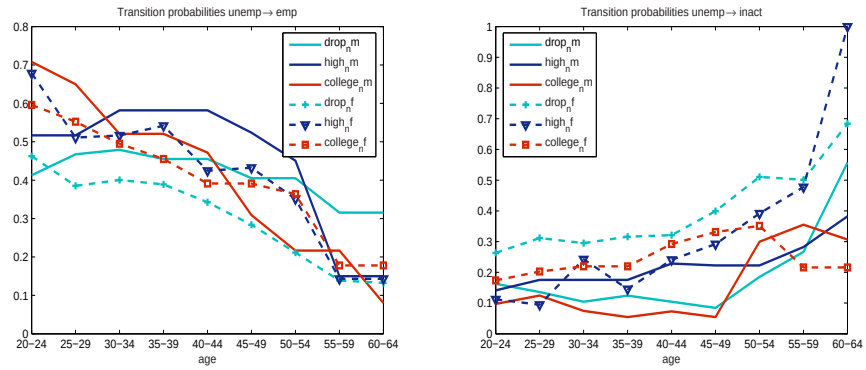
The Spanish Social Security System is a Defined Benefit Pay-as-you-Go System where the pension level depends only on the labor history of the worker (wages, number

Figure 10: Main transition probabilities

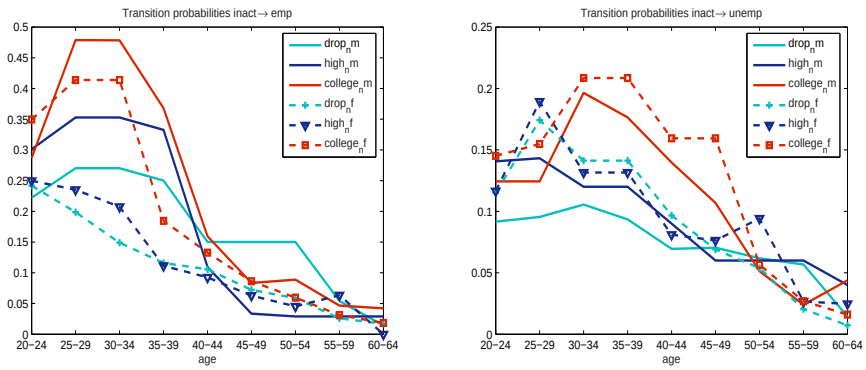
a. Employment - unemployment and employment - inactivity



b. Unemployment - employment and unemployment - inactivity



c. Inactivity - employment and inactivity - unemployment



of years of contribution and age of retirement), so the calculation of the future pension is fixed in the moment of starting to contribute to the system and it not depends on the economic, demographic and financial conditions at the time of retirement. Eligibility depends on the number of years of contribution and on the retirement age. Pensions have been awarded to individuals who had contributed for at least 15 years, two of which in the last fifteen years prior to retirement, who had reached 65 years of age and had retired from the active labor force. Early retirement pensions are however available to 61 years old individuals with a minimum period of contribution of 30 years; they are indeed quite common in spite of between an 8% and a 6% actuarial reduction per each year of retirement prior to 65. To eligible individuals, the Spanish system provides an old age pension benefit equal to:

$$p_t = \alpha\theta\widetilde{w} \tag{5}$$

where $\widetilde{w}$ is the reference wage (Base Reguladora), θ is the replacement rate (% of the Base Reguladora) and α is the penalty for early retirement. The reference wage represents the weighted average of the base for social security contributions over the 15 years prior to retirement, with all wages, but those in the two years priors to retirement, indexed to inflation[2]. This reference wage needs not to coincide with the actual wage, due to the existence of a floor and a ceiling in the contribution base. This detail should be kept in mind because, as our simulations show, the width and evolution over time of the floor-ceiling interval is a crucial determinant of social security contributions and expenditure. The replacement rate depends on the number of years of contributions. For the first 25 years of contributions, each year adds 3% to the replacement rate; this drops to 2% between 26 and 35 years of contributions. At 35 years of contributions, the replacement rate is thus already equal to 100%, and further years of contribution have no marginal value for the workers[3]. Finally, the coefficient α relates the pension

[2]Concretely

$$\widetilde{w} = \frac{\left(\sum_{i=1}^{24} b_{t-i} + \sum_{i=25}^{180} b_{t-i}\frac{IPC_{t-25}}{IPC_{t-i}}\right)}{210}$$

where b_t is the contribution base at time t and IPC_t represents the consumer price index at time t.

[3]That is:

$$\alpha = \begin{cases} 0 & \text{for} \quad N < 15 \\ 0.5 + 0.03\,(N-15) & \text{for} \quad 15 \leq N \leq 25 \\ 0.8 + 0.02\,(N-25) & \text{for} \quad 25 < N < 35 \\ 1 & \text{for} \quad N \geq 35 \end{cases}$$

where N represents years of contribution.

benefits to the retirement age, according to the following formula:

$$\alpha = \begin{cases} 0 & \text{for} \quad R < 61 \\ 1 - \gamma\,(65 - R) & \text{for} \quad 61 \leq R < 65 \\ 1 & \text{for} \quad R = 65 \end{cases} \tag{6}$$

where R represents the retirement age. The discount parameter γ is equal to 8% for individuals with less than 30 years of contributions, and between 7% and 6% for the rest, depending on the number of years of contribution. This discounting formula plays a crucial role in the Spanish system, as most workers have so far been retiring before the normal retirement age. Since 1986, all pension benefits have been indexed to an inflation rate predetermined by the government, while they were previously linked to the nominal growth rate of the average wage.

Financing for the Spanish social security system comes from the contributions paid by employers and employees. A proportional contribution rate is imposed on all labor earnings between a floor and a ceiling, with the exception of over time pay. Both the contribution base and the contribution rate are established annually by the government. The social security contribution rate is equal to 28.3%, of which 4.7% paid by the employee and the remaining 23.6% by the employer.

The Spanish social security system features also a minimum (i.e. $p_{\min}$) and a maximum pension (i.e $p_{\max}$). The minimum pension is provided to those individuals who are eligible for an old age pension, but whose pension benefits would be below a certain threshold. Unlike all other pensions, the minimum pension has often been raised by more than the inflation rate (more than a 30% in the period $2004 - 2008$). The maximum pension, instead, aims at limiting the pension benefits of high-income individuals, by establishing a cap on the pension benefits awarded to a retiree. The maximum pension has been kept constant in real terms during the last two decades, by indexing it to the inflation rate. Therefore the old age pension that an individual receives is:

$$P = \begin{cases} p_{\min} & \text{for} \quad p < p_{\min} \\ p & \text{for} \quad p_{\min} \leq p \leq p_{\max} \\ p_{\max} & \text{for} \quad p \geq p_{\max} \end{cases} \tag{7}$$

where $p = \alpha\theta\widetilde{w}$ defined above. Employees and employers contribute to the social security system a fraction of the worker's labor earnings between a floor, $b_{\min}$, and a ceiling, $b_{\max}$. The contribution base is related to the wage, ω, according to:

$$b_t = \begin{cases} b_{\min} & \text{for} \quad \omega_t < b_{\min} \\ \omega_t & \text{for} \quad b_{\min} \leq \omega_t \leq b_{\max} \\ b_{\max} & \text{for} \quad \omega > b_{\max} \end{cases} \tag{8}$$

The combination of the minimum and the maximum pension, and of the minimum and maximum contribution base, introduces a crucial element of intragenerational redistribution in the Spanish system.This has been the object of much academic attention (see, e.g., Boldrin et al. (2000), Jimeno (2002), Alonso and Herce (2003) y Conde-Ruiz and Alonso (2004), Galasso (2006)). Figure 11 reports the evolution over time of such floors and ceilings. A few remarks, which are relevant for our simulations: i) the threshold level for maximum pension has increased with inflation but has not kept up with real earnings; ii) the maximum contribution base has increased in real terms; iii) the threshold level for the minimum pension and contribution base have increased with the growth rate of the economy; iv) in, for example, year 2007 the maximum pension is 8.9% lower than the maximum contribution base, while the minimum pension is 6.8% higher than the minimum contribution base.

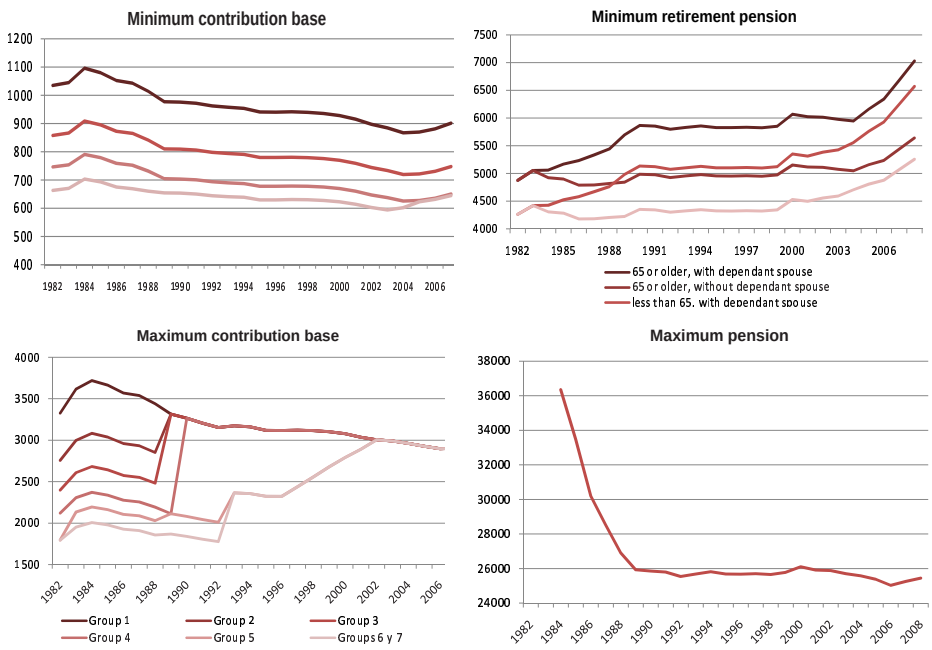
We could expect that over time wages will grow in a continued process, and so on the corresponding contribution base. However, is the maximum pension is not updated in the same line as wages, the ration pension/mean wage will reduce for those elegible to obtain the maximum pension, This will suppose that every time will be a greater number of pensions that reach maximum ceiling, reason why all the individuals would receive the same pension independently of their contributions. This would lead to a transformation of the system, denominated as "silent reform" and it would be turning our pension system from a contributive or Bismarkian type to a assistential or Beveridge system.

It should be clear, even from this short discussion, that the interplay of minimum and maximum pension/contribution is a key factor determining the future evolution of the Spanish pension system. These are, obviously, political decisions and there is no way in which our forecast exercise, no matter how sophisticated a model we use or the statistical techniques we bring to bear on these issues, will be able to exactly capture how those decisions will evolve over the next 40 years or so. All we can do is to set up some scenarios, make them as credible as possible and see what they imply, which is what we are going to do in our simulations. Hence, the reader should keep this aspect of the problem in his/her mind and condition all our predictions upon it, as it may be one of the few really important aspects to consider.

Apart for the old age pensions, we are also taking into account disability pensions and widowers' rights. In what follows we study how the labor history of an individual affect his/her pension's entitlements, focusing on the crucial determinants: years of

contribution, contributive base and retirement age. To do this we use the information contained in the MCVL (Muestra Continua de Vidas Laborales) in year 2006[4]. Notice first that, while the rules of the Regimen General (RG) are essentially the same as those of the Regimen Especial de Trabajadores Autónomos (RETA) there are two important differences: i) workers contributing to RETA can select almost freely their contribution base, and, ii) there is no possibility of early retirement for people affiliated to RETA.

Figure 11: Minimum and maximum contribution base and pensions (1982-2007) (real terms 2000)



Source: Ministerio de Trabajo e Inmigración

Contribution Bases. In figure 12, we see that those of the RG are, for each skill, gender and country of origin, concave respect to the age of the worker; further, those of women are uniformly lower than those of men. Also, for immigrants the skill premium attributable to secondary education relative to primary education is very low, which may signal either an underutilization of these workers (to be corrected in the future) or the fact that there is really no difference in skills between primary and secondary education immigrants. This is an open issue that available data do not allow us to resolve.

[4]For a more detailed description of the data base see Seguridad Social (2006).

Figures 13 and 14 (for native and immigrant workers respectively) show the distribution of contribution bases in the RG. They make clear the crucial role played by educational level in determining the contributive group someone belongs to, hence the need to forecast future educational levels in order to properly assess future contributions.

If we analyze the distribution of the contribution bases by educational level, for workers with primary level the distribution concentrates more mass in the low levels but of contribution, anticipating that a great number of these workers will accede to the minimum pension. On the other hand, the distribution of workers with greater educative level, concentrates more mass between greater levels anticipating that a high percentage of these workers will accede to the maximum pension. Again, there is no way in which one can properly predict how school attendance in Spain will evolve during the next 40 years, hence we will once again have to resort to "scenarios" built by ourselves, under the constraints that common sense imposes.

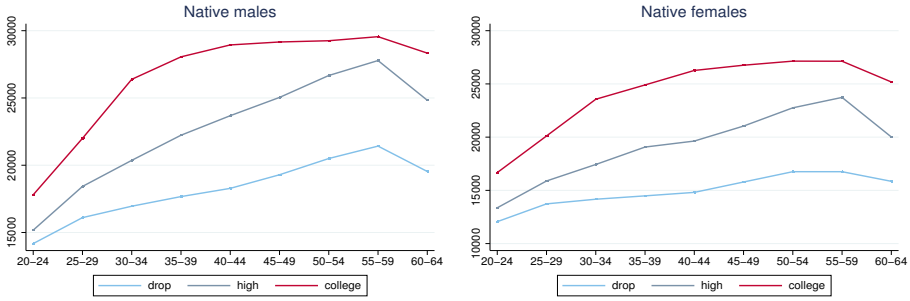
Figure 15 reports the same information for people contributing to RETA. This confirms, once again, that self-employed workers use strategically their freedom in electing the contribution base: they tend to contribute the minimum amount possible until age 50 and then increase it, during the last 15 years that are those determining $\widetilde{w}$ in the pension formula, in order to maximize their individual payoff. Again, this is a dimension that is open to political interventions, which could greatly alter the pattern of contributions and pensions for self-employed workers between now and 2050. Finally, we can also observe higher bases with higher educational levels and this strategic behavior more is accentuated in the case of the superior educational levels. In the case of immigrants, there is not much difference between men and women in the contributions to the RETA, although also it is observed slightly the same increase in the contribution bases in the previous years before retirement (i.e. the strategic behavior).

Retirement Age. Figure 16 shows a very well know pattern: workers retire either at 60 years of age, or at 65. As abundant literature has argued (Boldrin et al. (1999 and 2004), Jiménez-Martín and Sánchez-Martín (2004 y 2007), Brugiavini et al. (2003), among others) this is hard to reconcile with specific economic incentives and it seems to be determined more by social norms, habits and or family arrangements that are hard to model. Recent legislation has moved the earlier retirement age to 61, which should be taken into account and signals that, in the future, new increases in the minimum retirement age are certainly possible, if not likely. Furthermore, the data in the MCVL show that there is little difference between the behavior of highly educated versus lowly educated workers[5] since early retirements are more often between primary

[5]For doing this we have not used any specific evidence about the retirement patterns of immigrants, because the available data are quantitatively irrelevant.

Figure 12: RG Mean contribution bases

a. Natives



b. Immigrants

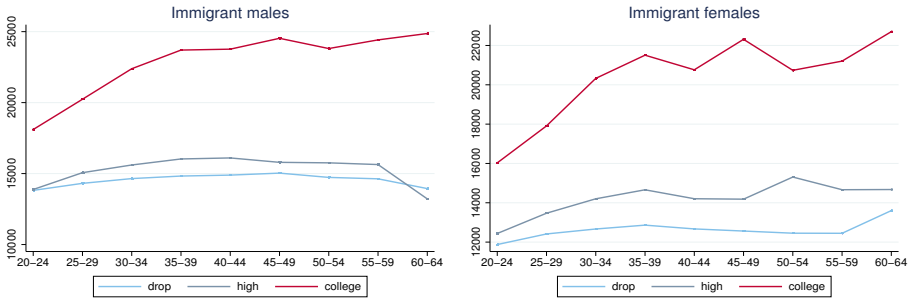


Figure 13: RG Histogram contribution bases - natives

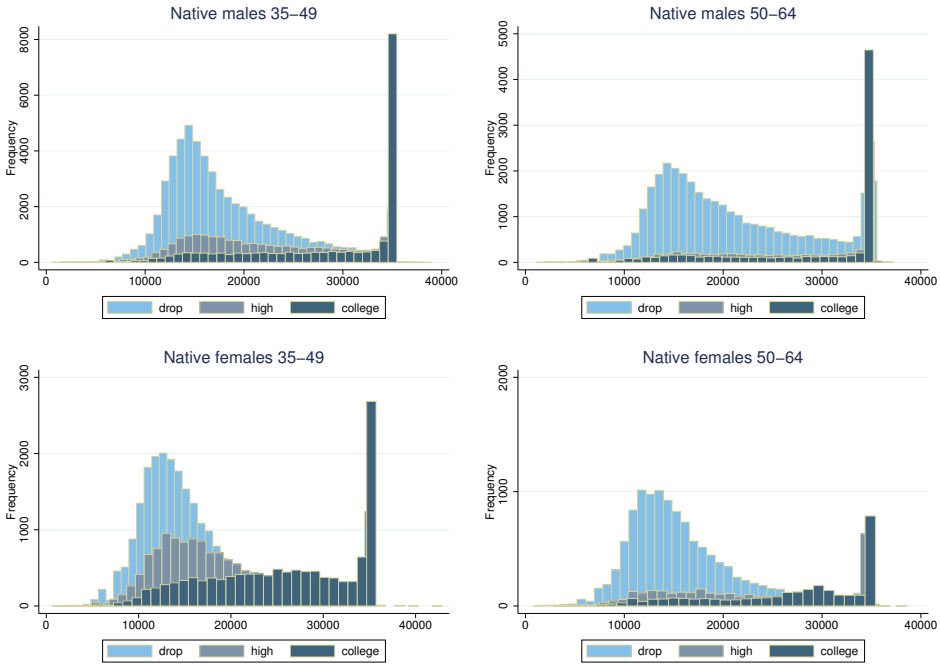


Figure 14: RG Histogram contribution bases - immigrants

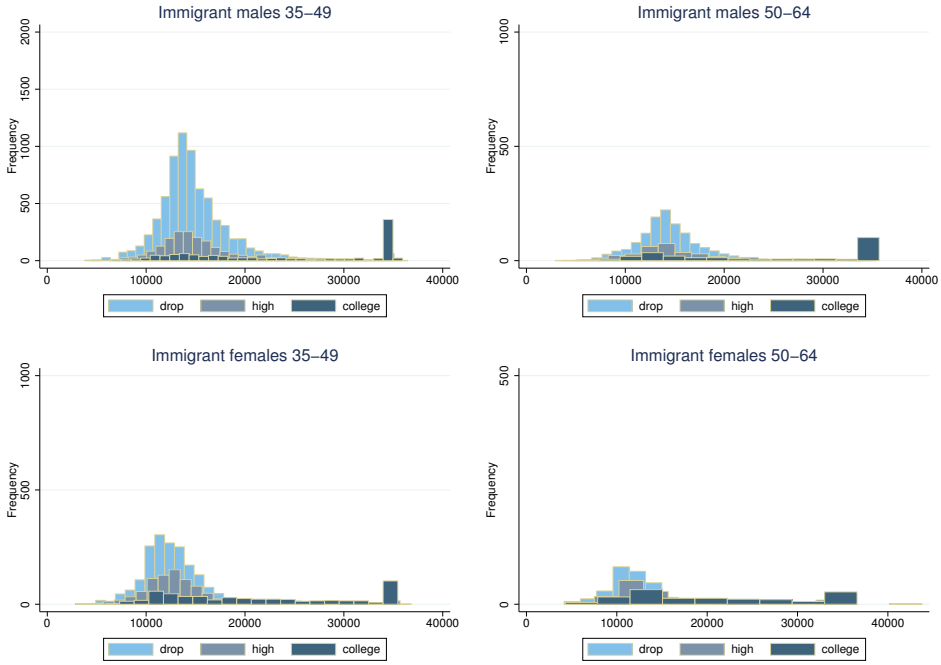
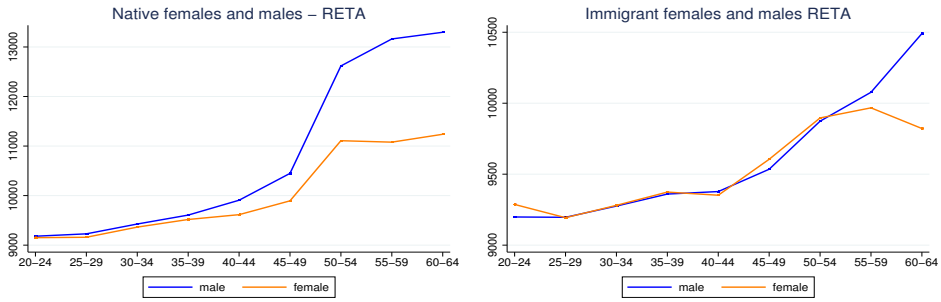
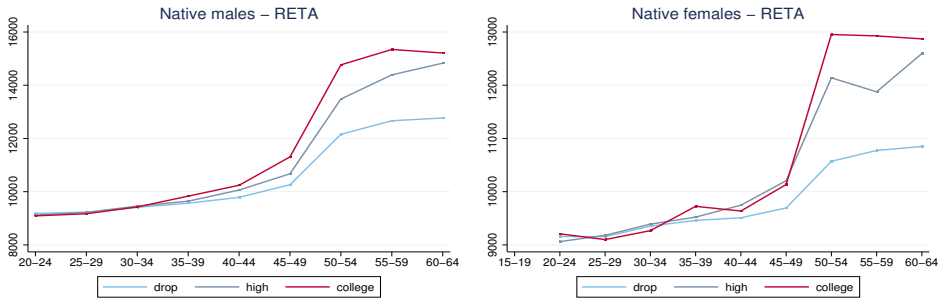


Figure 15: RETA Mean contribution bases

a. RETA natives vs immigrants

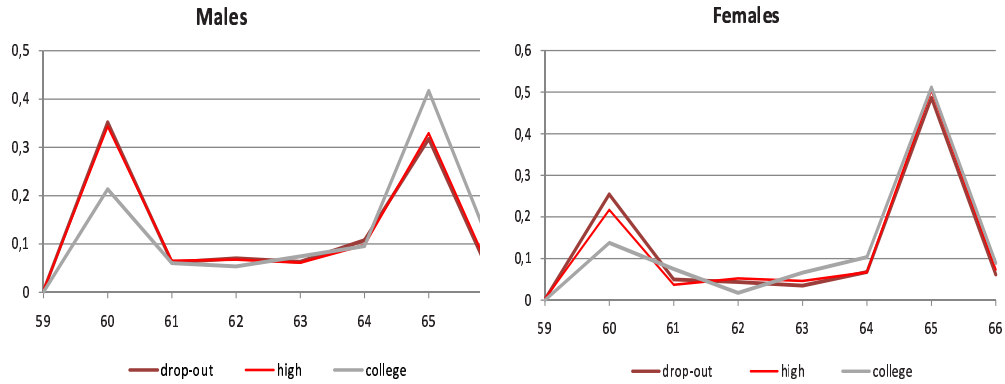


b. RETA natives females vs males



and secondary levels, while superior levels of education is greater at 65 years old. For women, it is observed the same but with a less proportion of early retirements due to their labor history in the database are shorter and have to work more years up to the 65 years old in order to be elegible for the retirement pension.

Figure 16: Retirement age



3 Projections of Revenues and Expenditures

3.1 Macroeconomic Scenario

The projection exercise of revenues and expenditures os the Social Security system to establish an overall macroeconomic scenario. This involves forecasting labor force participation, employment levels, labor productivity and wages, depending on the heterogeneity factors up to 2050. Our baseline assumption is that the relevant legislation will not change, hence contribution bases will grow in parallel to wages, which in turn will grow at the same rate at which labor productivity grows. In this sense we are just adopting the "official" position, by replicating the macroeconomic scenarios that MEH adopts in the estimations of the European Comission, (see Table A.1 in the Appendix).

3.2 Simulation Strategy

Our goal is to simulate contributions and pensions under well defined scenarios, using the situation in 2006 – 2007 as our starting point, and taking into account the great individual heterogeneity of our model. This involves to distinguish by age, gender,

nationality and educational level and means having 120 different groups to simulate their contributions to the system and their pensions when they will retire. Moreover, each of them can be during their life in five posible situations: employed, self employed, unemployed, disable or inactive.

Our goal is to simulate contributions and pensions under well defined scenarios, using the situation in $2006 - 2007$ as our starting point. We use the information provided by the Labor Force Survey (EPA-INE) to estimate transition probabilities during the working life, cohort by cohort. These will be used to project their future labor market conditions, wages, contributions and retirement decisions, again cohort by cohort and according to the sources of heterogeneity listed in the previous section. Because our sources of information about workers' behavior are MCVL and EPA, our estimated transition probabilities are purely a reflection of the past and of its trends. We increased, by forcing it into the simulation, the average employment rate[6] to make it compatible with the INE's demographic scenario. Everything else is based on the assumption that the Spaniard of the future will be, as far as the labor market is concerned, identical to the Spaniards of the past, and that only their composition (in terms of age, education, gender, nationality) will change.

Summing up: we have 120 groups of individuals for which we have a "real working history in the past", up to 2006, computed on MCVL data, and for which we simulate a "virtual labor history in the future"using the transition matrices also estimated using EPA and MCVL. By joining the two we obtain the full labor histories of the Spanish workers (native and immigrant as well) all the way to 2050. The rules of RG and RETA are then applied to such labor histories, to obtain predictions about revenues and expenditures of the Spanish Social Security System.

3.3 Revenues

In order to compute revenues we use the data from MCVL to estimate period by period the growth rate of the average contribution base according to age, gender, and nationality, incorporating in them the assumed growth rate of the wages (which corresponds to the growth rate of productivity). We make the assumption that within each group (of which we have 12) contributions are uniform and equal to the estimated group-average. We make two exceptions for the high school dropouts and those with

[6]The employment rate is defined as:

$$TE_t = \frac{\sum_{j=1}^{17} \sum_{g\in\{m,f\}} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} \left(o_{cp}\left(j,g,e,c\right) + o_{ca}\left(j,g,e,c\right)\right) Pop_t\left(j,g,e,c\right)}{Pop_t}$$

a college degree contributing to RG. For the dropouts we assume they contribute according to the minimum or the average base. For those with college, we assume they contribute either for the maximum or, again, the average base.

This gives us $\overline{b}_t^{cp}(j,e,g,c)$ and $\overline{b}_t^{ca}(j,e,g,c)$ in each period, where cp is RETA and ca is RG. For unemployed workers we feed in the unemployment compensation rules, which implies among other things that contributions should be computed on the wages earned when last employed and applying the corresponding replacement rate (a 70% the first six months and a 60% onwards). Total revenues are then equal to the sum of the contributions of the employed workers (ICS_t) and of those of the unemployed (IPD_t). We can express as:

$$ICS_t = \sum_{j=1}^{17} \sum_{g\in\{m,f\}} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} \overline{b}_t^{cp}(j,e,g,c)\, o_{cp}(j,g,e,c)\, Pop_t(j,g,e,c)\,\tau + \sum_{j=1}^{17} \sum_{g\in\{m,f\}} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} \overline{b}_t^{ca}(j,e,g,c)\, o_{ca}(j,g,e,c)\, Pop_t(j,g,e,c)\,\tau$$

and

$$IPD_t = \sum_{j=1}^{17} \sum_{g\in\{m,f\}} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} \left[(0,65)\,\overline{b}_t^{cp}(j,e,g,c)\, o_{cp}(j,g,e,c)\right] Pop_t(j,g,e,c)\,\tau \tag{9}$$

where τ is the contribution rate. We use as an anchor the actual revenues in the base year (2006), which are matched exactly by adjusting, using EPA's information, the fraction of workers that are employed part-time, according to skills, gender, nationality and age (Tables A.2 and A.3.)

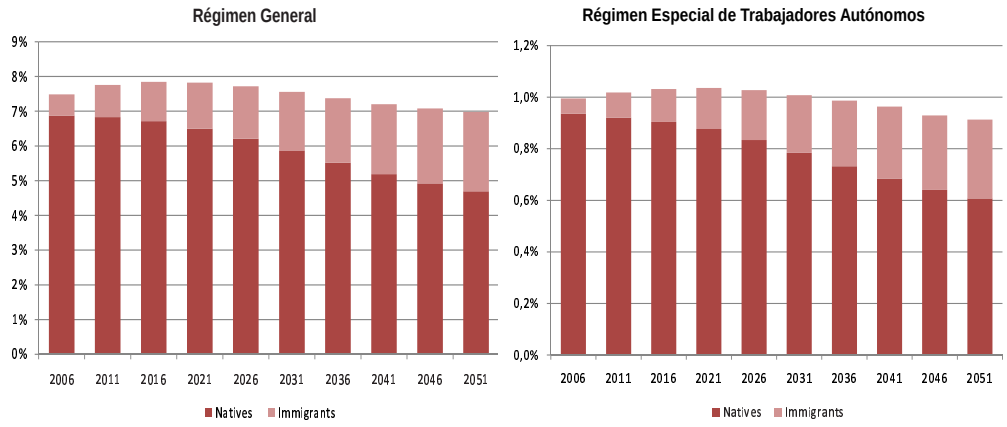
The following table (Table 2) summarizes our predictions for the baseline case: as a percentage of GDP they grow until 2025, after which they begin decreasing. The keys to understand these two facts are simple: the continuing immigration flow, together with productivity growth, drives the growth phase; the forward projection of the historically observed pattern (according to which the maximum contributive base grows less than productivity) explains the eventual decrease. After a couple of decades the number of workers that are constrained above has become very large, and the total revenues decrease.

It is interesting to point out in Figure 17 that while the contributions of immigrants (as percentage of GDP) grow from 0.75% in 2006 to 2.77% in 2050, they remain

Table 2: Revenues Evolution (% GDP)

	TOTAL	NATIVES				IMMIGRANTS			
	REVENUES	RG	RETA	UNEMP	TOTAL	RG	RETA	UNEMP	TOTAL
2006	8.86	6.88	0.94	0.29	8.10	0.61	0.06	0.38	0.75
2011	9.17	6.83	0.92	0.28	8.03	0.93	0.10	0.39	1.14
2016	9.21	6.72	0.90	0.22	7.84	1.13	0.13	0.33	1.37
2021	9.15	6.50	0.88	0.18	7.55	1.32	0.16	0.29	1.60
2026	9.04	6.21	0.83	0.16	7.20	1.51	0.19	0.29	1.83
2031	8.86	5.87	0.78	0.15	6.80	1.69	0.22	0.29	2.05
2036	8.65	5.51	0.73	0.14	6.38	1.86	0.25	0.29	2.27
2041	8.45	5.19	0.68	0.13	6.00	2.01	0.28	0.29	2.45
2046	8.30	4.92	0.64	0.12	5.68	2.16	0.29	0.29	2.62
2051	8.18	4.69	0.61	0.11	5.41	2.29	0.31	0.29	2.77

Figure 17: Revenues evolution by regime



relatively small compared to their weight in the labor force. This is obviosuly due to the projection forward of the relatively low wages they have experienced during the last decade.

3.4 Expenditures

To compute expenditures we need, for each individual, i) number of years of contribution, ii) wage earned; iii) retirement age. We make the assumption that within each group (of which we have 12) contributions are uniform and equal to the estimated group-average. We make two exceptions for the high school dropouts and those with a college degree contributing to RG. For the dropouts we assume they contribute according to the minimum or the average base. For those with college, we assume they contribute either for the maximum or, again, the average base. This allows us to compute the average pensions, for each group, at all points in time, $\overline{p}_t(j, c, g, e)$. We also assume:

- $\overline{p}_t(j, c, g, e) = \overline{p}_{t+1}(j + 1, c, g, e)$, implying that mortality rates do not change according to pension levels.
- For all j, e, g, c, let $\phi_t\,(j, c, g, e)$ be the percentage of people in that group that, at that time, has the right to receive a contributive pension. We assume $\phi_t(j, c, g, e) = \phi_{t+1}(j+1, c, g, e)$, implying that the mortality rate is the same for all retired people, independently of their matured right to receive a contributive pension.

Expenditure due to contributive retirement pensions can then be written as:

$$PJ_t = \sum_{j=11}^{17} \sum_{g\in\{m,f\}} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} \overline{p}_t(j, c, g, e)\phi_t\,(j, g, e, c)\,Pop_t\,(j, g, e, c) \tag{10}$$

From these, we compute the expenditure due to survivor's pensions. In every period there is a number of new widowhood pensions that coincides with the number of retirement pensions that disappear because of the dead of their owners multiplied by the percentage of those pensioners that are married. So the expenditures due to the new widowhood pension in period t is equal to:

$$PVa_t = \sum_{j=11}^{17} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} pva_t^m\,(j, e, c) + \sum_{j=11}^{17} \sum_{e\in\{c,h,d\}} \sum_{c\in\{n,m\}} pva_t^f\,(j, e, c) \tag{11}$$

where $pva_t^m(j,e,c)$ and $pva_t^f(j,e,c)$ is the expenditure of the new survivor's pensions in period t originated by the retirement pensions of men and women with characteristics (j,e,c) respectively, that is:

$$\begin{aligned} pva_t^m(j,e,c) &= \beta\overline{p}_t(j,e,m,c)\,\phi_{t-1}(j,e,m,c)\,\chi_t(j,e,m,c)\left(1-\psi_{t-1}(j,m)\right)Pop_{t-1}(j,e,m,c) \\ pva_t^f(j,e,c) &= \beta\overline{p}_t(j,e,f,c)\,\phi_{t-1}(j,e,f,c)\,\chi_t(j,e,f,c)\left(1-\psi_{t-1}(j,f)\right)Pop_{t-1}(j,e,f,c) \end{aligned} \tag{12}$$

In this cases the parameter $\beta = 0.52$ is the ratio between the survivor's pension and the original contributive pension, whereas $\chi_t(j,e,g,c)$ is the percentage in each group that is either married or has a legally recognized partner. The values for $\chi_t(j,e,g,c)$ have been obtained from Ahn and Felgueroso (2007) (see Table A.4). Moreover, for the calculation of the expenditure of widowhood pensions in a certain period T it is also necessary to take into account the pensions generated in previous periods $(t < T)$ and whose pensioners have survived until period T. By simplicity we will assume that all the couples are formed by individuals with the same age and different sex. So, if a married retired dies, he will generate a widowhood pension which survival period is equivalen to the life expectancy of the woman and vice versa.

The total expenditure from survivor's pensions is equal to:

$$\begin{aligned} PV_t \;=\; & PVa_t + \\ & \sum_{T=1}^{17}\left[\sum_{j=11}^{17}\sum_{e\in\{c,h,d\}}\sum_{c\in\{n,m\}} pva_{t-T}^m(j,e,c)\,\psi_t(j+T,f) + \right. \\ & \left. \sum_{j=11}^{17}\sum_{e\in\{c,h,d\}}\sum_{c\in\{n,m\}} pva_{t-T}^f(j,e,c)\,\psi_t(j+T,m)\right. \end{aligned} \tag{13}$$

Next, we assume that a pension for permanent disability can be obtained only at the age of 50, or later. This hypothesis, together with the current legislation, allow us to compute this segment of the total expenditure, which is:

$$PI_t = \sum_{j=1}^{10}\sum_{g\in\{m,f\}}\sum_{e\in\{c,h,d\}}\sum_{c\in\{n,m\}} \overline{pd}_t(j,e,g,c)\,d_t(j,g,e,c)\,Pop_t(j,g,e,c) \tag{14}$$

where $\overline{pd}_t(j,e,g,c)$ is the average disability pension for that group. Recall that all the disability pensions turn into retirement pensions at the age of 65, hence in the formula above we replace the disability pension with the retirement pension after the third period.

Once we have estimated the expenditure from each of the different pensions considered, the total amount of expenditures is:

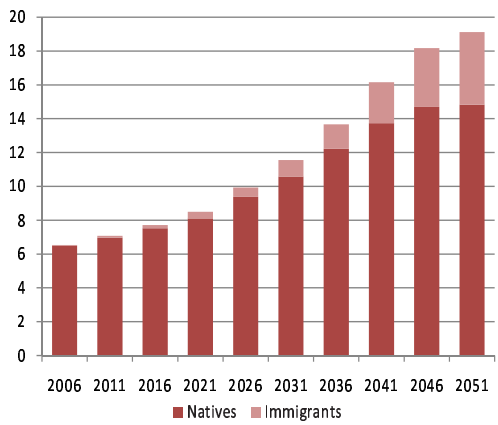
$$GT_t = PJ_t + PV_t + PI_t \tag{15}$$

Total expenditure, as it is clear from the figures below, grows over time but accelerates sharply between 2026 and 2046 (Table 3). As figure 18 suggests, this is due to the entrance of immigrants into the retirement stage of their lifecycle, which increases their weight until, in 2050, the pensions paid to immigrants are equal to $4,3\%$ of GDP. The impact of aging is also clear, as the generations that retire around 2040 have a much longer expected life in retirement, thereby increasing the expenditure burden.

Table 3: Expenditure evolution (% GDP)

	TOTAL	NATIVES				IMMIGRANTS			
	EXPEND	RET	WIDOW	DISAB	TOTAL	RET	WIDOW	DISAB	TOTAL
2006	6.54	4.19	1.43	0.86	6.48	0.00	0.00	0.05	0.05
2011	7.08	4.60	1.44	0.93	6.97	0.05	0.00	0.07	0.12
2016	7.72	5.20	1.38	0.93	7.52	0.13	0.00	0.07	0.20
2021	8.49	5.97	1.24	0.90	8.11	0.25	0.01	0.13	0.38
2026	9.93	7.26	1.19	0.92	9.37	0.41	0.02	0.13	0.56
2031	11.56	8.61	1.18	0.80	10.58	0.68	0.04	0.26	0.98
2036	13.67	10.13	1.30	0.78	12.22	1.12	0.07	0.26	1.45
2041	16.16	11.59	1.50	0.65	13.74	1.93	0.12	0.37	2.42
2046	18.17	12.41	1.68	0.61	14.70	2.93	0.19	0.34	3.47
2051	19.12	12.50	1.81	0.52	14.84	3.62	0.29	0.37	4.29

Figure 18: Expenditure evolution by nationality



3.5 Projection Results

Figure 19 summarizes our baseline projections for the overall system: it can be observed that the system will be in deficit around year 2023 according to the last official estimations of the Ministerio de Trabajo. Moreover, there is a great number of studies that analyze the future sustainability of the pensions system and all agree that the Spanish system will be in deficit in a range between 2015 and 2025 (Sánchez-Martín and Sánchez-Marcos (2008), Gil et al. (2007), Alonso and Herce (2003), Balmaseda et al. (2006), Da-Rocha and Lores (2005), Jimeno et al. (2006), Díaz-Giménez and Díaz-Saavedra (2006 y 2009) y Domenech and Melguizo (2008)).

If we compare this results with the previous situation, that is without the arrival of a large number of foreign workers, the conclusion is clear: on the short run immigration has a positive impact on the sustainability of the Spanish pension system, since it is offering the Social Security System roughly five years of additional time to correct its important underlying unbalances. After this brief period, nevertheless, the structural problems will resurface and may be even magnified by the presence of an additional number of retired immigrants. For that reason, the long due reform is only temporarily postponed but cannot be avoided in the next future.

In addition, as it can be seen in Figure 20 thanks to immigration, the deficit of the Social Security System year after year is lower until year 2040. Nevertheless, afterwards immigration worsens the deficit, because the greater cohorts of immigrants and natives will be retiring at the same time (see Figure 5).

Figure 19: Revenues and expenditures projections for the Spanish Pensions System

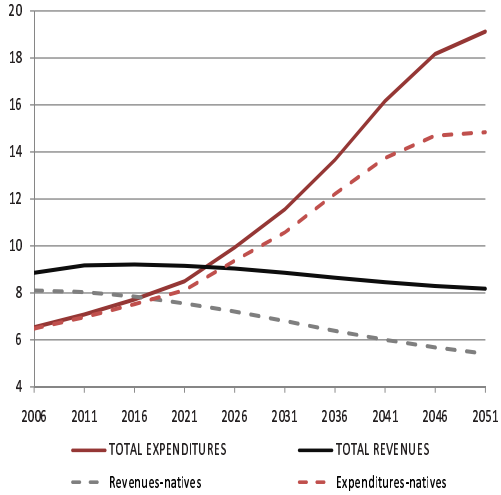
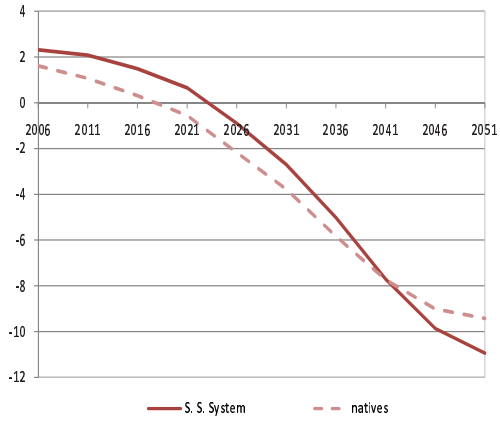


Figure 20: Surplus/deficit evolution of Social Security System



4 Alternative Scenario: gradual labor assimilation of immigrants

In order to understand the evolution of the revenues and expenditures it is important to remember that the youngest generations will have higher employment rates and higher wages because of their higher educational levels. Moreover, this effect is even amplified in the case of the women. On the contrary, in our baseline scenario for immigrants this improvement on the income by the improvement on their educational structure is truncated by two reasons. Firstly, because the educative wage premiums were inferior to those of the native and secondly because we even supposed that the average income of immigrants for the same educational level were also inferior to the native ones. There is a broad and recent academic literature that analyzes the situation of immigrants in the labor market and the evolution of their laboral assimilation (see Amuedo-Dorantes and de la Rica (2007 and 2009), Carrasco et al. (2008a and 2008b), Canal-Domínguez and Rodríguez-Gutiérrez (2008), Izquierdo and Lacuesta (2006) and Simón et al. (2008)).

However, immigration is a so recent phenomenon, that it is very soon for obtaining conclusive results about the final evolution of the assimilation of immigrants and specially in the case of second generations. Because of this reason, setting out an alternative scenario where immigrants labor history will gradually assimilate to the native ones with the same characteristics in age, gender and educational level becomes very interesting. In particular, the hypotheses for the assimilation scenario are the following:

i) as starting point contribution bases of the immigrants are 20% less than natives according to the observed with data from the MCVL in year 2006. We have to point out that these are contribution bases, if we had compared average wages, as in other previously papers mentioned, the difference would be around 30%.

ii) in following years, the wages of the immigrants are going to increase in a gradual way by 5% every period of five years, so that in year 2026 the assimilation is complete and immigrants contribute the same as natives.

As can be observed in Figure 21, revenues increase gradually at the same time than the gradual assimilation in wages. Expenditures also increase, being more significant in the future, when most of immigrants retire and gain access to higher pensions due to their higher contributions in line with their higher wages.

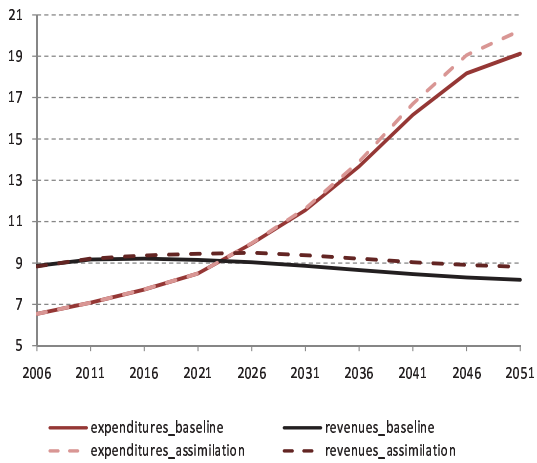
So, even if immigration achieves a total assimilation to the labor market it will not

be sufficient to avoid that the pension system will fall into deficit. As we have seen in this exercise, since the assimilation increases both revenues and expenditures, it is only able to delay in one year the entrance in deficit of the Social Security System, setting it in 2024.

Table 4: Increases in revenues and expenditures over the baseline scenario (% GDP)

	REVENUES (% PIB)				**EXPENDITURES (%PIB)**			
	TOTAL	IMMIGRANTS			TOTAL	IMMIGRANTS		
	REVENUES	RG	RETA	UNEMP	EXPEND	RETIRE	WIDOW	DISAB
2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2011	0.05	0.04	0.00	0.01	0.00	0.00	0.00	0.00
2016	0.15	0.14	0.00	0.01	0.00	0.00	0.00	0.00
2021	0.29	0.26	0.01	0.02	0.00	0.00	0.00	0.00
2026	0.46	0.40	0.03	0.03	0.02	0.02	0.00	0.00
2031	0.52	0.45	0.03	0.04	0.08	0.08	0.00	0.00
2036	0.55	0.47	0.04	0.04	0.24	0.23	0.00	0.00
2041	0.58	0.49	0.04	0.04	0.53	0.53	0.00	0.00
2046	0.60	0.52	0.04	0.04	0.88	0.87	0.01	0.00
2051	0.63	0.54	0.04	0.04	1.13	1.10	0.02	0.00

Figure 21: Revenues and expenditures evolution: assimilation scenario vs baseline scenario



5 Conclusions

Without any doubts immigration constitutes the phenomenon with the greatest impact in the Spanish labor market in the last decade. The arrival of more than four million immigrants, not only has rejuvenated the active population but it has also increased the number of contributors (maintaining constant the number of pensioners), reason why the public system has accumulated surpluses greater than 1% in the last years. However, what will happen in the future?. The objective of this paper is to analyze the effects of immigration on the public pension system in the long term. As far as we know, with the exception of Izquierdo et al. (2007), this is the first research that has tried to answer this question with sufficient degree of heterogeneity[7]. In order to answer it, an Overlapping Generation Model where the agents differ in nationality and moreover in gender and educational level was developed. For analyzing the evolution of revenues and expenditures, firstly we have constructed the corresponding demographic escenario, through the Cohort Component Population Projection Method with the same heterogeneity and secondly using data from EPA and MCVL we have simulated the labor history for all the different individuals.

The main result of this research is that immigration has delayed in roughly five years the entrance into deficit of the Spanish pension system . Therefore, immigration does not solve the unsustainability of the system in the long term, but it is allowing us to obtain very valuable additional time in order to carry out the necessary reforms.

Our demographic projections show that immigration not only has considerably rejuvenated the Spanish population, but also that the greater immigrant cohorts correspond with the greater native cohorts; as a result a parallel aging process will take place in the future. In other words, both greater cohorts retiring at the same time will lead to a major increase in the pensions expenditure, and this will trigger the unbalance of the system. We have to point out that the Spanish pension system is a Defined Benefit Pay-as-you-Go System and therefore the calculation of the pension is conditioned to the previous contributions and not to demographic or macroeconomic factors. Therefore, if contributions and the corresponding pensions are not adjusted by the increase in life expectancy, in the long term the financial solution to the system can not avoid to carry out the necessary reforms that could recover the balance, despite of temporary relieves thanks to the rise of the number of immigrant contributors.

In our opinion, despite the limitations mentioned before, the methodology developed in this paper constitutes a flexible framework for the demographic projection

[7]For other countries that have had previously a similar immigration phenomenon, exists excellent papers about this topic that obtain in certain sense similar results to the reached here, with special attention to Storesletten (2000).

and the analysis of the evolution of the labor market that will allow the evaluation of possible reforms. An obvious limitation of our approach is that we do not model the endogenous behavioral reactions of workers to changes in the rules of the system. In other words, our simulations are subject to the "Lucas critique", this is the big price, we pay, for trying to carry out the computational exercise at the highest disaggregated level that available data make it possible. The "tradeoff" is clear, and should be evaluated: while we gain in the microeconomic precision and data reliability of our simulations, we loose in not using economic theory to try capturing the behavioral response of rational individuals to the evolution of the economic and legal environment in which they act. This is left for future work and, possibly, for future researchers more capable than we are.

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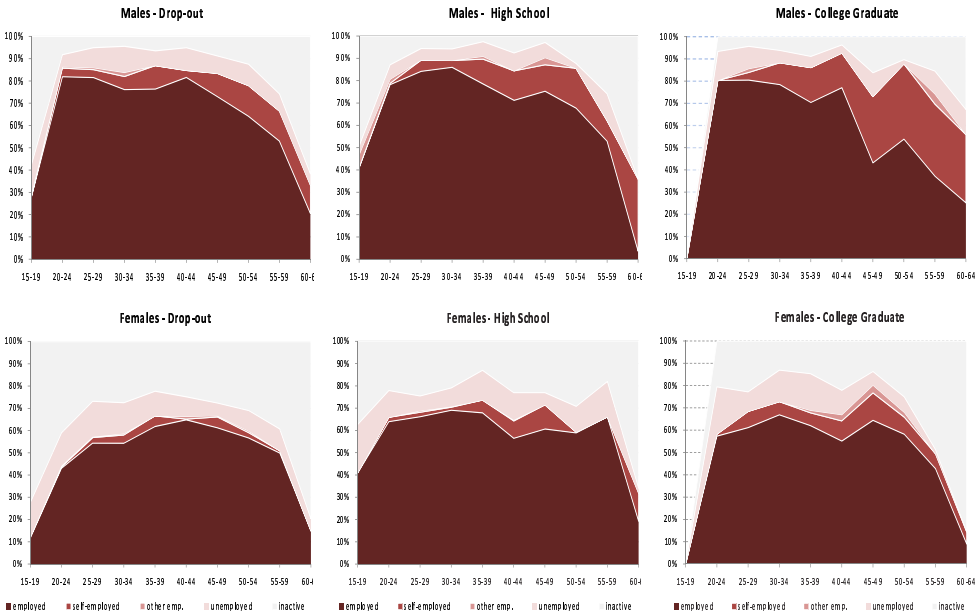
A Appendix

Figure A.1: Life cycle by age and educational level - Immigrants



Source: Labor Force Survey (EPA-INE)

Table A.1: Macroeconomic Scenario

	2007	2011	2021	2031	2041	2051
Real GDP (growth rate)	3.7	3.0	3.1	1.7	0.9	1.1
Labour productivity (growth rate, per hour)	1.0	1.0	2.7	1.9	1.7	1.7
Participation rate (15-64)	71.6	73.8	75.7	76.5	77.2	77.6
Employment rate (15-64)	65.6	67.5	71.0	71.8	72.4	72.8
Unemployment rate (15-64)	8.3	8.5	6.2	6.2	6.2	6.2

Table A.2: Part-time and Temporary rates for Natives

	PART-TIME						TEMPORARY					
	FEMALE			MALE			FEMALE			MALE		
age	**d**	**h**	**c**	**d**	**h**	**c**	**d**	**h**	**c**	**d**	**h**	**c**
15-19	4.8	10.7	0.0	1.6	8.6	0.0	45.9	30.6	59.9	67.5	55.6	41.4
20-24	5.7	10.4	5.2	1.0	5.0	3.1	41.8	34.6	49.3	53.4	39.4	47.9
25-29	10.4	9.6	5.6	0.6	2.6	2.2	32.4	26.6	36.8	42.7	31.3	35.9
30-34	14.4	13.1	9.0	0.8	1.1	1.3	24.1	18.6	23.1	35.3	22.4	21.1
35-39	17.5	19.2	10.6	0.6	0.7	0.8	24.9	13.1	20.1	30.8	16.4	14.6
40-44	18.0	11.1	8.2	0.7	0.8	0.8	22.5	14.9	13.4	28.5	11.9	8.7
45-49	19.8	12.3	5.8	0.6	0.2	1.0	18.4	12.6	10.9	22.7	7.7	3.9
50-54	19.2	7.3	4.5	0.8	0.1	0.8	14.4	10.3	6.7	18.3	6.4	4.4
55-59	21.8	8.3	2.6	1.4	1.0	2.5	12.7	4.5	3.5	16.5	7.0	4.5
60-64	26.3	6.3	15.7	3.7	1.9	9.4	8.5	10.7	3.2	15.7	4.1	3.2

Source: Labor Force Survey (EPA-INE)

Table A.3: Part-time and Temporary rates for Immigrants

	PART-TIME						TEMPORARY					
	FEMALE			MALE			FEMALE			MALE		
age	**d**	**h**	**c**	**d**	**h**	**c**	**d**	**h**	**c**	**d**	**h**	**c**
15-19	1.1	0.0	0.0	1.8	0.0	0.0	43.1	28.5	0.0	66.6	78.1	0.0
20-24	7.3	10.3	9.5	1.4	5.8	0.0	44.5	39.3	54.9	59.5	76.6	66.7
25-29	9.4	7.7	6.1	0.0	1.8	0.0	40.2	46.6	31.6	68.9	53.0	57.1
30-34	14.2	13.5	7.7	0.3	0.3	3.4	35.4	34.2	52.0	66.9	61.1	44.8
35-39	6.5	7.9	17.2	0.0	0.0	2.8	54.8	39.2	26.2	64.2	64.9	51.6
40-44	7.8	6.7	11.6	1.4	0.3	0.0	27.5	32.1	26.9	70.5	52.4	32.4
45-49	11.7	15.7	6.5	1.3	3.7	5.8	22.7	22.6	17.8	52.9	34.7	39.3
50-54	5.8	20.9	5.9	1.9	0.0	12.3	30.2	32.7	26.4	63.7	54.7	20.5
55-59	10.5	0.0	22.4	0.0	0.0	0.0	21.7	26.3	22.6	56.3	50.0	21.0
60-64	0.0	0.0	0.0	0.0	0.0	0.0	18.4	54.9	0.0	0.0	100.0	22.0

Source: Labor Force Survey (EPA-INE)

Table A.4: Marriage rate

male			female		
drop out	high	college	drop out	high	college
86.0	87.0	88.6	89.0	87.7	83.1

Source: Ahn and Felgueroso (2007)

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