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A general equilibrium evaluation of the sustainability of the new pension reforms in Italy

Riccardo Magnani*

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Abstract

Most European countries have recently introduced pension system reforms to face the financial problem related to population ageing. Italy is not an exception. The reforms introduced during the Nineties (Amato Reform in 1992 and Dini Reform in 1995), even if they will produce a strong reduction in pension benefits, are generally thought not sufficient to adequately face the population ageing problem. For this reason, in 2004, the Berlusconi government introduced a new reform that increases the retirement age to 60 years from January 2008 onwards, to 61 years from 2010 and to 62 from 2014. In 2007, the left-wing government replaced this reform with a softer one that fixes the minimum retirement age at 58 from 2008.

Using an applied overlapping-generations general equilibrium model with endogenous growth due to human capital accumulation, we analyse the impact of the new reforms on the macroeconomic system and in particular on the long-run sustainability of the pension system. We show that the increase in the retirement age would permit to reduce pension deficits in the short and medium run, while in the long run these reforms would become completely ineffective.

JEL Classification: D58; H55; J10

KEYWORDS: pension reforms; applied OLG models; immigration; human capital; endogenous growth

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1 Introduction

Industrialised countries will know a phase of significant demographic changes over the next 50 years. The increase in life expectancy, the reduction of fertility rates and, most of all, the baby-boom produced during the Fifties and Sixties have induced a population ageing that will put the financing of the social security systems under considerable stress. Italian demographics are quite representative of this largely European phenomenon. The demographic projections based on the central hypothesis presented by Istat (2006) show that the working age population - the number of people between 20 and 64 - will drop by 23% between 2000 and 2050 (Figure 1) and the old-age dependency ratio - the ratio of the number of people aged 65 and more to the working age population - will increase from 28.9% in 2000 to 68.1% in 2050 (Figure 2).

Figure 1: Working age population. Source: Istat, 2006

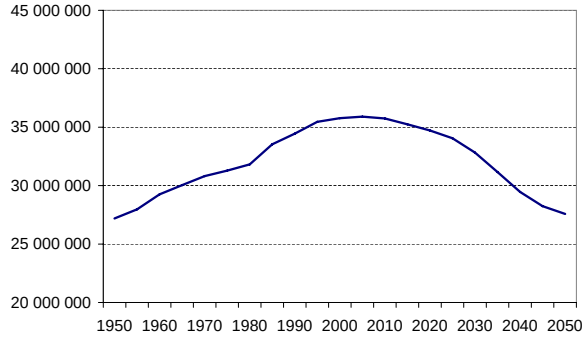
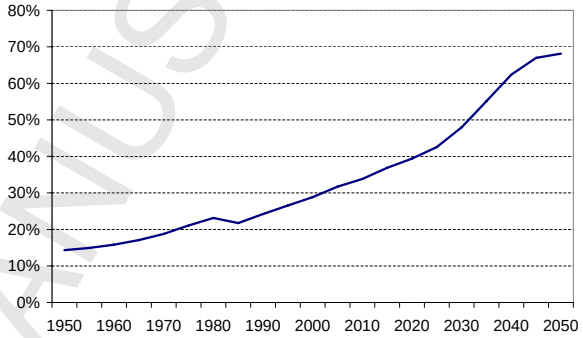


Figure 2: Old-age dependency ratio. Source: Istat, 2006



To face this problem, most European countries have recently introduced pension system reforms. Even if European pension systems remain essentially different, some similar measures have been introduced in order to reduce the pension expenditure burden: the indexation of pension benefits to prices, the increase in the retirement age and the increase of the role of private funding. However, the Pay-As-You-Go system is still largely the most important pillar of European pension systems.

During the Nineties, two reforms of the pension system were implemented in Italy, the Amato reform (1992), and the Dini reform (1995). Even if these reforms would induce a significant reduction in future pension benefits, they are unanimously regarded as being non sufficient in the medium run - because of the long transition phase imposed by the Dini reform that will produce important social security deficits - as well as in the long run: even when completely applied, the reforms cannot be expected to achieve the financial equilibrium of the pension system.[1]

In addition, the impacts on the macroeconomic system are likely to be negative: pension system deficits generate a fall in national savings, reduce capital accumulation and slow down economic growth.

[1] A partial equilibrium analysis carried out by the Italian Ministry of Labour and Social Policies (Nucleo di Valutazione della Spesa Previdenziale, 2006) shows that, even by considering very optimistic assumptions (the revision of the transformation coefficients, a 1.8% long run productivity growth rate, and an increase in the employment rate of people 15-64 from 57.5% in 2005 to 67.9% in 2050), the ratio of pension expenditures to GDP will deeply increase in the period 2010-2035, then it decreases and in 2050 the ratio displays the same value as in 2005.

As a consequence, a new pension system reform seemed inevitable and in 2004, the Berlusconi government decided to increase the minimum retirement age to 60 from January 2008 onwards. The Berlusconi reform, even if it would produce a significant reduction of the pension expenditures in the short term, has been considered deeply unfair with respect to the generations born after 1948. For this reason, and given the pressure exerted by Italian's trade unions, the left-wing Prodi government replaced in 2007 the Berlusconi reform with a softer one: the minimum retirement age is fixed at 58 from January 2008 and will gradually increase over time up to 62.

The aim of this paper is to evaluate and compare the Berlusconi and the Prodi reforms. We evaluate the effects on the pension system and on the macroeconomy of the increase in the retirement age proposed by the new reforms. We show that the Prodi reform induces an important reduction in pension deficits in the medium run, but less important than the reduction that could be induced by the Berlusconi reform. However, these two new reforms become completely ineffective in the long run.

Our assessment is based on simulation exercises using an applied overlapping-generations general equilibrium model. A dynamic general equilibrium perspective is indeed required in order to evaluate the effects of pension reforms on the macroeconomy and on the pension system, since population ageing will significantly affect labour supply (and thus the evolution of wages) and capital accumulation (and thus the evolution of investments, interest rates and GDP). The evolution of wages directly affects the evolution of social security contributions, whereas the evolution of GDP growth rates, with the application of the Dini reform, affects the evolution of pension benefits.

The model used in this paper is of the type pioneered by Auerbach and Kotlikoff (1987), though with significant differences: we introduce mortality, immigration, human capital accumulation, and endogenous growth. The introduction of mortality and immigration makes it possible to accurately reproduce the demographic projections and to simulate the effects of changes in immigration flows. The introduction of human capital makes it possible to introduce a mechanism of endogenous growth based on the average level of knowledge present in the economy *à la* Lucas (1988). Human capital accumulation results from explicit decisions made by young people to invest time in education.

An important aspect related to population ageing is the effects of demographic change and pension reforms on education decisions and consequently on economic growth.[2] Indeed, relative factor prices are likely to vary significantly in the next decades hence affecting the decision to invest or not in human capital. One can expect that the impact of population ageing on human capital formation will be positive, since ageing would boost wages and reduce interest rates, and that the increase in retirement age would encourage individuals to devote more time to schooling. The positive impact on economic growth could be important[3] and, as a consequence, produce positive effects on the financial situation of the pension system.

Our model treats Italy as a closed economy. The degree of the financial openness is a very important aspect

[2]Other OLG models including an endogenous growth mechanism based on human capital are provided by Fougère and Mérette (1999), Sadahiro and Shimasawa (2003) and Bouzahzah *et al.* (2002).

[3]Barro (2001) estimates that an additional year of schooling by people aged 25 and more induces an increase in the economic growth rate of 0.44% per year.

(see Börsh-Supan (2006), Aglietta *et al.* (2007), Chateau *et al.* (2008)) since it affects the determination of the interest rate that influences the evolution of the public debt, the evolution of capital accumulation, the economic growth, and so on. The choice to not consider Italy as an open economy is related to the fact that all developed countries are faced (even with different degrees) to an important ageing phenomenon that will deeply affect the world interest rate. So, we think that an open economy scenario, which implies that the interest rate is fixed at a constant world level, is not a plausible assumption in our ageing context.

The paper is organised as follows: in the next section, we describe the characteristics of the Italian pension system and the reforms recently introduced. In sections 3 and 4, we describe the structure of the OLG model and its calibration. Section 5 presents the simulation results concerning the Berlusconi and the Prodi reforms. Section 6 presents some sensitivity analysis concerning the immigration and the value of pension benefits. We draw our conclusions in the last section.

2 The Italian pension system

The Italian pension system is almost entirely composed of a compulsory public Pay-As-You-Go system. An important anomaly of the Italian pension system is that there is no clear separation between the pension system in its strict sense and the system of social aids in which benefits are not related to contributions. In particular, the Italian pension system includes pensions related to work (old-age pensions, disability pensions, pensions paid in the case of occupational diseases and industrial injuries), and other pensions (survival pensions and welfare benefits for people aged 65 and more lacking adequate means of support). In particular, in 2005:[4]

- *IVS* pensions, including old-age pensions, pensions to survivors and disability benefits, accounted for 13.64% of GDP with 18.383 millions pensions paid. The average pension benefit was 10557 euros.

- Pensions paid in the case of occupational diseases and industrial injuries accounted for 0.30% of GDP with one million pensions paid. The average pension benefit was 4132 euros.

- Social assistance pensions (for people aged 65 and more lacking adequate means of support) accounted for 1.16% of GDP with 3.841 millions pensions paid. The average pension benefit was 4306 euros.

- Total pensions then accounted for 15.10% of GDP with 23.257 millions pensions paid. The average pension benefit was 9239 euros.

During the Nineties two reforms were introduced in order to reduce future total pension expenditures and to harmonise the different pension regimes:[5] the Amato reform in 1992 and the Dini reform in 1995.

The most important innovations of the Amato reform (Law 421/1992) were *(i)* the indexation of pension benefits on inflation, and not on real wages; (*ii*) the increase of the age requirement to be entitled to an *old-age*

[4] Istat (2007), Statistiche della previdenza e dell'assistenza sociale. I trattamenti pensionistici. Anno 2005.

[5] Until 1992 the Italian pension system was characterised by a very large number of funds and schemes, in which contributions and benefit rules varied according to the sector (private or public sector, or self-employment). The harmonisation process of the different pension regimes, in particular concerning public and private employees, was accelerated by the Law 449/1997.

pension from 60 for men and 55 for women with at least 15 years of contributions to 65 for men and 60 for women with at least 20 years of contributions.

The Dini reform (Law 335/1995) introduced the following rules for the computation of the pension benefits:

- For people who started working after 1995, the pension benefits are computed according to a new rule: the *contribution based method*. In this case, the contributions paid during the whole working life are virtually capitalised at the average rate of growth of nominal GDP; the value of the pension is equal to the capitalised value of the contributions multiplied by a *transformation coefficient* depending on the retirement age.
- For people who had more than 18 years of contributions in 1995, the pension benefits remain computed according to the *earning based method*, i.e. on the basis of the average of the labour incomes earned during the 10 last years for salaried workers and the 15 last years for self-employed workers.
- For people who in 1995 had less than 18 years of contributions, the pension benefits are computed according to the *pro-rata method*. In this case, the pension benefits are given by a weighted average of the pension computed with the earning based method and the contribution based method.

With the Dini reform, the eligibility requirements to be entitled to a *seniority pension* were set as follows:

- For salaried workers aged more than 57, 35 years of contributions are required;
- For self-employed workers, 40 years of contributions are required; and it is reduced to 35 years of contributions if the person is aged more than 58.

Workers can thus decide to retire at 57, with at least 35 years of contributions. The main goal of the Dini reform was to penalise early retirement. In fact, with the contribution based method, if an individual works less, the value of pension benefits will be lower since he/she accumulates a lower amount of contributions and the transformation coefficient applied will also be lower.

In 2004, the Berlusconi government introduced a new reform (Law 243/2004) that increased the minimum retirement age. According to this reform, the eligibility requirements would become 40 years of contributions or 35 years of contributions at the age of 60 for salaried workers and 61 for self-employed workers starting from 2008. The minimum retirement age would be increased by one year in 2010 and by another year in 2014.

The Berlusconi reform was replaced by the one introduced by the Prodi government in 2007 (Law 247/2007). With the new reform, the increase of the minimum retirement age is more gradual: in 2008, the minimum retirement age for salaried workers is 58 with at least 35 years of contributions. From 2009 onwards, the eligibility requirements are related to the sum of the retirement age and the number of years of contributions. In 2009, salaried workers aged no less then 59 can retire if the sum is equal to 95. In 2011, salaried workers aged no less then 60 can retire if the sum is equal to 96. From 2013 onwards, salaried workers aged no less than 61 can retire if the sum is equal to 97. For self-employed workers, the minimum retirement age is given by the minimum retirement age for salaried workers plus one year.

The reforms introduced until now harmonised the pension schemes for public and private salaried workers. In contrast, the rules applied to self-employed workers remain different, not only in terms of the eligibility requirements, but also in terms of social contribution rates. For instance, the contribution rate of salaried workers in the public and private sectors is equal to 33%, while for self-employed workers it is quite lower and equal to 20%.

Finally, the Amato and the Dini reforms have introduced and improved the legislation on supplementary funded schemes. Nevertheless, the number of workers enrolled in private pension funds remains very low.

3 The model

3.1 General characteristics

The model presented in this paper is an applied overlapping-generations model of the type Auerbach-Kotlikoff (1987) with endogenous growth and immigration. We consider 15 age groups, indicated by $g = 1, ..., 15$, that coexist at each period t. The first age group considered is 20-24, the last one is 90-94. Each period consists of 5 years and all the variables are supposed to be constant during each period.

For each age group, individuals are characterised by their origin and the professional status. Concerning the origin, we distinguish two groups, indicated by z: those born in Italy (nat) and immigrants (imm).[6] Concerning the professional status, we distinguish two groups, indicated by $prof$, the salaried workers ($empl$) and the self-employed workers ($self$).

We assume the existence of a representative agent of people born in Italy and a representative agent of immigrants (intra-generation's heterogeneity). We also assume that agents have perfect foresight and there is no liquidity constraint.

At the end of each period, people belonging to the last age group ($g = 15$) die, a fraction of people belonging to the other classes dies, and a new generation enters the active population.

Individuals maximise an intertemporal utility function subject to an intertemporal budget constraint. Immigrants and people born in Italy have the same structure of preferences. They decide the intertemporal profile of consumption and leisure as well as the value of the voluntary bequests that will be left at the end of the last period of life. On the other hand, only people born in Italy decide the fraction of time to devote to studying. This decision allows the individual to constitute a stock of human capital that affects his/her productivity level and then his/her future earning profile. We introduce an endogenous growth mechanism *à la* Lucas (1988) where the productivity growth rate is related to the average level of knowledge present in the economy.

Intra-generation's heterogeneity is given by the assumption that immigrants differ from people born in Italy by a lower level of productivity and that they enter Italy with no capital. On the other hand, the

[6] We assume that immigration only concerns the age group 30-34. This assumption, that allows us an important simplification of the model, is justified by the fact that data concerning resident permits (Istat, 2004) are normally distributed with a peak for the age group 30-34. In any case, the introduction into the model of immigration at different age does not significantly change the results.

children of immigrants are considered identical to the children of people born in Italy. Consequently, they decide the fraction of time to devote to studying and they display the same productivity as the children of natives.

People who die in the last period of life (95 years old) decide to leave bequests to the other generations, on the basis of the maximisation of their utility function. These voluntary bequests are uniformly distributed among the other generations. On the other hand, the presence of involuntary bequests is avoided by introducing an insurance mechanism *à la* Yaari (1965).

Concerning the production side of the model, in our economy, only one good is produced by using labour and capital in order to maximise profits and given the following Cobb-Douglas technology:

$$Y_t = K_t^{\alpha} \cdot L_t^{1-\alpha} \tag{1}$$

where Y_t represents the production level of the period, K_t the physical capital demand, and L_t the per unit of effective labour demand. Labour and capital markets are assumed to be perfectly competitive. This implies that real wages and real interest rates adjust to equilibrate aggregate demand and aggregate supply.

Aggregate capital supply depends on the individual's capital accumulation, while aggregate labour supply depends on the demographic evolution and on the individual's labour market choices. Labour is supplied by salaried workers and self-employed workers aged between 20 and 64. Labour supply is endogenous for people aged between 20 and 54. In particular, people belonging to the first age group (20-24 years old) decide the fraction of time to devote to the accumulation of human capital and to work. The following age groups, until the class 50-54, decide the fraction of time to devote to working and to leisure. With regard to the two last age groups who work (55-59 and 60-64), the fraction of people who work is exogenously fixed, according to the 2005 data. This permits us to simulate the impact of an exogenous increase in the retirement age.

The distinction between (private and public) salaried workers and self-employed is introduced into the model because the social contribution rates, the computation rule of pension benefits and the eligibility criteria are different. Thus, it is important to distinguish individuals according to their professional status in order to model the pension system accurately. We do not explicitly model the choice of the professional status, and we simply assume that the proportion of salaried workers and self-employed workers is the same for each group and remains constant over time.

In the next paragraphs, we describe in more detail the demographic aspects of the model (i.e. the procedure adopted in order to reproduce the demographic projections by selecting the fertility rates, the survival probabilities and the immigration flows), the generations' behaviour and the government budget, focusing in particular on the pension system.

3.2 The demographic evolution

The first step of our modelling effort is to reproduce the demographic projections presented by Istat (2006) for the period 1950-2050. In particular, since only people aged 20 and more are taken into account in the

model,[7] our objective is to reproduce the demographic evolution of the population aged 20 and more, and in particular the old-age dependency ratio, i.e. the ratio between people aged 65 and more and people between 20 and 64, the structure of the population, i.e. the ratio between the number of people belonging to a specific age group and the total population, and the total population aged more than 20.

For the first nine age groups we used the survival rates presented by Istat (2006), while the survival probabilities for the other age groups and the fertility rates have been calibrated in order to reproduce the Italian demographic evolution. In particular, following Istat (2007), immigrants' fertility rates are supposed to be twice those of natives. We assume that the fertility rates of the second-generation immigrants are identical of those of natives.[8] Given the lack of data, we also assume that the survival rates are identical for the people born in Italy and immigrants. We adopt migratory flows of 150000 individuals per year since 1990, following Istat's assumptions.

The quality of the calibration of demographic variables to Istat's projections is summarised in the following figures where we report the old-age dependency ratio, the total population aged more than aged 20 and more and the weight of the different age classes in the total population. We can see that the quality of the fit is high.

Figure 3: Old-age dependency ratio

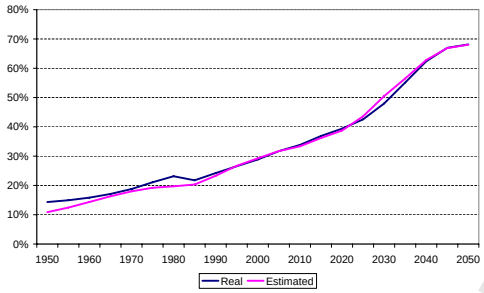


Figure 4: Total population > 20

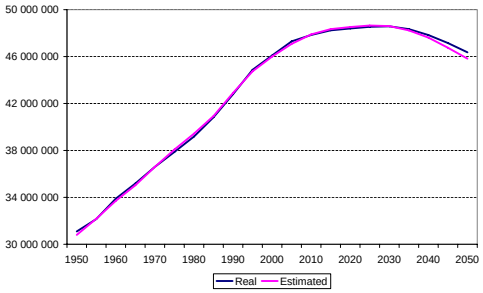


Figure 5: 20-34 / >20

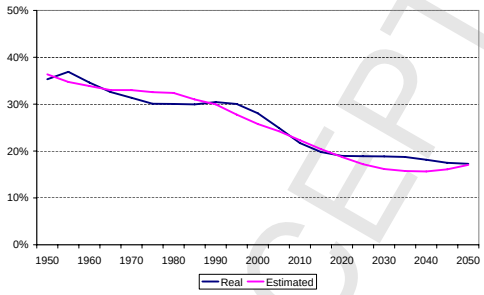
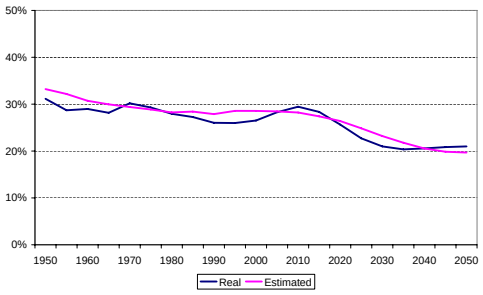


Figure 6: 35-49 / >20



[7] People under 20 are supposed completely dependent of their family.

[8] Mayer and Riphahn (1999) estimated that the fertility rates of immigrants tend to converge to the fertility rates of the natives.

Figure 7: 50-64 / >20

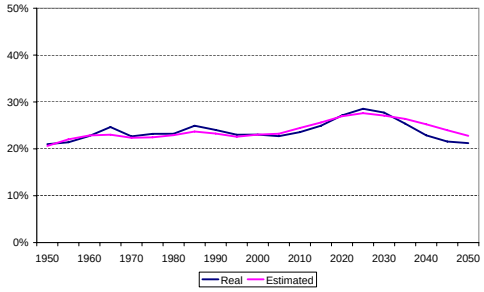
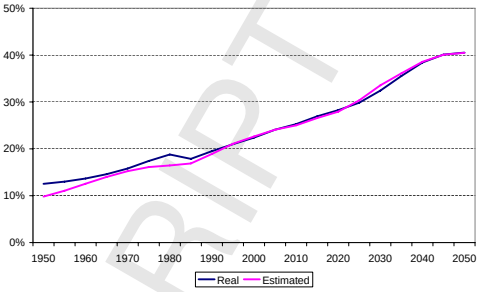


Figure 8: >65 / >20



3.3 The generations

3.3.1 Intertemporal preferences

Natives ($z = nat$) and immigrants ($z = imm$) have the same structure of preferences. The expected lifetime utility for the generation of origin z that becomes active in t depends on the consumption profile, on the leisure profile and on the bequests left at the end of the last period of life, according to the following relation:

$$U_t^z = \sum_g \Gamma_g \cdot \left\{ \frac{\left[c^z_{g,t+g-1}\right]^{\beta^z_{CONS_g}} \cdot \left[\Delta \cdot \left(1 - l^z_{g,t+g-1}\right)\right]^{\beta^z_{LEIS_g}} \cdot \left[beq^z_{g,t+g-1}\right]^{\beta^z_{BEQ_g}}}{1 - \frac{1}{\gamma}} \right\}^{1-\frac{1}{\gamma}} \cdot \Omega_{g,t+g-1} \qquad (2)$$

where $1 \leq g \leq 15$ for natives and $3 \leq g \leq 15$ for immigrants since we assume that they enter Italy aged 30-34.

The following notations have been used:

$c^z_{g,t}$ is the consumption of individuals of origin z and belonging to the age group g; $l^z_{g,t}$ represents the fraction of time devoted to working[9]; beq^z_t is the voluntary bequests left at 95 years old.

Γ_g is the actualisation factor ($\Gamma_g = \prod_{s=1}^{g} \frac{1}{1+\rho_s}$, where ρ_g is the intertemporal preference rate for an individual belonging to the age class g); Δ stands for the number of years that constitute one period (5 years); $\Omega_{g,t}$ is the probability that a person that belongs to the age group g is alive in t; γ is the intertemporal elasticity, while the intra-temporal elasticity is assumed to be equal to 1.

$\beta^z_{CONS_g}$, $\beta^z_{LEIS_g}$ and $\beta^z_{BEQ_g}$ measure respectively the intensity of the preference for consumption, for leisure and for bequests. In particular:

$$\begin{cases} \beta^z_{CONS_g} = 1 & , \ \beta^z_{LEIS_g} = 0 & , \ \beta^z_{BEQ_g} = 0 & \text{if} \quad g = 1 \\ \beta^z_{CONS_g} = 1 - \beta^z_{LEIS_g} & , \ \beta^z_{LEIS_g} > 0 & , \ \beta^z_{BEQ_g} = 0 & \text{if} \quad 2 \leq g \leq 7 \\ \beta^z_{CONS_g} = 1 & , \ \beta^z_{LEIS_g} = 0 & , \ \beta^z_{BEQ_g} = 0 & \text{if} \quad 8 \leq g \leq 14 \\ \beta^z_{CONS_g} = 1 - \beta^z_{BEQ_g} & , \ \beta^z_{LEIS_g} = 0 & , \ \beta^z_{BEQ_g} > 0 & \text{if} \quad g = 15 \end{cases}$$

[9] $1 - l^z_{g,t}$ represents the fraction of time devoted to leisure with $g > 1$, whereas for the first age group ($g = 1$) it represents the fraction of time devoted to studying.

3.3.2 Individual productivity and human capital accumulation

The labour income for an individual of origin z, belonging to the age group g and working in the professional activity $prof$, is given by the product between the wage per unit of effective labour (w_t) and the total productivity level specific to the individual ($A^z_{g,prof,t}$).

In particular, the wage per unit of effective labour, identical for each individual, is endogenously determined in order to guarantee the labour market equilibrium, see Equation (23).

The individual productivity level depends on five elements:

i) The individual's age, measured by EP_g. This component exerts a standard quadratic form:

$$EP_g = \theta_0 + \theta_1 g + \theta_2 g^2 \tag{3}$$

with $1 \leq g \leq 9$ since only people in the first nine age groups work, and $\theta_1 > 0, \theta_2 < 0$.

ii) The individual's education level, measured by $HC^z_{g,t}$. The stock of human capital accumulated by natives ($z = nat$) belonging to the first age group (20-24) depends on the number of years devoted to studying according to the following increasing and concave relation:

$$HC^{nat}_{1,t} = \left[\Delta \cdot \left(1 - l^{nat}_{1,t}\right)\right]^{\alpha_{HC}} \tag{4}$$

where $\left[\Delta \cdot \left(1 - l^{nat}_{1,t}\right)\right]$ is the number of years devoted to studying and $\alpha_{HC} > 0$. Afterwards, the individual human capital depreciates at a constant rate δ_{HC}:

$$HC^{nat}_{g,t} = (1 - \delta_{HC}) \cdot HC^{nat}_{g-1,t-1}$$

Given that immigrants enter Italy aged 30-34, they are not concerned by the choice of the education level, then their human capital stock ($HC^{imm}_{g,t}$) is considered exogenous.

iii) An externality component, measured by H_t, related to the average level of knowledge present in the economy, indicated by $\overline{H}_t$. This latter component is given by the weighted average of the stocks of human capital of each age class that works at the same period: $\overline{H}_t = \frac{\sum_z \sum_g HC^z_{g,t} \cdot l^z_{g,t} \cdot Pop^z_{g,t}}{\sum_z \sum_g l^z_{g,t} \cdot Pop^z_{g,t}}$. Moreover, we introduce an endogenous growth mechanism *à la* Lucas (1988) in the following way: the productivity growth rate (g_{H_t}), which represents the steady state growth rate of variables in per capita terms, is endogenous and supposed to be related to the average level of knowledge as follows:

$$g_{H_t} = \frac{H_{t+1} - H_t}{H_t} = \chi \cdot \overline{H}_t^{\frac{1}{\alpha_{HC}}} \tag{5}$$

where $\chi > 0$. As no individual could influence, by his/her decision to study, the value of this index, this stands as a positive externality.

iv) The individual's professional status, measured by Ψ_{prof}, that represents the (exogenous and constant) difference in productivity between salaried workers and self-employed workers.

v) The individual's origins, measured by θ^z, that represents the difference in productivity between natives and immigrants in the base year. However, note that the difference in productivity between natives and immigrants may change over time since the human capital stock of natives is endogenous.

Finally, the individual's total productivity ($A^z_{g,prof,t}$) is given by the product of the previous elements:

$$A^z_{g,prof,t} = EP_g \cdot HC^z_{g,t} \cdot H_t \cdot \Psi_{prof} \cdot \theta^z \tag{6}$$

Given that the productivity difference between salaried workers and self-employed workers is assumed to be constant and that the individual choice between these two options is not modelled, we can define an average productivity, indicated by $A^z_{g,t}$. This element is computed as the average of $A^z_{g,prof,t}$ weighted by the proportion (assumed to be the same for each age group and constant over time) of salaried workers and self-employed workers.

3.3.3 Pension benefits

Pension benefits are computed according to the rules introduced by the Amato and Dini reforms. In our analysis, we consider three types of pensions, indicated by *type*: direct pensions (*dir*), disability benefits (*dis*) and pensions to survivors (*surv*). These pensions are paid to the retirees according to their professional status *prof*, i.e. to salaried workers (*empl*) and self-employed workers (*self*). We begin with the description of the computation of direct pensions.

The value of direct pension benefits is computed in the model by applying the *earning based method* for the pensions paid until 2015, the *pro-rata method* for the pensions paid between 2015 and 2030, and the *contribution based method* for the pensions paid from 2030.

First of all, it is necessary to distinguish pension benefits paid to individuals belonging to the age group 55-59 and to individuals belonging to the age group 60-64. For the latter, only a fraction of people retires between 60 and 64, while the complement fraction retires during the previous period (55-59).

For the retirees belonging to the age group 55-59 ($g = 8$), pension benefits are computed in the following way:

- *Earning based method* ($t < 2015$): the annual pension benefit is computed on the basis of the average income earned during the last 10 years (the last two periods in our model) for salaried workers (*empl*) and during the last 15 years (the last three periods in our model) for self-employed workers (*self*):

$$Pens^z_{8,empl,dir,t} = n^z_8 \cdot 0.02 \cdot \left(\frac{w_t \cdot A^z_{8,empl,t} + w_{t-1} \cdot A^z_{7,empl,t-1}}{2} \right) \quad (7)$$

$$Pens^z_{8,self,dir,t} = n^z_8 \cdot 0.02 \cdot \left(\frac{w_t \cdot A^z_{8,self,t} + w_{t-1} \cdot A^z_{7,self,t-1} + w_{t-2} \cdot A^z_{6,self,t-2}}{3} \right) \quad (8)$$

The replacement ratio is then proportional to the number of years worked by the class 55-59, indicated by n^z_8.

- *Contribution based method* ($t > 2030$): the annual pension benefit for each professional status (salaried workers and self-employed) is computed by multiplying the *transformation coefficient* β_8 by the value of the contributions paid during the whole working life and capitalised on the basis of the average GDP growth rate (g_{GDP_t}):

$$Pens^z_{8,prof,dir,t} = \beta_8 \cdot \left(\sum_g \tau^c \cdot w_{t+g-8} \cdot A^z_{g,prof,t+g-8} \cdot \prod_{s=t+g-8}^{t} (1 + g_{GDP_s}) \right) \quad (9)$$

with $1 \leq g \leq 8$ for people born in Italy and $3 \leq g \leq 8$ for immigrants.

- *Pro-rata method* ($2015 \leq t \leq 2030$): the annual pension benefit is equal to a weighted average between the pension benefit computed with the earning based method and the contribution based method, where the weight depends on the number of years worked before and after 1995.

For the retirees belonging to the age group 60-64 ($g = 9$), we have to consider that only a fraction (noted by λ) of these individuals retires between 60 and 64 and that the complement fraction $(1 - \lambda)$ retires during the previous period (55-59). On average, the pension benefit obtained by the representative individual aged 60-64 is computed in the following way:

- *Earning based method* ($t < 2015$): the annual pension benefit for salaried workers and self-employed workers is given by:

$$\begin{aligned} Pens^z_{9,empl,dir,t} &= \lambda \cdot \left[n^z_9 \cdot 0.02 \cdot \left(\frac{w_t \cdot A^z_{9,empl,t} + w_{t-1} \cdot A^z_{8,empl,t-1}}{2} \right) \right] \\ &\quad + (1 - \lambda) \cdot Pens^z_{8,empl,t-1} \end{aligned} \quad (10)$$

$$\begin{aligned} Pens^z_{9,self,dir,t} &= \lambda \cdot \left[n^z_9 \cdot 0.02 \cdot \left(\frac{w_t \cdot A^z_{9,self,t} + w_{t-1} \cdot A^z_{8,self,t-1} + w_{t-2} \cdot A^z_{7,self,t-2}}{3} \right) \right] \\ &\quad + (1 - \lambda) \cdot Pens^z_{8,self,t-1} \end{aligned} \quad (11)$$

- *Contribution based method* ($t > 2030$):

$$Pens^z_{9,prof,dir,t} = \lambda \cdot \left[\beta_9 \cdot \left(\sum_g \tau^c \cdot w_{t+g-9} \cdot A^z_{g,prof,t+g-9} \cdot \prod_{s=t+g-9}^{t} (1 + g_{GDP_s})\right)\right] + (1-\lambda) \cdot Pens^z_{8,prof,t-1} \quad (12)$$

- *Pro-rata method* ($2015 \leq t \leq 2030$): with regard to the fraction λ of individuals who retire between 60 and 64, pension benefits are given by a weighted average between the pension benefits computed with the earning based method and the contribution based method, whereas the fraction $(1-\lambda)$ of workers who retire in the previous period, receives $Pens^z_{8,prof,dir,t-1}$.

Concerning the indexation of pension benefits, from 1992 onwards, pension benefits are not indexed to real wages, but to prices, and therefore remain constant over time in real terms:

$$Pens^z_{g,prof,dir,t+g-9} = Pens^z_{9,prof,dir,t} \quad (13)$$

with $10 \leq g \leq 15$.

The transformation coefficients β are defined by Law 335/1995 and vary according to the retirement age of the individual: they lie between 4.72% for people who retire at 57 and 6.136% for people who retire at 65. According to Law 335/1995, these coefficients must be updated every ten years according to the evolution of the life expectancy. In the model, the transformation coefficients used in the model for the age groups 55-59 and 60-64 (respectively β_8 and β_9) are endogenously determined by considering the average retirement age within the two age groups.

Concerning disability benefits and pension benefits to survivors we assume that they are proportional to the direct pension benefits. Disability benefits and pension benefits to survivors are then computed in the model by applying a coefficient that permits to reproduce the data concerning the average pension benefits (see below Tables 1a and 1b in Paragraph 4.1).

3.3.4 Intertemporal budget constraint

Each agent maximises his/her intertemporal utility function conditional on his/her intertemporal budget constraint. For people who live until the last age group (95 years old), the end of life wealth is left as voluntary bequests. In the case of premature death, in order to avoid the presence of involuntary bequests, we assume the existence of a life insurance sector which offers actuarially fair annuities, where the actuarial rate of interest exceeds the market rate of interest by the conditional mortality probability (Yaari, 1965).

The present value of the final wealth is given by the difference between the present value of future incomes and the present value of future consumption. In particular, incomes are given by net labour incomes, net pensions and inheritances.

Thus, for each period, the budget constraint for an individual of origin z and belonging to the age group g is as follows:

$$\begin{aligned} wealth^z_{g+1,t+1} &= [1+(1-\tau_t)\cdot r_t]\cdot wealth^z_{g,t} + (1-\omega_{g,t})\cdot wealth^z_{g+1,t+1} + (1-\tau_t-\tau^c)\cdot w_t \cdot A^z_{g,t}\cdot l^z_{g,t} + \\ &\sum_{prof}\sum_{type}(1-\tau_t)\cdot Pens^z_{g,prof,type,t}\cdot npens_{g,prof,type,t} + inh^z_g \cdot beq^z_{15,t}\cdot\frac{Pop^z_{15,t}}{Pop^z_{g,t}} - c^z_{g,t} \end{aligned} \quad (14)$$

where:

$wealth^z_{g,t}$ is the wealth owned by individuals of origin z and belonging to the age group g;

r_t is the interest rate;

τ_t is the income tax rate;

τ^c is the social contribution rate (computed as the average between the social contribution rate applied to salaried workers and to self-employed workers);

$npens_{g,prof,type,t}$ is the fraction of individuals belonging to the age group g who receives pension benefits, according to the professional status and the type of benefits;[10]

$\omega_{g,t}$ is the survival probability for an individual belonging to the class age g in t;

inh^z_g is a parameter computed in order to distribute the voluntary bequests uniformly among the generations.

3.3.5 Optimal individual choices

By maximising utility, each individual chooses simultaneously the fraction of time to devote to schooling, his/her intertemporal profile of leisure and consumption, and the amount of bequest to leave if he/she survives until 95 years old.

The first order conditions are the following:

i) Decision of studying, which only concerns natives ($z = nat$) belonging to the age group $g = 1$:

$$\begin{aligned} &(1-\tau_t-\tau^c)\cdot\frac{w_t\cdot A^{nat}_{1,t}}{\Delta} \\ &= \sum_{g=1}^{9} R_{t+g-1}\cdot(1-\tau_{t+g-1}-\tau^c)\cdot w_{t+g-1}\cdot l^{nat}_{g,t+g-1}\cdot\frac{\partial A^{nat}_{g,t+g-1}}{\partial\left[\Delta\cdot\left(1-l^{nat}_{1,t}\right)\right]}\cdot\Omega_{g,t+g-1} \end{aligned} \quad (15)$$

where R_t represents the discount factor, with $R_{t+g-1} = \prod_{s=t+1}^{t+g-1}\frac{1}{1+(1-\tau_s)\cdot r_s}$.

This condition means that if an individual decides at t to study one more year,[11] he gives up to one year of wage (the LHS) that, at the optimum, must be equal to the expected present value of all additional incomes

[10] The parameter $npens_{g,prof,type,t}$ is related to $l^z_{g,t}$. In fact $l^z_{g,t}$ represents not only the fraction of time devoted to working by the representative agent, but also the fraction of individuals that belong to an age class who work.

[11] Note that $\Delta\cdot\left(1-l^{nat}_{1,t}\right)$ indicates the number of years devoted to studying by people belonging to the first age group.

earned thanks to the increase in the productivity related to human capital (the RHS).

Ceteris paribus, individuals decide to devote more time to human capital accumulation when future wages are expected to increase or future interest rates are expected to decrease, and when the survival probabilities increase.

ii) Decision concerning the leisure (for age groups $2 \leq g \leq 7$):

$$1 - l^z_{g,t} = \frac{\beta^z_{LEIS_g}}{1 - \beta^z_{LEIS_g}} \cdot \frac{c^z_{g,t}}{(1 - \tau_t - \tau^c) \cdot w_t \cdot A^z_{g,t}} \tag{16}$$

Ceteris paribus, an increase in the net wage induces an increase in the individual's labour supply.

iii) Intertemporal profile of consumption:

$$\begin{aligned} \frac{c^z_{g+1,t+1}}{c^z_{g,t}} \quad = \quad & \left[\frac{1 + (1 - \tau_{t+1}) \cdot r_{t+1}}{1 + \rho_{g+1}}\right]^{\gamma} \cdot \left(\frac{1 - \beta^z_{LEIS_{g+1}}}{1 - \beta^z_{LEIS_g}}\right)^{\gamma} \cdot \\ & \left[\frac{\left[(1 - \tau_{t+1} - \tau^c) \cdot A^z_{g+1,t+1} \cdot w_{t+1}\right]^{\beta^z_{LEIS_{g+1}}}}{\left[(1 - \tau_t - \tau^c) \cdot A_{g,t} \cdot w_t\right]^{\beta^z_{LEIS_g}}} \frac{\left(\frac{\beta^z_{LEIS_g}}{1 - \beta^z_{LEIS_g}}\right)^{\beta^z_{LEIS_g}}}{\left(\frac{\beta^z_{LEIS_{g+1}}}{1 - \beta^z_{LEIS_{g+1}}}\right)^{\beta^z_{LEIS_{g+1}}}}\right]^{1-\gamma} \end{aligned} \tag{17}$$

iv) Voluntary bequests (for the age group $g = 15$):

$$beq^z_{15,t+14} = \frac{\beta^z_{BEQ_{15}}}{1 - \beta^z_{BEQ_{15}}} \cdot c^z_{15,t+14} \tag{18}$$

The individual's optimal bequests are then proportional to his/her consumption in the last period of life.

3.4 The government

3.4.1 The pension system

The Italian pension system is a Pay-As-You-Go system in which workers pay social security contributions (33% of wages for the public and private salaried workers and 20% of wages for self-employed workers) and the pension benefits are computed according to the rules introduced by the Amato and Dini reforms as described in Paragraph 3.3.3.

The deficit of the pension system is computed as follows :

$$
\begin{aligned}
Def_{PS_t} &= \sum_z \sum_g \sum_{prof} \sum_{type} Pop^z_{g,t} \cdot Pens^z_{g,prof,type,t} \cdot npens_{g,prof,type,t} \\
&- \sum_z \sum_g Pop^z_{g,t} \cdot \tau^c \cdot w_t \cdot A^z_{g,t} \cdot l^z_{g,t}
\end{aligned} \tag{19}
$$

3.4.2 Public expenditures and government savings

In the model, we consider three types of public expenditures: expenditures on the education of young people aged from 5 to 24, health care expenditures, and others public expenditures (public defence, public administration, etc.).

Public spending on education ($Gedu_t$) is assumed to be proportional to the number of people attending school, while health care expenditure ($Gmed_t$) is proportional to the number of people aged more than 60. We also assume that the average expenditure per student and the average health expenditure per old person vary over time according to the evolution of the GDP. Concerning the other public expenditures (G_t), we assume they grow at the same rate as the GDP.

Government savings (S_{gov_t}) are given by the difference between revenues (taxes on labour and capital incomes and on pension benefits) and expenditures (expenditures on education, on health and public expenditures, the deficit of the pension system, and the interests paid on the public debt):

$$
\begin{aligned}
S_{gov_t} &= \sum_z \sum_g Pop^z_{g,t} \cdot \tau_t \cdot \left(w_t \cdot A^z_{g,t} \cdot l^z_{g,t} + r_t \cdot wealth^z_{g,t} + \sum_{prof} \sum_{type} Pens^z_{g,prof,type,t} \cdot npens_{g,prof,type,t} \right) \\
&- (Gedu_t + Gmed_t + G_t + Def_{PS_t} + r_t \cdot B_t)
\end{aligned} \tag{20}
$$

We fix the ratio of the public debt (B_t) to GDP and we determine, for each period, the income tax rate (τ_t) that permits to respect this budget constraint.

3.5 Equilibrium conditions

There are three markets in the model: the market of goods and services, the capital market and the labour market. These markets are supposed to be perfectly competitive, so prices adjust in order to guarantee the market clearing. The equilibrium conditions are the following:

$$Y_t = \sum_z \sum_g Pop^z_{g,t} \cdot c^z_{g,t} + Gedu_t + Gmed_t + G_t + I_t \quad (21)$$

$$K_t + B_t = \sum_z \sum_g Pop^z_{g,t} \cdot wealth^z_{g,t} \quad (22)$$

$$L_t = \sum_z \sum_g Pop^z_{g,t} \cdot l^z_{g,t} \cdot A^z_{g,t} \quad (23)$$

Equation (21) represents the equilibrium in the market of goods and services: production must be equal to aggregate demand, given by the private and public consumption and by the investments.

Equation (22) represents the equilibrium in the capital market. In our model we consider two assets, physical capital and government bonds, that are supposed perfectly substitutes, so their remuneration must be the same. The equilibrium condition is that assets demanded by firms and government (LHS) should equal the aggregate household wealth, where $wealth^z_{g,t}$ is the individual wealth depending on his/her life-cycle saving profile defined in Equation (14).

Equation (23) indicates that the total labour supply expressed in per unit of effective labour (RHS) is entirely used in the production activity.

One of previous equations is redundant by the Walras' Law and we consider the domestic good as the *numeraire*.

3.6 Dynamics of the economy

The dynamics of the economy concern the evolution of labour supply, capital, government bonds and productivity. The evolution of labour supply depends on the individual labour choices (i.e. the choices concerning the fraction of time devoted to schooling and leisure) and on the demographic evolution (i.e. the evolution of fertility rates, survival probabilities and immigration flows). The labour productivity evolves over time according to the endogenous growth mechanism described in equation (5). Finally, the evolution of the capital stock depends on investments and on capital depreciation, while public debt depends on government savings, as follows:

$$K_{t+1} = K_t \cdot (1 - \delta) + I_t \quad (24)$$

$$B_{t+1} = B_t - S_{gov_t} \quad (25)$$

4 Calibration of the model

The aim of our calibration is two-fold: reproduce the 2005 Italian macroeconomic data (in particular, the value of the GDP, the ratio between aggregate consumption and GDP, the ratio between investments and GDP, and the ratio between public expenditures and GDP) and replicate the most important ingredients of

the pension system (the ratio of the number of retirees to the number of workers, the average pension benefits for each type of pensions, and the ratio of the total pension expenditure to GDP).

4.1 The calibration of the pension system

Given that our objective is to evaluate the impacts of pension reforms in the context of population ageing, we focus on the *IVS* pensions (including old-age direct pensions, pensions to survivors and disability benefits). *IVS* pensions account for 13.64% of GDP in 2005 (Istat, 2007).

However, in our analysis, we do not consider:

- *IVS* pensions paid by private institutions that account for 0.16% of GDP.
- Supplementary pensions[12] that account for 0.33% of GDP.
- Pensions paid to people aged less than 55.

Then, the pension system analysed in our paper accounts for 12.89% of GDP in 2005.

In particular, pensions to public and private salaried workers account for 10.50% of GDP, while pensions to self-employed account for 2.39%. Direct pensions account for 9.87% of GDP, disability benefits for 0.88% and pensions to survivors for 2.14%. Tables 1a and 1b present the main characteristics of the pension system analysed in our paper. Data show that, concerning direct pensions, the average pension benefits earned by self-employed are 40% lower than those earned by salaried workers. This relevant difference is not related to a different calculation rule of pensions: in fact, in 2005, the gross replacement ratio was very similar for salaried workers and self-employed.[13] The difference in the average pension benefits is then related to an important difference in remuneration between salaried workers and self-employed workers, represented in our model by the coefficient Ψ_{prof} in equation (6).

	Direct Pensions			**Disability Pensions**			**Indirect Pensions**		
	N. of pensions	Expenditure (000 euros)	Average pension	N. of pensions	Expenditure (000 euros)	Average pension	N. of pensions	Expenditure (000 euros)	Average pension
55-59	790 716	15 507 566	19 612	90 062	824 026	9 150	155 738	1 239 611	7 960
60-64	1 274 702	21 885 456	17 169	91 203	754 850	8 277	213 237	1 743 589	8 177
65-69	1 687 695	25 292 352	14 986	111 556	831 191	7 451	376 179	3 040 756	8 083
70-74	1 533 347	20 186 641	13 165	171 320	1 221 380	7 129	549 334	4 318 436	7 861
75-79	1 246 960	15 635 855	12 539	261 016	1 824 525	6 990	715 720	5 502 937	7 689
80-84	854 241	10 177 760	11 914	278 749	1 865 127	6 691	727 666	5 460 919	7 505
85-89	326 457	3 691 577	11 308	136 930	875 907	6 397	378 442	2 796 284	7 389
>90	202 327	2 092 297	10 341	88 636	538 449	6 075	296 497	2 150 206	7 252
Total	**7 916 445**	**114 469 504**	**14 460**	**1 229 472**	**8 735 454**	**7 105**	**3 412 813**	**26 252 738**	**7 692**

Table 1a: Pensions paid to the employees. Source: Istat, 2007

[12] Supplementary pension systems, recently introduced in the Italian system, are mostly funded and voluntary. They include closed-end funds and collective pension funds.

[13] In 2005, according to Ragioneria Generale dello Stato (2006), in the case of an individual aged 63 with 35 years of contributions, the gross replacement ratio was 70.7% for the employees and 69% for the self-employed. In the case of an individual with 40 years of contributions, the gross replacement ratio was 80.7% for the employees and 78.7% for the self-employed.

	Direct Pensions			Disability Pensions			Indirect Pensions		
	N. of pensions	Expenditure (000 euros)	Average pension	N. of pensions	Expenditure (000 euros)	Average pension	N. of pensions	Expenditure (000 euros)	Average pension
55-59	178 373	2 200 736	12 338	41 572	305 540	7 350	58 627	322 835	5 507
60-64	675 952	6 538 672	9 673	39 154	263 017	6 718	81 210	437 748	5 390
65-69	862 610	7 610 403	8 823	43 497	257 300	5 915	125 291	645 156	5 149
70-74	612 617	4 711 729	7 691	68 782	386 936	5 626	150 438	715 833	4 758
75-79	417 259	2 882 303	6 908	120 743	651 327	5 394	176 310	762 964	4 327
80-84	224 383	1 443 424	6 433	166 721	880 195	5 279	181 448	714 331	3 937
85-89	65 558	389 712	5 945	105 712	552 372	5 225	99 543	361 353	3 630
>90	41 348	228 313	5 522	90 814	469 756	5 173	90 442	302 753	3 347
Total	**3 078 100**	**26 005 293**	**8 448**	**676 995**	**3 766 444**	**5 563**	**963 309**	**4 262 972**	**4 425**

Table 1b: Pensions paid to self-employed. Source: Istat, 2007

4.2 The calibration of the macroeconomy

The model is calibrated conditional to the demographic change, to an endogenous annual productivity growth rate of about 1.5%, and to the pension reforms introduced in the Nineties. In particular, the demographic shock is introduced through a combination of changes in fertility rates, mortality rates and immigration flows, determined to reproduce as closely as possible the demographic projections presented by Istat as described in Paragraph 3.2.

Our model starts in 1950. The calibration is done in a way we reproduce the 2005 observed data.[14] In Table 2 we report the main values of the parameters used in the model, whereas in Tables 3a, 3b and 3c we report the values for some endogenous variables produced by the model that are compared to the 2005 data.

In particular, the parameter that measures the intensity of the preference for leisure (β^z_{BEQ}) and the intertemporal preference factor (Γ_g) used in the utility function (equation (2)) are calibrated to reproduce a wealth profile of the different age groups compatible with the 2005 data.[15] The parameters that measure the intensity of the preference for leisure ($\beta^z_{LEIS_g}$) in equation (2) are calibrated to replicate the employment rates of the different age groups in 2005. These parameters are allowed to change over time in order to take into account the increase in women labour participation in the next decades that mainly depends on cultural factors.

Concerning the individual productivity, the parameters θ_0, θ_1 and θ_2 in equation (3) are calibrated to replicate the earnings profile used by Fougère and Mérette (1999) that were set to produce the maximum level at the age of 52. The parameter α_{HC} in equation (4) is calibrated to replicate in 2005 the fraction of young people (20-24 years old) who study. The parameter χ in equation (5) is calibrated to obtain a productivity growth rate in 2005 close to 1.5%. The parameter θ^z is chosen such that the total productivity of immigrants is lower by 13% of the total productivity of natives.[16]

[14] In other words, we determine the stocks in 1950 and the intertemporal prices between 1950 and 2005 in order to reproduce the 2005 real data.

[15] Most of the OLG models consider an intertemporal preference rate identical for each age groups and no bequest motive, as for example in Miles (1999). Therefore, in this case, old people present a very negative value of the propensity to save, that is not consistent to real data.

[16] Storesletten (2000) finds, for the United States, that the productivity of immigrants aged 37 is lower by 13% with respect to that of natives. In our case, this assumption implies that immigrants have a level of productivity related to education lower by 13% compared to natives. In fact, we can suppose that an immigrant and a native, with the same age, have the same productivity related to the experience (EP) and that they profit in the same way of the knowledge present in the economy (H). By considering

Both the calibration and simulations were made by using numerical algorithms provided by GAMS (General Algebraic Modelling System).

Households		
Productivity related to the age	θ_0	0.675
	θ_1	0.350
	θ_2	-0.025
Productivity related to the education	α_{HC}	0.339
Productivity related to the average level of knowledge	χ	0.089
Intertemporal elasticity of substitution	γ	0.75
Index of preference for leisure	β_{LEIS_2}	0.597
	β_{LEIS_3}	0.713
	β_{LEIS_4}	0.744
	β_{LEIS_5}	0.754
	β_{LEIS_6}	0.761
	β_{LEIS_7}	0.735
Index of preference for bequests	β_{BEQ}	1.098
Firms		
Annual depreciation rate of physical capital	δ	5 %
Capital remuneration in the added value	α	0.412
Government		
Contribution rate applied to salaried workers		33 %
Contribution rate applied to self-employed workers		20 %
Average contribution rate	τ^c	23.3 %
Public debt / GDP		106.4 %
Total public expenditure / GDP		20.4 %

Table 2: Some parameters used in the model

equation (4), this assumption implies that immigrants have a stock of human capital lower by 10% relatively to natives.

Generated values of main endogenous variables compared with real data

	Simulated value	Real data
GDP (in milliards of euros)	1423.022	1423.049
Consumption / GDP	59.00 %	58.63 %
Investments / GDP	20.50 %	20.42 %
Gedu / GDP	4.58 %	4.62 %
Gmed / GDP	6.95 %	6.93 %
G / GDP	8.96 %	8.87 %
Income tax rate	14.8 %	
K / GDP	2.65	

Table 3a: Variables concerning the macroeconomy, year 2005

		Simulated value	Real data
Employment rates	20-24	41.16 %	41.11 %
	25-29	63.24 %	63.26 %
	30-34	74.06 %	74.36 %
	35-39	76.01 %	76.22 %
	40-44	76.23 %	76.40 %
	45-49	74.03 %	74.06 %
	50-54	66.71 %	66.87 %
	55-59	43.07 %	43.07 %
	60-64	17.99 %	17.99 %
National employment rate		61.29 %	61.48 %
Employment rate for natives		60.76 %	61.12 %
Employment rate for immigrants		69.85 %	70.05 %
Retirees / Workers			0.786

Table 3b: Variables concerning the labor market, year 2005

		Simulated value	Real data
All pensions		12.97 %	12.89 %
Salaried workers	direct pensions	8.09 %	8.04 %
	disability benefits	0.61 %	0.61 %
	indirect pensions	1.82 %	1.84 %
Self-employed workers	direct pensions	1.89 %	1.83 %
	disability benefits	0.26 %	0.26 %
	indirect pensions	0.30 %	0.30 %

Table 3c: Pension system expenditures with respect to GDP, year 2005

5 Effects of the recent reforms: Berlusconi and Prodi reforms

We now use the model to simulate and compare the pension reforms recently introduced: the Berlusconi reform (2004) and the Prodi reform (2007). Whereas with the Dini reform workers can decide to retire between 57 and 65, the two new reforms increase the minimum retirement age.

In particular, with the Berlusconi reform, the minimum retirement age is increased to:

- 60 (61 for self-employed workers), after January 2008.
- 61 (62 for self-employed workers), after 2010.
- 62 (63 for self-employed workers), after 2014.

The Berlusconi reform was replaced in 2007 by a new reform introduced by the Prodi government where the increase of the minimum retirement age is more gradual:

- 58 (59 for self-employed workers) with at least 35 years of contributions, after 2008.
- 59 (60 for self-employed workers) with at least 36 years of contributions, or 60 (61 for self-employed workers) with at least 35 years of contributions, after 2009.
- 60 (61 for self-employed workers) with at least 36 years of contributions, or 61 (62 for self-employed workers) with at least 35 years of contributions, after 2011.
- 61 (62 for self-employed workers) with at least 36 years of contributions, or 62 (63 for self-employed workers) with at least 35 years of contributions, after 2013.

These two reforms are compared with our base scenario in which the increase in the retirement age is not taken into account.

5.1 Macroeconomic impacts

First of all, the increase in the retirement age will have a direct impact on the labour supply. Figures 9 and 10 show that, with respect to the base case, the increase in the retirement age induces an increase in the employment rate, i.e. the ratio between the number of workers and the working age population (20-64), and a reduction in the ratio of the number of retirees to the number of workers.[17]

In the three cases, the population ageing phenomenon boosts the capital per unit of effective labour that raises the equilibrium per unit of effective wage and reduces the equilibrium (net of tax) interest rate (Figures 11 and 12). The fact that the two reforms induce an increase in the labour supply explains why wages are lower and the interest rate is higher with respect to the base case.

[17] Note that, from an economic point of view, the ratio of the retirees to the workers speaks more than the old-age dependency ratio, since it also takes into account the evolution of the employment ratio.

The increase of survival probabilities and future wages and the decrease of future interest rates affect positively the optimal time devoted to studying by young people (Figure 13). Moreover, with respect to the base scenario, the increase in the retirement age and then in the overall lifetime spent working, induce young people to devote additional time to human capital accumulation. The productivity growth rate, that depends on the weighted average of the productivity levels of each age group, increases over time from 1.5% in 2005 to 1.7% in 2055 (Figure 14). However, a more important investment in human capital, with respect to the base case, is not sufficient to induce a greater pace of the productivity growth rate. This is related to the fact that the two reforms induce an increase of the weight of people aged 55-64 (characterised by a lower human capital stock given the hypothesis of the depreciation of human capital) which reduces the average level of human capital.

Figure 9: Employment rate

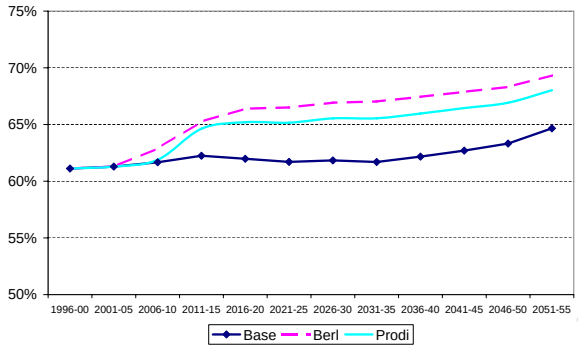


Figure 10: # retirees / # workers

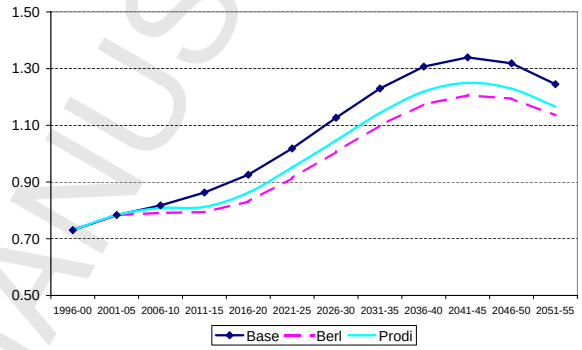


Figure 11: Wage, per unit of effective labor

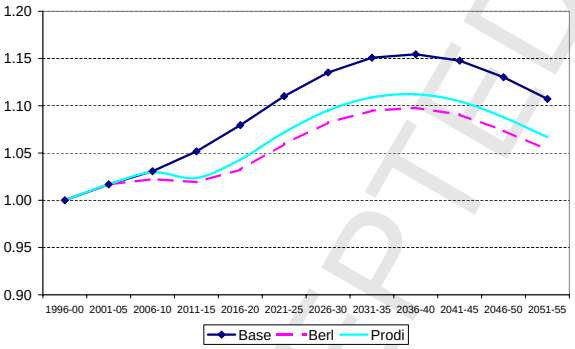
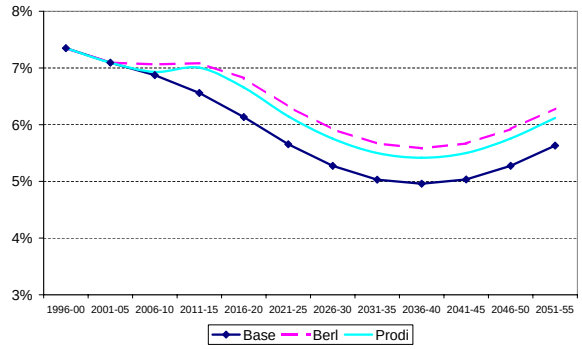


Figure 12: Interest rate



The macroeconomic effects, in terms of economic growth, of the increase in retirement age are positive until 2025. Starting from 2025, the difference with respect to the base scenario becomes insignificant.

In the base scenario, the ratio of investments to GDP (Figure 15) increases until 2020 and then it drastically decreases. The initial increase is related to the Dini reform that will significantly reduce pension benefits with the application of the contribution based method, and to the Amato reform that introduced an indexation

Figure 13: Time devoted to schooling

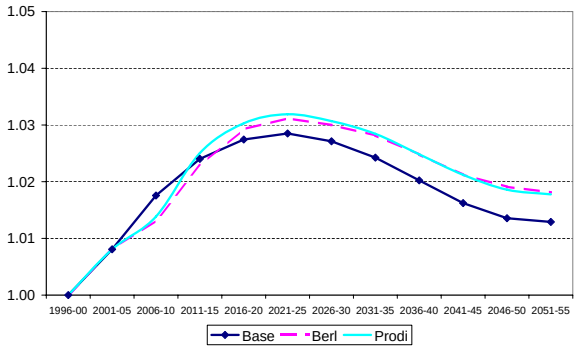
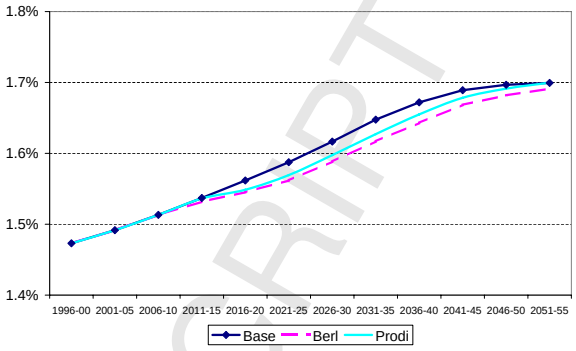


Figure 14: Productivity growth rate



mechanism of pension benefits to prices. It is well known that a reduction in the generosity of the pension system stimulates national savings by modifying the individual behaviour in terms of consumption and saving. However, after some periods, investments over GDP decrease because the positive effect on private savings is more than compensated by the high deficits generated by the pension system.

With respect to the base scenario, the increase in the retirement age has a negative impact on the ratio of investments to GDP. With the reform, in fact, individuals expect to work more and to earn more in the future (both in terms of labour incomes and pension benefits) so they can increase their consumption levels and reduce their actual savings.

The evolution of GDP is mainly affected by the demographic projections. The strong reduction in the population aged between 20 and 64 implies negative rates of growth of the number of workers from 2015 to 2055 (Figure 16) and explains the negative evolution of the GDP growth (Figure 17) and of the per capita GDP growth (Figure 18). The evolution of the investment ratio plays another negative role in the economic growth, while the increase in the productivity growth rate and the increase in the employment rates are not sufficient to compensate the previous negative effects.

With respect to the base scenario, the reforms would induce an increase in the growth rate of the number of workers and consequently of the GDP growth rate and the per capita GDP growth rate until 2025. Afterwards, the economic growth rates are very similar in the three scenarios.

5.2 Effects of the Berlusconi and Prodi reforms on the pension system

Figures 19 and 20 show the evolution of the pension system in terms of expenditures and deficits produced. We see that initially the two reforms that increase the retirement age have a significant positive impact on the financial situation of the pension system with respect to the base scenario, both in terms of the deficit and of the aggregate expenditure, as a ratio to GDP. For example, the Berlusconi reform makes it possible to reduce the ratio of the deficit to GDP of about 0.7 percentage points in 2015 and 0.3 p.p. in 2030. As could be expected, the reduction in the pension deficits with the Prodi reform is less important in the short run than with the Berlusconi reform. The reduction is 0.5 p.p. in 2015, 0.2 p.p. in 2030 with respect to the base

Figure 15: Investments / GDP

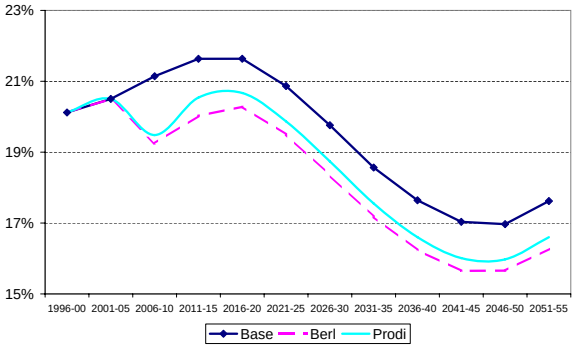


Figure 16: Growth rate of the # of workers

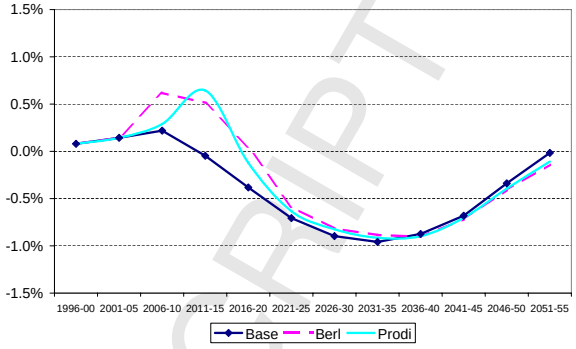


Figure 17: GDP growth rate

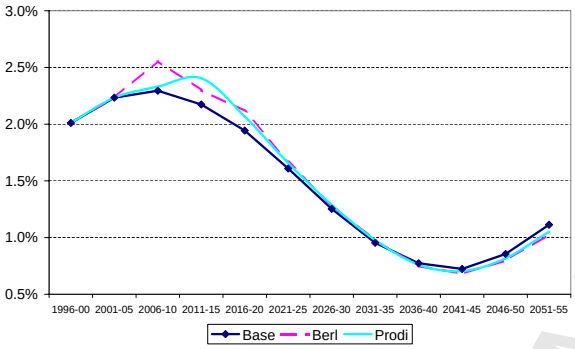
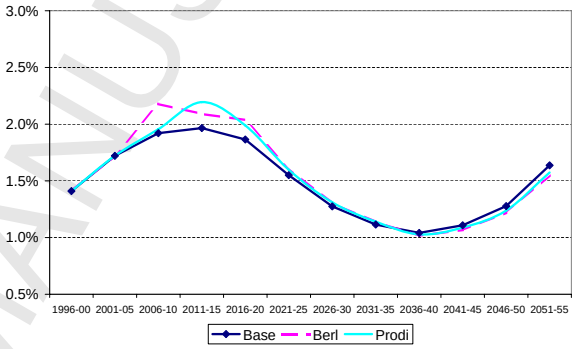


Figure 18: Per capita GDP growth rate



scenario.

However, in the long run, the increase in the retirement age becomes completely ineffective. In year 2035, the two reforms display the same ratio of the pension system deficit to GDP as in the base scenario, and afterwards, this ratio becomes more important than in the base case.

In order to understand the reason behind the inefficiency of these reforms in the long run, we have to consider that an increase in the retirement age induces, for individuals obliged to postpone retirement, a present loss (represented by the additional contributions paid and by the foregone pension benefits) and future gains (represented by the increase in the value of the pension thereafter). In the early years of the introduction of the reform, the increase in the retirement age can only have positive effects on the pension system. However, as time passes, a larger number of individuals receives an increase in pension benefits. To show this, let us imagine that before the reform each individual retires at 58 and that the reform increases the retirement age by one year from 2008 onwards. In 2008, people who are forced to postpone retirement pay one more year of contributions and loose one year of pension benefits. Their loss represents a net gain for the pension system since pension benefits do not change for any age group that year. The next year, the pension system receives the same increase in contributions but this gain is now partially compensated by the increase

Figure 19: Pension system deficit / GDP

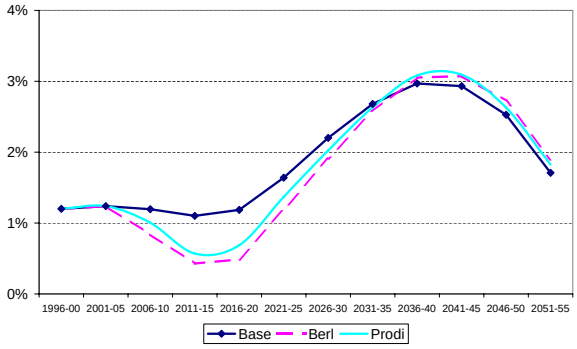
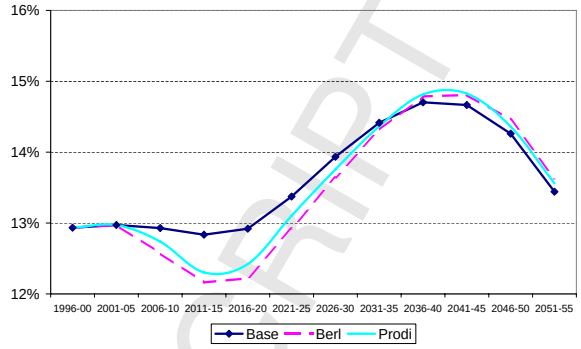


Figure 20: Pension expenditure / GDP



in pension benefits paid to the retirees who, without the reform, would have retired at 58 in 2008 but, with the reform, retire at 59 in 2009. In 2010 two age groups benefit from the increase in pensions: people who, without the reform, would retire at 58 in 2008 and at 58 in 2009 but, with the reform, are constrained to work one additional year. And so on. So, as time passes by, the number of individuals who earn a greater level of pension benefits increases and the increase in the pension expenditure compensates the increase in the social contributions paid by the workers obliged to work more, and the reform ceases to be effective.

Another element that makes the reform ineffective in the long run is related to the contribution based method introduced by the Dini reform in order to penalise early retirement. In 2005, as Table 4a and 4b show respectively for salaried workers and self-employed workers, the rate of return on contributions[18] for those who retire at 57 was largely higher than that of individuals who postpone retirement; in contrast, from 2040 onwards, the difference between the rates of return on contributions is significantly reduced. This implies that, when the earning based method is applied and the rate of return on contributions are different according the retirement age, if an individual works one more year the increase in the value of his/her pension is less important than in the case where the rates of return on contributions are equal for all individuals. In contrast, with the contribution based method and the presence of an actuarial link between pension benefits and contributions paid, if an individual decides to work one more year, the increase in the value of his/her pension is more relevant. Thus, in every case, the increase in the retirement age causes an increase in pension benefits, but this increase is more important when the contribution based method is applied. The fact that starting from 2045 the majority of the retirees receive a pension computed with the contribution based method represents another element that negatively influences the evolution of pension system.

[18] The rate of return on contributions is defined as the rate that equalises the expected capitalised value of the contributions paid and the expected present value of the pension benefits earned. Note that if an individual decides (or is constrained by the law) to work one more year, and assuming that the rate of return on contributions does not depend on the age of retirement, the increase in pension benefits must be such that the expected present value of the future increase in pension benefits is equal to the sum of the additional contributions paid and the pension benefits given up.

Retirement age	57	58	59	60	61	62	63	64	65
Years of contributions	35	36	37	38	39	40	41	42	43
2001-05	3.20%	3.05%	2.89%	2.73%	2.45%	2.30%	2.14%	1.98%	1.81%
2006-10	3.29%	3.14%	2.98%	2.82%	2.51%	2.36%	2.20%	2.04%	1.86%
2011-15	3.33%	3.18%	3.01%	2.84%	2.52%	2.36%	2.19%	2.01%	1.83%
2016-20	2.90%	2.78%	2.66%	2.53%	2.34%	2.24%	2.13%	2.03%	1.92%
2021-25	2.77%	2.66%	2.56%	2.45%	2.29%	2.21%	2.12%	2.03%	1.93%
2026-30	2.57%	2.49%	2.40%	2.31%	2.20%	2.13%	2.06%	1.98%	1.90%
2031-35	2.21%	2.16%	2.10%	2.05%	2.01%	1.97%	1.92%	1.87%	1.82%
2036-40	2.06%	2.01%	1.97%	1.91%	1.88%	1.85%	1.80%	1.76%	1.71%
2041-45	1.91%	1.88%	1.83%	1.79%	1.76%	1.73%	1.69%	1.64%	1.60%
2046-50	1.80%	1.77%	1.73%	1.69%	1.66%	1.63%	1.59%	1.55%	1.51%
2051-55	1.75%	1.72%	1.68%	1.64%	1.62%	1.59%	1.55%	1.51%	1.47%

Table 4a: Rate of return on contributions; native employees; base scenario. Source: Author's calculations

Retirement age	57	58	59	60	61	62	63	64	65
Years of contributions	35	36	37	38	39	40	41	42	43
2001-05	4.92%	4.75%	4.57%	4.38%	4.09%	3.93%	3.75%	3.57%	3.38%
2006-10	5.02%	4.85%	4.66%	4.47%	4.16%	4.00%	3.82%	3.63%	3.44%
2011-15	5.07%	4.89%	4.71%	4.51%	4.17%	4.00%	3.81%	3.62%	3.41%
2016-20	3.90%	3.74%	3.58%	3.41%	3.17%	3.03%	2.89%	2.75%	2.61%
2021-25	3.52%	3.38%	3.24%	3.10%	2.90%	2.79%	2.67%	2.55%	2.43%
2026-30	3.05%	2.94%	2.83%	2.72%	2.58%	2.49%	2.40%	2.30%	2.21%
2031-35	2.21%	2.16%	2.10%	2.05%	2.01%	1.97%	1.92%	1.87%	1.82%
2036-40	2.06%	2.01%	1.97%	1.91%	1.88%	1.85%	1.80%	1.76%	1.71%
2041-45	1.91%	1.88%	1.83%	1.79%	1.76%	1.73%	1.69%	1.64%	1.60%
2046-50	1.80%	1.77%	1.73%	1.69%	1.66%	1.63%	1.59%	1.55%	1.51%
2051-55	1.75%	1.72%	1.68%	1.64%	1.62%	1.59%	1.55%	1.51%	1.47%

Table 4b: Rate of return on contributions; native self-employed; base scenario. Source: Author's calculations

Retirement age	57	58	59	60	61	62	63	64	65
Years of contributions	35	36	37	38	39	40	41	42	43
2001-05	70.3%	72.7%	75.0%	77.4%	77.8%	80.0%	82.3%	84.5%	86.8%
2006-10	70.1%	72.5%	74.9%	77.3%	77.5%	79.8%	82.2%	84.5%	86.9%
2011-15	70.2%	72.7%	75.2%	77.6%	77.7%	80.0%	82.4%	84.8%	87.3%
2016-20	62.8%	65.6%	68.6%	71.7%	74.5%	78.1%	81.9%	86.0%	90.4%
2021-25	59.8%	62.8%	65.9%	69.3%	72.7%	76.5%	80.7%	85.1%	89.9%
2026-30	56.1%	59.2%	62.4%	65.9%	70.0%	74.0%	78.4%	83.0%	88.1%
2031-35	51.9%	55.3%	58.8%	62.6%	67.8%	72.3%	77.0%	82.1%	87.7%
2036-40	48.9%	52.1%	55.4%	59.0%	65.7%	70.1%	74.7%	79.7%	85.1%
2041-45	47.6%	50.7%	54.0%	57.6%	62.6%	66.8%	71.2%	75.9%	81.1%
2046-50	46.7%	49.8%	53.1%	56.6%	61.6%	65.6%	70.0%	74.6%	79.7%
2051-55	46.7%	49.8%	53.1%	56.6%	61.3%	65.4%	69.7%	74.3%	79.3%

Table 5a: Gross replacement ratio; native employees; base scenario. Source: Author's calculations

Retirement age	57	58	59	60	61	62	63	64	65
Years of contributions	35	36	37	38	39	40	41	42	43
2001-05	66.3%	68.7%	71.1%	73.5%	74.0%	76.2%	78.5%	80.7%	83.0%
2006-10	65.9%	68.3%	70.7%	73.1%	73.7%	75.9%	78.2%	80.4%	82.7%
2011-15	65.9%	68.4%	70.9%	73.4%	73.6%	75.9%	78.3%	80.6%	83.0%
2016-20	49.3%	51.2%	53.1%	55.2%	56.6%	58.9%	61.3%	63.9%	66.7%
2021-25	44.1%	46.0%	48.1%	50.2%	52.1%	54.5%	57.1%	59.8%	62.8%
2026-30	38.5%	40.5%	42.5%	44.7%	47.0%	49.6%	52.2%	55.1%	58.2%
2031-35	31.5%	33.5%	35.6%	37.9%	41.1%	43.8%	46.7%	49.8%	53.1%
2036-40	29.6%	31.6%	33.6%	35.8%	39.8%	42.5%	45.3%	48.3%	51.6%
2041-45	28.8%	30.7%	32.7%	34.9%	37.9%	40.5%	43.1%	46.0%	49.2%
2046-50	28.3%	30.2%	32.2%	34.3%	37.3%	39.8%	42.4%	45.2%	48.3%
2051-55	28.3%	30.2%	32.2%	34.3%	37.2%	39.6%	42.2%	45.0%	48.0%

Table 5b: Gross replacement ratio; native self-employed; base scenario. Source: Author's calculations

Even if the reforms are not sufficient to reach the equilibrium of the pension system, Tables 4a and 4b and Tables 5a and 5b (concerning respectively the rate of return on contributions and the gross replacement ratio) show the strong reduction in the generosity of the pension system induced by the application of the contribution based method.

The previous tables show another important aspect of the Dini reform. The actual situation is very

convenient for self-employed workers since they receive pension benefits computed with a rule similar to salaried workers while they pay contributions on the basis of a lower rate (20% vs. 33%). This explains the reason behind the high level of the rates on return on contributions for self-employed workers with respect to the salaried workers when the earning based method is applied, even if the replacement ratios are similar. However, when the contribution based method is applied, pension benefits are perfectly related to contributions and the replacement ratio for self-employed workers will strongly reduce.

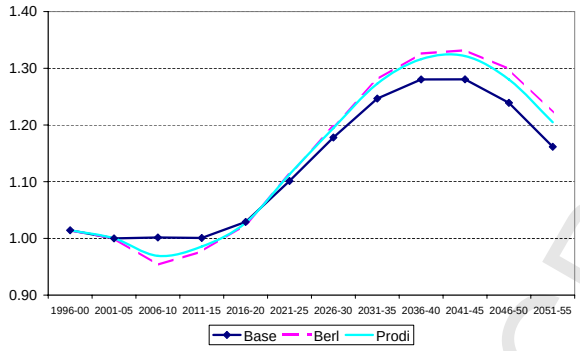
Finally, Table 6 shows the decomposition of the pension expenditure into direct pensions, disability benefits and indirect pensions paid to salaried workers and self-employed workers. We can see that in all the three cases the important increase in the total pension expenditure in the next decades is driven by the rise in the direct pensions paid to salaried workers while, for the other categories, the pension expenditure is essentially under control.

			2001-05	2006-10	2011-15	2021-25	2031-35	2041-45	2051-55
Employees	Direct pensions	Base	8.09%	8.05%	8.03%	8.53%	9.19%	9.29%	8.50%
		Berl	8.09%	7.76%	7.45%	8.11%	9.00%	9.23%	8.48%
		Prodi	8.09%	7.91%	7.60%	8.33%	9.14%	9.35%	8.49%
	Disability benefits	Base	0.61%	0.61%	0.60%	0.62%	0.69%	0.72%	0.66%
		Berl	0.61%	0.61%	0.60%	0.63%	0.71%	0.76%	0.70%
		Prodi	0.61%	0.61%	0.60%	0.62%	0.69%	0.74%	0.69%
	Indirect pensions	Base	1.82%	1.81%	1.81%	1.87%	2.08%	2.19%	2.03%
		Berl	1.82%	1.80%	1.79%	1.87%	2.13%	2.30%	2.15%
		Prodi	1.82%	1.81%	1.79%	1.85%	2.08%	2.24%	2.10%
Self-employed	Direct pensions	Base	1.89%	1.89%	1.83%	1.80%	1.84%	1.82%	1.64%
		Berl	1.89%	1.85%	1.77%	1.77%	1.85%	1.84%	1.66%
		Prodi	1.89%	1.85%	1.76%	1.76%	1.84%	1.83%	1.65%
	Disability benefits	Base	0.26%	0.27%	0.26%	0.26%	0.29%	0.32%	0.30%
		Berl	0.26%	0.27%	0.26%	0.26%	0.30%	0.33%	0.32%
		Prodi	0.26%	0.27%	0.26%	0.26%	0.29%	0.32%	0.31%
	Indirect pensions	Base	0.30%	0.30%	0.29%	0.29%	0.31%	0.33%	0.30%
		Berl	0.30%	0.30%	0.29%	0.29%	0.32%	0.34%	0.32%
		Prodi	0.30%	0.30%	0.29%	0.29%	0.32%	0.33%	0.31%

Table 6: Pension expenditure / GDP. Source: Author's calculations

Finally, the evolution of pension deficits clearly affects the evolution of the income tax rate τ_t (see Figure 21). This is related to the fact that the income tax rate is endogenously determined at each period in order to keep constant the ratio of the public debt to GDP. By comparing Figures 19 and 21, we can note that the time paths of the income tax rate and of the ratio of public debt to GDP, in the three scenarios, are very similar.

Figure 21: Income tax rate, normalized to 1 in 2001-2005



5.3 Generational accounting

We now use the generational accounting approach introduced by Auerbach *et al.* (1994) to evaluate the gains and the losses for each generation associated with the introduction of the Berlusconi and the Prodi reforms. For each generation, we compute the ratio of the expected present value of the revenues (pension benefits and per capita government expenditures) to the expected present value of the payments (income taxes and social security contributions).

As shown in Table 7, the first generation considered in the generational accounting analysis is that born in the period 1926-1930, while the last one is that born in the period 1996-2000. The analysis concerns only native salaried workers who start working at 22.

In the base scenario, all the generations stop working at 58. In the simulation concerning the Berlusconi reform, all the generations born before 1946 stop working at 58, the generation born in the period 1946-1950 stops working at 61, and all the generations born after 1950 stop working at 62. In the simulation concerning the Berlusconi reform, all the generations born before 1946 stop working at 58, the generation born in the period 1946-1950 stops working at 59, and all the generations born after 1950 stop working at 61.

	Base		Berl		Prodi	
year of birth	retirement age	year of retiring	retirement age	year of retiring	retirement age	year of retiring
1926-30	58	1984-88	58	1984-88	58	1984-88
1931-35	58	1989-93	58	1989-93	58	1989-93
1936-40	58	1994-98	58	1994-98	58	1994-98
1941-45	58	1999-03	58	1999-03	58	1999-03
1946-50	58	2004-08	61	2007-11	59	2005-09
1951-55	58	2009-13	62	2013-17	61	2012-16
1956-60	58	2014-18	62	2018-22	61	2017-21
1961-65	58	2019-23	62	2023-27	61	2022-26
1966-70	58	2024-28	62	2028-32	61	2027-31
1971-75	58	2029-33	62	2033-37	61	2032-36
1976-80	58	2034-38	62	2038-42	61	2037-41
1981-85	58	2039-43	62	2043-47	61	2042-46
1986-90	58	2044-48	62	2048-52	61	2047-51
1991-95	58	2049-53	62	2053-57	61	2052-56
1996-00	58	2054-58	62	2058-62	61	2057-61

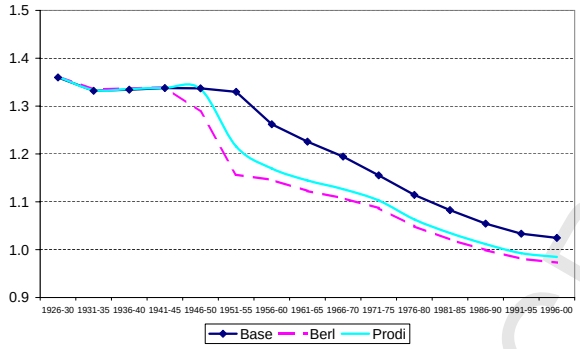
Table 7: Generations considered in the generational accounting analysis

The results of this analysis are shown in Figure 22. First of all, by considering the base case, we note that the value of this index decreases starting from the generation born in the period 1956-1960. The reason of this decrease is the reduction of the generosity of the pension system related to the introduction of the pro-rata method and the contribution based method, and the strong increase in the income tax rate necessary to keep constant the ratio between the public debt and the GDP (see Figure 21).

With respect to the base case, the Berlusconi reform causes a sharp fall of the index for the generation born in 1946-1950, which is the first generation who must work until 61, while with the Prodi reform the reduction of the index begins for the generation born in 1951-1955. It is important to note that the generations born in the periods 1946-1950 and 1951-1955 are the first generations forced to pay more contributions and they receive a pension computed with the earning based method which implies, as we have already seen, that the increase in the value of their pension benefits is not much important. In contrast, the following generations are forced to pay more contributions, but receive pension benefits computed with the pro-rata method or the contribution based method; for these generations, therefore, the increase in pension benefits is more significant and the difference between the three indexes tends to shrink. Observe, however, that the value of the index remains significantly lower with respect to the base case in the scenarios with increased retirement age.

We can conclude that the Berlusconi and the Prodi reforms have a positive impact on the pension system in the medium term but, after 2040, they appear completely ineffective: the increase in the retirement age does not induce a reduction of pension system deficits, which remain of about 1.7% of GDP. Moreover, these reforms induces important losses for the next generations.

Figure 22: Expected present value of revenues / Expected present value of payments



6 Sensitivity analysis

6.1 Immigration

We now analyse the robustness of our results concerning the Prodi reform introduced in 2007. The first element of uncertainty that we consider concerns the demographic evolution by focusing on the role played by immigration. The base case assumes that immigrants of the second generation have the same fertility rates as natives. We consider here the case in which immigrants of the second generation have the same fertility rates as their parents, i.e. the double of fertility rates compared to the natives. As Figures 23 and 24 show, this scenario has important effects on the demographic evolution by reducing the dependency ratio and increasing the working age population.

Figure 23: Old-age dependency ratio

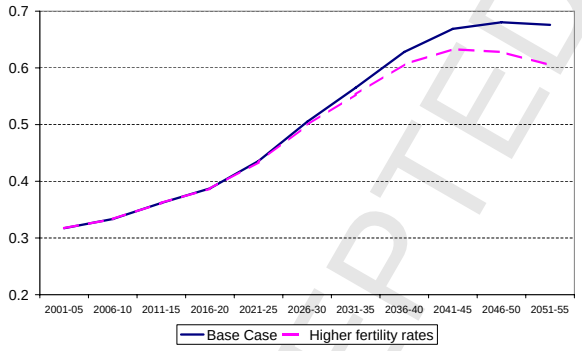
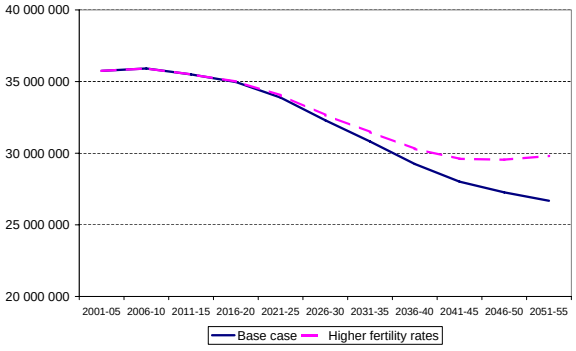


Figure 24: Working age population



Even if this scenario implies, with respect to the Prodi reform, a reduction in future wages induced by the increase in the labour supply (see Figures 25 and 26), it determines an important reduction of the ratio between the pension system deficits and GDP since 2030 (Figure 27). In particular, this scenario implies in 2055 a reduction of this ratio of about 0.5 percentage points.

The previous simulation shows the importance of immigration as a key element that affects the sustain-

Figure 25: Employment rate

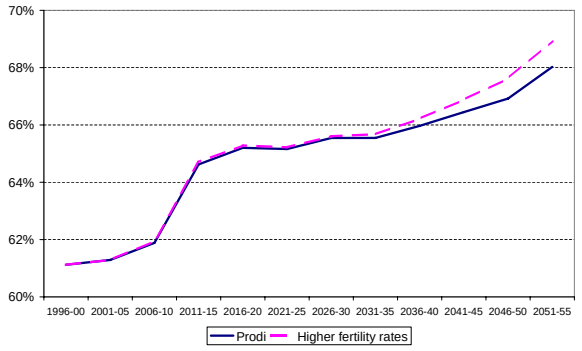


Figure 26: Wage, per unit of effective labor

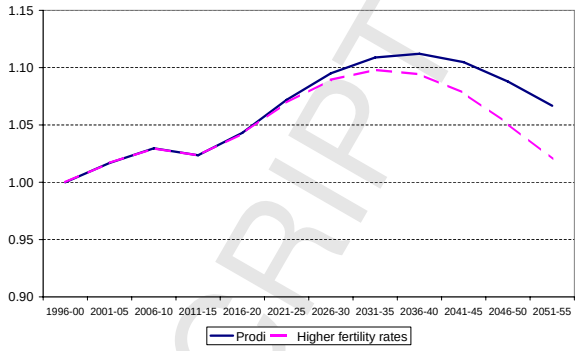
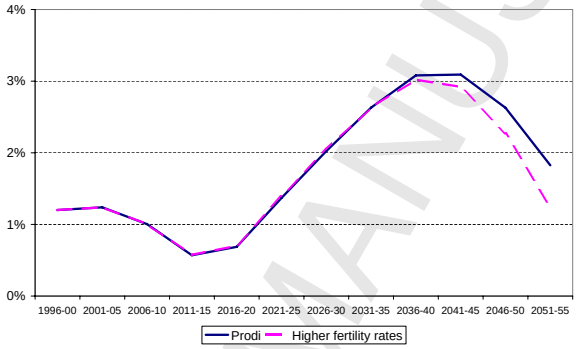


Figure 27: Pension system deficit / GDP



ability of the pension system. As a consequence, we can imagine immigration as a policy tool that could be used in order to balance the pension system in the long run.

We consider here a scenario in which additional migrants enter Italy starting from the period 2026-2030. In particular, in the periods 2026-2030 and 2051-2055, we assume 250,000 additional immigrants per year, while between 2031 and 2050 (i.e. when the size of pension deficits is larger) we suppose more important flows, as shown in Figure 28.

Figures 29 and 30 show the demographic implications of this policy: the increase of the weight of immigrants on the total population (more than 30% vs. 18% in the base case in 2055) and the reduction of the old-age dependency ratio.

The economic effects of this reform are the following. The effect on the GDP growth rate (Figure 31) is positive from the period 2026-2030 onwards, i.e. since the immigration policy is applied. Before, the negative effect on economic growth is related to an expectation mechanism. Individuals, indeed, expect a future reduction in tax levels thanks to the reduction in pension deficits due to the immigration policy. The increase in future expected incomes induces individuals, when the information is available (in the period 2006-2010), to increase consumption and leisure demand. The reduction of savings (and thus of capital accumulation) and of

Figure 28: Number of yearly immigrants

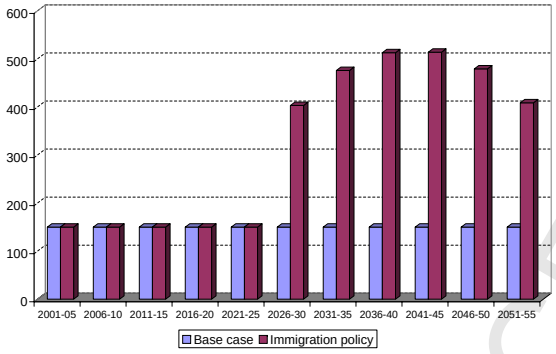


Figure 29: Immigrants / Total population

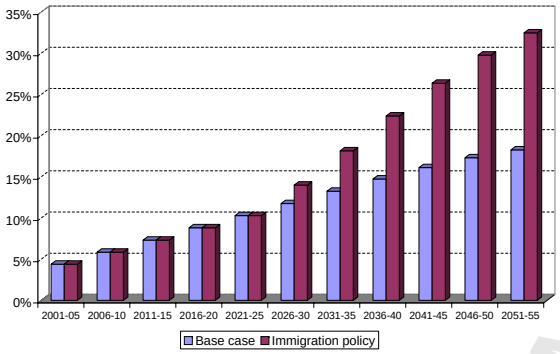
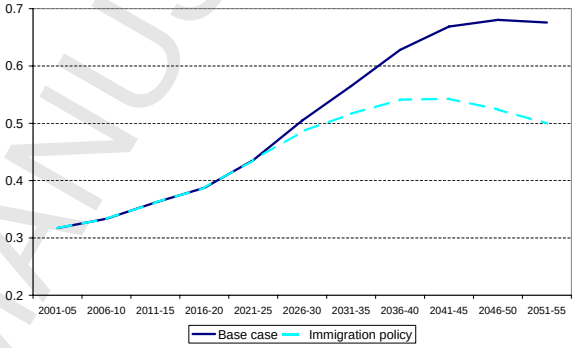


Figure 30: Old-age dependency ratio



labour supply explain the initial reduction of the GDP growth rate. Moreover, by stimulating labour supply, this policy reduces wages with respect to the base case (Figure 32). Another important economic aspect is the effect on the productivity growth rate that depends on the weighted average of the stocks of human capital of each age class working at the same period (see equation (5)). Given that immigrants are supposed to be less productive than natives, the immigration policy has a negative effect on the productivity growth rate, as shown in Figure 33. In particular, in 2055, the difference would be equal to 0.16%.

The effects on the pension system (see Figure 34) are positive starting from the period 2026-2030 and the immigration policy allows to balance the pension system in 2055. Before 2025, the negative effect is explained by the evolution of GDP in the first periods.

6.2 Pension benefits

Another important element of uncertainty in our simulation exercise concerns the value of pension benefits. The uncertainty is related to the fact that the Dini reform (Law 335/1995) states that the transformation coefficients used in the computation of pension benefits, with the contribution based method and the pro-rata method, must be updated every ten years according to economic and demographic evolutions, in particular

Figure 31: GDP growth rate

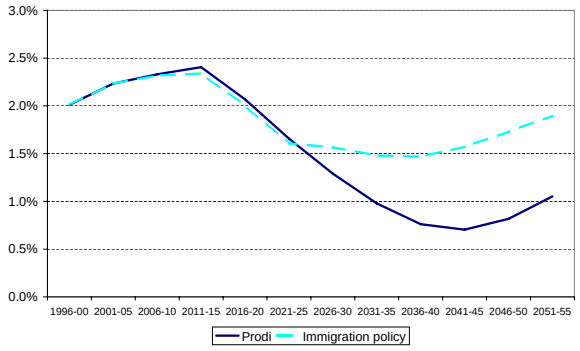


Figure 32: Wage, per unit of effective labor

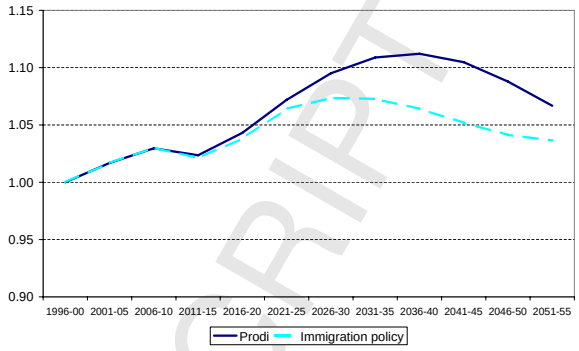


Figure 33: Productivity growth rate

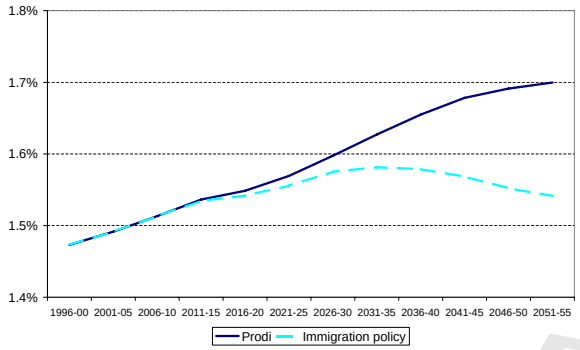
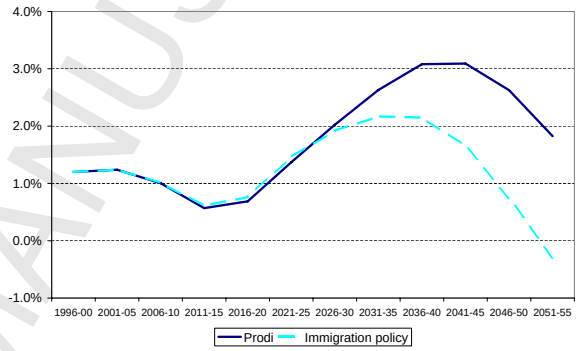


Figure 34: Pension system deficit / GDP



the increase in life expectancy. In 2005, i.e. ten years after the introduction of the Dini reform, no revision of the transformation coefficients were made, reflecting the enormous difficulty, in the Italian political context, to reform the pension system in a way that penalise the retirees.

However, in 2007, the Prodi reform (Law 247/2007) appointed a commission of ten experts supposed to propose new criteria for the determination of the transformation coefficients by December 2008. The new criteria would take into account the macroeconomic and demographic evolutions, the relationship between life expectancy and retirement age, and the persistency of career paths. At the same time the Law 247/2007 introduced new transformation coefficients that thus replace those of 1995[19]. Given that these new coefficients will be applied with the pro-rata method, i.e. starting from 2015, and given the pressure that the national trade unions will exert in next years, the probability that they will be effectively applied without any modifications before 2015 is not so high in our opinion.

In the following simulation we compare the Prodi scenario with a scenario in which we assume that the

[19]The new coefficients are computed by considering data about life expectancy of 2002 (instead of 1990), probabilities to die leaving survivors of 2002 (instead of 1989), surviving spouse's probabilities to die or to get new marriage of 2002 (instead of 1990).

new coefficients introduced by the Law 247/2007 will effectively replace the previous ones. As shown in Table 8, the new coefficients are from 6 to 8% lower than the previous ones, implying a reduction in the same proportion in pension benefits.

	Old coefficients	New coefficients	% variation
57	4.720%	4.419%	-6.4%
58	4.860%	4.538%	-6.6%
59	5.006%	4.664%	-6.8%
60	5.163%	4.798%	-7.1%
61	5.334%	4.940%	-7.4%
62	5.514%	5.093%	-7.6%
63	5.706%	5.257%	-7.9%
64	5.911%	5.432%	-8.1%
65	6.136%	5.620%	-8.4%

Table 8: Transformation coefficients (Law 335/1995 and Law 247/2007)

The macroeconomic effect of a reduction of the generosity of a Pay-As-You-Go pension system are well known: the forward looking behaviour together with the rational expectations hypothesis imply that, when the information is available, agents react to a future reduction in pension benefits by saving more. This induces a better evolution of the ratio between investments and GDP (Figure 35), a greater capital accumulation and a greater economic growth (Figure 36).

Figure 35: Investments / GDP

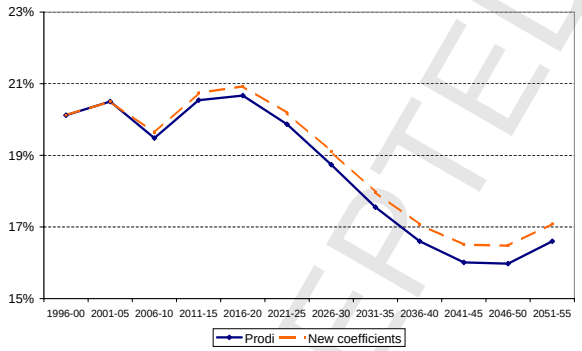
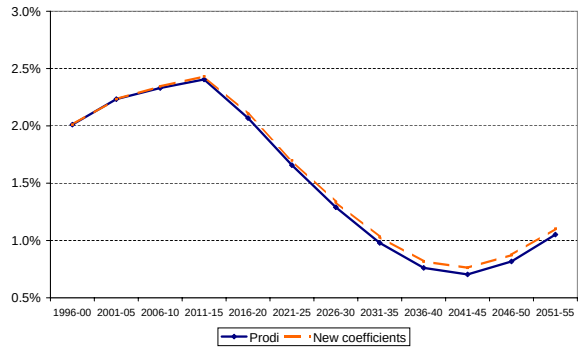


Figure 36: GDP growth rate



The simulation exercise shows (see Figures 37 and 38) that the revision of the transformation coefficients is a good tool in order to guarantee the sustainability of the pension system. In 2055, the pension system deficit would be equal to 0.8%, i.e. a half than in the base case. The results suggest that further revisions of these coefficients would permit to completely solve the financial problems of the Italian pension system.

Figure 37: Pension system deficit / GDP

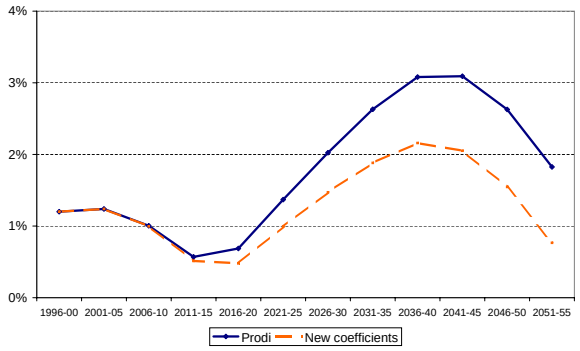
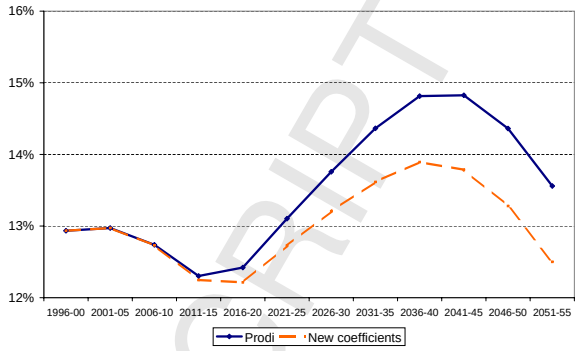


Figure 38: Pension system expenditure / GDP



Clearly, from a political point of view, the problem is that such a policy implies that the burden is completely born by the retirees. Table 9 compares, for native salaried workers, the replacement ratios with and without the revision of the transformation coefficients. For example, in 2055, the reduction of the replacement ratio would be 7% for those who retire at 61, 7.5% for those who retire at 63, and 8% for those who retire at 65. Note that the percentage reductions in the replacement ratios are a little bit less important with respect to the ones displayed in Table 8. This is related to the fact that the reduction of the generosity of the pension system induces a better evolution of wages and GDP allowing a (small) positive effect on pension benefits that partially compensates for the reduction of the transformation coefficients.

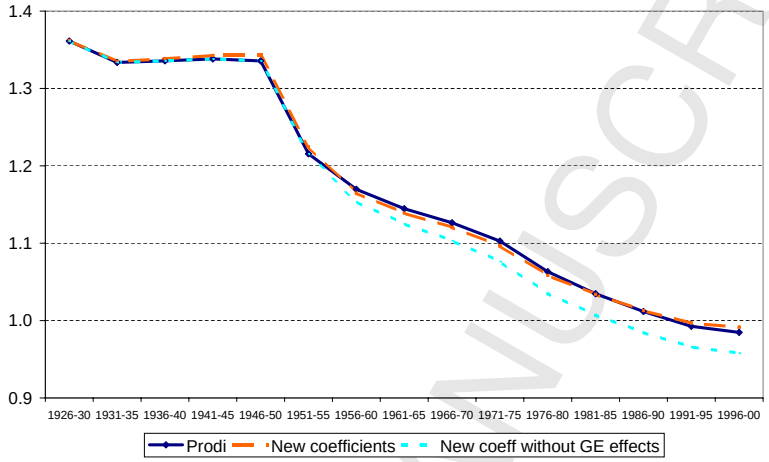
Retirement age	61			63			65		
Years of contributions	39			41			43		
	Prodi	New coeff	% variation	Prodi	New coeff	% variation	Prodi	New coeff	% variation
2006-10	77.5%	77.5%	0.0%	82.1%	82.1%	0.0%	86.8%	86.8%	0.0%
2011-15	77.5%	77.5%	0.0%	81.8%	81.8%	0.0%	86.1%	86.2%	0.1%
2016-20	75.9%	72.9%	-4.0%	83.2%	79.4%	-4.6%	91.6%	86.9%	-5.2%
2021-25	74.4%	70.7%	-4.9%	82.4%	77.9%	-5.5%	91.7%	86.2%	-6.1%
2026-30	71.5%	67.4%	-5.8%	80.1%	75.0%	-6.3%	89.8%	83.6%	-6.9%
2031-35	69.3%	64.4%	-7.2%	78.6%	72.6%	-7.6%	89.4%	82.1%	-8.2%
2036-40	66.8%	62.1%	-7.1%	75.9%	70.1%	-7.6%	86.4%	79.3%	-8.1%
2041-45	63.0%	58.7%	-6.7%	71.6%	66.4%	-7.2%	81.5%	75.2%	-7.8%
2046-50	61.9%	57.8%	-6.6%	70.4%	65.3%	-7.1%	80.1%	73.9%	-7.7%
2051-55	61.8%	57.5%	-7.0%	70.2%	65.0%	-7.5%	79.9%	73.5%	-8.0%

Table 9: Gross replacement ratio; native employees. Source: Author's calculations

It is interesting to note that the generational accounting analysis (Figure 39) shows that the reduction in pension benefits does not penalise future generations with respect to the Prodi scenario, i.e. without the revision of the transformation coefficients. The ratio between the expected present value of the revenues and the expected present value of the payments is essentially the same in the case of the revision of the

transformation coefficients as in the case of the Prodi scenario. This result is due to a general equilibrium effect: the revision of the transformation coefficients, in fact, permits a reduction in pension deficits and then in general taxation. For future generations, the present value of the reduction in pension benefits is equal to the present value of the reduction in taxation. It is clear that if this general equilibrium effect on taxation is neglected, the revision of the coefficients would lead to an important loss for future generations.

Figure 39: Expected present value of revenues / Expected present value of payments



7 Conclusions

The reforms introduced during the Nineties (the Amato reform in 1992 and the Dini reform in 1995) imply a strong penalisation for people who pay low amounts of contributions (in particular people who retire at 57 and self-employed workers). However, these reforms fail to ensure long run solvability of the Italian pension system and, during the transition phase, the pension system would produce deficits as high as 3-5% of GDP. For this reason, in 2004, the Berlusconi government introduced a reform that increases the minimum retirement age to 60 years after 2008. In 2007, the Prodi government replaced the previous reform by a softer one implying that the minimum retirement age is fixed at 58 from 2008 and will gradually increase over time up to 62.

The objective of this paper is to provide an evaluation of the impacts of these reforms by using an applied overlapping-generations general equilibrium model. We show that the increase in the retirement age will induce a significant improvement of the financial conditions of the pension system, but only in the short and in the medium run. After 2040, the positive effect related to the increase in the labour supply, and then in contributions paid by the workers, is compensated by the increase in the value of pension benefits perceived by people forced to postpone retirement. The increase in the retirement age has no positive impact on the financial conditions of the pension system from 2045 onwards, and the pension deficit remains at about 1.7% of GDP in 2055.

From the point of view of equity among generations, the generational accounting approach shows that, with respect to the base scenario, the increase in the retirement age will cause an important loss for the generations forced to work more, especially for the generations born in the periods 1946-1950 and 1951-1955 who receive pension benefits computed with the earning based method.

We have also shown the sensitivity of our results to the hypothesis concerning immigration. In particular, we analysed a scenario in which also the second-generation immigrants displays fertility rates higher then those of natives, and a scenario in which the government introduces an ambitious immigration policy. In both cases, immigration permits to reduce the old-age dependency ratio and can be considered as an instrument that can be used to guarantee the long-term solvability of the pension system.

Finally, we analysed an important aspect of the Dini reform (1995). The transformation coefficients used in the computation of the pension benefits with the pro-rata method and the contribution based method are supposed to be updated every ten years according to the evolution of several elements, especially the increase in life expectancy. In 2005, i.e. when the first revision would have been made and close to national elections, nothing happened. In 2007, the Prodi government proposed new transformation coefficients, but (i) at the same time, the Prodi reform appointed a commission that will propose before December 2008 new criteria for the determination of the transformation coefficients (ii) the transformation coefficients will be applied starting from 2015, i.e. with the pro-rata method. This suggests that the new transformation coefficients are likely to be modified before 2015. In any case, we have shown that the transformation coefficients proposed with the Prodi reform would permit an important reduction in pension deficits. Moreover, even if this implies important income losses for the retirees, a generational accounting analysis shown that the future generations will not be penalised, since the loss in pension benefits will be compensated by a lower taxation.

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