Working Paper Series
Congressional Budget Office
Washington, DC

Early Announcement of a Public Pension Reform in Italy

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January 2006
2006-1

Abstract

There has been much discussion about the need for public pension reforms in most of the Organization for Economic Cooperation and Development (OECD) countries, but what is the macroeconomic impact of announcing reforms in advance? The Italian pension system reform in 1992 represents an illustrative case to address this question. The Italian government announced the pension system reform with the aim of slowing the growth of the system's expenditures by raising the eligibility retirement age. The present paper develops an overlapping generations (OLG) model, with endogenous retirement, in order to analyze the impact of this pre-announced reform on the agents' retirement decision and pensions' expenditure. We calibrate the model to Italian data in 1992 and then we simulate the announcement of a five-period increase in the eligibility age for retirement. The delay between the announcement of the reform and its enactment creates the possibility for eligible individuals to decide whether to retire immediately or keep working under the new public pension system. The model shows that the transition to the new pension system would be characterized by a drop in the employment rate of workers ages 55 and older and explains 77 percent of the actual drop. The model also predicts an 8.25 percent increase in pensions' expenditure, and explains 83 percent of the actual increase. Finally, the welfare analysis highlights a loss for almost all the transitional generations because of the specific structure of the Italian reform and its early announcement.

1 Introduction

This paper analyzes the macroeconomic effects of public pension reforms when they are announced and then enacted with a delay. The illustrative case for the study is Italy in 1992.

In the early 1990s, the pay-as-you-go (PAYG) public pension systems in many European countries experienced significant financial distress due to high dependency ratios (the ratio of workers entitled to social security benefits to those paying payroll taxes). During the 1980s, the Italian public pensions' expenditure as a percentage of gross domestic product (GDP) grew by almost 4 percentage points, from 7.4 percent in 1980 to 11.3 percent in 1991 (Fig. 1). Among other things, the growth in spending in the Italian public pension system stemmed from amendments passed in the 1970s that indexed pensions to nominal wages.[1]

In 1992 and 1993, Italy experienced an economic downturn,[2] and not surprisingly the employment rate (total employment to total population ratio) dropped sharply, by 2.6 percentage points, between 1991 and 1993.

However, a disproportionate part of the drop in the employment rate was accounted for by workers ages 55 and older (Fig. 2). The total employment rate of those 16 to 24, 25 to 40, and 41 to 54 years old declined by 2.8, by 2.1, and by 1.5 percentage points, respectively, between 1991 and 1993. The employment rates for those 55 years and older, instead, fell by 5.0 percentage points[3] and accounted for 44 percent of the entire drop in the total employment rate in those years.

Most of the decline for workers ages 16 to 54 was due to the economic downturn, as had been true during other Italian recessions. However, in earlier recessions there was no comparable drop in the employment rate of

[1] Indexation to nominal wages was introduced in 1975 and this feature increased the burden of the pension system through the 1980s due to the oil price shocks that occurred at the beginning of that decade. Pension benefits increased at regular intervals with nominal wages, i.e. consumer price growth plus real wages growth.

[2] The time frame in which the 1992 reform was announced is dense with negative economic events. The Italian GDP fell by almost 5 percentage points per capita with respect to a 2 percent trend (from 107.0 percent to 102.1 percent). Italy was forced to abandon the European Monetary System because of persistent pressure toward the devaluation of the lira.

[3] In particular, the largest drop in the employment rate for this age band intervened between October 1992 and January 1993, as the labor market quarterly data show.

workers ages 55 and older. Furthermore, if we look at more disaggregated data, the largest drop was among 60- to 65-year-old men (-7.8 percentage points, Fig. 3) and 55- to 59-year-old women (-3.6 percentage points, Fig. 4).

This study suggests that a large part of this decline was due to the early announcement of a major public pension system reform. The reform (known as the "Amato reform" from the name of the prime minister then in charge) was announced on September 5, 1992, but took effect only in February 1993. The reform mainly changed two crucial features concerning the pension system: it raised the eligibility age for retirement (from 60 to 65 for men, and from 55 to 60 for women) and the minimum number of years of contribution by five (from 15 to 20).

The formal announcement focused on the increase in the eligibility age by five years. This announcement affected the retirement decision of several cohorts of the working population, inducing them to retire earlier than planned. In fact, eligible workers received a "time window" to decide whether to keep working or retire at the time of the announcement. This paper shows that announcing an increase in retirement ages may have induced a significant number of older workers to retire early.

Existing analyses of the role of information within a policy reform process can be mainly divided into two branches. In the first, agents receive announcements about the content and the timing of a policy change under the assumption of perfect foresight. Auerbach and Kotlikoff (1987) use this framework in a dynamic fiscal policy model with exogenous retirement to examine questions concerning the announcement's effects on consumption and savings of tax reforms within a social security system. They find that early announcement can significantly alter economic behavior in periods before new tax legislation is enacted, in most cases reversing the intended tax policy goals. In the same framework, Huang, İmrohoroğlu, and Sargent (1997) analyze a pre-announced transition from an unfunded to a fully funded social security system, analyzing the implications of the announcement on consumption and saving in the short as well as in the medium run.

In the second branch of the literature, researchers focus on the anticipation effects of future possible policy shifts and deal with the uncertainty about timing and measures adopted to reform the system, without the perfect foresight assumption. Drazen and Helpman (1990) analyze inflationary effects of an anticipated expansionary monetary policy in the presence of a clearly unsustainable fiscal deficit. Bütler (1999) pointed out how the two dimensions of uncertainty (the content and the timing of a reform) could affect consumption and saving household behavior within a pay-as-you-go public pension system, especially when the pension system is no longer financially viable. Rossi and Visco (1995) provided an empirical study on 1991 cross-section data finding that younger cohorts clearly show an anticipation of a possible pension reform in their saving decisions.

This paper aims to contribute to the first branch of literature, following the perfect foresight approach. It focuses on retirement instead of consumption and saving behavior, and models the retirement decision, making it endogenous. This feature allows the study of the impact of pension reforms when they are enacted with a delay after the formal announcement, since individuals can optimally choose a new retirement age at announcement. In fact, the delay opens a window for a short time when workers are able to change their retirement date planned under the existing system.

The paper extends Auerbach and Kotlikoff's (1987) framework to an endogenous retirement decision and introduces uncertainty in agents' life span. Using an overlapping generations model, the paper analyzes the effects on aggregate labor supply and on pensions' expenditure of the delay between the announcement and the enactment of the pension system reform of 1992 within the Italian PAYG social security system. Three sources of agents' heterogeneity are introduced in order to capture empirical differences in retirement behaviors: gender, age efficiency profile, and health endowment. The model is calibrated to Italian data and then simulated with the announcement of an increase in the eligibility age for normal retirement from 60 to 65 for men and from 55 to 60 for women.

The paper finds that announcing such a reform produces largely undesirable effects, in the short term, on key macroaggregates that contrast with the reform's intended objectives of decreasing pensions' expenditure and increasing the average retirement age. The model predicts that some workers who would otherwise have retired later decide to retire earlier, thus causing employment to fall. It also shows that almost all the transitional generations face a loss in welfare if the reform is announced early. Consistent with the data, the paper shows that the Italian pension system reform of 1992 did not produce the intended reduction in social security spending.

The paper is organized as follows. Section 2 introduces the macroeconomic model. Then, a brief review of the public pension system existing before the reform announcement is presented in Section 3, which also describes the computation of pension benefits. Section 4 presents equilibrium definition for the economy and calibration of the model to Italian data, followed by a description of the results of the announcement simulation and welfare analysis in Section 5. Finally, concluding remarks are given in Section 6.

2 The model economy

Italy is modeled like a small open economy populated by overlapping generations *à la* Auerbach and Kotlikoff (1987) and an infinitely lived government. The agents are rational, forward-looking, and face no liquidity constraints. They are born at age $a = 1$, as 25-year-old people, and live at most until the age $a = T = 65$, as 89-year-old people, facing an exogenous mortality profile. One model period is equivalent to one year. For any variable, a subscript t is for calendar time and superscript a is for age.

Individuals are considered as heterogeneous with respect to gender $g \in \{m, f\}$, namely male and female, and conditional on their gender are heterogeneous with respect to three dimensions. The first one is represented by a gender-specific mortality profile $\psi^{a,g}$. As a second source of heterogeneity, we introduce $\varepsilon^{a,g}$, which represents an age and gender-specific productivity parameter. It is assumed to be constant over time and exogenously taken from an age-efficiency profile computed as in Hansen (1993). Individuals are endowed with one unit of time per period that can be transformed into one unit of leisure or $\varepsilon^{a,g}$ unit of labor l_t^a. Finally, individuals within the same generation and gender are born as ex-ante heterogeneous with respect to their attitude to work, represented by a fixed preference parameter θ, following a known gender-specific distribution Θ^g, as it will be specified in the following.

In every period, supplying labor agents receive $l_t^a \varepsilon^{a,g} w_t$ income, where w_t is the real wage per efficiency unit of labor. They can also invest in two types of assets: physical capital, k_t^a, and government bonds, b_t^a, which deliver a capital income $(k_t^a + b_t^a) r_t$ in each period. Agents pay taxes τ_t, proportional to their labor income, $l_t^a \varepsilon^{a,g} w_t$, to contribute to the pension system (payroll taxes) and collect pension benefits when retired.

They live two stages in their life, labeled as "not eligible" (n_e) and "eligible" (e) for retirement, that also depend on their gender g. During the first stage of life ($a = 1, ..., a_e^g$, where a_e^g is the eligibility age for normal retirement depending on the gender g), the consumer chooses the time allocation between labor and leisure, and decides how much of her income to allocate between consumption and saving. The second stage of the life (the last $T-(a_e^g+1)$ years, $a = a_e^g+1, ..., T$) is characterized by the choice between labor and retirement.

Agents with a different gender do not make joint retirement decisions, and each agent belongs to a one-headed household, for simplicity. There exists a strong empirical evidence by Blau (1998) and Blau and Gilleskie (2001) that older married U.S. couples enjoy spending leisure time together, and thus, jointly decide the optimal retirement age. We abstract from the possibility of a joint retirement decision for two main reasons. First, consistent with the goal of the paper, gender heterogeneity is mainly introduced in the model in order to capture differences in pension rules for men and women within the Italian PAYG system. Second, we do not observe the same U.S. empirical features for Italian households. Weak empirical evidence is provided by Colombino et al. (2003): Italian males and females who are approaching retirement show no strong similarities.

Retirement is considered an absorbing state and a complete withdrawal from the labor market. We set the eligibility age for retirement to be $a_e^m = 35$ (60-year-old) and $a_e^f = 30$ (55-year-old) to match the features of the existing Italian public pension system, as it will be specified in Section 3. A reform that changes the eligibility age for retirement affects the length of the two stages of the consumer's life, and also, the total amount of the pension benefits the individual can get from the eligibility age for retirement, a_e^g, until the end of the life, T.

The government provides a public pension system: it collects payroll taxes from workers and pays pensions to eligible individuals. In order to maintain the balanced budget the government also sets the eligibility age for retirement a_e^g, considered as not mandatory in the model. In the real world, governments cannot determine directly workers' retirement age by mandatory retirement but they can only create incentives to drive the retirement timing decision.

2.1 Demographics

At each date t, a cohort of measure μN_t^1 of gender $g = m$ and one of measure $(1-\mu)N_t^1$ of gender $g = f$ individuals is born and lives at most during periods $t, t+1, ..., t+T$.

They face a certain mortality risk dependent on the age a and gender g, $1 - \psi^{a,g}$, where $\psi^{a,g}$ represents the gender-specific probability of being alive at age a until age $a+1$, conditional on having been alive at age $a-1$, so that $N_{t+1}^{a+1,g} = \psi^{a,g} N_t^a$.

The unconditional stationary[4] probability that a person born at $t-a$ survives to age a is given by $\Psi^{a,g} = \prod_{j=1}^{a} \psi^{j,g}$ such that the population of m and f individuals moves according with the survival probabilities in the following way:

$$\begin{aligned} N_t^{a,m} &= \Psi^{a,m} \mu N_{t-a}^1 \\ N_t^{a,f} &= \Psi^{a,f} (1-\mu) N_{t-a}^1 \end{aligned} \tag{1}$$

The total population of age a at time t is defined by:

$$N_t^a = N_t^{a,m} + N_t^{a,f} \tag{2}$$

Newborn individuals enter the labor market immediately after they are born; hence, defining a population growth rate actually determines the growth rate of potential workers. Assume that γ_t is the path of the population growth rate and $G_t = (1+\gamma_t)$ is the growth factor, the law of motion of the birth of potential workers is $N_t^1 = \prod_{h=1}^{t} G_h \; N_0^1$.

The fraction of population of age a and gender g at time t is represented by:

$$f_t^{a,g} = \frac{\Psi^{a,g} \prod_{h=1}^{t-a} G_h}{\sum_{i=0}^{T} \Psi^{i,g} \prod_{h=1}^{t-i} G_h} \tag{3}$$

While the total population alive of age a and gender g at time t is given by:

$$N_t^{a,g} = \Psi^{a,g} \prod_{h=1}^{t-a} G_h N_0^1 \tag{4}$$

The total population at time t is a sum over all the live age generations:

$$N_t = \sum_{g=m}^{f} \sum_{a=1}^{T} N_t^{a,g} \tag{5}$$

where N_t^a is the number of individuals of age a and gender g alive at time t, according with (*4*).

[4] I abstract from demographic transition by assuming a stationary survival probability given that this is not relevant for the short-run focus of this paper.

2.1.1 Working population aggregates

Total employment[5] L_t, as the total number of agents working at any time t, is obtained aggregating over all the population of different ages a and genders g that either are not eligible to retire ($a \leq a_e^g$) or, if eligible ($a > a_e^g$), have chosen to keep working:

$$L_t = \sum_{g=m}^{f} \sum_{j=1}^{a_e^g} N_t^{j,g} + \sum_{g=m}^{f} \sum_{j=a_e^g+1}^{T} (1 - \varphi_t^{j,g}) N_t^{j,g} \tag{6}$$

where $\varphi_t^{j,g}$ accounts for the fraction of individuals of any age $j > a_e^g$ and gender $g = m, f$ that are retired after the eligibility age a_e^g and is endogenously determined in the model once agents decide the optimal retirement age a_r^*. Individuals are not allowed to retire earlier than this age, no matter how many years they have worked.

The total employment rate e_t is derived as the total employment to the total population ratio, $e_t = L_t / N_t$.

Other aggregates can be useful in order to study the dynamics of the old-age working population after the age $a \geq \min(a_e^m, a_e^f)$. We define the total employment of workers 55 and over at time t as the sum over the working population of age $a \geq 30 = a_e^f$:

$$L_t^{30} = \sum_{j=30}^{a_e^m} N_t^{j,m} + N_t^{a_e^f,m} + \sum_{g=m}^{f} \sum_{j=a_e^g+1}^{T} (1 - \varphi_t^{j,g}) N_t^{j,g} \tag{7}$$

The employment-to-population ratio or *employment rate of 55-and-older* workers at any time t is then obtained as follows:

$$e_t^{30} = L_t^{30} \big/ N_t^{30} \tag{8}$$

normalizing the working population of any age $a \geq 30 = a_e^f$, L^{30}, over the total population of the same age:

$$N_t^{30} = \sum_{j=30}^{T} N_t^j \tag{9}$$

[5] Total employment is computed under the assumption that labor factor is not mobile and is a pure demographic variable abstracting from labor supply measure in efficiency units.

2.2 Preferences

Time t preferences for an age a and gender g individual are given by the following utility function:

$$U^{\theta}(c_t^a, l_t^a) = \log c_t^a + \alpha \log(1 - l_t^a) - d\theta \tag{10}$$

where c_t^a, $(1 - l_t^a)$ are the age a consumer's consumption and leisure and α is the leisure preference parameter. θ is the heterogeneity parameter, drawn from a gender-specific known distribution Θ^g, and accounts for different attitudes with respect to work or different health conditions, as gender and individual specific (see Phelan and Rust, 1997). This source of heterogeneity is able to capture the empirical fact that not all the agents within the same cohort decide to retire at the same age. The d is an indicator function, defined as follows:

$$d = \begin{cases} 1 & \text{if the individual works} \iff l_t^a > 0 \\ 0 & \text{if the individual doesn't work} \iff l_t^a = 0 \end{cases}$$

At any time t gender g newborn consumer maximizes her lifetime utility function over the two stages, n_e and e, and faces a discrete choice problem, "retire" or "keep working", after the eligibility age:

$$\max_{d, a_r, c_t^j, l_t^j, s_{t+1}^j} \sum_{j \in \mathcal{A}} \beta^{j-1} \Psi^{j,g} (\log c_{t+j-1}^j + \alpha \log(1 - l_{t+j-1}^j) - d\theta) \tag{11}$$

the parameter $\beta \in (0, 1)$ is a discount factor capturing intertemporal preferences. The maximization is subject to two kinds of constraint.

1) The *eligibility age constraint,* depending on gender $g \in \{m, f\}$, that is:

$$a_r \geq a_e^g \tag{12}$$

which means that retirement age cannot be less than the eligibility age and at any age $j \in \mathcal{A} = 1, ..., T$.

2) The *budget constraint*:

$$\begin{array}{cc} s_t^1 = 0 & \forall t \\ s_{t+1}^j = s_t^{j-1} R_t + d(1 - \tau_t) \varepsilon^{j,g} w_t l_t^j + (1 - d) P_t^j - c_t^j & \forall t \\ s_t^T = 0 & \forall t \end{array} \tag{13}$$

where s_t^j is the asset holding by an age j individual at the end of any time t and $R(\cdot) = 1 + r(\cdot)$ is the gross return factor from the previous period asset holding. Agents can either invest their savings in physical capital, k_t^j, and government bonds, b_t^j so, at any time t, $s_t^j = k_t^j + b_t^j$. Income from labor in efficiency units is represented by $\varepsilon^{j,g} w_t l_t^j$, net of payroll taxes τ_t, while P_t^j stands for the pension benefits. The model abstracts from the possibility of voluntary bequest, hence $s_t^1 = s_t^T = 0$.

Given their gender g, agents choose the optimal retirement age, a_r^*, and the indicator function d, comparing different levels of utility associated with the budget constraints, depending on different retirement ages such that the consumption and leisure are the *argmax* of the utility function [*11*].

3 The pension system prior to the reform

The main features of the existing public pension system in the early 1990s were established in 1969. The system's resources come mainly from the employers' and employees' contributions (payroll taxes) distributed in an uneven way between the two entities.

In 1992, an employee was paying the 30.7 percent of the total payroll taxes and a further 7.4 percent to a severance pay fund ("Trattamento di Fine Rapporto" or TFR). These contributions were retained by the employer and built up in a fund offering a legal rate of return (1.5 percent plus 75 percent of the annual inflation rate) and providing a lump-sum benefit upon employee retirement. The employer paid the remaining 69.3 percent of the total contributions to the system. The system was set as a pay-as-you-go mainly characterized by two kinds of eligibility requirements in order to receive pension benefits:

1. eligibility requirements for *normal retirement* (old-age pension retirement): being 60 years old for men and 55 years old for women and having worked for at least 15 years.

2. eligibility requirements for *early retirement* (seniority pension retirement): having worked for at least 35 years as a private employee or 20 years as a public employee. The age requirement is irrelevant in this case, and this option clearly represents an incentive to retire earlier than the minimum age set for the old-age retirement.

When eligible, the individual is entitled to pension benefits calculated as a percentage of the last five years (moving) average labor earnings, as will be shown in detail in the following.

3.1 Modeling pension benefits

We model the pension rules for *normal (old-age) retirement* ones as gender dependent, reflecting the law. However, we do not account for TFR contributions and the relative lump-sum benefit when retired since Brugiavini (1999) finds that this kind of benefit does not alter dynamic incentives for the retirement decision. Pension benefits are computed as they were drawn in the Italian public pension system prior to the announcement of the reform in 1992.

The government designs those benefits through a set of *policy rules* $\{b, a_e^g, \nu\}$. The benefits are represented by a fixed percentage of the average labor earnings over an averaging period ν at any time t for each individual of age a. The consumer plans to retire after reaching the eligibility age a_e^g, choosing an optimal retirement age a_r^* and, in doing so, decides the level of *pension benefits* P_t^a, which is related to the earnings by a replacement rate b in the following way:

$$P_t^a = \begin{cases} 0 & \text{if } a < a_r^* \\ b\ A_{\bar{t}}^a & \text{if } a \geq a_r^* \end{cases} \tag{14}$$

where $\bar{t}$ represents the calendar date t, at which the individual plans to retire (such that $a = a_r^*$), and $A_{\bar{t}}^a$ is the average labor earning at time $t = \bar{t}$, over an averaging period ν:

$$A_t^a = \frac{1}{\nu} \sum_{j=a_r-1-\nu}^{a_r-1} \varepsilon^{j,g} w_t\ l_{t+j-a_r}^j \tag{15}$$

At any time $t > \bar{t}$ and age $a > a_r^*$ the individual faces the same pension benefits P_t^a as a function of her choice variable a_r^*, the optimal retirement age, and of government policy parameters $\{a_e^g, \nu\}$, through the average earning function $A_{\bar{t}}^a(a_r^* \geq a_e^g, \nu)$. These benefits are not updated through an indexation rule to a growth rate of wages. Stationary wages are fixed and given in a partial-equilibrium approach, and this feature makes indexation useless. As for the economy's transition after the reform, we are interested in analyzing the impact of the 1992 reform announcement in the short run thus indexation becomes less appealing.

The parameter b is the *policy rule* through which the government decides the replacement rate and is defined as $b = fixrate * a_r^*$, where $fixrate$ was set at 2 percent in Italy, in 1992, and a_r^* here accounts for the number of years worked.

3.2 The government

As mentioned above, the infinitely lived government in this economy only provides a public pension system, in a PAYG form, facing a public pension system's budget at each time t. The government collects payroll taxes from workers, pays pensions to eligible individuals who have decided to retire, and provides a full confiscation of (involuntary) bequests, i.e. collects a 100 percent tax on bequests. The resulting public pension system debt, B_t, in period t is determined by:

$$B_t = R_{t-1}B_{t-1} + P_t - T_t \tag{16}$$

where P_t represents the total pensions' expenditure, at time t:

$$P_t = \sum_{g=m}^{f} \sum_{j=a_e+1}^{T} \varphi_t^{j,g} P_t^j N_t^{j,g} \tag{17}$$

that accounts for the fraction $\varphi_t^{j,g}$ of the population of each gender alive of any age j who decide to retire after the eligibility age a_e^g and the corresponding population at those ages. Conversely, T_t represents the total amount of contributions to the system, collected at time t, as a proportion τ_t of labor earnings from live individuals that are not eligible for retirement $(a \leq a_e^g)$, and from the fraction $(1-\varphi_t^{j,g})$ of those who keep working after the eligibility age $(a_r^* > a_e^g)$. Accidental bequests are collected from individuals whose assets available at the beginning of time t are s_t^{j-1}, and who do not survive at time t.

$$T_t = \tau_t \sum_{g=m}^{f} \sum_{j=1}^{a_e} \varepsilon^{j,g} w_t \; l_t^j N_t^{j,g} + \tau_t \sum_{g=m}^{f} \sum_{j=a_e+1}^{T} (1-\varphi_t^{j,g}) \varepsilon^{j,g} w_t \; l_t^j N_t^{j,g}$$
$$+R_t \sum_{g=m}^{f} \sum_{j=1}^{T} (1-\psi^{j,g}) s_t^{j-1} N_{t-1}^{j-1,g} \tag{18}$$

Given an initial level of the pension system debt, the level of the tax rate τ_t is endogenously determined in the model (in order to maintain the budget in balance) given the population structure as a function of the survival probability distribution and the fraction of individuals who decide to retire, after solving the maximization problem (*11*). The boundary constraint that government debt cannot grow faster than the interest rate, in the long run, is imposed as follows:

$$\sum_{t=0}^{\infty} \left[\prod_{s=0}^{t} R_t^{-1} \right] T_t = \sum_{t=0}^{\infty} \left[\prod_{s=0}^{t} R_t^{-1} \right] P_t + B_0 \tag{19}$$

where B_0 represents the pension system as initial level of debt.

4 Equilibrium definition

A competitive equilibrium for this economy is: a set of *allocations* $\{c_t^{a,g}$, $l_t^{a,g}$, $s_{t+1}^{a,g}\}$, a *retirement age* a_r^g, a *decision rule* d, and a set of *government policies* $\{fixrate$, a_e^g, ν, τ_t,$B_t\}$ s.t.,

for each $a \in \mathcal{A}$, $g \in \{m, f\}$, and θ is distributed according to Θ^g :

1. Given an exogenous path for the population growth γ_t and an exogenous profile for the mortality $\psi^{j,g}$, endogenous population dynamics are generated by (*5*);

2. Given the prices r_t and w_t and the government policy and the initial debt B_1, the allocations, the decision rule, and a_r^g solve the household's maximization problem (*11*);

3. Allocations and government policy satisfy the government budget constraint as in (*16*), at each date t;

The steady state is considered as a particular case of the *equilibrium path* defined in the previous points, where the population grows at a constant rate and aggregate variables grow at a fixed rate.

4.1 Calibration and initial steady state

In order to solve numerically for an initial steady state, we calibrate the model to Italian data before the 1992 announcement of public pension reform, at the beginning of 1992. We pick the set of government policy parameters $\{fixrate,\ a_e^g,\ v\}$ from the set of rules defined for the *normal retirement* (old-age retirement), as described in Section 3. Then, given an exogenous mortality and age-efficiency profile, we calibrate the remaining parameters to match the following main Italian facts:

i) The demographic structure, in accordance with a given dependency ratio (the ratio of workers entitled to public pension benefits to those paying payroll taxes);

ii) The key retirement ages and retirement behaviors;

iii) The capital/output ratio;

iv) Hours worked.

Facts *i)* and *ii)* are crucial for the focus of the paper and they determine how household retirement behavior is affected by the particular pension system. All parameters' values are summarized in the following Table 1a and 1b.

Table 1a: Exogenous parameters

Param.	**Values**	**Definition**
μ	0.495	male population measure (25-year-old) in 1992
$\psi^{a,g}$		gender-specific mortality profile (1991)
$fixrate$	2%	rate to transform years worked into replacement rate in 1992
v	5	averaging period for pensionable income in 1992
τ	0.247	payroll taxes in 1992
a_e^m	35	eligibility age for men in 1992
a_e^f	30	eligibility age for women in 1992
T	65	life span
r	0.062	gross interest rate in 1992 (Hviding and Mérette, 1998)
$\epsilon^{a,g}$		Italian SHIW 1980-91 following Hansen (1993) algorithm

Table 1b: Parameters calibrated to pre-reform data

Param.	**Values**	**Facts to match**
β	0.984	average age-consumption profile
α	1.69	average (men and women) weekly hours worked (32.1)
γ	0.0056	dependency ratio (36.4%)
θ		different retirement ages
Θ^g		gender-specific hazard function (SHIW 1980-1991)

Note: SHIW=Survey on Household Income and Wealth.

4.1.1 Demographic structure

The demographic structure is the result of three leading parameters:

- γ_t, which determines the growth path of the population as a mixed combination of fertility and immigration profiles. The model doesn't distinguish between these two components because the impact of net immigration flows on announcement effects of public pension system changes is weak. The great majority of immigrants are between 20 and 40 years old in many OECD countries. We pick this parameter in order to match, in the initial steady state, the old dependency ratio as it was at the beginning of 1992 (0.364);
- μ, which defines the fraction of the population of gender $g = m$ at the birth. We pick it to match the average gender distribution of 25-year-old individuals within the Italian population prior to 1992;
- $\psi^{a,g}$, which states the age-dependent gender-specific conditional survival probability. We take it according with the mortality profiles issued by ISTAT (Italian National Institute of Statistics) as the population scenarios for the 1990s.

4.1.2 Preference parameters and factor prices

The coefficient α that accounts for the individual's preference for leisure is picked in order to match the observed average weekly hours worked for male population at the beginning of 1992. This drives the parameter to a value of 1.69 to account for 32.1 average hours worked per week.

We get a value of 0.984 for the rate of time preference β used to discount utility over time, taking in consideration the average age consumption profile over the 20 years prior to the announcement and the mortality profile, for a given empirically plausible capital-to-output ratio (3.01).

Finally, we set the exogenous real gross interest rate r to be 0.062 and the real wage rate w per efficiency unit to be 4.5 in the stationary equilibrium of the economy. The stationary age-efficiency profile represented by ε is computed using the Hansen (1993) algorithm on an Italian 10-year sample, 1983-1992, provided by the Bank of Italy's Survey on Household Income and Wealth (SHIW).

4.1.3 The parameter θ

The parameter θ accounts for gender- and individual-specific conditions (e.g.: health conditions) that make the labor supply decision differently costly for agents within the same cohort. Individuals born at the same time t but with different θ choose different optimal retirement ages a_r^{g*}, as observed in the data.

We first deal with the calibration of θ endowment that makes it optimal for individuals to retire at the different ages observed in Italy during the pre-reform period. Hence, we assign a value to $\theta \in \Re_+$ such that men $(g = m)$ within the same cohort decide to retire at different ages: $a_r^{m*} \in \{35, ..., 45\}$ and so do women $(g = f)$, $a_r^{f*} \in \{30, ..., 45\}$[6]. The model deals with 27 types of agents so θ is indexed to the gender $g = m, f$ and to the different retirement ages a_r^{g*}.

Secondly, we distribute these 27 types of agent among the model population according with a distribution Θ^g that matches the model's stationary fraction of the retired workers at each age of both genders, $h^{g,a}$, to actual *hazard functions* for men $(g = m)$ and women $(g = f)$. The actual and the model stationary hazard functions are displayed in Fig. 5, for both genders. These functions are computed as the ratio between the number of eligible individuals of a certain age who retire and the number of workers of the same age. The actual hazard function is computed using the 10-year sample (1983-92) provided by the Bank of Italy's SHIW. The men's hazard appears to be more regular and well represented by the four-peak calibrated one, while the females' hazard shows a less regular behavior.

4.1.4 Pension benefits

In order to define the public pension system described in Section 3 we pick some parameters $\{fixrate,\ a_e^g,\ \nu, \tau_t\}$ as the government policy rules and we set the initial level of the public pension system debt B_1 in order to match the one in 1992.

[6] We assume that all the population is retired when 70 years old ($a = 45$ in the model), according to the empirical cumulative distribution function by Brugiavini and Peracchi (2000).

The eligibility age for old-age pension retirement a_e^m is chosen to be 35 (as a 60-year-old individual, given the assumption of agents born as a 25-year-old) and a_e^f is chosen to be 30 (as a 55-year-old individual).

The averaging period ν that transforms the cumulative income into pensionable income is set to five so the pensionable income is obtained from a five-year (moving) average labor earning.

Finally, the coefficient applied to the number of years worked in order to get the final replacement rate, $fixrate$, takes the value of 2 percent.

4.2 Computational insights

To solve the model and conduct our experiment, we adopt the following procedure. First, we compute the decision rules in the presence of a stationary unfunded public pension system, as described in Section 3. For given r and w, the algorithm solves for the equilibrium conditions such that consumers maximize their expected utility, choose an optimal retirement age a_r^*, and the stationary government budget equation is satisfied at each time t.

Second, using the resulting decision rules, we analyze the impact of the experiment of announcing a future raise of the eligibility age by five years. On the basis of those decision rules, agents have a certain amount of assets at any point t in the calendar time and at any age a, consistent with an optimal retirement age a_r^*, chosen facing the existing eligibility age ($a_e^g \in \{35, 30\}$). The announcement of a future raise in the eligibility age in a perfect foresight environment induces agents to solve again the maximization problem over their remaining life with new eligibility age constraints and given a certain asset accumulation. Furthermore, the fraction $(1 - \varphi_t^{j,g})$ of workers matching the current pension system eligibility age at time t can decide whether to retire immediately, after the announcement (i.e. changing their optimal retirement age), or to continue to work undergoing the new retirement rules.

5 Experiment: simulation of the reform announcement

Before a certain point in time $t = 0 = t_R$, the economy is assumed to be in the initial stationary equilibrium described in Section 4. In September 1992, that is the $t = 0$, the Italian government announced the intention to pass, for (September) 1993, that is $t + 1$, a pension reform that will change the eligibility age for *normal retirement* a_e^g, raising it by *five* periods (years) for both genders m and f.

Let $a_e^{R,g}$ define the new eligibility age announced at time $t = 0 = t_R$, such that now $a_e^{R,m} = 40$ and $a_e^{R,f} = 35$.

The change will occur after $t + 1$, and the eligibility age will remain constant at $a_e^{R,g}$ through a transition period and forever. For simplicity, we assume that the reform will interest all agents, ignoring the fact that the eligibility age does not affect the retirement decision of those who have already worked for 35 periods (years) or more, and could strike the early retirement option, as the model mainly considers the pension system rules for normal (old-age) retirement.[7] As in Bütler (1999), we abstract from dealing with any sort of grandfathering rights for the aged workers. This choice is mainly related to the difficulty to model different expectations of the elderly with respect to the announcement[8], and is equivalent to set those expectations to the worst possible scenario: the sudden five-period raise in the eligibility age. The perspective of a future reform that does not account for some degree of preserving benefits claims for the elderly actually implies a transition that shifts the burden from the current young generation to the current old one.

The transition is characterized by the fact that consumers born between $-T+t$ and 0 (and still alive at $t = 0$) were surprised by the announcement at that date, and they planned the future on the basis of a different constraint set, represented by the government policy parameter$\{a_e^g\}$. Now they solve their maximization problem starting in $t = 0$, taking their level of assets, $s_{t=0}^{a-1}$, and cumulative income, $A_{t=0}^a$, as given from the past. Two main issues are interesting to analyze: the reaction of "surprised" people, born between

[7] Furthermore, the Italian government suspended the possibility to apply for early retirement from September 1992 until December 1993.

[8] The Septemeber 1992 announcement did not specify the treatment of the different cohorts within the Italian working population.

$-T+t$ and 0, at time $t=0$ to the announcement (what we defined as the "announcement effect") and the transition of the economy in the short run. The analysis mainly focuses on the short-term effect because, during 1995, the Italian pension system was amended with a new reform. The number of surprised individuals at $t=0$ is given by those born between $-T+t$ and 0:

$$N_{t=0} = \sum_{g=m}^{f} \sum_{j=1}^{-T+t} N_{t-j}^{0,g} \tag{20}$$

The announcement influences live agents whose optimal age of retirement a_r^*, based on the previous system's eligibility age constraint, lies in the interval $\{a_e^g, ..., a_e^{R,g}\}$.

Those agents can be divided into three sets, represented by the three regions in Fig. 3, depending on their age a and on their optimal age of retirement a_r^{g*}. When the announcement is given, each agent, belonging to each of those sets, solves a maximization problem characterizing the discrete choice to "retire immediately" or "keep working" (or, i.e., retire under the old system or under the new system). We discuss the details of the problem in the appendix.

5.1 Results

The simulation of the 1992 announcement produces large effects in the economy affecting the individuals' retirement decisions. Fig. 6 and Table 2 show the short-term impact of the simulation on the employment and pension system aggregates. The announcement generates an increase in the fraction of total workers retired (h) between time t and time $t+1$. This fraction increases from 0.344 to 0.361, between time $t=0$ (1992) and $t+1=1$ (1993).

In the model, agents can move from the employed state to the unemployed one only if they retire. A predicted increase in the retirement rate leads to a predicted drop in the *total employment rate*, Δe, as shown in Table 2.

Tables 3a and 3b show how the increase in the fraction of retired workers is distributed among the male $(g=m)$ and female $(g=f)$ populations and the age groups that changed their retirement behavior through the model hazard functions or fractions of retired workers $(h^{g,a})$. To simplify the presentation, we refer to the calendar age[9] instead of model age a when describing the agents' retirement behavior after the announcement.

Those males surprised by the announcement who choose a different retirement age are those 60 years old at the time of the announcement in 1992 (61 years old in 1993), whose optimal retirement age is either 61, 62, or 63 years old. If they do not retire at age 60 at the time of the announcement they will not be allowed to retire at 61, 62, 63 under the new system, but only after age 65.

A similar problem is faced by individuals age 61 at the time of the announcement (62 years old in 1993), whose optimal retirement age is either 62 or 63, and those 62 years old at the time of the announcement (63 years old in 1993), whose optimal retirement age is 63. Individuals age 60 at the time of the announcement, planning to retire at 64, do not retire immediately since the result of the optimization problem still makes them better off retiring at 65 instead of 60.

A comparable mechanism can explain the retirement behavior of the females.

Because of the increase in the retired population, the model predicts a transition characterized by a drop in total employment of workers ages 55 and older and an increase in the pensions' expenditure. The drop in the number of 55-and-older workers, ΔL^{30}, between time t and time $t+1$ [10], is able to explain roughly 75 percent of the actual drop in the number of 55-and-older workers in 1992-93. Because of it, the model predicts a drop in the employment rate of 55-and-older workers, Δe^{30}, of 3.88 percentage points[11], able to explain 77 percent of the observed one. The model also generates predictions that almost replicate the observed dynamics for the employment

[9] That is the age counting from the birth rather than from the entry in the model. Agents enter in the model only when they are 25 years old.

[10] The reform's timing and its effect on aggregate employment data overlap two years, 1992 and 1993, so I compare model predictions between t and $t+1$ with these two years' data.

[11] We conduct a sensitivity analysis of the simulation results to different levels of individuals preference for leisure. The range of the parameter values considered in the analysis is $[1.69, 1.3]$. We find that if α falls to 1.3, the drop in employment for workers 55 and older, Δe^{30}, falls by 27.5 percent, from 3.88 percentage points to 2.81 percentage points, still explaining 56 percent of the actual drop. A value of α equal to 1.3 implies an unrealistic measure for the average number of hours worked per week: 48. For this reason we do not try for values less than 1.3. Even with a very low preference parameter for leisure the model still predicts a relevant effect of the reform's early announcement.

rate for men and women ages 55 and older (Fig. 7).

Employment dynamics, though, were highly affected by the negative economic downturn that characterized the Italian economy in 1992. The downturn probably hit all the employment age bands but, as we mentioned, the observed drop was concentrated on 55-and-older workers. The model's goal is to explain how the announcement of a future increase in the eligibility age for retirement can account for the *difference* between the drop in employment of those 55 and older and the other age bands' drops, shown in Fig. 2. It ends up, instead, explaining the great majority of the employment dynamics for the elderly.

Consequently, the predicted increase in *pensions' expenditure* ($\Delta P/P$) in 1992-1993, determined by the increased fraction φ of individuals retired after the eligibility age, results very high. The increase accounts for about 83 percent of the actual one, while the business cycle and inflation were among the main factors responsible for such an increase.[12] Many workers, for example, were forced by their employers to retire early because of the recession, not because of the reform announcement.

The main reason why the simulated announcement can create a larger effect on employment comes from the model's public pension rules. As already mentioned, the model's public pension rules do not account for the possibility of retiring early with a seniority pension. The announcement didn't actually affect the retirement decision of individuals who had already worked for more than 35 years (seniority pension requirements), no matter their age. Those individuals were not affected by a possible five-year increase in the eligibility age for old-age retirement but could have been among the ones forced to retire early because of the business cycle.

[12] The model does not account either for inflation or for the business cycle.

Table 2: Simulation of the announcement of a five-year increase in the eligibility age for normal retirement: macroeconomic effects

Variable change	**Data (1992-1993)**	**Model [1992-1993]**
h (total fraction of retired workers)	0.344	0.361
ΔL^{30} (number of workers, in thousands)	-361.83	-270.52
Δe^{30} (empl. rate 55 and older)	-5.04	-3.88
$\Delta e^{30,m}$(empl. rate 55 and older, males)	-6.72	-4.98
$\Delta e^{30,f}$ (empl. rate 55 and older, females)	-2.22	-1.63
Δe (total empl. rate)	-2.55	-0.90
$\Delta P / P$ (%) (pensions' expenditure)	9.87	8.25

Table 3: Change fraction of retired workers by age group and gender ($h^{a,g}$) in the model: announcement effect

	$g = m$ (males)	
	1992	*1993*
h^{35}(60 year old)	0.61	0.61
h^{36}(61 year old)	0.40	0.56
h^{37}(62 year old)	0.39	0.56
h^{38}(63 year old)	0.20	0.29
h^{39}(64 year old)	0.21	0.21
h^{40}(65 year old)	0.45	0.45
h^{41}(66 year old)	0.37	0.37
h^{42}(67 year old)	0.41	0.41
h^{43}(68 year old)	0.32	0.32
h^{44}(69 year old)	0.41	0.41
h^{45}(70 year old)	1	1

	$g = f$ (females)	
	1992	*1993*
h^{30}(55 year old)	0.29	0.29
h^{31}(56 year old)	0.28	0.48
h^{32}(57 year old)	0.19	0.29
h^{33}(58 year old)	0.18	0.31
h^{34}(59 year old)	0.16	0.16
h^{35}(60 year old)	0.43	0.43
h^{36}(61 year old)	0.20	0.20
h^{37}(62 year old)	0.16	0.16
h^{38}(63 year old)	0.21	0.21
h^{39}(64 year old)	0.16	0.16
h^{40}(65 year old)	0.32	0.32
h^{41}(66 year old)	0.15	0.15
h^{42}(67 year old)	0.14	0.14
h^{43}(68 year old)	0.28	0.28
h^{44}(69 year old)	0.3	0.3
h^{45}(70 year old)	1	1

5.1.1 Welfare analysis

In this section we discuss the implications of an early announcement of the Italian reform for the intergenerational redistribution of welfare during the transition. The reform *per se* alters the utility level of each cohort, alive at the time of the announcement, since they made retirement plans conditional on the previous pension system.

We compare welfare gains and losses for transitional generations when the reform is immediately enacted (benchmark case) with the ones that appear when the reform is announced in advance (preannounced case). In order to make this comparison, we measure welfare gains and losses as the fraction ζ of the full lifetime resources needed under the original pension system to generate the same level of lifetime utility achieved with the new system (i.e. new eligibility age). Under the hypothesis of a homothetic utility function, ζ is defined as follows:

$$\sum_{j=a}^{T} \beta^{j-1} \Psi^{j,g} u(\zeta c^{j}_{t+j-1}, \zeta(1 - l^{j}_{t+j-1})) = \widehat{u} \tag{21}$$

$$\zeta = \left[\left(\frac{\widehat{u}}{\overline{u}} \right) \right] \tag{22}$$

where $\overline{u}$ and $\widehat{u}$ are, respectively, the level of lifetime utility under the current system and the new system.

We take two interesting types of agents to analyze welfare effects during the transition: agents whose θ type makes them choose as optimal retirement age $a_r^{g*} = \{35, 40\}$ and whose gender is $g = m$[13]. The mechanics driving the welfare outcomes of these two agent types can be easily extended to others whose optimal retirement age is:

$$a_r^{m*} \in \{a_r^{m*} : a_r^{m*} = 36, ..., 39\} \cup \{a_r^{m*} : a_r^{m*} = 41, ..., 50\} \tag{23}$$

Fig. 8 and Fig. 9 report the findings of the analysis for agents whose optimal retirement age is $a_r^{m*} = \{35, 40\}$ (60 and 65 years old). They display, on the vertical axis, the measure of the welfare gains and losses, comparing the

[13]Symmetrically we can consider the cases of a gender $g = f$ agent whose optimal retirement age on the basis of the θ type is $a_r^{f*} = \{30, 35\}$.

benchmark case of an immediate reform that raises the eligibility age by five years (dashed line) with the case of the same reform (five-year increase in the eligibility age) but preannounced and enacted with a one-year delay (solid line).

Firstly, with a few exceptions, the announcement (dashed line) makes the transitional generations worse off. Agents whose age allows them to retire immediately are the only ones made better off by the early announcement. They can benefit, in fact, from a "time window" in which to decide whether to enter into the new system or not.

Fig. 8 displays this mechanism for the agent type planning to retire at $a_r^{m*} = 35$ (60 years old) under the existing system. This agent type is hit the most by the reform with respect to others whose optimal retirement age is $a_r^{m*} \in \{36, ..., 39\}$, and is made even worse off if the reform is announced early. As we said, all the generations are then made worse off by the announcement, except for the agents whose age allows them to retire at the time of the announcement: $a = 35$ (60 years old) in $t = 0$ (1992). This cohort is indifferent when the reform is announced early (solid line), while it would be worse off in the case of an immediate and non-preannounced reform (dashed line). In the latter case, in fact, they cannot retire at age $a = 35$ (60 years old) in $t = 0$ (1992), as planned, since an immediate enactment of a new retirement age would not allow them to retire earlier than $a = 40$ (65 years old).

For the other generations, which cannot retire at the time of the announcement but whose optimal retirement age was $a_r^{m*} = 35$ (60 years old), Fig. 8 displays two driving forces, affecting the welfare outcomes:

1. As mentioned in the previous section, after the announcement, some cohorts decided to retire earlier than the planned age. This drop in employment boosts payroll taxes for the working generations during the transition, due to the increase in pensions' expenditure.

2. The second force that directly reduces the agents' welfare is the disutility of working five years more than the optimal decided under the previous system. Based on that optimal retirement age, in fact, workers decided (depending on the generation) their asset accumulation.

While the first effect on the life-time utility of the reform reduces welfare only if the reform is preannounced, this second effect reduces welfare in both the benchmark (immediate) case and the preannounced case.

The five-year increase in the eligibility age boosts the welfare of agents whose optimal retirement age a_r^{m*} was already 40 (65 years old) in case the reform is immediately enacted (dashed line, Fig. 9). The reason is the dampening effect on payroll taxes. On the contrary, if the reform is enacted with a delay (preannounced, solid line in Fig. 9), the same agents face a welfare loss due to the increase in payroll taxes. As already mentioned, the latter effect is caused by the fact that many of those aged $a = 35$ (60 years old) in $t = 0$ (1992), whose optimal retirement age under the previous system was $a_r^{m*} \in \{36, ..., 39\}$, retire earlier, at the time of the announcement.

6 Concluding remarks

We develop an overlapping generations model *à la* Auerbach and Kotlikoff (1987) with endogenous retirement to analyze the macroeconomic effects of a preannounced public pension reform of the Italian pay-as-you-go public pension system in 1992. Three sources of ex-ante heterogeneity are introduced to model the system of incentives designed by the existing public pension regime: gender, age efficiency profile, and health endowment. These features capture different retirement behaviors of individuals belonging to the same cohort but characterized by different gender and individual characteristics, such as health conditions.

We calibrate the model to Italian data to set the economy at the initial steady state in 1992 ($t = 0$). Then, we simulate the announcement in 1992 ($t = 0$) of a five-period increase in the eligibility age for retirement enacted with a one-year delay, in 1993 ($t = 1$).

The delay between the announcement of the reform and its enactment enables eligible individuals to assess how the reform will affect them and choose an earlier retirement date than they had planned. They need to decide between retiring immediately or keeping working under the new public pension system, which implies a new eligibility age. Some workers who planned to retire before this new eligibility age will not be able to do so if they decide to keep working. After solving their maximization problem with the new rules, we find that many eligible workers in the model decide to retire at announcement.

For this reason, the transition to the new pension system is characterized in the short term by a drop in the employment rate of 55-and-older workers that explains 77 percent of the actual one. The model also predicts a 8.25 percent increase in pensions' expenditure, which explains 83 percent of the actual one. Finally, the welfare analysis highlights a loss for almost all the transitional generations when the reform is announced early.

The main economic message of the paper is that preannounced pension reforms can deeply affect economic behavior prior to the implementation of the new policy in the short run as well as in the medium run, because of the absorbing state of retirement. A given reform announcement can induce behavioral changes that affect some of the economic gains of the reform itself. As we showed in the Italian case, the time between the announcement and the enactment of the new legislation allowed individuals to change their retirement choices. This reduced the intended effect of mitigating the pensions' expenditure because it increased the number of retired individuals collecting benefits and increased the length of time that participants drew those benefits.

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7 Appendix

7.1 Agents' maximization problem after the announcement

Model individuals can be divided into three sets in order to analyze the announcement effect of the 1992 reform on their retirement behavior.

Agents not eligible for retirement at time $t = 0$ belong to a first set, $\mathbb{N}_1 \equiv \{N^{a,g}_{t=0} : a < a^g_e \in \{35, 30\}, a^{*,g}_r \in \mathcal{A}^{\mathcal{R},g}\}$, where $a^{*,g}_r$ and $\mathcal{A}^{\mathcal{R},g} = \{a^g_e, ..., a^{R,g}_e\}$. They optimize over their remaining expected life, conditioned to be alive at age a, facing a new eligibility age constraint $a^{R,g}_e$ and taking the initial assets $s^{a-1}_{t=0} > 0$ as given in (*13*).

$$\max_{d, a_r, c^j_t, l^j_t, s^j_{t+1}} E\{\sum_{j=a}^{T} \beta^{j-1} U^{\theta}(c^j_{t+j-1}, l^j_{t+j-1})\} \tag{24}$$

The maximization is subject to the new *eligibility age constraint*:

$$a_r \geq a^{R,g}_e \tag{25}$$

(retirement age cannot be less than the new announced eligibility age $a^{R,g}_e$) and, at any age $j \in \{a, ..., T\}$ with $a < a^g_e \in \{35, 30\}$, to the *budget constraint*:

$$\begin{array}{rlr} & s^{j-1}_t[a^{*g}_r(\theta)] > 0 & t = 0 \\ s^j_{t+1} = & s^{j-1}_t R_{t-1} + d(1-\tau_t)\varepsilon^{j,g} w_t l^j_t + (1-d)P^j_t - c^j_t & \forall t \\ & s^T_t = 0 & \forall t \end{array} \tag{26}$$

The second set of the population consists of agents that at time $t = 0$ are eligible according to the previous eligibility age, hence $\mathbb{N}_2 \equiv \{N^{a,g}_{t=0} : a^g_e \in \{35, 30\} \leq a < a^{R,g}_e \in \{40, 35\}, a^{*,g}_r \in \mathcal{A}^{\mathcal{R},g}\}$. Those individuals have the possibility to choose between retiring immediately or keep working. If they decide to keep working, retirement must be postponed after the new eligibility age $a^{R,g}_e$. This sort of indivisibility mainly affects the decision of eligible agents ($a \geq a_e^g \in \{35, 30\}$) in $t = 0$ whose optimal retirement age, conditional on their type θ, is $a_r^{*,m} = \{36, 37, 38, 39\}$ and $a_r^{*,f} = \{31, 32, 33, 34\}$.[14] Those consumers at age a in $t = 0$ compare the optimal value functions delivered by the two options: retire immediately or keep working. Thus, defining preferences recursively, the Bellman equation for the household's optimization problem is given by:

$$W^a(s_t^{a-1}, A_t^a) = \max\{W_r^a(s_t^{a-1}, A_{t=0}^a), W_l^a(s_t^{a-1}, A_t^a)\} \tag{27}$$

where A_t^a is the cumulative income function used to compute pension benefits, described in Section 3, and W_r^a represents the value function associated to the retirement at age a in $t = 0$. It represents the value function associated to $(a_r^{R,g})^* = a$ if $(a_r^{R,g})^*$ is defined as the new optimal retirement age (immediate retirement). Hence:

$$W_r^a(s_t^{a-1}, A_{t=0}^a) = \max_{c_t^j, s_{t+1}^j} \{U^\theta(c_t^a) + \beta E[W_r^{a+1}(s_{t+1}^a)]\} \tag{28}$$

subject to:

$$\begin{array}{rlr} s_t^{a-1}[a_r^{g*}(\theta)] > 0 & & t = 0 \\ s_{t+1}^a = s_t^{a-1} R_{t-1} + P_t^a - c_t^a & & \forall t \\ s_t^T = 0 & & \forall t \end{array} \tag{29}$$

where $s_{t=0}^{a-1}[a_r^{g*}(\theta)]$ is the level of the consumer's asset holding at the end of age $a - 1$, taken as given in the maximization problem at the beginning of age a and time $t = 0$. This level is conditional on the retirement age $a_r^{g*}(\theta)$, as a function of the agent type θ, chosen to be optimal under the previous steady-state pension system.

W_l^a in (27) is the value function associated at time $t = 0$ to the choice of keep working and to the new eligibility age constraint $a_e^{R,g} \in \{40, 35\}$. If the individual keeps working then the possibility to retire is shifted by

[14] In fact, m individuals whose optimal retirement age is $a_r^* = 35$ are actually not affected by the announced raise of the eligibility age. If their age is $a = a_e$ at $t = 0$ they retire immediately as they already planned to do. If, conversely, their age is $a_e = 35 < a < a_e^R = 40$ at $t = 0$ they are already retired. The same reasoning could be extended to f individuals.

five periods, given the new eligibility age constraint associated to the future reform. The following value function accounts for this:

$$W_l^a(s_t^{a-1}, A_t^a) = \max_{a_r^R \geq a_e^{R,g}, c_t^j, l_t^j, s_{t+1}^j} \{U^\theta(c_t^a) + \beta E[W^{a+1}(s_{t+1}^a, A_{t+1}^{a+1})]\} \tag{30}$$

subject to:

$$\begin{array}{cr} [s_t^{j-1} \diagup a_r^*(\theta)] > 0 & t = 0 \\ s_{t+1}^j = s_t^{j-1} R_{t-1} + d(1-\tau_t)\varepsilon^{j,g} w_t l_t^j + (1-d)P_t^j - c_t^j & \forall t \\ s_t^T = 0 & \forall t \end{array} \tag{31}$$

where A_t^a, the cumulative income function used to compute the pension benefits, represents a state variable for the consumer optimization problem.

The discrete choice problem characterized by (*27*) determines the new fraction $\varphi^{R,g}$ of individuals retired after the eligibility age, or i.e. the retirement rate.

Finally agents belonging to the third set $\mathbb{N}_3 \equiv \{N_{t=0}^{a,g} : a \geq a_e^{R,g} \in \{40, 35\}\}$ were not affected by the announcement because either they are already retired or their optimal retirement age is $a_r^{*,g} \geq a_e^{R,g}$.

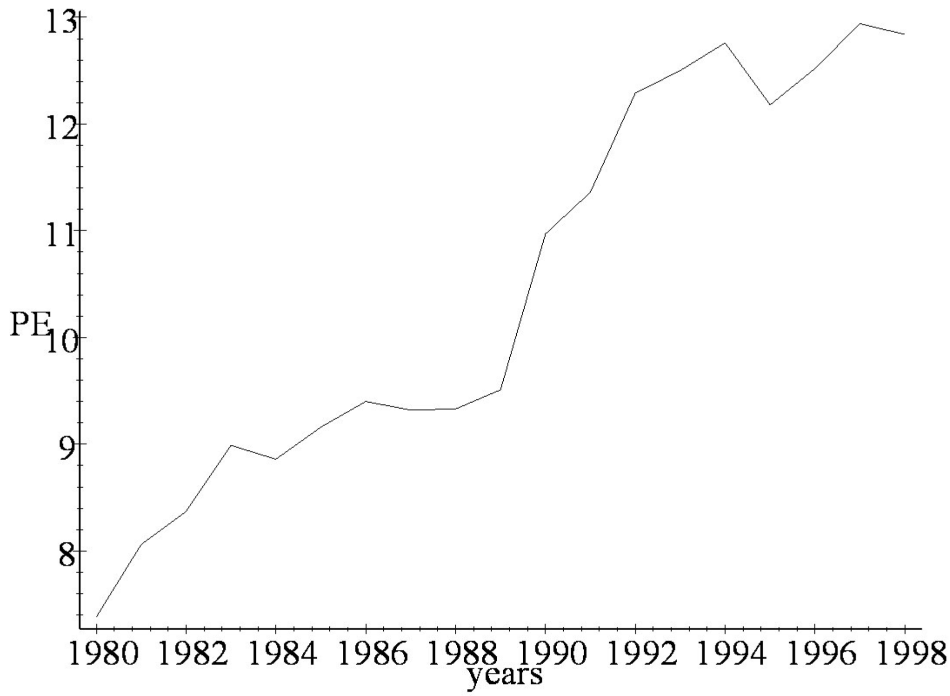

Fig. 1: Pensions' Expenditure (PE) (% of GDP) - Italy 1980-98.
Source: OECD Social Expenditure Database.

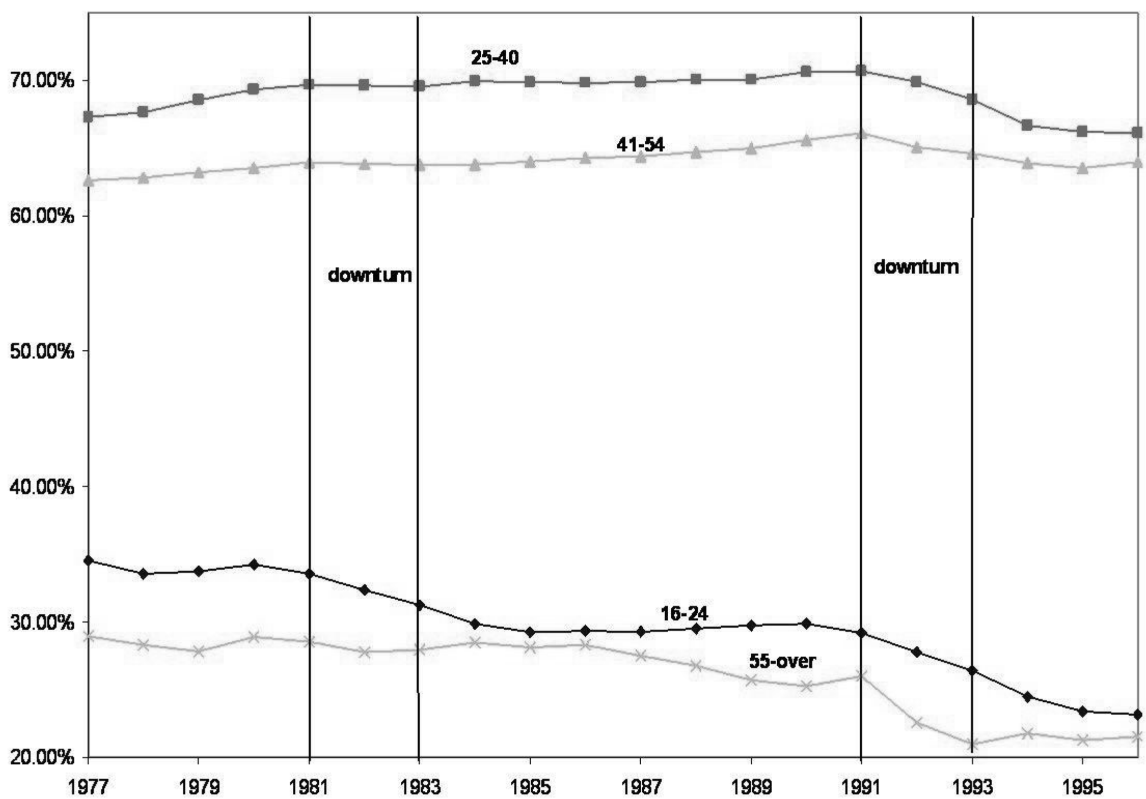

Fig. 2: Employment rate broken down in four age bands. Italy 1977-96.
Source: ISTAT.

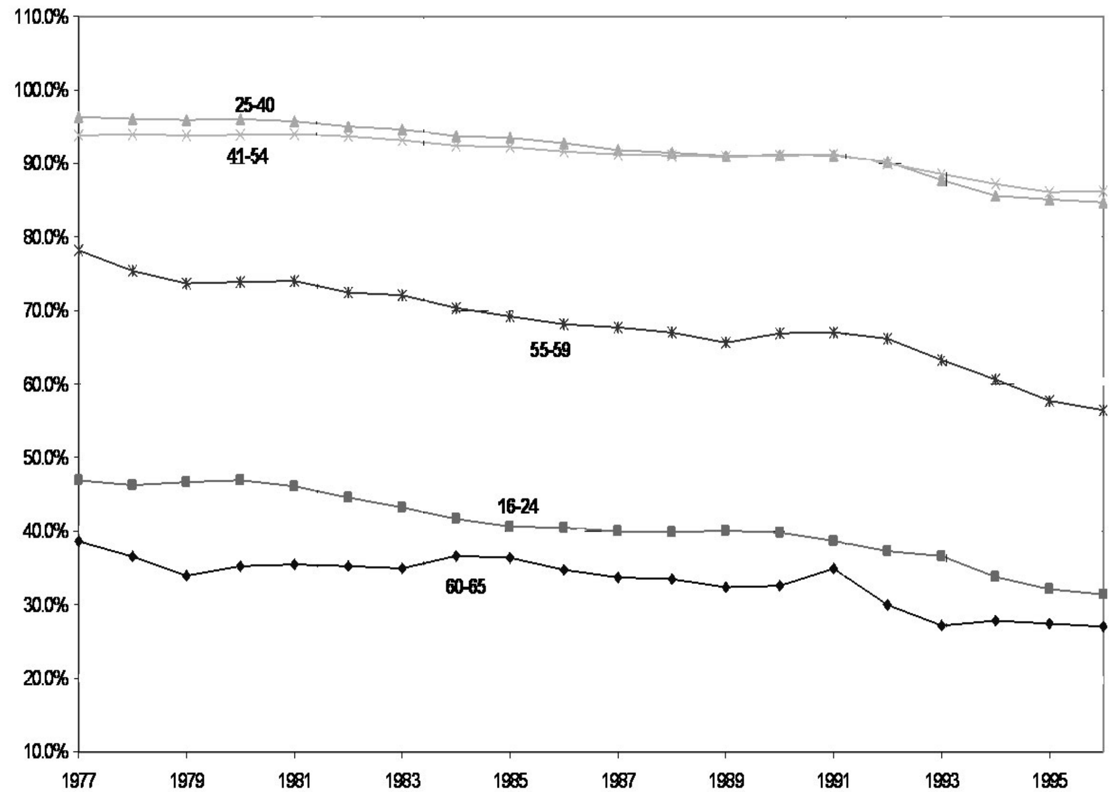

Fig. 3: Employment rate broken down in four age bands (men). Italy 1977-96.

Source: ISTAT.

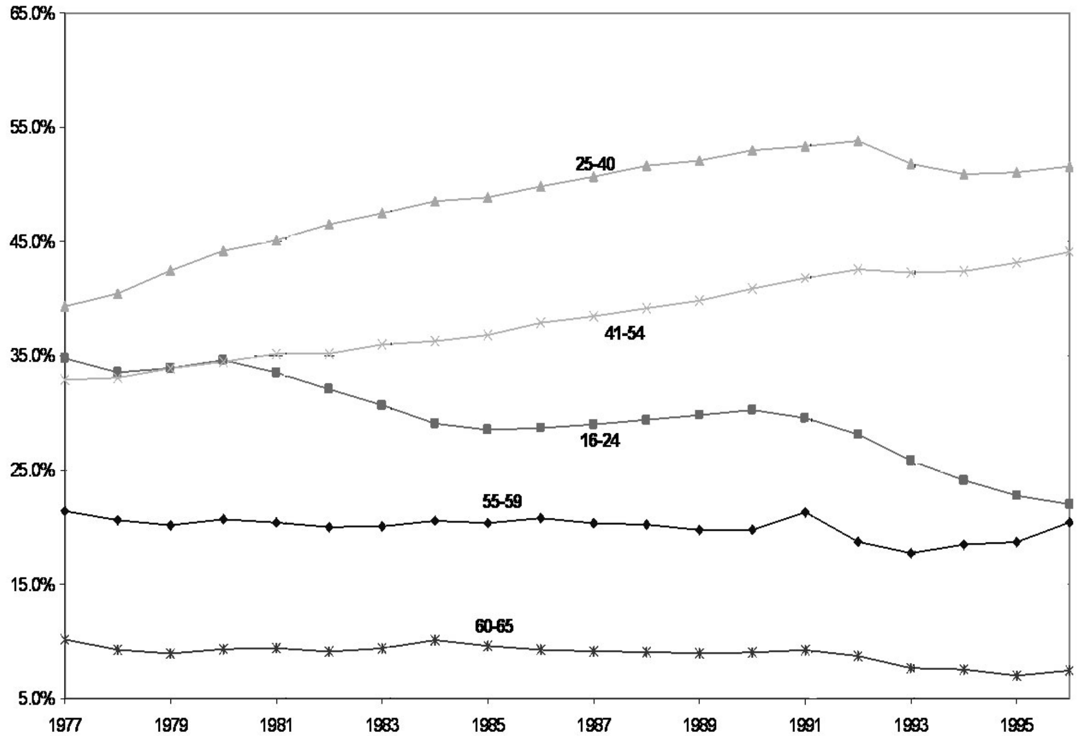

Fig. 4: Employment rate broken down in four age bands (women). Italy 1977-96.

Source: ISTAT.

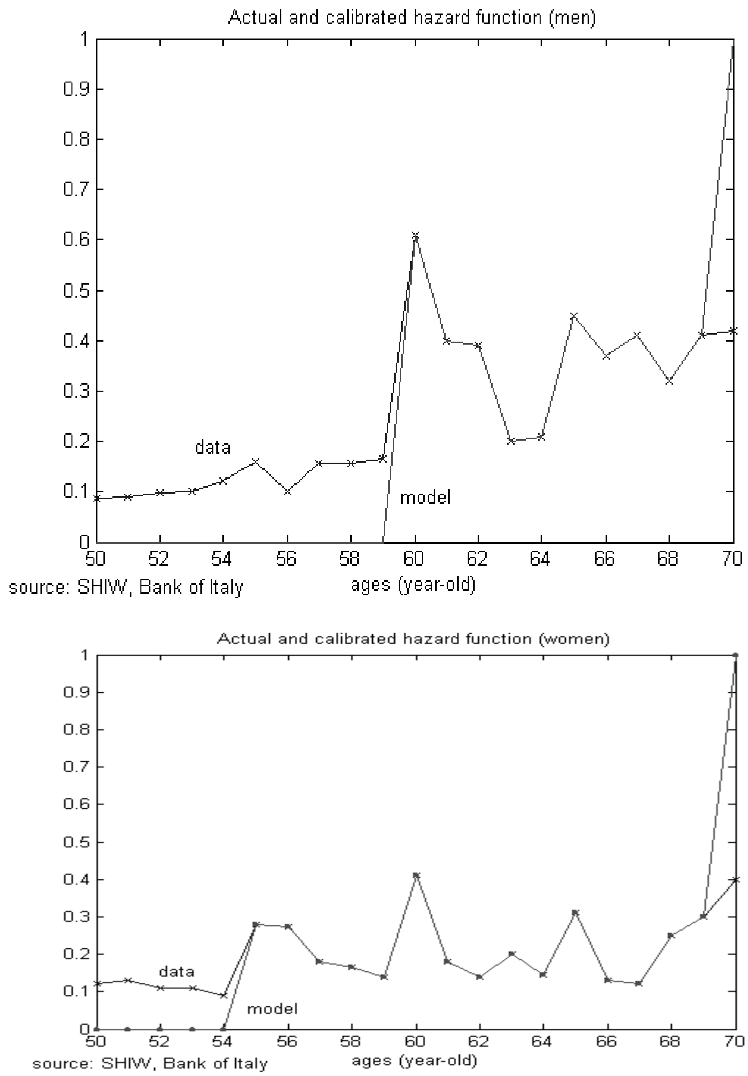

Fig. 5: Raw hazard function, Italy 1983–92 (men and women).

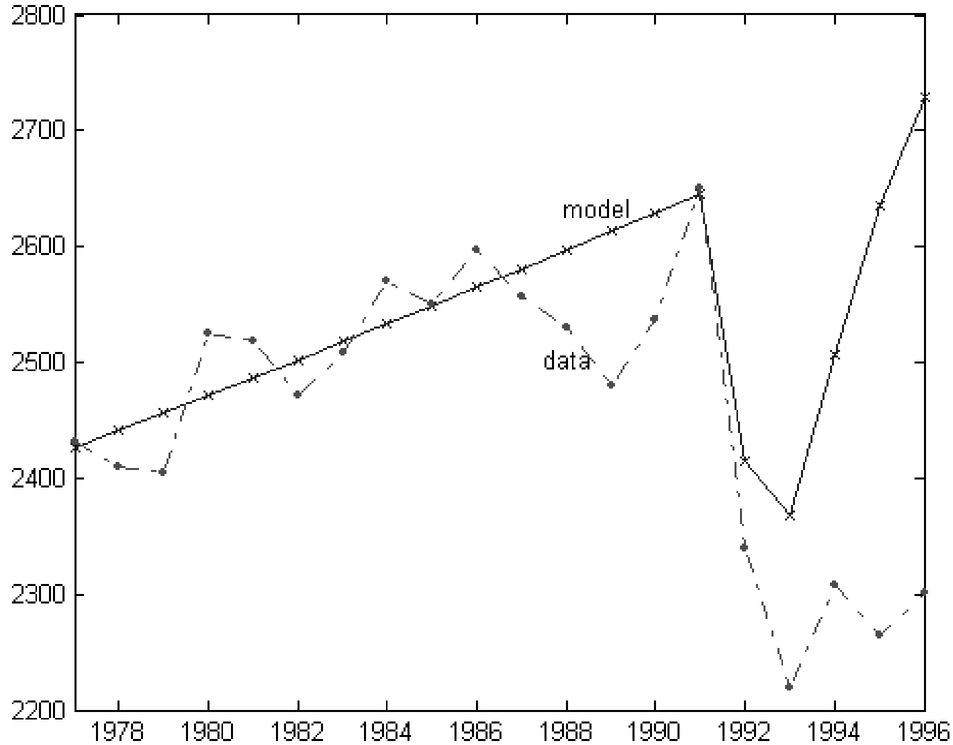

Fig. 6: Total employment of 55-and-older workers (thousand persons): model prediction and data. Italy 1977-1996.

Source: ISTAT.

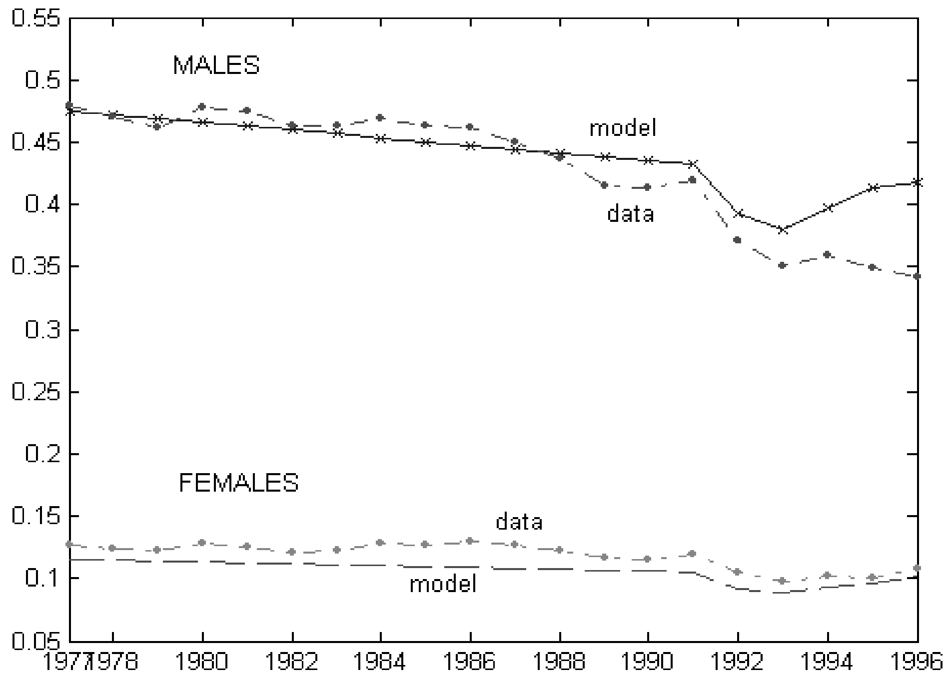

Fig. 7: Male and female employment rates of 55-and-older workers: model prediction and data. Italy 1977-1996.

Source: ISTAT.

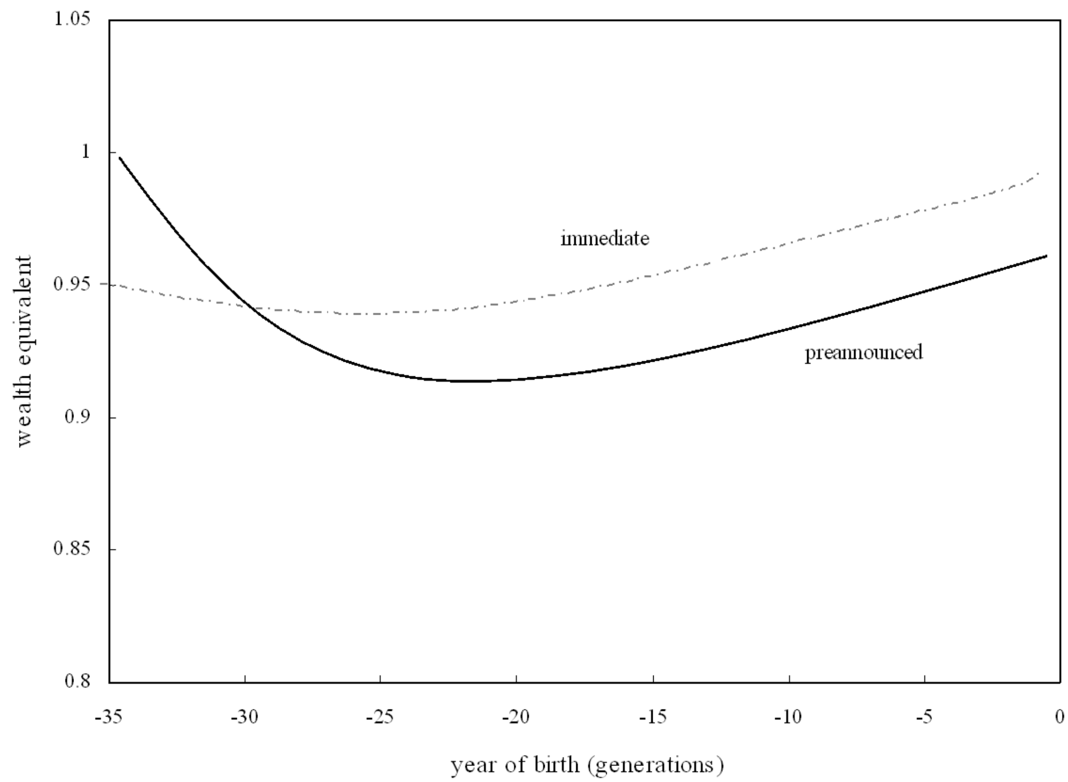

Fig. 8: Welfare effects of immediate and preannouced five-year raise of retirement eligibility age ($g = m$ type agent whose optimal retirement age is $a_r^{m*} = 35$).

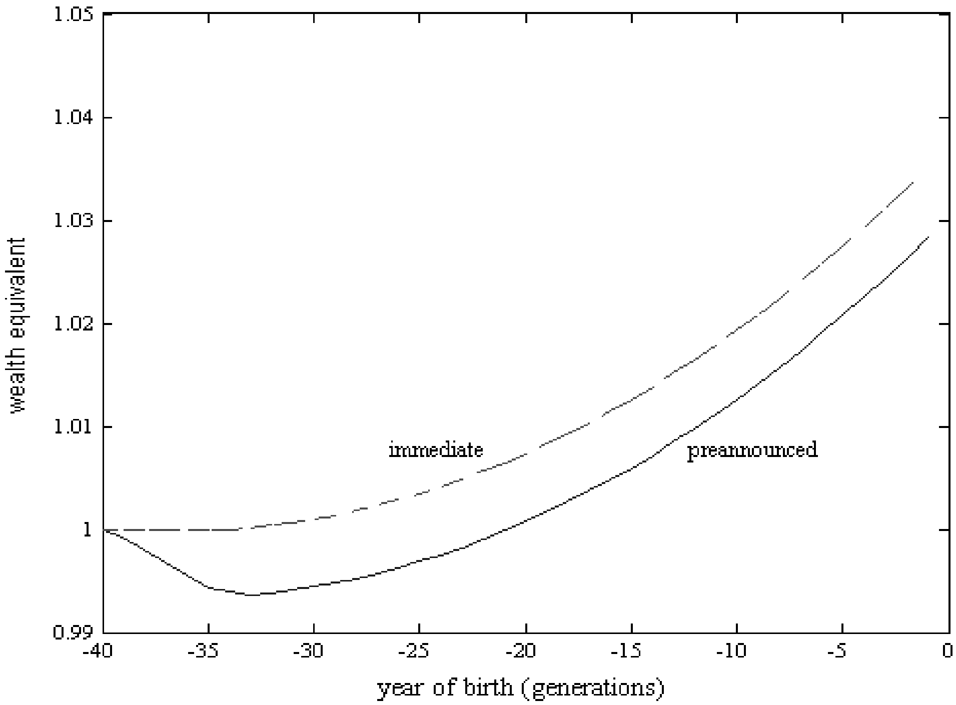

Fig. 9: Welfare effects of immediate and preannouced five-year raise of retirement eligibility age ($g = m$ type agent whose optimal retirement age is $a_r^{m*} = 40$).