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THE 2011 PENSION REFORM IN ITALY AND ITS EFFECTS ON CURRENT AND FUTURE RETIREES

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Abstract

We analyse the effects of the pension reform of 2011 on individuals' retirement age, adequacy and distribution of the benefits for various categories of Italian workers. The main findings are an increase in the average retirement age, generally raising over time, coupled with a sizeable increase in average replacement rates. However, the most affected group is represented by women employees born in 1955 and retiring in the period 2012-2021, who face an average increase in retirement age of four years, while benefiting from an increase in the average replacement rate of thirteen percentage points.

Keywords: pension reforms, microsimulation, wage profiles.

JEL: H55; C63, J31

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1. INTRODUCTION

In the autumn of 2011, the financial crisis, which in Europe had turned into a "sovereign debt" crises for those countries with high public debt, reached a peak. At that time in Italy, in order to quickly recover financial stability, a major reform of the public pension system was introduced (law 214/2011).

The key elements of the reform are: *i*) the immediate abolition of the early retirement option, which allowed to retire up to five years before reaching the old age requirement,; *ii*) the application of the Notional Defined Contribution (NDC) benefit computation mechanism to all workers for seniority accrued since 2012; *iii*) the strict link between the increase in life expectancy and age and seniority requirements; and *iv*) the (further) homogenization of requisites between genders – the old-retirement age requirement for women will be harmonized to that for men by 2018 - and between working schemes.

The sensible increase in the minimum age of retirement and the short transition phase helped reaching financial stability by reducing pension expenditure by about 20 GDP percentage points in the period 2012-2050 (RGS, 2014). Indeed, the reform contributed to recover the trust of international financial operators in the solvability of Italy.

In this work we use a microsimulation model to analyse the adequacy and the distributive properties of the pension system after the reform of 2011 as compared to the pre-reform setting. Microsimulation is increasingly recognised as a key ingredient of a careful, evidence-based evaluation of the design of the tax-benefit and social security policy reforms (Figari et al., 2014). Its main strength lies in being a tool able to generate

synthetic micro-unit based data which may be used to answer "what-if" questions that otherwise could not be addressed (Li and O'Donoghue, 2013).

The microsimulation model we build, CeRPSIM3, is the third release of the microsimulation model elaborated to study the Italian pension system in its evolution from a Defined Benefit to an NDC system (Borella and Coda Moscarola 2006, 2010). CeRPSIM3 is a partial equilibrium dynamic microsimulation model by cohorts, according to the taxonomy proposed by Bourguignon and Spadaro (2006). Other microsimulation models designed to capture the different aspects of the Italian labour market and pension system include: Vagliasindi et al. (2004), Mazzaferro and Morciano (2008) and Caretta (2013), who analyze the long term redistributive effects of social policies; Dekkers and Belloni (2009) who focus on adequacy issues; Ando and Nicoletti-Altimari (2004) who analyze the effects of pension reforms on aggregate income, savings and asset accumulation; Leonbruni and Richiardi (2006), who build an agent-based model to study labour supply in Italy.

Our strategy to study the effect of the 2011 reform is to build a relatively simple simulation model, featuring a detailed modelization of the pension rules characterizing the main social security schemes of Italian workers before and after the reform, and a realistic estimation of the labour income profiles. We simulate representative earnings histories decomposing the earnings process into a deterministic, group specific age profile, and an unobserved component modelled as an ARMA process plus an individual effect. The needed parameters are estimated on a panel sample of administrative data. We then simulate retirement patterns and pension benefits for various cohorts of workers, including individuals born in 1955, who retire between 2012 and 2020, and younger cohorts who will retire in the future.

We find that the reform of 2011 increased the average retirement age by 2 to 3 years for all the cohorts considered, with younger cohorts in general facing a higher increase. The greatest increase in the average retirement age occurs among women currently retiring (i.e. those born in 1955 in our simulations), for whom not only the early retirement option has been supressed but also the old-age requirement has been gradually increased in order to match the requirement for men by 2018.

On the adequacy side, we find that average replacement rates from the first pillar increase for all cohorts and groups considered. The largest increase in the replacement rate following each year of retirement postponement occurs among the youngest, purely NDC, cohorts, a consequence of the actuarial adjustment of the benefits in the NDC system.

The reform of 2011 also affects intergenerational redistribution as measured by the ratio of the present value of benefits and the present value of the contributions paid (benefit-to-tax ratio, or Present Value Ratio, PVR). This ratio, before the reform, was ranging between 1.5 and 3 for the generation born in 1955; as a result of the reform these values are reduced, although remaining well above one. As expected, younger cohorts display an average PVR very close to one, due to the implementation of the NDC system.

The remaining of the paper is organized as follows. Section 2 summarizes the evolution of the pension legislation in Italy. Section 3 describes the microsimulation model, section 4 presents the results and section 5 concludes the paper.

2. THE PENSION LEGISLATION IN ITALY

In the last two decades the Italian pension system has undergone a number of major reforms, all directed to recover long-term financial sustainability of the pay-as-you-go first pillar and to boost the development of a funded second pillar.

The second pillar pension system, based on private pension plans, was formally established in 1993 (Legislative Decree, n.124) and incentives to its development have been subsequently introduced at various times. The 2011 reform did not intervene on this field, so in this section we will focus on the first pillar. In particular, in section 2.1 we describe the pension rules in place right before the 2011 reform, while in section 2.2 we illustrate the reform.

2.1 The first pillar before the 2011 reform

Before 1992 the pension system was characterised by a Defined Benefit (DB) pension formula, based on the last few years of earnings, combined with soft eligibility rules, without any actuarial correction for age at retirement. The first reform, which took place in 1992, set new — and more stringent — eligibility requirements while preserving the DB system. After the transition phase, pensionable earnings were based on the entire worker's earnings history and revalued at the nominal GDP growth rate. No actuarial correction for age at retirement was provided for, but the pension indexation mechanism was downgraded from wages to prices. Such an indexation mechanism has been since maintained by all subsequent reforms.

A second major reform approved in 1995 rescheduled a new (and long) transition towards an NDC formula. The NDC formula harks back to actuarial fairness principles. Benefits are commensurate with the amount of payroll taxes paid capitalised at an interest rate equal to GDP's rate of growth and annuitised according to life

expectancy at retirement. Access to retirement was initially quite flexible, as individuals were allowed to retire in the 57-65 age range, subject only to the constraint of having a pension higher than 1.2 times the minimum old age allowance. The reforms of 1992 and 1995 have thus opened a long transition period which will end in 2030. Until then, in fact, the rules for accessing retirement and to calculate the pension benefit will evolve differently for different generations of workers. In particular, one can distinguish three groups:

1 - workers who accumulated at least 18 years of service at the end of 1995: the pension for these workers is calculated with the DB rules as modified by the 1992 reform. The age requirements for retirement have also been raised, as will be discussed shortly. Hence to these workers a Modified Defined Benefit (MDB) applies;

2 - workers who started to contribute to the pension system before 1995 but accumulated less than 18 years of contributions at the end of 1995: for these workers the pension is calculated with a pro-rata (PR) system. The first part of the pension covers the seniority accrued up to the end of 1995 and is calculated with the DB formula. The second part of the pension instead refers to seniority accrued after 1995 and is calculated with the NDC formula.

3 - Workers who entered the labour market since January 1, 1996: to these workers the NDC system fully applies.

It is useful to describe the above mentioned pension formulae for the computation of the benefits, as the results of our analysis largely depend on them. In the MDB system, the benefit depends on pensionable income, that is an average income earned at the end of the career. As a consequence of the reform of 1992, the benefit consists of two parts, in which pensionable income is computed taking the average over

a longer period for seniority accrued after 1992. Apart from this complication, the MDB check is a traditional defined benefit pension computed as:

$$P_{MDB} = \alpha * (c_1 W_1 + c_2 W_2)$$

Where W_1 and W_2 is pensionable income, that is an average income over the last five (W_1) or ten (W_2) years of the working career (ten to fifteen for the self-employed), revalued according to inflation (W_1) or nominal GDP growth (W_2), and c_1 and c_2 are the years of contribution accrued before and after 1992 respectively. The annual accrual rate α is equal to 2 per cent up to a certain threshold, gradually reduced for higher pensionable incomes.

The NDC pension, for all categories of workers, is computed as:

$$P_{NDC} = \left(\sum_{i=\underline{a}}^{\bar{a}} C_i * (1+g)^{\bar{a}-i} \right) \cdot \delta_{\bar{a}+1}$$

where C_i is the contribution paid by the worker at age i, g is the five years moving average of the nominal GDP growth rate, δ is an age-specific annuity rate, $\underline{a}$ is the age at which the worker entered the labour market and $\bar{a}$ is the individual's age in his final working year. In other words, the pension benefit in the NDC system is equal to the notional capital, that is the sum of all contributions paid, revalued to a rate equal to the five years moving average of the nominal GDP growth rate, multiplied by an age-specific coefficient δ. The annuity rates δ are set by law as the inverse of the present value at retirement of a one unit annuity benefit, and are updated according to the life expectancy. In section 3.3 we describe them in more detail.

The NDC pension formula fully applies to NDC workers, who entered the labour force after 1/1/1996. During the transition, that is for workers already active in the labour force in 1995, the pension benefit will be computed with a *pro-rata* mechanism,

that is as a weighted average of the MDB and NDC check, with the weights given by years of seniority accrued before and after 1/1/1996.

Due to the length of the transition, numerous legislative measures have gradually raised the requirements for access to retirement, but without changing the method of calculating the pension. The legislative decree 30 August 2004 n. 243, the law 24 December 2007, n. 247 and the law 30 July 2010, n. 122, gradually raised the eligibility requirements for retirement. In particular, the 2007 reform introduced the system of "quotas", according to which the right to retire is perfected not only with 35 years of contributions, but also with the achievement of a “quota” given by the sum of age and seniority contribution gained by the worker. This eligibility mechanism applies regardless of the pension scheme, MDB, PR, or NDC, and was expected to increase over time until 2013. The 2007 law also restated the transformation coefficients for calculating the NDC pension benefit (in force since 2010), and expected them to be updated every three years on the basis of demographic tables and long-term trend of GDP measured by the Italian National Statistics Institute (ISTAT). Finally, the Law of 30 July 2010, n. 122, introduced a new "deferral" system of the time of retirement; with this mechanism the right to receive the pension benefits matures twelve (or eighteen, for the self-employed) months after meeting the requirements. Importantly, the same law also adopted an automatic update mechanism (every three years) of the age requirements for retirement, both for early retirement with the system of the "quota" and for old-age retirement, so that these ages are linked to changes in life expectancy (while seniority requirements are kept constant). In table 1 and 2 we summarize the eligibility requirements in place right before the reform of 2011.

<Table 1 around here>

<Table 2 around here>

2.2 The reform of 2011

The reform of 2011, namely the Decree-Law December 6, 2011, n. 201 converted into law December 22, 2011, n. 214, further tightened the requirements for accessing retirement, while maintaining the important principle of the adjustment of all the age requirements to the evolution of life expectancy, and extending this principle to seniority requirements as well. In particular, since 2012 individuals can access retirement benefits through two channels only: the *old age* pension or the *seniority* pension, where the latter rules the access to retirement benefit before the standard age, imposing obligations in terms of contribution paid.

This reform also accelerates the introduction of the contributory formula to compute the pension benefits for all workers, starting from seniority accrued from January 1, 2012 (with a pro-rata system). While previous reforms were limited to reinforce the requirements (age and years of contribution) to enter retirement, in fact, this reform intervenes on the method of calculating the benefit, extending the application of the pro-rata method to all workers who, having completed at least 18 years of contributions in 1995, would have accrued a pension entirely retributive (MDB workers, in our terminology). In this way, the reform pursues the principle of the uniformity of treatment of workers. Benefit checks for MDB workers, in fact, had been preserved by all previous reforms, creating a sharp discontinuity of treatment with workers who, having accumulated less than 18 years of contributions in 1995, have their benefits computed with the pro-rata mechanism (PR workers). The eldest individuals in the latter group will have roughly half the pension calculated by the MDB system, and half with the NDC system – and the share of the NDC component will increase over

time, as younger generations of workers reach retirement age. After the reform, also MDB workers will receive a pension calculated using the PR system, although for a much shorter period and with little influence on the amount of their pension.

The law also changes the age and seniority requirements for accessing retirement, aiming to increase in the average retirement age. In particular, as summarised in table 3, the early retirement route based on the "quota" has been abolished, and the legal old age requirement increased by one year, but at the same time the "deferral" of the first benefit is abolished. In addition, the new reform speeds up the convergence of the old age of retirement of men and women in the private sector[1]. It is still possible to claim seniority pensions, with seniority requirement increased to 42 years and 1 month of contribution for men and to 41 years and 1 month for women[2]. All age and seniority requirements are linked to increases in life expectancy.

<Table 3 around here>

The law also contains some mechanisms to smooth the transition to the new rules. For example, workers that accrued, by the end of 2012, the requirements valid in 2011 for early retirement (60 years of age and 36 of contributions, or 61 years of age and 35 years of contributions, i.e. quota 96) will be granted access to retirement at the age of 64, that is two years earlier than the normal retirement pension.

The reform of 2011 also confirms the possibility of early retirement for women, by opting for a benefit fully computed according to the NDC pension formula. This rule, already introduced by the reform of 2004 (art. 1, paragraph 9 of Law 243/2004), gives the possibility, until December 31, 2015, for female workers to get the early

[1] The old age of retirement for women will equate that for men in the year 2018, while before the reform convergence was due by the year 2026.

[2] Starting with the year 2017, the pension check will be gradually reduced if the seniority pension is claimed before reaching the age of 62.

retirement pension with at least 35 years of contributions and a minimum age of 57, if female employees, and 58, if self-employed, provided they opt for the calculation of the pension according to the rules of the contribution system.

The law also amends the rules for NDC workers, reintroducing some flexibility in retirement, however binding it to the passing of a minimum amount of the pension, as summarised in table 4.

<Table 4 around here>

In 2012, the age for accessing retirement with the NDC system is between 63 and 70 years: the "normal" old-age requirement is 66 years. It is possible to access the "anticipated" retirement, between 63 and 65 years of age, only if in possession of at least 20 years of contributions and if entitled to a benefit equal to at least 2.8 times the social allowance granted to the elderly Italian citizens in need.[3]

Starting from 66 years of age (what the law labels the "normal" age of retirement) the conditions for accessing retirement are less stringent, being required at least 20 years of actual contributions and an amount of pension equal to 1.5 times the social allowance. In the absence of these requirements, it is possible to claim a pension with only five years of contributions and without any constraint on the amount of the accrued pension at the age of 70 years. In addition, also for NDC workers it will be possible to claim seniority pensions with a minimum seniority of 42/41 years for men/women. All the age and seniority requirements set by the law are indexed to life expectancy.

[3] In 2012, the annual (gross) amount of the social allowance was € 5.577,00.

3. METHODOLOGY

Our analysis makes use of CeRPSIM3, an updated version of CeRPSIM (Borella and Coda Moscarola, 2006, 2010). According to the taxonomy proposed by Bourguignon and Spadaro (2006), our model is a dynamic partial-equilibrium microsimulation model of the social security system.[4] It is designed to analyse the distributional features embedded in the Italian pension system during its transition from a DB to an NDC system, fully accounting for the rules characterizing the main social security schemes and for the heterogeneity in the working careers of individuals. It simulates the main life-time events – i.e. all the events that can influence the retirement pattern and the pension benefits amount – of cohorts of individuals born since 1950, computes their retirement age and their retirement benefits and derives indicators to evaluate the adequacy and the inter- and intra- generational distribution of resources. CeRPSIM3 allows to isolate the effects of the change in legislation on retirement patterns and pension benefits of different cohorts of workers, as we can apply different pension rules (pre and post 2011 reform rules) to the same group of individuals (our simulated population), so that the outcomes vary only in response to the pension reform.

The model is made up of two main modules. The population module builds up an artificial cohort of individuals at a time. Life of the simulated individuals evolves according to a set of probabilistic rules estimated from the main available surveys and administrative datasets and conditioned to the year of birth and the available socio-economic characteristics. To each individual it randomly assigns the gender and a date of birth. In succession it simulates her education pattern, marital status, and career

[4] For a survey on microsimulation models see also Creedy and Kalb (2006) and Li and O'Donoghue (2013).

profile, which includes the number of weeks worked in a given year and earnings, and contributions paid into social security. The number of weeks worked may vary from zero (if unemployment lasts a whole year) to 52 for full employment: the probability of working a certain amount of weeks in a particular year depends on the number of weeks worked in the previous year and on demographic characteristics, such as age, cohort, gender, geographical area. The earnings profiles of individuals, conditional on working, are accurately estimated as the sum of a group-specific deterministic component (that is a group-specific age profile) and an individual-specific stochastic component estimated from a panel of administrative data. Given the pivotal role of the estimated earnings profiles in the determination of the model outcomes, section 3.2 presents more extensively their derivation procedure.

The pension module computes pensionable earnings and contributions paid, checks eligibility requirements, and calculates the pension benefits for a number of schemes (employees and self-employed) and different regimes (MDB, PR, NDC). If an individual is eligible, than the pension benefit is computed under the assumption that the individuals retires as soon as eligible. Indeed, in recent years (after the 2008 reform), minimum retirement ages have been increased so much that this became the most likely scenario. Borella and Coda Moscarola (2010) show that for the cohort born in 1995 the desired retirement age estimated according to the behavioural rule of Belloni and Alessie (2009) is almost equal or even higher (as in the case of private employees) than the minimum retirement age, as set by the legislation in force in 2008.

We analyse four cohorts of individuals born between 1955 and 1985, in order to show the effects of the reform for MDB workers, retiring between 2012 and 2020, for PR workers, retiring between 2018 and 2030, and for NDC workers, retiring after 2030.

Pension benefits are computed according to both the pre- and to the post-2011 reform rules. For each cohort we simulate 15,000 heterogeneous individuals.

We focus on self-employed and private employee workers pertaining to the main private employee scheme (FPLD). In the paragraph that follows we report a brief description of the main parameters and settings used in the simulations. A detailed description of the micro-simulation model is reported in the Appendix.

3.1 Parameters and settings

In the microsimulation model the unit of analysis is the individual. In building up the probability matrices used to model transitions across states, we refer to the available official statistics from the National Statistical Institute (ISTAT), to the Bank of Italy Survey on Household Income and Wealth (SHIW) and to administrative datasets provided by National Social Security Institute (INPS). We do not model the household composition, or household income and wealth, but we account for the marital status of our simulated individuals for the computation of the survival pensions.

The assumptions about the evolution of the mortality play a key role in the simulations as they govern the survival of individuals over time, i.e. they determine whether simulated individuals reach the retirement age and when and if they will be entitled to a survivor pension; in addition, mortality determines the evolution over time of the annuity rates used to compute the NDC part of the pension benefits hence affecting the distributive impact of the pension rules[5]. In our analysis we use the official ISTAT mortality tables from 1974 to 2010 and the official ISTAT projections from 2011 on. As for the macroeconomic variables, we set the interest rate, the inflation rate

[5] Also the evolution of retirement age strictly depends on the evolution of life-expectancy, but this is already embedded in the projections about the minimum age and seniority requirements provided by INPS.

and the GDP real growth rate at their historical levels up to the year 2013. For the future they are supposed to reach and maintain the levels of 2 per cent, 1.6 per cent and 1.5 per cent respectively. All the minimum and maximum thresholds for the determination of the payrolls and the benefits are updated with nominal GDP growth to avoid the "fiscal drag effects" (Sutherland et al., 2008). Indexation of pension benefits to inflation are done according to the current rules.

3.2 Earnings

Earnings age profiles have been estimated using a dataset drawn from the INPS archive[6]. The INPS archive officially records the complete earnings and contribution histories of all participants, that is, employees in the private sector and some categories of self-employed (for our purposes, craftsmen and tradesmen). The available sample is formed by all individuals born on the first and the ninth of each month of any year — so that the theoretical sample frequency is 24:365 — and reports employment spells from 1975 until 2012. The archive contains very rich information about the earnings histories of the workers, recording spells of unemployment, sickness, as well as labour income earned each year.

Based on these data, we estimate gross earnings profiles separately for men and women, self-employed and private sector workers, white and blue collar.[7] We base our estimates on the sub-sample of individuals working full time and for the whole year. Later in our simulations, to allow unemployment spells, we rescale the simulated annual incomes for the relevant number of weeks worked in any given year.

The estimated equation is:

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[6] The file LoSai (Longitudinal Sample Inps) is available at the Italian Ministry of Labour website (http://www.cliclavoro.gov.it/Barometro-Del-Lavoro/Pagine/Microdati-per-la-ricerca.aspx).

[7] Earnings are gross of the income tax and of the payroll tax paid by the worker.

$$\ln y_{it} = x_{it}\beta + \gamma_i + \varepsilon_{it}$$
$$\varepsilon_{it} = \rho\varepsilon_{it-1} + \eta_{it}$$

$$\gamma_i \sim (0,\ \sigma_\gamma^2)\ ;\ \ \eta_{it} \sim (0,\ \sigma_\eta^2)$$

where x_{it} is a vector of individual characteristics, including a constant, a polynomial in age (third degree for self-employed, fourth degree for employees), ten-year cohort dummies (cohorts 1935, 1945, 1955, 1965, 1975), regional dummies (north, centre, south), and time dummies, which are assumed to sum to zero and be orthogonal to a time trend (Deaton and Paxson, 1994, Deaton, 1997). The unobserved component is assumed to be the sum of a random effect (γ_i) which does not vary over time and is uncorrelated with the explanatory variables included into the equation, plus an autoregressive AR(1) component with parameter ρ. The AR(1) process plus individual random effect has been found to be a good characterization of the unobserved component of earnings in Italy in previous work (Borella, 2004). The estimated coefficients are reported in tables A5 and A6 in the Appendix.

The availability of a long panel of administrative data is clearly an advantage, as it permits the estimation of relatively flexible specifications of earnings profiles for various groups of the population and for different generations, without having to rely on restrictive assumptions needed when the data source is a cross section (Vagliasindi et al., 2004, Mazzaferro and Morciano, 2008) or a short administrative panel (Caretta et al. 2013).

The average profiles obtained are shown in figures 1 and 2. In figure 1 we draw the estimated earnings profiles for private sector employees born in the centre of Italy in 1975 (that is, between 1970 and 1980). White collar men have the higher income profile, followed by white collar women, blue collar men and women. The average

annual growth rate in real wages in the private sector is 2.7 per cent per year for white collar males, while white collars females have flatter profiles with an average yearly growth of 1.9 per cent. For blue-collars, average annual growth is 1.9 per cent for males and 1.3 per cent for females. Figure 2 shows the estimated real income profiles for self-employed workers born in 1975. Also in this case, the average rate of growth is higher for men, about 1.5 per cent, while women display flatter income profiles (with an average growth of about 1.2 per cent).

<Figure 1 around here>

<Figure 2 around here>

In the simulations, each individual is given his average log earnings profile for his age and group (defined by cohort, gender, region and occupation) plus an error term formed by the sum of the two unobserved components. The first one is drawn from a normal distribution with variance σ_γ^2, and it permanently shifts up or down the average profile for the individual it refers to. The second component, which is also individual-specific and varies over time, is formed by the shock from the previous period, times the autoregressive parameter ρ plus an error term drawn from a normal distribution with variance σ_η^2.

3.3 The annuity rates

An important ingredient for a correct evaluation of the pension coverage of future generations of PR and NDC workers are the annuity rates, i.e. the coefficients used to annuitize the present value of contributions. The law n. 247 of 2007 rules the automatic adjustment, every three years, of the annuity rates to life expectancy. The law n. 122 of 2010 explicitly provided for the extension of the coefficients for ages greater

than 65 years, when the evolution of the age requirement for accessing to the old age pension would have increased over age 65. The law n. 214 of 2011 anticipated the update in 2013 and introduced an automatic adjustment to life expectancy every 2 years from 2018 onwards.

The effect of the adjustment of the annuity rates to the demographic evolution is a reduction in the coefficient at any given retirement age, because of the increase in life expectancy. However, as we show in the rest of this section, the annuity rates are substantially constant at the age of the old age requirement, as the latter is also evolving with life-expectancy.

Using the latest demographic forecasts published by ISTAT (2011) and the formulae published by the State General Accounting Office (RGS, 2014), we calculate the annuity coefficients in each year in our simulation. To summarise their evolution, in table 5 we report the predicted coefficients at some relevant ages for the PR and NDC generations considered in our simulation, that is those born in 1965, 1975 and 1985. The table highlights how, for example, the coefficient for retirement at age 65 is reduced over time. For clarity, the inverse of the annuity coefficient is also reported, representing approximately the average expected life captured by the coefficient, which is a weighted average computed over men and women[8]. To interpret the table, consider individuals born in 1965: their projected minimum age of retirement in the NDC system is 65 years and 2 months[9]. As shown in table 5, the annuity coefficient at age 65 for this generation implies an average expected life of about 21 years (that is, the NDC pension

[8] More precisely, it is the expected life of the pension benefit, whose duration depends on the gender of the pensioner and on the probability of leaving a heir who will receive the corresponding survivor benefit.

[9] That is, according to the projections provided by INPS, in 2030 the minimum age of retirement in the NDC system will be 65 years and 2 months.

for individuals aged 65 will be computed by dividing the present value of the contributions by about 21). For the generation born in 1975, the expected evolution of mortality implies that the projected minimum age of retirement in the NDC system in the relevant year will be 66 years (and 9 months). In that year, 2041, also the annuity rate will be different as it is constantly updated to mortality: indeed, the coefficient at age 66 implies an expected life of about 21 years, reflecting the lower (predicted) mortality of that generation. For the following generation the same reasoning applies: the minimum age for retirement in the NDC system is higher by about one year (it is predicted to be 67 years and 11 months in 2052), and the annuity rate at age 67 again is updated and reflects an expected life of 21 years. The same indexation mechanism applies to all the relevant ages (normal and maximum age of retirement), as they are all linked to life expectancy. As life expectancy increases, the legal ages of retirement increase, the annuity rates at any given age are reduced, but the annuity rates at the legal ages of retirement remain more or less constant.

<Table 5 around here>

4. RESULTS

In this section we show the effects of the 2011 reform on the age of retirement, the ability of the pension system to preserve pre-retirement income levels and the degree of actuarial fairness. In doing this, we are implicitly considering the pension system in terms of an insurance for the longevity risk (in line with the study by Feldstein and Liebman, 2002) with premia represented by the payroll taxes paid during the working life upon which the benefits (the pensions) should commensurate.

4.1 The age of retirement

We begin by exploring the effect of the reform of 2011 on the retirement path of the various cohorts. In Figure 3 we draw the percentage of retirees per year and cohort; as in our model individuals retire as soon as they reach minimum requirements, the graph shows the path of minimum requirements through time for both scenarios, before and after the reform. For example in the upper panel, displaying the "before reform" scenario, the first cohort on the left, born in 1955, retires between 2012 and 2023. In 2013, corresponding to age 58, there is a spike in the exit rate due to the option given to women to retire with the NDC benefit at age 57 plus a deferral time of 12 months (or 18, if self-employed). This same cohort exhibits another spike in the years 2017-18, that is when reaching the minimum age requirement to claim the seniority pension with the quota mechanism.[10] As the age requirement was necessary but not sufficient to claim an early benefit, as a seniority requirement (in terms years of contribution) was also requested, some workers retire later than the early retirement age. In addition, workers reaching 40 years of contribution could retire irrespective of their age, hence the proportion of workers retiring in each year is different from zero. At the age of 66 (67 with the deferral), that is when the old-age requirement for men is met, there is a smaller spike, of about 10 per cent, as most workers are already out of the labour force. The second cohort, born in 1965, retires in the period 2022-2036; the path is similar to the one displayed by the cohort born in 1955, absent the spike at age 58 (because the NDC option for women is no longer available). The spike corresponding to the early retirement age (plus deferral) for this cohort is visible at ages 63 and 64 (years 2028 and 2029), and the spike for old-age is in the year 2033 at age 68, a consequence of the

[10] The minimum age for early retirement before the reform would have been 61, which with the deferral of 12 (18) months would become 62 (and a half) years. As our population is born uniformly over the year, individuals born in December 1955, say, meet their minimum age requirement in the year 2018.

indexing of requirements to life expectancy. A similar path is visible for the cohort born in 1975, where the spikes are at ages 65 in 2040 and 69-70 in the years 2044-45, and, finally, for the cohort born in 1985, with spikes at ages 66-67 and 70-71.

<Figure 3 around here>

The bottom panel of the figure shows the impact of the reform on the retirement pattern. The most striking feature is the disappearance of the early retirement spikes from the figure: starting with the eldest cohort, born in 1955, the highest spike, of about 45 per cent, is at age 67, the old-age requirement for both men and women that will be in place in 2022. However, the possibility for women to opt for the NDC and retire at age 58 is still in place and evident in the figure. Subsequent cohorts show the retirement path in the presence of the two exit routes allowed by the reform, that is either a total seniority of at least 41/42 years for women/men (for the 1965 cohort, but increasing with mortality for subsequent cohorts) or the attainment of the old-age requirement, coupled with a minimum of 20 years of seniority. The old age at which it is possible to claim the pension check is also expected to increase with longevity: for example, for the generation born in 1965 the old-age requirement is equal to 68 years and 8 months in the years 2033 and 2034. As in our model individuals are born uniformly within the year, individuals born in the first quarter of 1965 accrue the age requirement in 2033 and receive their first pension benefit in that year, while the others accrue the age requirement in the following year (hence the spike in the year 2034). The cohort born in 1975, in addition to the old age spike in 2045, exhibits a spike in 2042, due to NDC workers (that is workers who entered the labour market after 1995) retiring at the minimum age, which is 66 and 8 months. The workers born in 1985 all belong to the NDC scheme, and exhibit a spike in 2053 (when they reach the minimum retirement age

of 68 years and 2 months). Only workers whose accrued pension is at least 2.8 times the social allowance, however, can retire at that minimum age; a second spike in present in 2056-57, when this cohort reaches the normal retirement age, when it is possible to retire having accrued a pension greater than 1.5 times the social allowance. Workers with poorer working careers remain in the labour force until they reach the maximum age of 75 years and 11 months in the year 2060, or of 76 years and 2 months in 2061.

<Table 6 around here>

We next show the average age of retirement for the various sub-groups of workers considered in the model. In table 6 we report the average age of retirement before and after the reform, distinguishing between private employees and self-employed workers, and between men and women. Starting with the upper left panel, in the absence of the reform the average retirement age for male private employees born in 1955 would have been 63.5 years: these workers could retire because they reached the legal old age (65 years, plus a minimum of 20 years of contribution), because they had accumulated 40 years of contributions, or because they were at least 61 with at least 35 years of contribution (with the sum of the two numbers reaching quota 97). Once they reached one of these minimum requirements they still had to wait 12 months (deferral time) before being entitled to the benefit. The average figure shown in the table reflects the fact that, in our simulations, about one third of the simulated private employees were entitled to retire because they reached the contribution ceiling, while about 43 per cent could retire with the early option of quota 97. Even in the pre-reform scenario, the legal retirement ages were linked to expected longevity, hence for subsequent cohorts the average age of retirement increased accordingly, reaching 65.6 years on average for the cohort born in 1985, which is completely NDC, but in the pre-reform scenario could

retire with same rules as the previous MDB or PR cohorts. A similar pattern is followed by male self-employed workers, in the upper right panel of the table, who reached retirement on average 1.2 years earlier than private employees because their careers are less unstable and they are more likely to complete 40 years of contributions.

For women, shown in the lower panel of table 6, the pre-reform scenario is more or less the same, but with an important distinction, as they had the possibility to opt for the NDC system until December 31, 2015[11]. This possibility is reflected in the relatively low average retirement age displayed by the cohort born in 1955, for which our model simulates that about 30 per cent retires meeting the requirements for the option to the NDC regime[12]. In addition, the 1955 cohort benefitted from an old age of retirement lower than men, while subsequent cohorts faced an increase in the old age requirement to meet the one for men (parity of requisites was due by the year 2026). Hence, younger cohorts had no longer the option to opt for the NDC system, and were requested an increased old age: as a consequence the average retirement age increased substantially: for example, for the cohort born in 1965 it increased to almost 66 years, that is about five years more than the 1955 cohort. It is interesting to notice that the predicted average age of retirement was higher for women than for men: this follows the fact that relatively less women reach the maximum contribution level for which it is possible to retire irrespective of age (which was equal to 40 years of seniority before the 2011 reform).

The comparison with the results obtained in the "after the reform" scenario shows that the average retirement age increases for all categories of workers and for all

[11] This possibility has been confirmed by the reform of 2011.

[12] That is age equal to at least 57 years and 3 months, and 35 years of contributions, plus a deferral of 12-18 months for employees/self-employed workers.

the cohorts considered. Starting with men private employees born in 1955, the average age of retirement increases to 65.9 years, with an average increase of almost 2.4 years with respect to the pre-reform scenario. Younger generations, for which the NDC system gradually phases in, face a bigger increase in average retirement age of about 3 years. For the self-employed men the pattern is the same, with an average retirement age increasing by about 2 years for the eldest cohort born in 1955, and by 3 to 3.7 years for younger cohorts. In addition, their average retirement age is lower than that for employees because they tend to retire with seniority pensions.[13]

For women the increase is less pronounced, with the sole exception of the 1955 cohort for which the increase, in the case of employees, is about 4 years, a result due to the acceleration imposed by the reform in the alignment of the old age requirements between genders. Before the reform, the old age requirement 61 (62, including deferral time) in the years 2016-2017; after the reform, in the same years, it becomes 65, further increasing to 66 in 2018, hence women born in 1955 will be able to retire, with the old age option, in 2021[14]. Women born in 1965 already in the pre-reform scenario faced the increase in the old age requirement, and now display a smaller increase of about 2.2 years. For subsequent cohorts, the average increase in retirement age ranges from 2 to 3 years both for employees and for the self-employed. In addition, the average retirement age is about 1 year higher than that for men, again because for women, especially when private employees, the total number of years of contributions tends to be lower than for men, and as a consequence they are less likely to qualify for a seniority pension.

[13] The required years of contributions were gradually increased after the reform, but less than the old age requirement.

[14] In our simulations, about 62 per cent of women employees retires with the old age option.

4.2 The replacement rate

As a measure of the ability of the pension system to preserve income levels, we compute the replacement rate as the ratio between the first benefit and the average income of the last 4 years before retirement[15]. The ability of the pension system to preserve income levels can be considered a spurious but very intuitive and widespread indicator of the adequacy of a pension system[16].

<Table 7 around here>

Looking at the scenario before the 2011 reform, the effect of the gradual shift to the contribution-based benefit is quite striking. For example, private employees men born in 1955 (MDB workers) were entitled on average to a benefit equal to about 72 per cent of their last salaries. For the generation born in 1965, which includes pro-rata workers, the replacement rate reduced to 65 per cent, although the average retirement age increased by 0.9 years, as already shown in table 6. The pre-reform replacement rate reduced to about 64 per cent for younger generations, for which the contribution-based part of the benefit was almost (born in 1975) or completely (born in 1985) active. For the self-employed workers the reduction in the average replacement rate was even more dramatic, as in the MDB system their benefit was computed with more or less the same rules in force for the employees, while their payroll tax rate was considerably lower.

[15] We take the average to smooth out temporary shocks to income. All figures are gross of the income tax and of the payroll tax paid by the worker, so this is a gross replacement rate.

[16] Indeed, it focusses on the sole pension system and does not account for the compensatory (re)distributive effects of the tax system or of the other welfare state programs. In addition, in a life cycle framework the adequacy does not directly imply the constancy of the income as individuals more generally smooth (the marginal utility of) consumption across times.

Before the reform, the average replacement rate for men falls from 74.7 per cent (1955 cohort, MDB) to about 42.9 per cent (1985 cohort, NDC).

For women, both employee and self-employed, the pre-reform situation was analogous, although it should be noted that for the cohort born in 1955 the average replacement rate was lower with respect to men, reflecting the lower average retirement age already shown in the previous section (due to the possibility to retire earlier if opting for the NDC system and to the lower old age requirement).

The "after the reform" scenario shows the great increase in the benefit and in the replacement rate that follows from an increase in the retirement age when the benefit is computed with the contribution-based formula. This is due to the increase in the annuity rates which govern the computation of the pension check in the NDC system: as they reflect residual life expectancy at the moment of retirement, a one-year postponement induces to an increase of the coefficient of about 4 per cent. For example, while for the cohort born in 1955 the increase in the replacement rate is about 6.6 percentage points for men private-employees men, that is about 3 percentage points for each year of postponement, for younger cohorts of employees the advantage of each year of postponing retirement is an increase of about (and even in excess of) 4 percentage points in the replacement rate. Hence, for example, an employed men born in 1985 could expect to retire with an average replacement rate equal to 64.2 per cent before the reform, while after the reform he can expect to retire with a replacement rate equal to 77.5 per cent (having worked four years longer). For self-employed workers the figures are about the same, with the cohort born in 1955 benefiting very little from the postponement of retirement, while the subsequent cohorts increase their replacement rate by about 4 percentage points per additional working year. Hence, the increase in the

retirement age contrasts, at least partially, the reduction in the replacement rates faced by self-employed workers.

Finally, the cohort of women born in 1955, which face the greatest increase in the retirement age, benefit from an increase of 13.2 percentage points in their replacement rates[17].

4.3 The Present Value Ratio

As a money's worth measure we compute the so-called Present Value Ratio (PVR) or, in other words, the benefit-to-tax ratio, i.e. the ratio between the present value of the pension benefits to be received and the present value of payroll taxes paid, both valued at retirement. If the PVR is greater than one when calculated at an interest rate equal to the GDP's growth rate, then the system is granting to retired individuals more than would be justified in a pension system in financial equilibrium. Hence this quantity also measures inter-generational redistribution, indicating, when greater than one, that on average the system is redistributing resources from generations active in the labour market to currently retired ones.

<Table 8 around here>

Inspection of table 8, pre-reform scenario, reveals how in the MDB system (cohort born in 1955) the average present value of pension benefits was higher than the

[17] Our model is also able to simulate the second pillar pension, as in 2007 a reform incentivized the participation in the second pillar. Assuming a contribution rate of 6.91 per cent (that is, the percentage devoted to the severance pay - Trattamento di Fine Rapporto, TFR – that the reform incentivized to divert to the second pillar) for all workers, a real return of 2 per cent, and contributions starting in 2007, would result in an additional 5 percentage points in the replacement rate for the cohort born in 1955, increasing to 16 percentage points for the cohort born in 1985.

present value of the payroll taxes paid: private employees men, before the reform, had a ratio equal to 1.55, or, in other words, on average they received from the system 55 per cent more than they paid in. As the PR and the NDC systems phased in, the PVR was reduced: in the NDC system, for men employees, it was very close to one (1.03). Self-employed workers born in 1955 had a much higher PVR (2.71), as they benefitted from a defined benefit check and a payroll tax rate lower than employees. Under the NDC system (cohort born in 1985) self-employed men still had a PVR greater than 1 (1.36 before the reform) as they were more likely than employees to qualify for the social allowance. Women followed the same pattern, with a higher PVR on average due both to higher life expectancy and to a higher probability to qualify for the social allowance.

After the reform the PVR is reduced for all categories. For the cohort born in 1955 this reduction is also due to the change in the benefit computation formula which, although only for the last working years, is based on the contributions effectively paid. This shift, coupled with a less likely resort to the minimum benefit, implies a reduction in the PVR of about 20 percentage points for all the categories considered.

As the NDC reform is phased in, the reduction in the PVR implied by the 2011 reform is lessened, although it does not disappear especially for women and for self-employed workers, both men and women. This is due to the fact that the increase in their retirement age implies an increase in their pension check as well, and the probability that they end up receiving the social allowance is consequently lower.

<Figure 4 around here>

In figure 4 we show the path of the individual PVR, before and after the reform, through time. For the cohort born in 1955, formed by workers of the MDB type, the PVR is almost always greater than one, decreasing with retirement age. For the

following cohorts, as the NDC system phases in, not only the average PVR decreases, but individuals retiring later, within each cohort, tend to earn a higher PVR. This is due to the eligibility requirements for the pure NDC workers, who must wait until the maximum age if their accrued pension check is lower than a certain threshold, and hence have a higher probability to qualify for the social allowance. After the reform, this tendency is mitigated by the increase in the maximum age requirement, which lowers the probability of qualifying for the social allowance.

5. CONCLUSIONS

In this work we use a microsimulation model to analyse the evolution over time of retirement ages, adequacy and the distributive properties of the Italian pension system after the reform of 2011, as compared to the pre-reform setting. We follow four artificial cohorts born between 1955 and 1985, retiring between 2010 and 2060, uncovering the evolution of the pension system until the NDC system will be fully phased in.

Our simulations show that after the reform of 2011 the average retirement age increases for all categories of workers and for all the cohorts considered. In particular, for men private employees born in 1955, the average age of retirement is 65.9 years, with an average increase of 2.4 years with respect to the pre-reform scenario. Younger generations, for which the NDC system gradually phases in, face a bigger increase in average retirement age of about 3 years. For self-employed men the pattern is the same, with an average retirement age increasing by about 2 years for the eldest cohort born in 1955, and by 3 to 3.7 years for younger cohorts. For women the increase is less pronounced, with the exception of the 1955 cohort for which the increase, in the case of employees, is about 4 years, a result due to the harmonization of the old age

requirement between genders. For subsequent cohorts, the average increase in retirement age ranges from 2 to 3 years both for employees and for the self-employed.

The postponement of retirement enhances the adequacy of the benefits. The replacement rate increases with the retirement age as a consequence of the application of the defined contribution rule for all individuals starting from the year 2012. Pre- versus post-reform results reveal, for the cohort born in 1985, an increase of 13-15 percentage points in the replacement rates for men and about 9-11 per cent for women. This is particularly relevant for self-employed workers, who contribute with a lower payroll tax rate to the system, and are at risk of not accruing adequate pension benefits in the NDC system. Participation in the second pillar, which at present is still not pervasive in Italy (Commissione di Vigilanza sui Fondi Pensione, 2013), would increase replacement rates and adequacy in an obvious way.

As an effect of the introduction of the notional defined contribution (NDC) rule, inter- and intra-generational distribution is greatly reduced. The results, in particular, show the strong reduction in the present value ratio (PVR) granted to self-employed workers as the NDC system is applied. Among the cohort fully covered by the NDC rule the average PVR is, as expected, very close to one. However, redistribution is still in place for women, on average characterized by less rich career profiles, and for self-employed workers who in addition pay lower payroll taxes and accrue lower pensions.

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TABLES AND FIGURES

Table 1 – MDB and PR workers, eligibility requirements in 2011 (before the reform)

		Men	Women
Old age		65 years of age 20 years of contribution	60 years of age 20 years of contribution
Seniority		40 years of contribution	
Early retirement	Private employees	Quota 96: with at least 60 years of age and 35 years of contribution	
	Self-employed	Quota 97: with at least 61 years of age and 35 years of contribution	

Note: all ages linked to life expectancy. Deferral time: 12/18 months (private empolyees/self-employed)

Table 2 – NDC workers, eligibility requirements in 2011 (before the reform)

		Men	Women
Old age		65 years of age 5 years of contribution	60 years of age 5 years of contribution
Seniority		40 years of contribution	
Early retirement	Private employees	Quota 96: with at least 60 years of age and 35 years of contribution	
	Self-employed	Quota 97: with at least 61 years of age and 35 years of contribution	

Note: all ages linked to life expectancy. Deferral time: 12/18 months (private empolyees/self-employed)

Table 3 – MDB and PR workers, eligibility criteria in 2012 (after the reform)

	Men	Women
Old age	66 years of age 20 years of contribution	62/63 years of age (private employees/self-employed, reaching 66 in 2018) 20 years of contribution
Seniority	42 years	41 years
Early retirement	Abolished	

Note: all ages and seniority requirements linked to life expectancy. Deferral time: abolished

Table 4 – NDC workers, eligibility requirements in 2012 (after the reform)

	Men	Women
Old age	70 years of age (minimum seniority 5 years) Possibility of anticipated retirement at age 63 if check is at least 2.8 times the social allowance, or at age 66 if check is at least 1.5 times the social allowance (minimum seniority 20 years).	
Seniority	42 years and 1 month	41 years and 1 month
Early retirement	Abolished	

Note: all ages and seniority requirements linked to life expectancy. Deferral time: abolished

Table 5 – Annuity rates – evolution over time

Born in:	1965		1975		1985	
Age	δ	1/δ	δ	1/δ	δ	1/δ
65	0.04750	21.1	0.04617	21.7	0.04455	22.4
66	0.04888	20.5	0.04749	21.1	0.04567	21.9
67	0.05027	19.9	0.04825	20.7	0.04693	21.3
68	0.05231	19.12	0.05017	19.9	0.04911	20.4
69	0.05240	19.08	0.05155	19.4	0.04957	20.2
70	0.05516	18.1	0.05391	18.5	0.05118	19.5

Note: predicted annuity rates (δ) at different ages for different generations. 1/δ is approximately the average life expectancy in years implied by δ. The generation born in 1965 is aged 65-70 in the years 2030-35, the generation born in 1975 in the years 2040-45 and the generation born in 1985 in the years 1950-55.
Source: Authors' calculations.

Table 6 – Average age of retirement

	Private Employees				Self-Employed			
	1955	**1965**	**1975**	**1985**	**1955**	**1965**	**1975**	**1985**
Men								
Before the reform	63.53	64.42	65.05	65.65	62.45	63.44	63.85	64.23
After the reform	65.94	67.48	68.21	68.78	64.34	66.17	67.12	67.96
Women								
Before the reform	60.75	65.79	66.85	67.51	60.74	64.22	64.93	65.76
After the reform	64.87	68.02	69.15	70.15	62.77	66.32	67.59	68.79

Source: Authors' calculations.

Table 7 – Average and Median Replacement Rate (first pillar, per cent)

	Private Employees				Self-Employed			
	1955	**1965**	**1975**	**1985**	**1955**	**1965**	**1975**	**1985**
Men								
Before the reform								
Average	72.06	65.00	63.18	64.25	74.72	50.83	44.58	42.88
Median	*72.13*	*65.10*	*62.92*	*64.02*	*76.66*	*51.43*	*44.74*	*40.84*
After the reform								
Average	78.70	76.64	77.40	77.55	76.62	59.94	56.70	57.41
Median	*80.78*	*77.10*	*77.35*	*77.24*	*78.23*	*60.31*	*56.78*	*56.98*
Women								
Before the reform								
Average	62.78	64.03	62.92	64.20	67.30	49.72	46.39	45.95
Median	*61.78*	*63.92*	*62.42*	*63.29*	*71.43*	*50.06*	*45.82*	*43.02*
After the reform								
Average	76.00	72.10	72.49	73.97	70.33	56.72	54.76	56.41
Median	*70.56*	*71.22*	*71.51*	*72.86*	*71.25*	*57.46*	*54.11*	*57.56*

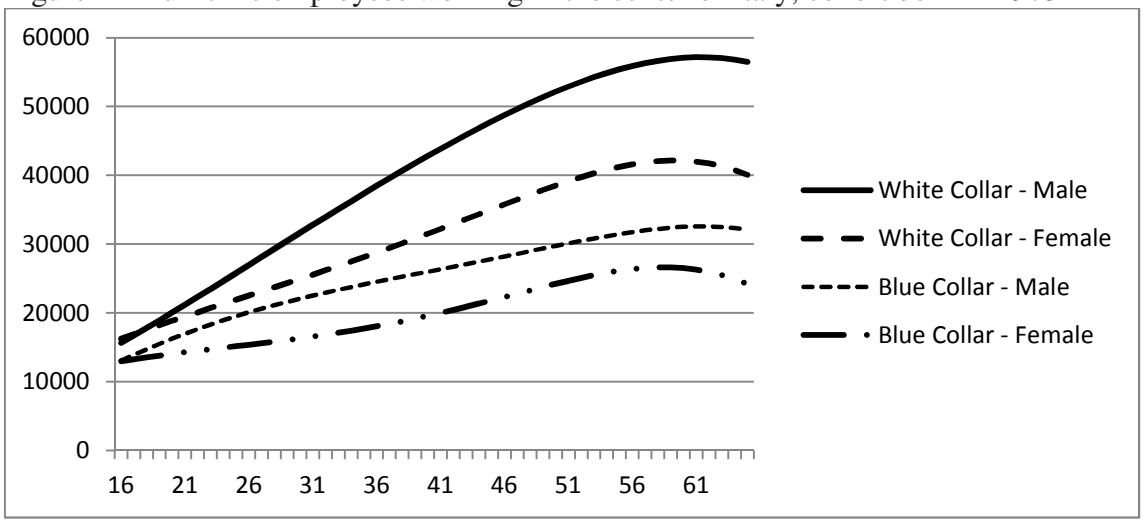
Source: Authors' calculations.

Table 8 – Average Present Value Ratio (PVR)

	Private Employees				Self-Employed			
	1955	**1965**	**1975**	**1985**	**1955**	**1965**	**1975**	**1985**
Men								
Before the reform	1.55	1.12	1.02	1.03	2.71	1.52	1.43	1.36
After the reform	1.41	1.09	1.00	1.01	2.37	1.33	1.17	1.10
Women								
Before the reform	1.88	1.21	1.13	1.18	3.11	1.66	1.63	1.71
After the reform	1.64	1.18	1.10	1.13	2.75	1.44	1.30	1.26

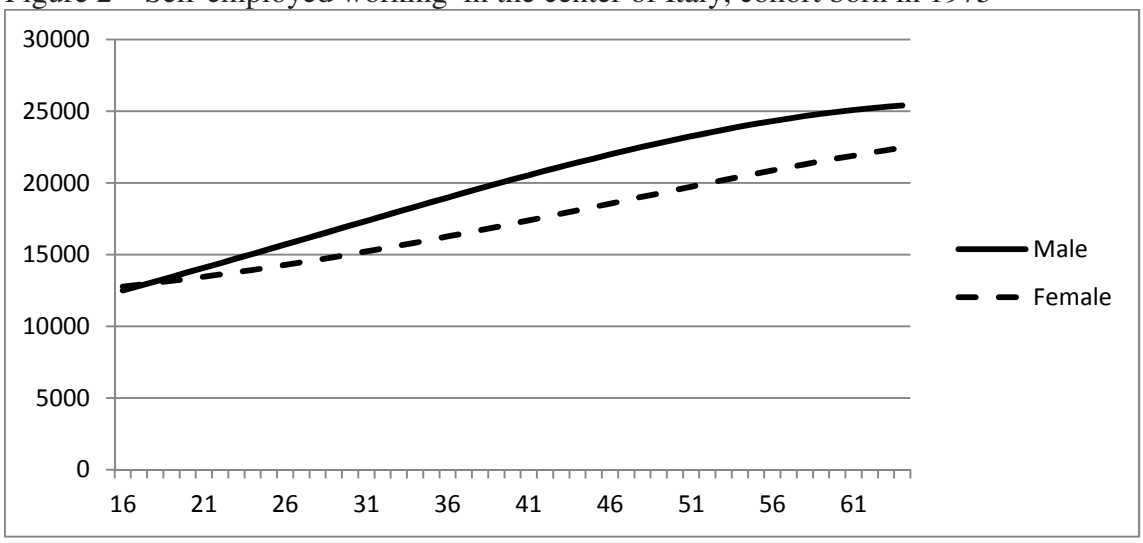
Source: Authors' calculations.

Figure 1 – Full-time employees working in the center of Italy, cohort born in 1975



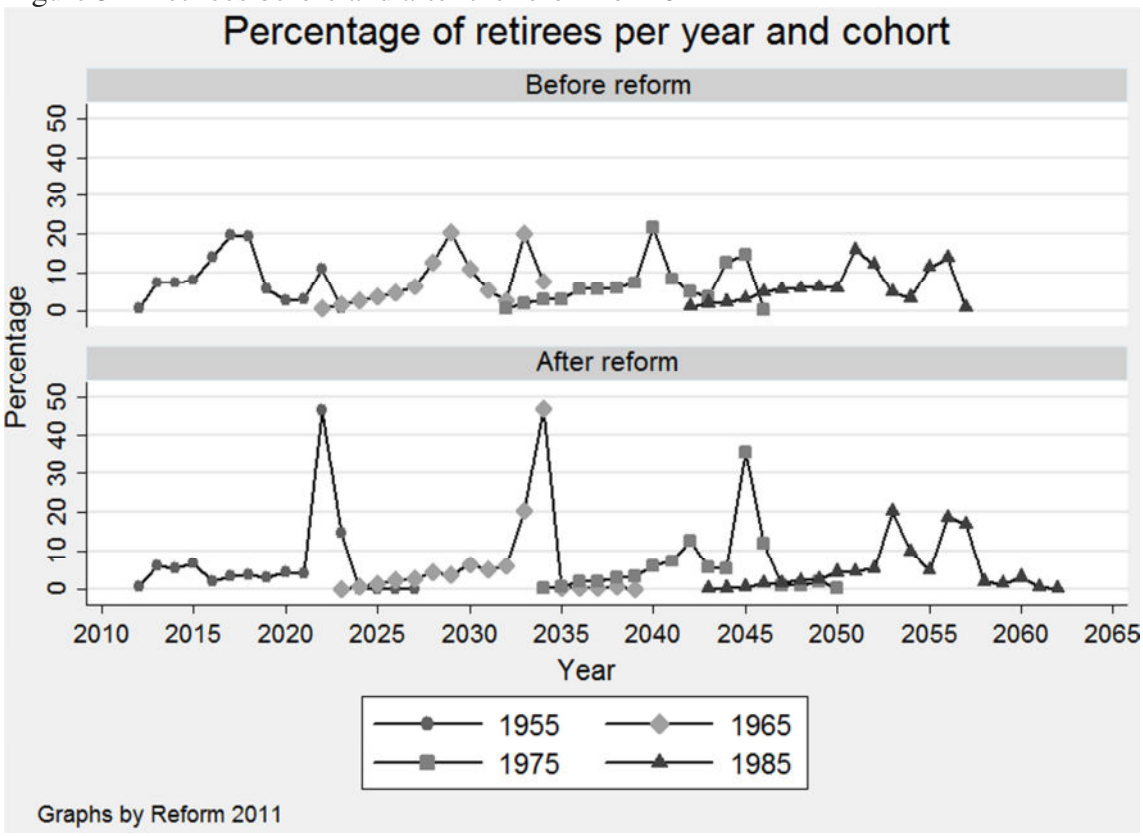
Note: values expressed in 2010 euro. Source: Authors' calculations.

Figure 2 – Self-employed working in the center of Italy, cohort born in 1975



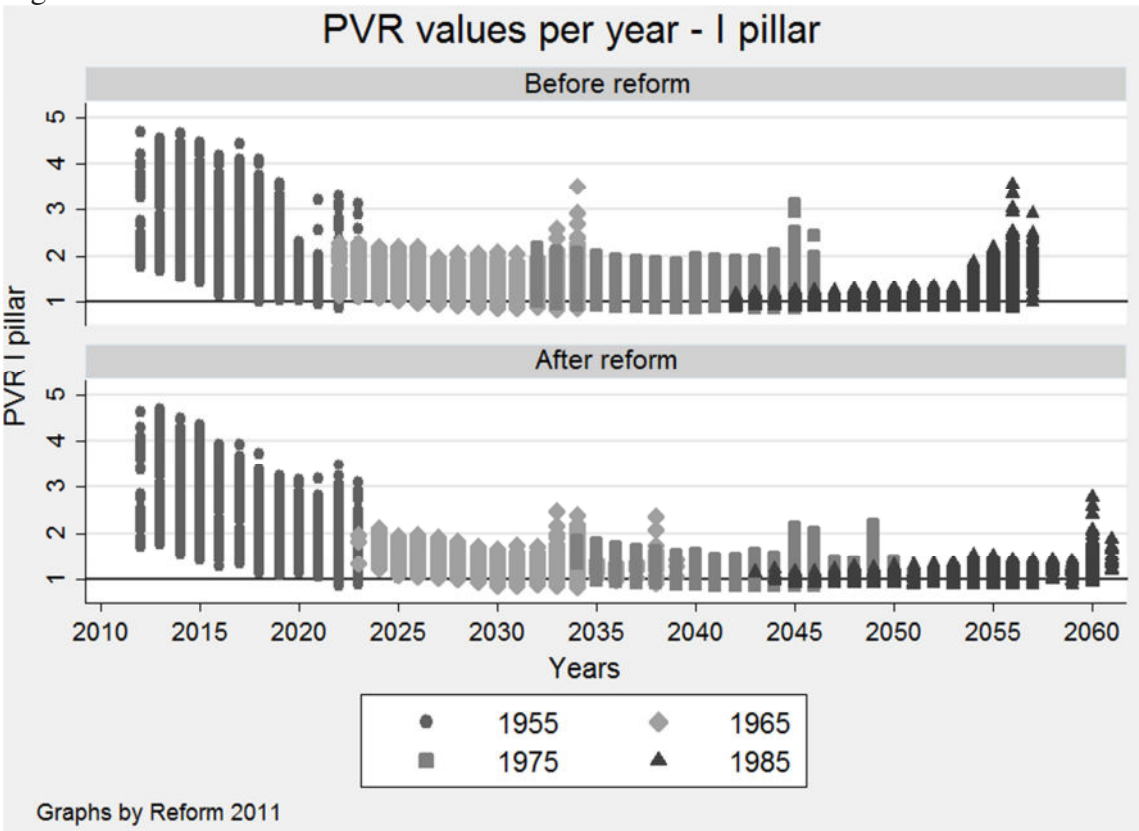
Note: values expressed in 2010 euro. Source: Authors' calculations.

Figure 3 – Retirees before and after the reform of 2011



Source: Authors' calculations.

Figure 4 – Present Value Ratio before and after the reform of 2011



Source: Authors' calculations.

Appendix - The microsimulation model

The microsimulation model is designed to analyse the distributional features embedded in the Italian pension system during its transition from a DB system to an NDC system. It is composed of two main modules: the population and the pension module.

A1.The cohort population module

This module includes a demographic section and a labour market section, which simulate all the main life events of individuals. Individuals' transitions across different states (marital status, labour status, etc.) are conditioned on individual socioeconomic characteristics and are modelled throughout a Monte Carlo procedure, that is, they are evaluated by performing a random draw from a uniform distribution and comparing it to the relevant probability taken from available sociodemographic surveys or from national statistics data. If the value of the draw is higher than the sample probability, the individual changes his status; if not, the individual remains in the initial state.

Once individuals are born, their lives evolve according to various routines which determine the day and month of birth, gender, region of residence, performance in the labour market, family status, and survival. We illustrate these routines in turn after briefly describing the data sources used.

A1.1. Data sources

Transition probabilities are drawn from the national statistics (*Istituto Nazionale di Statistica*, ISTAT) data and from two national micro datasets: the Bank of Italy's

Survey of Household Income and Wealth (SHIW) and a sample of administrative data drawn from the main social security scheme (Istituto Nazionale di Previdenza Sociale, INPS) archive, the file LoSai (Longitudinal Sample INPS).

The INPS archive officially records the complete earnings and contribution histories of all participants, that is, employees in the private sector and some categories of self-employed (craftsmen, tradesmen, and farmers). The available sample is formed by all individuals born on the first and the ninth of each month of any year — so that the theoretical sample frequency is 24:365 — and reports employment spells until 2012. The archive contains very rich information about the earnings histories of the workers, recording spells of unemployment, sickness, as well as labour income earned each year.

As typical with administrative data, demographic information is, on the other hand, less rich: the sample records the date and province of birth of the worker, as well as gender. No information about family status is available, nor about the education level of the worker. For this reason we complement it with information contained in the SHIW, which is run about every two years since 1989 to 2012 on a representative sample of about 8,000 Italian households.

A1.2. Life-invariant characteristics

At the beginning of the simulation of each cohort, a user-set number of individuals aged 0 are created. The *life-invariant characteristics* routine randomly assigns each individual a date of birth, gender, and region of residence through a Monte Carlo procedure. In each cohort the date of birth is uniformly distributed through the year: this feature of the program allows to accurately model the moment when a worker

is eligible to claim a pension benefit. Gender and region of residence are randomly assigned according to the gender and the regional distribution of newborn in the year 2013 (ISTAT website, www.demo.istat.it, 2013).

<Table A1 around here>

A1.3. Mortality

In each time period every individual enters the mortality subroutine, which determines whether that individual will survive or not in the simulated time period on the basis of gender-specific mortality tables. Individuals who are predicted to die in the simulated year still enter all subsequent routines until the cycle for the year in progress is completed. Afterwards, they are recorded as dead and are no longer taken into account in the population routines.

All our simulations are based on mortality tables provided by ISTAT. We use historical data from 1974 to 2010 and official ISTAT projections from 2011 to 2065. From 2065 on, mortality rates are kept constant.

A1.4. Education

In the program, individuals are forced into school until they turn 16 (that is, they complete compulsory education) and they cannot start contributing into the pension system before then. Compulsory school age increased along years. However, according to SHIW data, the fraction of individuals starting to work before the age of 16 is low even for the cohort born in 1955.

After completion of compulsory schooling, the individual decides whether to continue studying or not. The routine models this decision as a random process and the probabilities of getting a higher degree or a university degree are derived from the SHIW data. Frequencies are allowed to vary according to gender and region of residence (north, centre, or south).

We do not account for school dropouts and once an individual decides to start a cycle of study, he or she completes it. This hypothesis is forced by SHIW data, which only report the highest educational degree achieved by each individual. Individuals who choose not to continue studying and individuals who complete their college enter the participation routine[18].

<Table A2 around here>

A1.5. Participation

When individuals choose to no longer be students (or are forced to quit school by the program because they are university graduates), they decide whether or not to enter the labour force. This decision is modelled as a once and for all choice: if an individual decides to enter the labour force, that individual will remain active in the labour market until retirement (or death), possibly facing spells of unemployment. On the other hand, if an individual decides not to enter the labour force, he or she will remain forever out of it.

[18] Postgraduate education in Italy is still quite limited and is not modelled.

Participation rates are specific for cohorts (born before and after 1970), gender, and region. In particular, we take the participation rate for the age class 25-34 in two different calendar years, 1993 and in 2010, from the Labour Force Survey (ISTAT), and treat the first one as the participation rate of the cohorts born before 1970 and the second one as the participation rate of the cohorts born after that date. The participation rates are reported in table A3.

<Table A3 around here>

A1.6. First job

An individual joining the labour force for the first time enters the first-job routine. According to the observed probabilities, the individual can succeed in finding a first job in the current year. If a job is not found, the individual is recorded as not employed and will re-enter this routine in the following time periods. The probability of finding a first occupation is drawn from SHIW data for the only cohort for which we have enough data to compute the relevant probabilities (individuals born between 1970 and 1979). We assume the same probabilities apply to all cohorts. The probabilities also vary according to age class (younger or older than 24 years), gender, and region of residence (north, centre, and south). As the probabilities vary according to age class, we implicitly take into account the education level (college graduates enter the labour force after they turn 24).

<Table A4 around here>

A1.7. Kind of employment and social security scheme

Once an individual finds an occupation, he or she is randomly assigned to a social security scheme and a professional qualification. These characteristics do not change throughout the individual's lifetime.

The assignment of the social security scheme proceeds in two steps: A first random draw determines to which of three main schemes the worker belongs: private sector employees, or self-employed. The relevant probabilities, computed from the SHIW data, vary according to region of residence (north, centre, or south), education level (mandatory school, high school, or university degree), gender, and cohort (born before or after 1960).

A second random draw determines the social security sub-scheme to which the self-employed worker belongs: craftsman (61 percent if males, 40 percent if females) or tradesman (39 percent if males, 60 percent if females). The appropriate frequencies are computed for each gender using our administrative data sample.

A third random draw determines, where relevant, whether the individual is white collar or blue collar, conditional on being a private sector employee. Individuals who start working before age 18 are registered as blue collar, individuals who start working after that age have a probability of 35 percent of being blue collar.[19] These frequencies are computed from the administrative data without any further sub-grouping.

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[19] According to both administrative data and the SHIW sample, blue collar workers are about 70 percent of all workers employed in the private sector, irrespective of their age at entry into the labour market.

A1.8. Number of weeks

Conditional on having a job and on the number of weeks worked in the previous year, this routine determines the number of weeks worked.

We compute sample frequencies for private employees. To do so, we take two steps: We first discretize the number of weeks worked each year in our administrative panel into six classes (0, 1-13, 14-26, 27-39, 40-47, 48-52) and then we compute transition probabilities for each age class (16-24, 25-34 and 35-64) and for each region (north, centre, and south).

For the self-employed, we assume that, conditional on working, they work 52 weeks per year[20]. Using our administrative sample, we compute the probabilities of being unemployed conditional on the past year's employment status. These probabilities vary according to age (in classes), gender, and region of residence[21].

A1.9. Earnings

Earnings profiles are estimated on administrative data separately for private sector and self-employed workers, men and women, white and blue collar[22].

The estimated equation, as stated in the main text is:

$$\ln y_{it} = x_{it}\beta + \gamma_i + \varepsilon_{it}$$
$$\varepsilon_{it} = \rho\varepsilon_{it-1} + \eta_{it}$$

$$\gamma_i \sim (0,\ \sigma_\gamma^2)\ ;\ \ \eta_{it} \sim (0,\ \sigma_\eta^2)$$

---

[20] According to our administrative data, the fraction of self-employed working less than a full year is negligible and we do not model it.

[21] The probability of being employed conditional on being unemployed in the previous year varies only according to age class and gender.

[22] The self-employed are further differentiated into craftsmen and tradesmen.

where x_{it} is a vector of individual characteristics, including a constant, a polynomial in age (third degree for self-employed, fourth degree for employees), cohort dummies (cohorts 1935, 1945, 1955, 1965, 1975), regional dummies (north, centre, south), and time dummies, which are assumed to sum to zero and be orthogonal to a time trend. Ln y_{it} are the logarithm of earnings for full time workers working a full year, expressed at 2010 prices. The estimated coefficients are reported in tables A6 and A7.

The unobserved component is assumed to be the sum of a random effect (γ_i) which does not vary over time and is uncorrelated with the explanatory variables included in the equation, plus an AR(1) component with parameter ρ. In the microsimulation model, each individual is given an average log earnings profile for his or her age and group (defined by cohort, gender, region, and occupation) plus an error term formed by the sum of the two unobserved components. The first one is drawn from a normal distribution with variance σ_γ^2 at the beginning of active life and it permanently shifts up or down the average profile for the individual to whom it refers. The second component, which is also individual specific and varies over time, is formed by the shock from the previous period times the autoregressive parameter ρ plus an error term drawn from a normal distribution with variance σ_η^2.

<Table A5 around here>

<Table A6 around here>

A1.10. Marital status

In this routine individuals are recorded as children (as opposed to heads of households) until they finish their schooling years. When they are between 14 and 50 years of age, provided they are no longer students, they may get married according to the gender- and age-specific probabilities derived from Istat data 2013. Conditional on being married, an individual faces the possibility of becoming divorced (probabilities also derived from Istat 2013 data) or widowed according to the mortality table used in the program. It should be noted that we do not explicitly model the spouse or his or her income. Marital status becomes relevant, however, when computing individual social security wealth.

A2.The pension module

The pension module is a very detailed module able to compute pensionable earnings and contributions paid, check the eligibility requirements, and compute the pension benefit for a number of schemes and for different regimes. Pension benefits of the first and second pillars are computed for individuals who retire from the year 2010 onwards.

The program is able to replicate the pre-2011 reform system as well as the 2011 reform, which further tightened eligibility requirements and introduced an NDC pro-rata benefit formula for all workers from 2012 onwards.

The schemes covered, as already mentioned, are private sector employees and the self-employed, the latter categorized into craftsmen and tradesmen. These schemes greatly differed in eligibility rules, payroll taxes and the computation of benefits until

the 1995 reform imposed uniformity. The equalising process, which has been gradual, is at present almost complete. Differences in the definition of pensionable earnings (or income) and in payroll tax rates are nonetheless also maintained in the future.

This module further computes for each individual the present value of payroll taxes paid during the whole working life and the present value of the pension benefits to be received. These two quantities are the building blocks of the Present Value Ratio (PVR), used in the analysis to assess intergenerational redistribution.

The second-pillar module

We also model participation in the second pillar. Since June 2007 a tacit approval mechanism is in place, i.e. the severance payment flows of private employees (6.91 of their gross wages) are automatically redirected to the complementary pension schemes, unless the worker explicitly denies it. Despite this, adhesion rates to the second pillar are still very low, reaching in 2012 only the 25.5 per cent of the total working population (Commissione di Vigilanza sui Fondi Pensione data, 2013).

In our simulations, we model participation in the second pillar pension system simply assuming that either no-one participates or all workers participate. In particular, in the latter case, we assumed that all private workers and self-employed automatically transfer 6.91 percent of their gross earnings to pension funds from 2007 onwards.

Table A1. Gender and region of residence incidence.

Newborn males incidence		51.30%
Dwelling place incidence		
	North	45.88%
	Centre	19.57%
	South	34.55%

Source: Istat, www.demo.istat.it, year 2013.

Table A2. Education level by gender, region, and cohort (percentage).

	Males			Females		
	North	Centre	South	North	Centre	South
Cohort 1940-1959						
Compulsory school	52.6	55.2	62.8	60.6	62.7	69.4
High school	36.7	35.0	27.7	30.1	27.4	22.8
College	10.7	9.8	9.5	9.3	9.9	7.8
Cohort 1960-1979						
Compulsory school	38.4	37.7	49.6	32.6	33.5	47.9
High school	47.9	48.1	38.4	50.8	49.3	36.8
College	13.7	14.3	12.0	16.6	17.2	15.3

Source: our elaborations on SHIW data 1991-2010

Table A3. Participation rates by cohort, gender, and region (percentage).

	Men			Women		
	North	Centre	South	North	Centre	South
Cohorts born in 1970 or before	0.954	0.949	0.919	0.687	0.632	0.434
Cohorts born after 1970	0.925	0.889	0.917	0.779	0.687	0.460

Source: our elaborations on ISTAT data, Labour Force Survey, various years.

Table A4. Probability of unemployment conditional on looking for a first job (percentage).

Males	Younger than 24 years	24 years or older
Cohort 70-79		
North	9.2	5.3
Centre	24.9	13.3
South	51.2	32.2
Females	**Younger than 24 years**	**24 years or older**
Cohort 70-79		
North	18.0	6.8
Centre	27.9	16.5
South	66.5	47.8

Source: our elaborations on SHIW data 1989-2010.

Table A5. Estimated Coefficients for log-income profiles

	Men			Women		
	Blue collar	White collar	Self-employed	Blue collar	White collar	Self-employed
Age	0.201873	0.138882	0.02948	0.103233	0.1107746	0.002049
Age^2 /10	-0.00637	-0.00305	-0.00014	-0.0043	-0.00340846	0.000305
Age^3 /100	9.64E-05	3.86E-05	-6.78E-07	8.83E-05	6.02E-05	-2.73E-06
Age^4 /1000	-5.51E-07	-2.17E-07		-6.34E-07	-4.10E-07	
Constant	7.381727	7.920373	8.835824	8.473592	8.383372	9.245498
North	0.203177	0.201374	0.223784	0.164581	0.240599	0.142439
Centre	0.140626	0.152709	0.164712	0.124945	0.191567	0.109449
South	0	0	0	0	0	0
Born in 1935	-0.40038	-0.5244	-0.37894	-0.80243	-0.68071	-0.38645
Born in 1945	-0.23434	-0.35535	-0.24867	-0.48498	-0.50368	-0.234
Born in 1955	-0.17549	-0.23372	-0.17033	-0.26276	-0.37672	-0.1383
Born in 1965	-0.1196	-0.12842	-0.06603	-0.13353	-0.21208	-0.03874
Born in 1975	-0.064	-0.09335	-0.01393	-0.00513	-0.08584	0.013576
Born in 1985	0	0	0	0	0	0
Craftsmen			-0.03688			0.011514
N	8,704,608	3,868,698	4,300,649	2,687,639	2,854,982	1,794,531

Source: Authors' calculations, based on LoSai (Longitudinal Sample INPS). Note: all coefficients are statistically significant at the 0.1% level.

Table A6. Estimates for unobserved error components.

	Men			Women		
	Blue collar	White collar	Self-employed	Blue collar	White collar	Self-employed
ρ	0.540733	0.69937	0.544281	0.393984	0.406608	0.544307
σ_η	0.296131	0.372813	0.349698	0.430697	0.365474	0.29045
σ_γ	0.176466	0.156546	0.294566	0.289615	0.230275	0.253327

Source: Authors' calculations, based on LoSai (Longitudinal Sample INPS)

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