Working Paper 42/05

DISTRIBUTIVE PROPERTIES OF PENSIONS SYSTEMS: A SIMULATION OF THE ITALIAN TRANSITION FROM DEFINED BENEFIT TO DEFINED CONTRIBUTION

Margherita Borella
Flavia Coda Moscarola

Distributive Properties of Pensions Systems: a Simulation of the Italian Transition from Defined Benefit to Defined Contribution

Margherita Borella[♣] and Flavia Coda Moscarola[♣]

[♣] Center for Research on Pensions and Welfare Policies (CeRP), Via Real Collegio 30 – 10024 Moncalieri (Torino), Italy – Tel. +39 011.670.5040 – Fax. +39 011.670.5042.
E-mail: borella@cerp.unito.it, coda@cerp.unito.it

We are grateful to Elsa Fornero for her help and comments. Onorato Castellino, Cathal O'Donoghue, participants at the CeRP Conference "How much redistribution within pension systems?" (Moncalieri, 25 June 2004) , participants at the Fifth Workshop of the RTN Project on Economics of Ageing (Tilburg, 7-9 October 2004) and participants at the Wild@Ace Workshop on Industry and Labor Dynamics "The Agent-based Computational Economics approach" (Moncalieri, 3-4 Dicember 2004) provided very useful comments.
We also gratefully acknowledge the financial support from MIUR (Italian Ministry for Education, University and Research) .

1. Introduction

The Italian pension system underwent a major reform process during the Nineties and is now moving from a defined benefit system to a defined contribution one, while maintaining the pay-as-you-go financing. The reform process originated from the financial unbalances of the previous system, which were predicted to worsen - due to the demographic development - in the future. The pension system has been deeply reshaped, although through an extremely long transition, as the reforms will be fully phased in - for the flows of new pensions - after 2030.

These changes raised a number of issues, which have been and still are studied by economists: how will pension expenditure evolve in the future (RGS, 2004), how money's worth measures for the different cohorts will change (Fornero and Castellino, 2001), how have workers reacted in terms of labour supply (Borella, Belloni and Fornero, 2005) or in terms of saving behaviour (Attanasio and Brugiavini, 2003), how reforms influenced household's expectations on retirement outcomes and wealth accumulation decisions (Jappelli, Padula and Bottazzi, 2003), and so on. A point that has been less studied until now is how the redistributive features of the pension system will be affected by the reforms.

Previous work on redistribution induced by the Italian pension system design has focused either on the pre-reform system (Castellino, 1995) or on a comparison between the pre-reform and the post-reform one (Borella, 2004b). Those studies found that the defined benefit (DB) pre-reform system, intrinsically redistributive, also operated a "perverse" redistribution, from the poor to the rich. The new notional defined contribution (NDC) system, which does not have a direct redistributive aim, will certainly reduce the inequities of the previous system[1].

Our simulation study is focused on the long transition process, during which retiring workers will be entitled to benefits computed with a *pro-rata* mechanism, that is as an

[1] Although some redistribution still originates from the natural dispersion of the individuals around the average socio demographic characteristics the NDC formula is calibrated to, i.e. mortality, gender and marital status.

average of the DB and of the NDC benefit, weighted for the number of years spent in each regime.

We address this issue by building a micro-simulation model, CeRPSIM, able to simulate heterogeneous lives and earnings histories for individuals belonging to various cohorts, and to compute the resulting pension benefits, covering the various stages of the transition process until the reforms will be fully operative.

Pension benefits crucially depend on the earnings pattern of each individual: in order to build realistic earnings histories we decompose 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 sample of administrative data. In addition, the rules governing the computation of the pension benefits have been implemented in the model with great detail and a good approximation to the effective rules, following their evolution until convergence to the new NDC system.

This procedure gives us the possibility to study the distribution of the benefits within each cohort, and to follow its evolution – induced by the pension reform – through successive cohorts, until convergence to the new rules.

We evaluate within- and between-generation redistribution against an actuarial fairness benchmark. As discussed in Disney (1999), actuarial fairness has an intra- and an inter-generational dimension. A system can be considered actuarially fair from an intra-generational perspective if, as underlined by Palmer (1999), it assigns the same return to contributions to individuals belonging to the same cohort and retiring at the same age, irrespectively to their working patterns.

That system is actuarially fair also in a inter-generational point of view if, being a pay-as-you-go system, it grants to each cohort an internal rate of return equal to the historical rate of growth of the economy. In other words, an actuarially fair social security system can be seen as an almost pure insurance scheme against longevity with no redistributive aim.

Since the main objective of this paper is to study the evolution of the interpersonal distribution of the pension benefits through the transition process, the analysis is conducted at the individual level. Other studies consider households as the objects of the analysis and argue that measures of income including leisure and home production are to be preferred to the solely evaluation of individual wage income (Coronado, Fullerton, Glass, 2000). However, taking households as the units of the analysis would require a thorough modelling of the income tax and subsidy system, which goes beyond the scope of this work.

In addition, our model does not include the potential behavioural responses induced by the social security system in terms of consumption, savings and labour supply. While individual behavioural responses to the incentives and constraints generated by the social security system can have a non negligible impact on the income distribution (see for example Hugget and Ventura, 1999, and Bianchi, Romanelli and Vagliasindi, 2003), they are not going to affect the degree of the actuarial fairness of the system – which only depends on the rules by which pension benefits are computed.

A full consideration of those factors and their effect on the income distribution is left for future research.

In section 2 we give a brief description of the Italian pension system, while in section 3 we describe the micro-simulation model. Section 4 describes the simulations and the results obtained, and section 5 concludes.

2. The Italian Pension System

2.1. *The reforms*

The reforms that took place in Italy in 1992, in 1995 and in 1997 have deeply changed the public pension system[2]. The "traditional" system (i.e. before the first reform) was characterised by a defined benefit (DB) pension formula; different schemes were (and still are) in place with different rules. In the main scheme, the *Pension Fund for Private Employees* (FPLD), the pension was based on pensionable earnings – computed as the average of the last five years' earnings - multiplied by the number of working years and by the annual accrual rate:

$$P_{DB} = a * \gamma * \sum_{i=1}^{5} w_{age-i+1} / 5 \qquad \text{(DB)}$$

where *age* is the individual's age in his final working year, w is his gross annual earnings indexed for inflation, γ is the annual accrual rate and a is the number of years the individual has been active in the labour market. For public sector employees, pensionable earnings coincided with the last wage (w_{age}), while for self-employed workers the average was computed over the last ten years of taxable income from their activity. A redistributive feature of this system was represented by the non linearity of the annual accrual rate γ, which was equal to 2 per cent up to a given threshold, and gradually lowered for earnings exceeding that ceiling. In addition, a means-tested minimum benefit was guaranteed to all workers whose benefit is below a certain level. Other redistributive elements included generous survivors benefits, and the computation of notional contributions for workers temporarily out of the labour force. Benefits were indexed to wage growth.

In addition, for private sector employees and for self-employed it was possible to claim a "seniority" pension after 35 years of contribution into the scheme, while public sector employees could retire after 20 years of work (15 years for married women). In both cases, seniority pensions were computed with the same mechanism as the old-age pensions, without any actuarial correction for the age at retirement.

The first reform in 1992 modified the DB system, by setting different – and more stringent – eligibility rules and by gradually augmenting the number of years over which pensionable earnings are to be computed[3]. After the transition, pensionable earnings should have been computed for all schemes over the entire workers' earnings history.

However, the 1992 reform will never be fully phased in, given that the new 1995 reform started the (long) transition to a notional defined contribution (NDC) pension formula. After the 1995 reform will be fully in place the pension will be based on the contributions paid during the entire working period, notionally capitalised at the GDP nominal growth rate and converted into an actuarially fair annuity. 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.

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

$$P_{NDC} = \left(\sum_{i=\underline{a}}^{age} c_i \, * (1+g)^{age-i} \right) \cdot \delta_{age+1} \qquad \text{(NDC)}$$

[2] Parts of this paragraph are drawn from Borella (2004b). For a detailed exposition of the Italian Social Security system and its recent reforms, see also Brugiavini and Fornero (2001), Brugiavini (1999).

[3] The 1992 reform also ruled the indexation of pensions to prices.

where c_i is the contribution paid by the worker at age i, g is GDP nominal growth rate, δ is an age-specific annuity rate and $\underline{a}$ is the age at which the worker entered the labour market.

The annuity rates δ are set by law as the inverse of the present value of a one unit benefit for the ages between 57 and 65. This present value has been computed as a weighted average for men and women, taking into account the probability of a worker's heir to qualify for a survivor benefit and the amount of this benefit, assuming that in a couple the wife is three years younger than the husband. Until the first revision of the annuity rates planned for the year 2005, the mortality tables used are those issued by the Italian National Statistics Institute (ISTAT) for the year 1990, and the rate of return has been set equal to 1.5 per cent (which corresponds to long-run real GDP growth)[4]. Benefits are then yearly adjusted only for price inflation, with partial indexation to high earners.

As the coefficients vary only with the age at retirement, redistribution will still occur among men and women, as well as among married and unmarried individuals – ignoring the redistribution induced by differential mortality among members of each socio-demographic group (provided there is a correlation between mortality and wealth). Ceilings still apply as contributions are not paid on the fraction of earnings above a given threshold. Since the benefit is computed on the basis of the contributions paid, however, ceilings do not have any redistributive feature[5]. Different schemes and seniority pensions will gradually disappear, and flexibility of retirement age will be introduced. In particular, workers will be allowed to retire before reaching age 65, either if they paid contributions for not less than 40 years, or, having paid contributions for not less than 5 years, if they are aged 57 or more, and the benefit they are entitled to is greater than 1.2 times the yearly income support provided to the elderly in needs[6]. The limit does not apply when workers reach age 65: at that age any worker can claim his pension and, if eligible, means-tested old-age income support.

[4] See table A in the reform law (335/1995). The same law states that the coefficients will have to be revised every 10 years, on the basis of the changes in longevity and in GDP growth.

[5] In fact, this corresponds to an advantage offered to high-income earners as long as the composition of the pension portfolio is inefficiently unbalanced in favour of the pay-as-you-go component; see Fornero (1995).

[6] Means-tested income support is provided in Italy to every person aged 65 or more.

The 1997 reform preserved the new benefit computation formula (NDC), but intervened to further restrict the eligibility requirements to claim a seniority pension during the transition.

A new enabling bill (28 July 2004) introduces new – and more stringent – eligibility rules for seniority and old age pensions, both during the transition and in the new NDC regime. As the legislation is still under development, however, in our simulations we only show results based on the reforms made until 1997.

The reform process of the '90s also aimed to develop the funded private component: indeed, as shown in Borella, Fornero and Ponzetto (2004), the fraction of Italian families participating in supplementary private pensions schemes has increased over the last decade. Due to the their contributory nature and to the substantial regressive feature of their taxation, this would be an important element of an analysis of the redistributive impact of the pension reforms. Nonetheless, these schemes still represent no more than a very small fraction of the assets of Italian households and are consequently neglected in the rest of the analysis.

2.2. *The rules applying to current and future retirees*

The transitional period implied by the reforms will affect new pensioners until the 2030's. Until then, the eligibility rules and the formulae to compute the benefits will evolve affecting in different ways different cohorts of workers. Starting with the year 2000, the first year in our simulations, we can thus distinguish three main groups of retiring workers:

1 - Workers who had a seniority of at least 18 years at the end of 1995 (and thus under a regime which we call modified defined benefit, MDB): their pension benefit is computed completely with the defined benefit formula, but pensionable earnings are computed, for seniority after 1992, averaging over a longer period, according to the modified DB system set up by the 1992 reform and modified by 1997's one. Eligibility requirements have been tightened with respect to the pre-1992 system: seniority pensions can be claimed only if the worker meets an age constraint (57 years, 58 for self-employed) in addition to seniority (35 years for all workers).

2 - Workers who entered the labour market before 1995 but had less than 18 years of seniority at that date (*pro-rata*, PR): their pension benefit is computed according to a *pro-rata* mechanism. The first part of the benefit refers to the pre-1995 years of contribution and is

computed as for MDB group. The second part refers to the post-1995 years of seniority and is computed with the NDC formula. Eligibility rules are the same as for the MDB group.

3 - Workers who entered the labour market since the beginning of 1996 (notional defined contribution, NDC): these are the workers to whom the notional defined contribution system will fully apply.

Finally, it should be noted that MDB and PR workers still benefit of minimum pensions, while NDC workers can only claim the means-tested old-age maintenance when they turn 65.

3. The micro-simulation model

CeRPSIM is a micro-simulation model designed to analyse the distributional features embedded in the Italian pension system. It is composed of two main modules: the population module and the pension module. The pension module computes pension benefits according to the Italian legislation, for each simulated worker retiring from the year 2000. The normative framework supporting the transition has been implemented with great detail. A high degree of flexibility allows to implement relatively easily various possible reforms. Disability and pre-retirement survivors benefits have not been implemented yet.

The population module is designed to support a cohort population and is able to simulate lifetime patterns for individuals born since 1950. As typical with multiple cohort populations, individuals belonging to successive cohorts to do not interact with each other. This kind of models has proved to be particularly useful in the analysis of inter-generational transfers and equity issues (Nelissen 1994, Caldwell et al. 1999; O'Donoghue, 2001, surveys the existing micro-simulation models).

The simulated population evolves throughout a set of deterministic and stochastic elements.

Discrete-state changes (marital status, labour status, …) are conditional on individual socio-economic characteristics and are modelled throughout a Montecarlo procedure. They are evaluated by taking a random draw from a uniform distribution and comparing it to the relevant probability taken from the available socio-demographic 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.

The process for the lifetime earnings paths is modelled, for each individual, as the sum of a group-specific deterministic component and of a group-specific stochastic component, estimated from a sample of administrative data.

In what follows, we give a more detailed description of both modules.

3.1. *The cohort population module*

This module includes a demographic section and a labour market section, which simulate all the main life events for individuals belonging to different cohorts. As typical in artificial populations organised by cohorts, individuals, who do not interact with each other, are simulated from birth to death.

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

3.1.1. Data sources

In addition to the information available from the national statistics data, we obtain the relevant probabilities (and labour income profiles) using two micro data sets: the Bank of Italy survey (Survey of Households' Income and Wealth, *SHIW*), and a sample of administrative data, drawn from the INPS archive '*Estratti Conto*'.

The INPS archive officially records the complete earnings and contribution histories of all participants, i.e. 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 5 of March – so that the theoretical sample frequency is 1:365 – and reports spells from 1985 to 1998. The archive contains very rich information about the earnings histories of the covered workers, recording spells of unemployment 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 the province of birth of the worker, and gender. No information about the family status is available, nor about the education level of the worker. This kind of information, for a sample representative of the Italian population, is available on the Bank of Italy survey (Survey of Households' Income and Wealth, *SHIW*), which is run about every two years since 1989 to 2002[7].

3.1.2. Life-invariant characteristics

At the beginning of the simulation of each cohort, a user-set number of individuals aged zero are created. Each individual then enters the *life-invariant characteristics* routine which assigns the date of birth, gender and the region of residence.

The routine randomly assigns, through the extraction of a random number from the uniform distribution, a day of the year in which the individual is born. It follows that in each cohort the date of birth is uniformly distributed through the year of birth: this feature of the program permits to model accurately the moment in which a worker is eligible to claim a pension benefit according to the so called "exit windows", as this moment depends, among other things, on the date of birth.

Gender and region of residence are also randomly assigned, through a Monte Carlo procedure, according to the gender and regional distribution of newly born children in the year 2002 (source: ISTAT, 2003a).

Gender and region of residence incidence		
New born males incidence		51.25%
Dwelling place incidence		
	North	44.87%
	Centre	19.15%
	South	35.98%

Source: ISTAT, 2003a

3.1.3. Mortality

In each time period every individual enters the mortality subroutine, which determines whether he will survive or not in the simulated time period on the basis of gender specific

[7] See Brandolini and Cannari (1994) for a detailed description of the data and a comparison with macroeconomic data.

mortality tables. Individuals who are predicted to die in the simulated year still enter all the subsequent routines, until the cycle for the year in progress is completed. Afterwards, they are recorded as dead and they do not enter the population routines again.

All our simulations are based on ISTAT 2000 mortality tables, as we assume that survival reached its steady state level in the year 2000.

3.1.4. Education

In the program, individuals are forced into education until they turn 15 (that is, they complete compulsory education). As recorded in the Bank of Italy Survey of Households Income and Wealth (SHIW), the fraction of individuals who do not complete compulsory education for cohorts born after 1950 is low and tends to zero for younger cohorts. In addition, according to the Italian legislation, individuals cannot work before reaching the age of 15, which means that they cannot start contributing into the pension system before that age.

After an individual has completed his compulsory school, he decides whether to continue studying or not. The routine models this decision as a random process, and the probabilities of getting a higher or university degree are computed using the SHIW data. The probabilities vary according to: cohort (born before 1959, born on or after 1960), gender, region of residence (north, centre or south).

Once the individual decides to start a cycle of study, he completes it (in other words, there are no drop-outs); this hypothesis is induced by the information available from the SHIW data, which report the degree achieved by each individual. Individuals who choose not to continue studying and individuals who complete their college enter the participation routine[8].

[8] Post-graduate education in Italy is still quite limited and it is not modelled.

Education level by gender, region and cohort (percentage)

	Males			Females		
	North	Centre	South	North	Centre	South
Cohort 1950-1959						
compulsory school	45.38	50.82	58.95	49.85	53.58	61.76
high school	41.85	38.46	30.67	38.26	34.27	29.35
college	12.77	10.72	10.38	11.89	12.15	8.89
Cohort 1960-1969						
compulsory school	42.92	45.26	49.20	35.90	39.74	48.37
high school	45.72	46.21	39.52	51.45	48.14	40.78
college	11.36	8.53	11.29	12.64	12.12	10.86

Source: SHIW, various years

3.1.5. *Participation*

When individuals choose (or are forced by the program as they are college graduates) to be no longer students, 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, he will remain active into the labour market until he retires (or dies), possibly facing spells of unemployment. On the other hand, if an individual decides not to enter the labour force, he will remain forever out of it.

Participation rates are specific for cohorts (born before and after 1968), gender and region, and refer to the year 2002 (source: Istat, 2003b).

Participation rates by cohort, gender and region (percentage)

	Men			Women		
	North	Centre	South	North	Centre	South
Cohorts born in 1968 or before	0.95	0.94	0.91	0.68	0.63	0.43
Cohorts born after 1968	0.95	0.94	0.91	0.79	0.68	0.46

Source: Istat, 2003b

3.1.6. *First job*

When an individual first enters the labour force, he enters the first job routine, where he succeeds in finding his first job in the current year according to a certain probability. If he is not successful, he is recorded as not employed; in the subsequent time periods he will reenter this routine until he succeeds in finding an occupation. Once a worker finds his first job, he will never enter this routine again.

The probability of finding the first occupation is drawn from SHIW data, for the only cohort for which this kind of information is available (individuals born between 1970 and 1979); we are therefore assuming that there are no cohort effects in the probability of finding the first job.

The probabilities vary according to: age class (less or more than 24), gender, region of residence (north, centre and south). As the probabilities vary according to age class, we are implicitly taking into account the education level (college graduate enter the labour force after 24).

Probability of unemployment conditional on looking for first job (percentage)

Males	Less than 24	24 or more
cohort 70-79		
North	9.2	5.3
Centre	24.9	13.3
South	51.2	32.2

Females	Less than 24	24 or more
cohort 70-79		
North	18.0	6.8
Centre	27.9	16.5
South	66.5	47.8

Source: SHIW, various years

3.1.7. Kind of employment and social security scheme

Once an individual finds an occupation, he is randomly assigned a social security scheme and a professional qualification. He will not change these characteristics through all his life.

The assignment of the social security scheme proceeds in two steps: a first random draw determines which of the three main schemes the worker belongs to: FPLD (private sector employee), INPDAP (public sector employee), 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, university degree), gender, and cohort (born before or after 1960).

A second random draw determines the social security sub-scheme to which the worker belongs, when relevant: "regular" private sector employee (86.7%) or agricultural worker (13.3%), if the main scheme is private sector employee; craftsman (40%), tradesman (40%) or farmer (20%) if the main scheme is self-employed. The relevant frequencies are computed from our administrative data sample, without any further sub-grouping as the number of observations at this level of disaggregation is limited. Although there is a variety of different social security sub-schemes also in the public sector, all the public workers are modelled as belonging to the main sub-scheme[9].

A third random draw determines, where relevant, whether the individual is a white or a blue collar, conditional on the scheme he belongs to. Individuals who start working before age 18 are registered as blue collars, individuals who start working after that age face a probability of being blue collars equal to 35% in the private sector, and to 10% in the public one[10]. These frequencies are computed from the administrative data (SHIW for public sector workers), without any further sub-grouping as the number of observations at this level of disaggregation is limited.

3.1.8. Number of weeks

Conditional on having a job, this routine determines, in two stages, *a)* whether the individual is employed or unemployed in a given year, and *b)* the number of weeks worked during that year, conditional on them being greater than zero.

Probabilities of being unemployed given that in the previous year the worker was employed, and of being employed given that in the previous year the worker was unemployed have been computed using our administrative sample separately for private

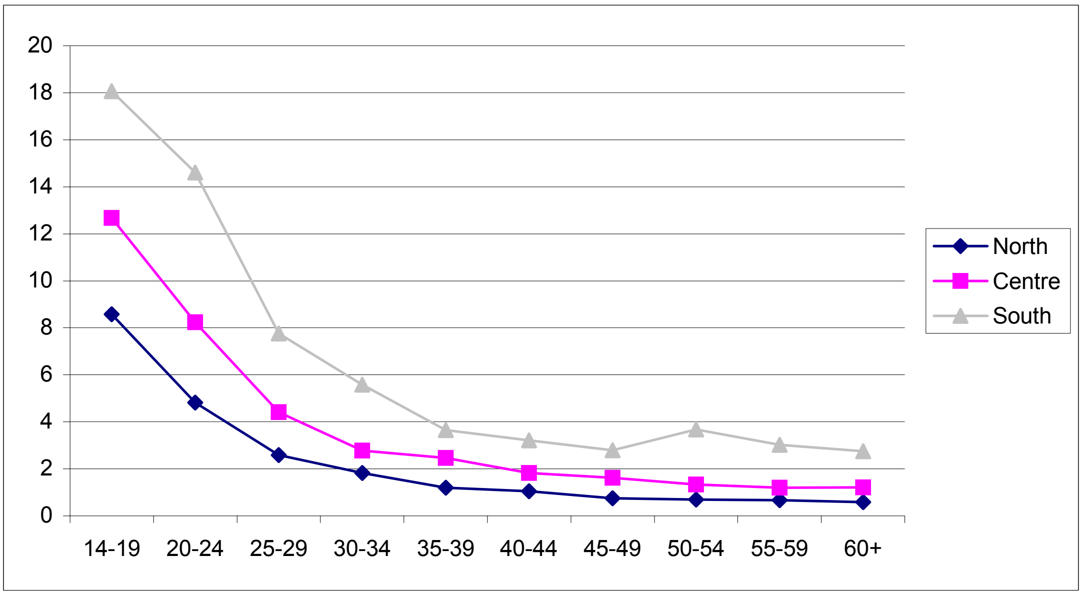
[9] Which is the sub-scheme for local government employees (CPDEL).

[10] According to both administrative data and the SHIW sample, blue collars are about 70% of workers employed in the private sector, irrespective of their age at entry into the labour market. As for the public sector, according to the SHIW sample blue collars are about 20%.

employees, employees in the agricultural sector, and self-employed[11]. These probabilities vary according to age (in classes), gender, and region of residence[12].

In addition, private employees and employees in the agricultural sector face a certain probability of working less than a full year, conditional on being employed. These probabilities have been also computed from administrative data for the two groups of workers, and vary according to age and gender. Self-employed workers are assumed, conditional on working, to do so for a full year[13].

Unemployment rate – men, blue collar, by region and age class



[11] Public sector employees do not face unemployment spells: on the one hand, we lack data to compute unemployment probabilities for this group of workers, on the other, it seems a reasonable assumption given the stability of work relationships in the Italian public sector.

[12] Due to sample size, the probability of being employed conditional on being unemployed in the previous year varies only according to age class and gender.

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

3.1.9. Earnings

Earnings profiles have been estimated on administrative data separately for private sector and self-employed workers, men and women, white and blue collars[14].

The estimated equation is:

$$\ln y_{it} = x_{it}\beta + \gamma_i + \varepsilon_{it}$$

$$\varepsilon_{it} = \rho\varepsilon_{it-1} + \eta_{it}$$

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

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), cohort dummies (cohorts 1935, 1945, 1955, 1965, 1975), regional dummies (north, centre, south), and time dummies, which are assumed to sum up to zero and be orthogonal to a time trend.

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 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, 2004a).

In the micro-simulation model, 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 at the beginning of the active life, 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.

[14] Self-employed are further distinguished in craftsmen and tradesmen, excluding farmers. Farmers in our administrative sample who do not report zero income are less then 5%, resulting in a sample size too small to enable an estimate of the income profile. The zero-income report is mainly due to the pension legislation which requires a minimum payroll tax to be paid up to a threshold. All farmers with income below that threshold (i.e. the very vast majority) report zero income and pay the minimum payroll tax.

Estimates for unobserved error component

	Males			Females		
	Blu collar	white collar	Self-employed	Blu collar	white collar	Self-employed
ρ	0.432	0.529	0.165	0.419	0.440	0.070
σ_η	0.126	0.110	0.313	0.175	0.162	0.309
σ_γ	0.242	0.335	0.263	0.332	0.360	0.229

3.1.10. 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 aged between 14 and 50, provided they are no longer students, they may get married according to the gender- and age-specific probabilities available from the 1991 Census data. Conditional on being married, and individual faces the possibility of becoming divorced (probabilities also in 1991 Census data) or widow(er) according to the mortality table used in the program.

3.2. The pension module

The pension module is a very detailed module able to compute pensionable earnings and the contributions paid, to check the eligibility requirements and to compute the pension benefit for a number of schemes and for different regimes. Pension benefits are computed for individuals who retire from the year 2000 onwards. The program flexibility enables the user to easily implement various parametric reforms of the pension system.

The regimes covered in the program are: *a)* the modified defined benefit (MDB) regime, applying to those workers who contributed into their scheme at least for 18 years in 1995; *b)* the *pro-rata* (PR) regime, which applies to workers who started contributing to their scheme before 1996 but had a seniority lower than 18 years in 1995; *c)* the notional defined contribution (NDC) scheme, which applies to workers who started contributing into their scheme on or after 1996[15].

[15] See section 2.2 for a more detailed description.

In addition, the same module computes the minimum pension – applying to retirees in regimes *a*) and *b*) – and the old age income maintenance – applying to non-retirees in regimes *a*) and *b*) and to all individuals in regime *c*).

The schemes covered, as already mentioned, are: private sector employees, employees in the agricultural sector, public sector employees and self-employed, distinguished in craftsmen, tradesmen, farmers and farmers in disadvantaged regions. All these schemes differed in eligibility rules, payroll taxes and computation of benefits formulae before the 1995 reform. The reform in 1995 set the principle of the uniformity of rules, and since that year a convergence process started, which is at present almost completed. Differences in the definition of pensionable earnings (or income) and in payroll-tax rates are nonetheless maintained also in the future.

As retirement behaviour is not modelled, individuals are assumed to claim their pension benefit as soon as they are eligible: this requires not only that they meet the minimum eligibility requirement but also that they wait for an "exit window" to be active[16].

This module also computes, for each individual at the moment of retirement, the present value of payroll taxes paid during the whole working life and the present value of the pension benefits to be received[17]. These two quantities are the building blocks for various money's worth measures used in the subsequent analysis.

Finally, this module computes a measure of permanent income, defined as the present value at retirement of lifetime working incomes.

4. Results

4.1. Parameters setting

To cover the transition to the NDC regime, we simulated 5 cohorts born in 1955, 1965, 1975, 1985 and 1995. This choice allows the study of the distribution of the pension benefits for workers belonging to the different regimes outlined in section 2.2 above (MDB, PR, and NDC workers).

[16] Workers eligible to claim a pension can retire only in four predetermined periods during the year (the so-called exit windows).

[17] See the Appendix for details and for the formulae used.

Throughout all the calculations presented in this paper we use a discount rate equal to 1.5% in real terms. However, as the results are likely to be sensible to the choice of this parameter, we also experiment with higher discount rates.

We use historical values for the GDP real growth and the inflation rates until they are available (i.e. 2003), and we set the future GDP real growth rate equal to 1.5% and the future inflation rate equal to 1.6%.

We assume that survival reached its steady state level in the year 2000. All the simulations are based on ISTAT 2000 mortality tables. From the year 2005 on, the annuity rates for the NDC formula are also upgraded to ISTAT 2000.

4.2. Measures used to analyse redistribution

The results of the simulations are described by a number of different measures. A first group of indicators is related to the measure of the benefit; among these we consider the first pension and the replacement ratio, defined as the first benefit received over the last wage. These statistics enable to analyse for each simulated cohort the income level and its variation in consequence of retirement.

We also use measures able to capture the expected money's worth of participating to the public pension system, built on the present value of the pension benefits to be received and the present value of the payroll taxes paid, both valued at the time of retirement for each individual. The expected worthiness of participating to the social security system is expressed with respect to the opportunity cost of a lost alternative exogenously fixed (represented by the discount rate used for the calculations).

A first possibility would be to compute the difference between these two present values, obtaining the well-known social security wealth (SSW) at retirement. If its value is greater than zero, participation advantages the individual respect to an alternative investment that gives a return equal to the discount rate applied in calculating his social security wealth. This measure allows to discriminate among individuals who benefit and individuals who loose from participating to the public social security system. However, gains and losses are expressed in absolute terms and do not capture individual differences in income. As we are interested in analysing redistribution among individuals with different income profiles and retiring at different ages, we use relative measures such as the present value ratio (PVR) and the lifetime tax rate.

The PVR is 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.

This measure has the advantage, with respect to SSW, of being scale invariant. When computed at retirement, it allows immediate evaluations about the actuarial fairness of the social security rules. A PVR greater than one suggests that the individual is going to receive in terms of social security benefits more then it has actually paid in terms of payroll taxes.

The lifetime tax rate is defined as minus the ratio between SSW and the present value of the lifetime working incomes. If the tax rate is positive, the individual pays more than he receives in terms of pension benefits; if negative, the individual pays less. Following Coronado et al. (2000) we use this measure to assess the progressivity of the system; if the tax rate is increasing in (permanent) income, the system is progressive[18].

4.3. Results

We show results for five cohorts of simulated individuals, born since 1955 to 1995 with a ten year gap. Each cohort is formed by 15,000 heterogeneous individuals. In the first cohort, born in 1955, about 60% of the individuals receive a benefit computed according to the modified DB formula (MDB workers), while about 40% of them fall into the pro-rata mechanism (PR workers). In the second cohort, representing individuals born in 1965, almost all the workers receive a benefit computed with the pro-rata mechanism. In the third cohort (born in 1975) about 40% individuals receive a benefit entirely computed with the NDC system (NDC workers), while all the others are PR workers. Cohort 4 and 5 are both completely under the NDC system, and in some figures only cohort 4 is displayed.

To better illustrate the pension rules driving the results, in figure 1 we show the first monthly benefit received by each individual in each cohort against the present value of the contributions paid during the entire working life. In particular, figure 1 focuses on workers

[18] Unlike Coronado et al. (2000), we take an individual perspective in which we do not account for measures of total household income and for potential differential mortality rates among different socio-economic groups.

retiring at 58, the mode age of retirement. All monetary values are expressed in euro at 2000 prices; the present value of contributions is expressed in million euro.

The figure shows how for the first cohort (upper left panel) the benefit is on average increasing in the contributions paid; the variance of the benefit itself, given the value of the contributions paid, is also notable. In particular, a group of individuals tend to receive a higher benefit given the contributions paid: these are public sector employees, who still have, in the MDB system, higher rates of return from public social security.

For cohort 2, where individuals are all PR workers, the picture is equivalent but (not surprisingly) the dispersion is reduced, as the transition process implies a convergence of the rates of return from the pension system.

Moving to cohort 3 and 4, the effect of the NDC system becomes apparent: the benefit is strictly linked to the amount of contributions paid by the worker during his life, and there is some residual variance especially at very low values of contributions paid. In particular, there still is a group of workers receiving on average a (slightly) higher benefit given the contributions paid: these workers are employed in the agricultural sector, and the payroll tax they actually pay converges more slowly, with respect to other workers, to its long-run value, over which the benefit is computed.

This difference disappears in cohort 5 (graph not shown) where the only redistribution left is in favour of low income individuals, and it is due to the presence of means tested income support granted to individuals aged 65 or more.

From another perspective, the evolution of the PVR through time is also suggestive of the evolution of the pension system rules. Figure 2 reports the evolution over time of the PVR at retirement for the five cohorts simulated: workers belonging to cohort 1 start retiring in 2010 and workers of cohort 5 finish retiring in 2061. This figure highlights the two main dimensions of variability in worthiness of participation induced by the pension system: there is variability "between and within cohorts", and, among individuals belonging to the same cohort, "between and within different ages of retirement".

The PVR is, on average, well above 1 for all cohorts, indicating that on average workers receive in terms of pension benefit more than they actually paid through the payroll taxes during their active life. It is worth noticing that in cohort 1 the PVR is greater than one for virtually all workers. Given the real discount rate used, which is equal to 1.5%, this circumstance is true also for younger (i.e. NDC) cohorts, mainly because in the NDC system the payroll tax actually paid is (slightly) lower than the one used to compute the benefit[19]. When raising the real discount rate, the PVR proportionally decreases for each individual (the present value of the contributions paid increases while the present value of future pension benefits is reduced with respect to our base case). For example a real interest rate of 4% results in an average and/or median PVR still greater than one for the first cohort, while it is well under unity for all the subsequent cohorts[20].

Another striking feature is that the PVR is on average decreasing through time (and so, between cohorts), as a consequence of the transition process. Once the NDC regime is fully implemented, that is from cohort 4 onwards, the average PVR stabilises. The box plot in figure 2bis better illustrates the point. In this figure, each box extends from the 25th to the 75th percentile of the PVR (the so called interquartile range, IQR). The line in the middle represents the median PVR. The lines emerging from the box extend to the upper and lower adjacent values (defined as the largest point less than or equal to: 75th percentile+1.5*IQR; the smallest point greater than or equal to: 25th percentile-1.5*IQR). Outside points are individually plotted. As shown in figure 2bis, both the median and the IQR are decreasing through cohorts.

Within cohort variability is also decreasing, although without fully disappearing[21]. While the reform process brings to a greater uniformity of rules and, as a consequence, of treatment among individuals, some differences in rules across schemes persist in the NDC system (within cohorts 4 and 5). These differences are mainly due to the discrepancy between the payroll tax paid and the rate used to compute notional contributions, which varies across different schemes (employees/self-employed). Individual personal characteristics (gender, marital status, working careers and age of retirement) explain the remaining variability. As the coefficient in the NDC benefit computation formula depends on the average life expectancy for men and women, and on the average probability of having a heir, part of the within cohort variance is due to individual dispersion around these averages. Differences in working patterns among individuals bring to heterogeneity in the age of

[19] Other features of the NDC system drive this result: for example, the annuity coefficients are adjusted to life-expectancy only every ten years.

[20] Results not shown but available on request.

[21] While this result holds in general, the exact amount of variability and of its reduction depends on the relative dimension of the demographic socio-economic groups, i.e. on the hypotheses made when building the artificial population.

retirement. In particular, if the worker retires before 57 or after 65 the pension rule is not actuarially fair any longer. Finally, incomplete price-indexation of the benefit for amounts above a certain level also results in some additional dispersion.

To further investigate the redistributive features of the system, we plot the lifetime tax rate against permanent income, defined as the present value of earnings received by each worker during his active life, valued at retirement. This is shown, again for cohorts 1 to 4, in figure 3. Results for cohort 1, in the upper left panel, show that the MDB system is, on average, progressive: the lifetime tax rate is on average increasing in permanent income. It is also apparent that the system is redistributing along dimensions other than permanent income: for a particular value of permanent income, a worker can end up with a range of tax rates. On the other hand, a given value of the tax rate is associated with different values of permanent income. These differences depend both on the heterogeneity of earnings careers experienced by workers, i.e. steeper or flatter profiles, and on the rules applying to the different schemes the workers belong to.

It is apparent from this figure that the MDB system is redistributing both from the rich to the poor and in the opposite direction. Looking at subsequent cohorts, the variance in the tax rate tends to diminish (see also figure 3bis), although without disappearing: the reform process dramatically reduces both the perverse redistribution and the "good" one. There is still some redistribution in the NDC cohort (fourth panel) which occurs for the same reasons indicated for the PVR.

Finally, as illustrated in figure 2 for the PVR, virtually all workers in cohort 1 receive from the system more than they paid, as their tax rate is almost always negative; the fraction of workers having a positive tax rate is increasing when moving to subsequent cohorts. These are typically single men employed in the private sector, which do not benefit from the averaged annuity rate.

When experimenting with a higher discount rate, two effects tend to emerge. First, the tax rate increases for each individual: with an interest rate equal to 4%, the average tax rate becomes positive for cohort 2 onwards. Second, the effect of the contribution ceilings and of the minimum contribution requirements for lowest wages can cause the NDC system to become regressive (although with an interest rate as high as 4% the system turns only slightly regressive)[22].

To further investigate the differences in tax rates for different groups of workers, tables 1 and 2 report the average, the interquantile range and the variance of the tax rate and of the permanent income, distinguishing between men and women and between employees and self-employed. The average tax rate is always negative, indicating that individuals are, on average, actually receiving a benefit. The tax rate is higher for the eldest cohorts, gradually decreasing, and it is on average higher for women than for men and for self-employed workers than for employees. The slight decrease in permanent income observed for younger cohorts of self-employed is due to our hypothesis on retirement behaviour, which results in a lower number of years in which they are active in the labour market[23].

For the same groups of the population, tables 3 and 4 report the average, the interquantile range and the variance of the replacement rate and of the years of work. The replacement rate is on average decreasing, from one cohort to the next one, for all the groups considered. The decrease for the self-employed is dramatic, as their NDC payroll tax is 14 percentage points lower than that for the employees, and the NDC system strictly links the pension benefit to the contributions paid (while the MDB system assigns about the same accrual rate to both the self-employed and the employees, irrespectively of their payroll tax rate). It should also be noticed that the average years of work also tend to decrease as the rules to claim a pension benefit are less stringent for younger cohorts (NDC system) and we made the hypothesis that individuals retire as soon as they become eligible to claim the benefit.

5. Conclusions

In this work we analysed the redistributive features of the Italian pension system along its transition to the new NDC regime as figured out from the major reform process of the Nineties.

[22] This effect is also documented by Coronado et al. (2000) for the US.

[23] See next table.

To address this issue we built a micro-simulation model, operating in discrete time, in a steady state macroeconomic environment, and with a probabilistic treatment of events. We simulated the most relevant life episodes of 5 cohorts from birth till death. The transition probabilities used in the model vary between different cohorts and socio-economic groups and are derived from a sample of administrative data and from the Bank of Italy Survey of Household Income and Wealth (SHIW). In particular we aimed to realistically simulate the labour income patterns followed by individuals: to this purpose we decomposed the earnings process into a deterministic, group-specific age profile, and an unobserved component modelled as an ARMA process plus an individual effect.

The simulated normative framework has been studied to faithfully replicate the set of rules of the Italian Social Security system in its transition process towards the new steady state.

We found that the pension system for the cohort born in 1955 (starting to retire since 2010) is highly redistributive along many dimensions, not just earnings. This is due to the working (fully or with a *pro-rata* mechanism) of the modified defined benefit formula and to the residual heterogeneity of rules governing the different schemes still in place at this time.

For subsequent cohorts, in parallel with the phasing in of the NDC system, redistribution in all dimensions is also gradually reduced, to reach a minimum level in the new steady state (due to the less than full application of the actuarial principle).

By ensuring uniformity of treatment among different categories of workers, the new system thus dramatically reduces both the perverse and the "good" redistribution of the past. The first effect is certainly positive; the second follows from the aim to separate the insurance from the assistance goal of the pension system, in order to improve its transparency.

On the other hand, the adequacy of benefits is still an open question, as this will crucially depend on the characteristics of the labour market. From this perspective, it is possible that our results underestimate the dimension of the problem, if future working careers will be more flexible and discontinuous with respect to the past. The investigation of these aspects is left for future research.

Figure 1 – Monthly pension benefit by cohort, individuals retiring at 58.

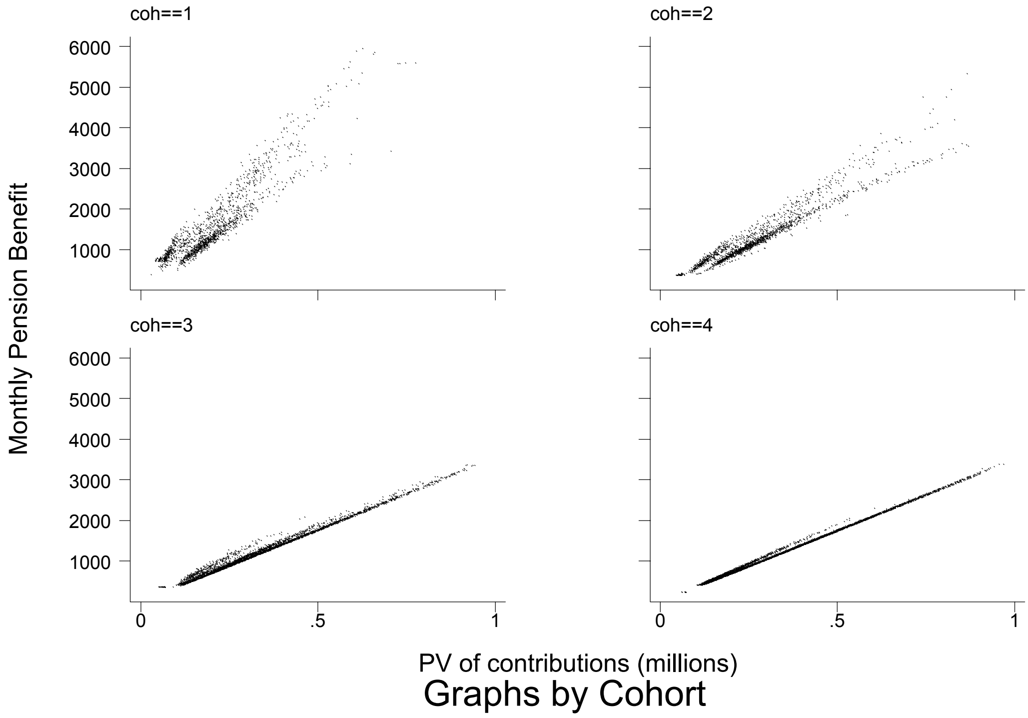


Figure 2 – PVR through time

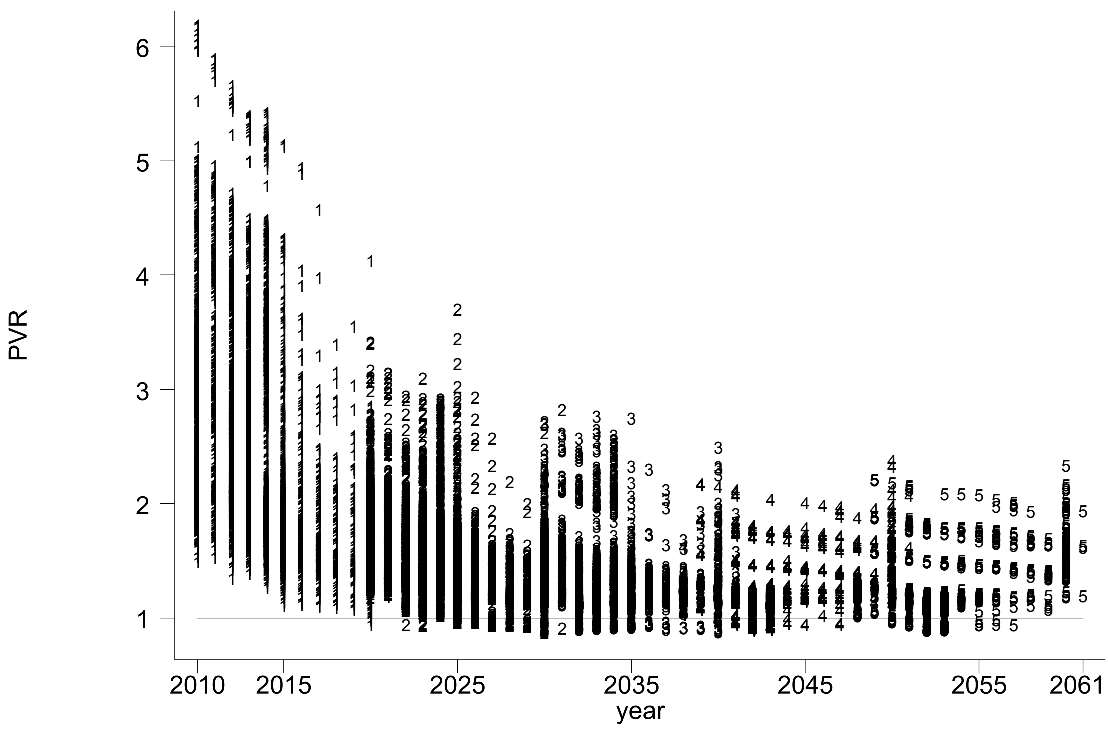


Figure 2bis – PVR through time, box plot by cohort

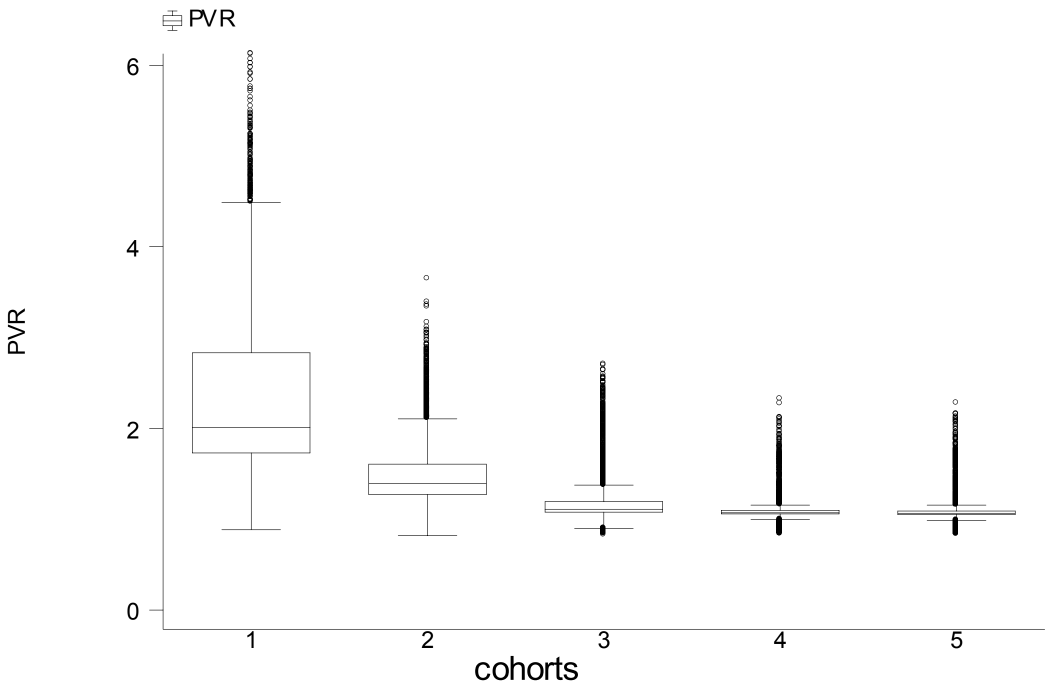


Figure 3 – Tax rate by cohort

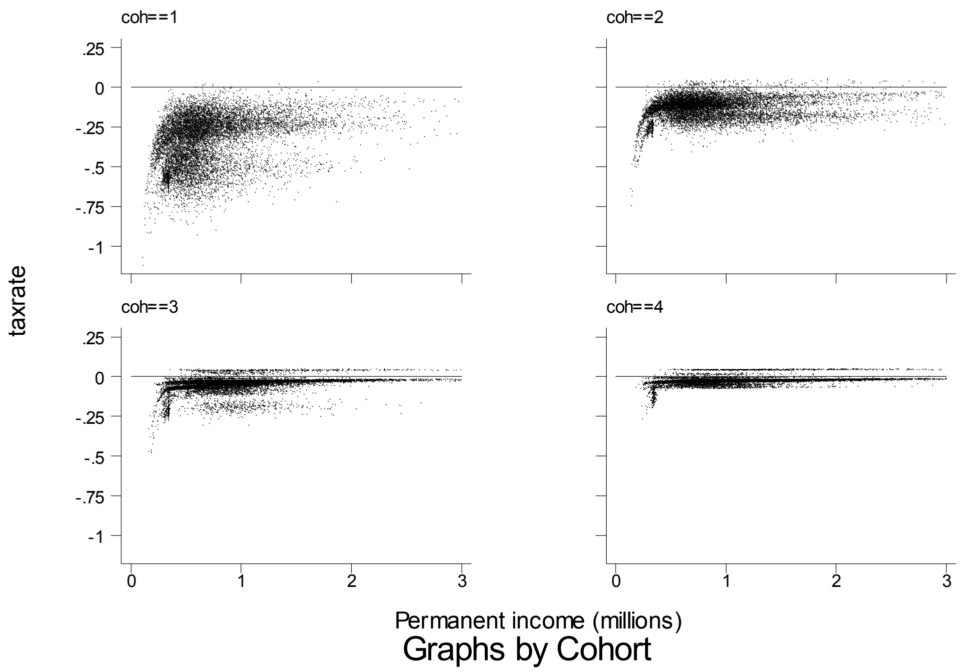


Figure 3bis – Tax rate, box plot by cohort

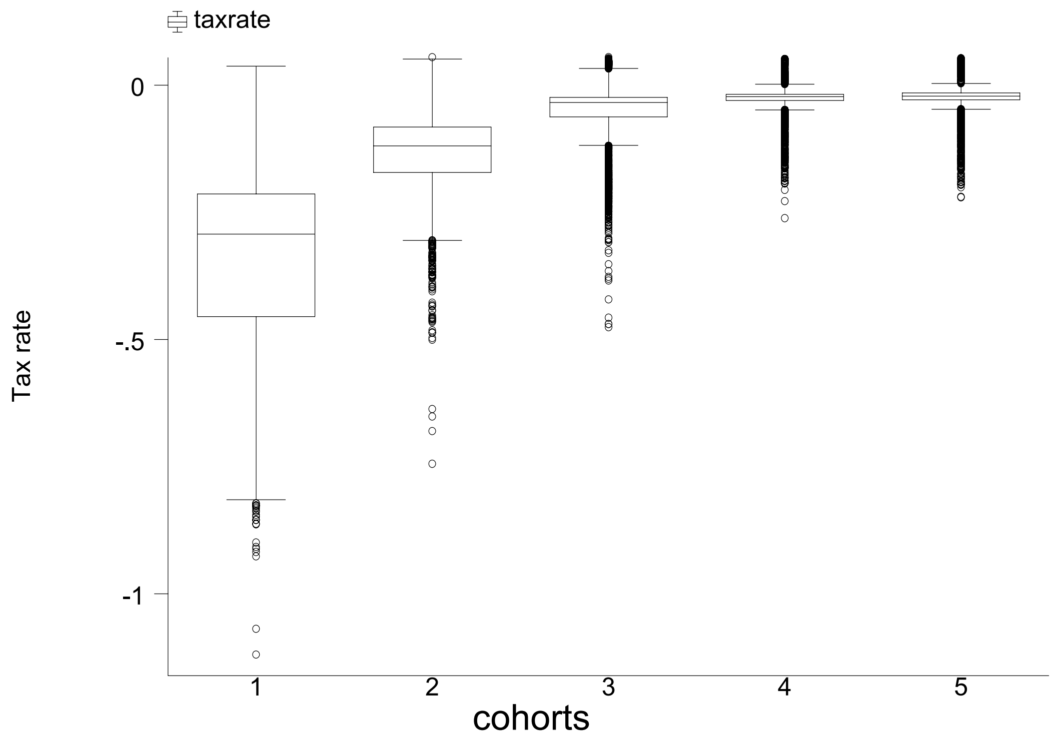


Table 1 – Tax rate, by group

	Employee		Self employed	
	Male	Female	Male	Female
cohort 1				
Average tax rate (%)	-28.23	-35.17	-43.13	-48.23
IQR (percentage points)	15.73	22.22	16.49	13.72
Var (percentage points)	2.01	2.58	1.77	1.32
cohort 2				
Average tax rate (%)	-10.71	-14.78	-14.90	-17.89
IQR (percentage points)	8.76	7.42	8.83	9.40
Var (percentage points)	0.38	0.44	0.40	0.49
cohort 3				
Average tax rate (%)	-3.37	-5.87	-7.62	-9.53
IQR (percentage points)	2.22	3.60	5.64	5.68
Var (percentage points)	0.18	0.26	0.36	0.43
cohort 4				
Average tax rate (%)	-1.54	-2.93	-3.70	-5.71
IQR (percentage points)	0.62	0.58	2.69	2.69
Var (percentage points)	0.06	0.02	0.10	0.24

Table 2 – Permanent income, by group

	Employee		Self employed	
	Male	Female	Male	Female
cohort 1				
Average PY (thousands euro)	882.08	588.52	452.61	408.23
IQR (thousands euro)	519.73	377.59	205.93	136.91
Var (billions euro)	189.00	83.30	20.80	12.70
cohort 2				
Average PY (thousands euro)	1095.23	676.36	613.09	557.16
IQR (thousands euro)	610.87	432.26	329.75	303.14
Var (billions euro)	241.00	114.00	53.60	36.20
cohort 3				
Average PY (thousands euro)	1168.76	744.49	776.74	774.77
IQR (thousands euro)	604.41	423.89	428.38	403.94
Var (billions euro))	240.00	125.00	105.00	93.70
cohort 4				
Average PY (thousands euro)	1311.22	883.65	757.45	750.00
IQR (thousands euro)	690.53	488.79	401.20	375.70
Var (billions euro)	280.00	162.00	93.30	81.80

Table 3 – Replacement Rate, by group

	Employee		Self employed	
	Male	Female	Male	Female
cohort 1				
Average RR (%)	70.65	72.77	79.10	80.93
IQR (percentage points)	15.07	23.57	17.81	18.49
Var (percentage points)	295.77	523.78	1291.76	1770.13
cohort 2				
Average RR (%)	62.21	64.65	48.73	49.20
IQR (percentage points)	11.61	16.38	13.97	13.34
Var (percentage points)	263.30	488.36	250.95	523.29
cohort 3				
Average RR (%)	52.28	59.30	39.23	38.65
IQR (percentage points)	16.95	20.62	10.16	9.70
Var (percentage points)	327.13	708.17	232.30	303.15
cohort 4				
Average RR (%)	48.58	57.52	33.75	32.71
IQR (percentage points)	12.87	17.87	10.80	9.71
Var (percentage points)	238.71	629.14	186.37	210.18

Table 4 – Years of work, by group

	Employee		Self employed	
	Male	Female	Male	Female
cohort 1				
Average YOW	36.46	35.17	34.86	34.33
IQR	2.92	5.17	4.75	8.79
Var	7.58	17.38	64.16	71.78
cohort 2				
Average YOW	35.76	33.29	34.61	33.53
IQR	2.03	5.82	4.75	10.48
Var	8.49	23.31	61.64	68.71
cohort 3				
Average YOW	34.47	32.99	33.77	33.72
IQR	4.71	4.80	10.00	11.37
Var	15.02	20.12	61.40	64.28
cohort 4				
Average YOW	33.90	33.69	33.17	33.00
IQR	5.49	5.62	8.25	9.48
Var	15.46	18.29	51.35	55.57

References

Attanasio, O.P. and A. Brugiavini (2003) "Social security and Households Savings", *Quarterly Journal of Economics,* Vol. 118, Issue 3 - August 2003, pp. 1075-1120.

Bianchi C., M. Romanelli and P. Vagliasindi (2003) "Microsimulating the Evolution of Italian Pension Benefits: The Role of Retirement Choices and Lowest Pensions Indexing". *Labour*, Vol. 17, pp. 139-173, August 2003.

Borella, M. (2004a) "The Error Structure of Earnings: an Analysis on Italian Longitudinal Data", *Rivista Internazionale di Scienze Economiche e Commerciali / International Review of Economics and Business*, 51(3), pp. 405-422.

Borella, M. (2004b) "The Distributional Impact of Pension System Reforms: An Application to the Italian Case", *Fiscal Studies*, 25(4), pp. 415-437.

Borella, M., M. Belloni and E. Fornero (2005) "Retirement Choices of Older Workers in Italy", in Fornero, E. e P. Sestito, *Pension Systems: Beyond Mandatory Retirement*, Cheltenham: Edward Elgar, forthcoming.

Borella, M., E. Fornero and G. Ponzetto (2004) "The Market for Annuities in Italy: Reality or Chimera?" in E. Fornero and E. Luciano Eds., *Developing an Annuity Market in Europe*, Cheltenham, Edward Elgar, pp. 262-290.

Brandolini A. and Cannari L., "Methodological Appendix", in *Saving and the Accumulation of Wealth*, Albert Ando, Luigi Guiso and Ignazio Visco eds. Cambridge: Cambridge University Press, 1994.

Brugiavini, A. (1999) "Social Security and Retirement in Italy", in J. Gruber and D. Wise eds., *Social Security and Retirement around the World*, The University of Chicago Press, Chicago, pp. 181-237.

Brugiavini, A. and E. Fornero (2001) "Pension Provision in Italy", in Richard Disney and Paul Johnson Eds., *Pension Systems and Retirement Incomes across OECD Countries*, Edward Elgar, Cheltenham, pp. 197-235.

Caldwell S., M. Faverault, A. Gantman, L. J. Kotlikoff, and T. Johnson (1999) "Social Security's Treatment of Post-War Americans", in J. Poterba, *Tax Policy and the Economy*, 13, NBER, MIT Press.

Castellino, O. (1995) "Redistribution Between and Within Generations in the Italian Social Security System", *Ricerche Economiche*, 49, 317-327.

Coronado, J.L., Fullerton, D. and Glass T. (2000) "The Progressivity of Social Security", NBER Working Paper n. 7520.

Disney, R. (1999), "Notional Accounts as a Pension Reform Strategy: An Evaluation", Social Protection Discussion Paper Series n. 9928.

Fornero, E. (1995) "Totally unfunded versus partially funded pension systems: the case of Italy", *Ricerche Economiche*, 49, 357-74.

Istat (2003a) "Annuario Statistico Italiano 2003".

Istat (2003b) "Rilevazione trimestrale sulle forze di lavoro".

Jappelli, T., M. Padula and R. Bottazzi (2003) "Retirement Expectations and Pension Reforms", CSEF Working Paper n. 92.

Lerner, A.P. (1959), 'Consumption-loan interest and money', *Journal of Political Economy*, 67, 512-518.

Liebman J.B. (2002) "Redistribution in the Current U.S. Social Security System", in M. Feldstein and J. B. Liebman Eds., *The Distributional Aspects of Social Security and Social Security Reform,* Chicago: University of Chicago Press.

Nelissen, J. H. M. (1994), "Income Redistribution and Social Security: An Application of Microsimulation", London: Chapman and Hall.

O'Donoghue C. (2001) "Dynamic Microsimulation: a Methodological Survey", BEJE (Brazilian Electronic Journal of Economics, http://www.beje.decon.ufpe.br), vol. 4, n. 2, 2001.

Palmer, E. (1999), 'The Swedish pension reform — framework and issues', *mimeo*, National Social Insurance Board, Stockholm.

RGS (2004), "Le tendenze di medio-lungo periodo del sistema pensionistico e sanitario: previsioni elaborate con i modelli della RGS aggiornati al 2003", Rapporto n°5, May, Roma.

APPENDIX: The present value of social security benefits

The formula for the evaluation at retirement of the present value of the social security benefits directly derives from the NDC system conversion coefficients formula.

The present value of social security benefits is computed only for those individuals who are still alive at the time of retirement. As described in the text, mortality is modelled according to gender specific mortality tables, issued by the National Statistics Institute (ISTAT) for the year 2000. In order to keep into account the fact that death can occur even during the first year of retirement, we reconstructed monthly probability tables on the basis of the yearly ones by assuming that deaths are uniformly distributed along the whole year.

When an individual dies, he might leave a heir, depending on his marital status at retirement. We assign probability one of leaving a heir to people that at retirement were married, and probability zero to everybody else. As the model does not contain information about spouses, we follow the assumptions made by the legislator to construct the NDC conversion coefficients and assign to each married individual a spouse exactly 3 years younger if the pensioner is man, 3 years older if woman.

The present value of the pension benefit, for a worker of gender *s*, is the sum of two parts. The first part is the direct component, or the net present value of the benefits to be paid to the pensioner:

$$pv\_direct_s = \sum_{i=1}^{agemax-age+1} p(age+i-1)*(m\_pens(age+i-1))*\left(\frac{l_s(age+i-1,12)}{l_s(age, ret\_month)}\right)*\left(\frac{1}{1+r}\right)^{(i-1)}$$

[1]

where:

s:	gender;
age:	age at retirement;
agemax:	maximum age at which an individual can be alive
p(j):	pension at age j;
ret_month:	month of retirement;
m_pens(j):	number of months in year j the benefit is received. In the first year of retirement this depends on the month of retirement and it is equal to (12-ret_month+1)+((12-ret_month+1)/12); in the following years it is always equal to 13;
$l_s(x,y)$:	gender-specific number of individuals (out of 10,000 new-borns) still alive at age *x* years and *y* months; if *x*=agemax+1 then $l_s(x,y)=0$;
r:	rate of return.

The second part is the <u>indirect component</u> or the net present value of the fluxes of the survival pension to be paid to the heir.

For the first year of retirement this is equal to:

$$pv\_ind\_first_s = \left(1 - \frac{l_s(age,12)}{l_s(age, ret\_month)}\right) * surv * red_s * theta_s * alpha_s(1)$$

[2]

while for the following years:

$$pv\_ind\_follow_s = \sum_{i=1}^{age\max - age} \left(\frac{l_s(age+i-1,12)}{l_s(age, ret\_month)}\right) * \left(\frac{1}{1+r}\right)^{(i-1)} * \left(1 - \frac{l_s(age+i,12)}{l_s(age+i-1,12)}\right) * surv * red_s * theta_s * alpha_s(i)$$

where alpha(*i*) is defined, when *i* is equal to 1 as:

$$alpha_s(1) = \sum_{g=1}^{age\max - age\_spouse+1} p(age+g-1) * m\_pens(age+g-1) * \left(\frac{l_s(age\_spouse+g-1,12)}{l_s(age\_spouse, ret\_month)}\right) * \left(\frac{1}{1+r}\right)^{(g-1)}$$

else, for *i* greater than 1:

$$alpha_s(i) = \sum_{g=1}^{age\max - (age\_spouse+i)+1} p(age+i+g-1) * m\_pens(age+i+g-1) * \left(\frac{l_s(age\_spouse+i+g-1,12)}{l_s(age\_spouse+i,12)}\right) * \left(\frac{1}{1+r}\right)^{(g)}$$

[3]

where:

surv:	fraction of the direct benefit that converts into a survival pension, according to the Italian legislation (equal to 0.6 for the spouse)
red_s:	reduction of the survival pension due to income ceilings. It is equal to 0.7 if the pensioner was a woman and 0.9 otherwise.
$theta_s$:	probability of having a heir. It is equal to one if the pensioner at the retirement is married. It is zero otherwise.
age_spouse:	age of the spouse at the time of individual's retirement. We suppose that, in a couple, the wife is always exactly 3 years younger than the husband.
p(j):	direct pension that would be paid to the pension-owner if he was alive at age *j*.

Our papers can be downloaded at:

http://cerp.unito.it

CeRP Working Paper Series

N° 1/00	Guido Menzio	Opting Out of Social Security over the Life Cycle
N° 2/00	Pier Marco Ferraresi Elsa Fornero	Social Security Transition in Italy: Costs, Distorsions and (some) Possible Correction
N° 3/00	Emanuele Baldacci Luca Inglese	Le caratteristiche socio economiche dei pensionati in Italia. Analisi della distribuzione dei redditi da pensione (only available in the Italian version)
N° 4/01	Peter Diamond	Towards an Optimal Social Security Design
N° 5/01	Vincenzo Andrietti	Occupational Pensions and Interfirm Job Mobility in the European Union. Evidence from the ECHP Survey
N° 6/01	Flavia Coda Moscarola	The Effects of Immigration Inflows on the Sustainability of the Italian Welfare State
N° 7/01	Margherita Borella	The Error Structure of Earnings: an Analysis on Italian Longitudinal Data
N° 8/01	Margherita Borella	Social Security Systems and the Distribution of Income: an Application to the Italian Case
N° 9/01	Hans Blommestein	Ageing, Pension Reform, and Financial Market Implications in the OECD Area
N° 10/01	Vincenzo Andrietti and Vincent Hildebrand	Pension Portability and Labour Mobility in the United States. New Evidence from the SIPP Data
N° 11/01	Mara Faccio and Ameziane Lasfer	Institutional Shareholders and Corporate Governance: The Case of UK Pension Funds
N° 12/01	Roberta Romano	Less is More: Making Shareholder Activism a Valuable Mechanism of Corporate Governance
N° 13/01	Michela Scatigna	Institutional Investors, Corporate Governance and Pension Funds
N° 14/01	Thomas H. Noe	Investor Activism and Financial Market Structure
N° 15/01	Estelle James	How Can China Solve ist Old Age Security Problem? The Interaction Between Pension, SOE and Financial Market Reform
N° 16/01	Estelle James and Xue Song	Annuities Markets Around the World: Money's Worth and Risk Intermediation
N° 17/02	Richard Disney and Sarah Smith	The Labour Supply Effect of the Abolition of the Earnings Rule for Older Workers in the United Kingdom
N° 18/02	Francesco Daveri	Labor Taxes and Unemployment: a Survey of the Aggregate Evidence
N° 19/02	Paolo Battocchio Francesco Menoncin	Optimal Portfolio Strategies with Stochastic Wage Income and Inflation: The Case of a Defined Contribution Pension Plan
N° 20/02	Mauro Mastrogiacomo	Dual Retirement in Italy and Expectations

N° 21/02	Olivia S. Mitchell David McCarthy	Annuities for an Ageing World
N° 22/02	Chris Soares Mark Warshawsky	Annuity Risk: Volatility and Inflation Exposure in Payments from Immediate Life Annuities
N° 23/02	Ermanno Pitacco	Longevity Risk in Living Benefits
N° 24/02	Laura Ballotta Steven Haberman	Valuation of Guaranteed Annuity Conversion Options
N° 25/02	Edmund Cannon Ian Tonks	The Behaviour of UK Annuity Prices from 1972 to the Present
N° 26/02	E. Philip Davis	Issues in the Regulation of Annuities Markets
N° 27/02	Reinhold Schnabel	Annuities in Germany before and after the Pension Reform of 2001
N° 28/02	Luca Spataro	New Tools in Micromodeling Retirement Decisions: Overview and Applications to the Italian Case
N° 29/02	Marco Taboga	The Realized Equity Premium has been Higher than Expected: Further Evidence
N° 30/03	Bas Arts Elena Vigna	A Switch Criterion for Defined Contribution Pension Schemes
N° 31/03	Giacomo Ponzetto	Risk Aversion and the Utility of Annuities
N° 32/04	Angelo Marano Paolo Sestito	Older Workers and Pensioners: the Challenge of Ageing on the Italian Public Pension System and Labour Market
N° 33/04	Elsa Fornero Carolina Fugazza Giacomo Ponzetto	A Comparative Analysis of the Costs of Italian Individual Pension Plans
N° 34/04	Chourouk Houssi	Le Vieillissement Démographique : Problématique des Régimes de Pension en Tunisie
N° 35/04	Monika Bütler Olivia Huguenin Federica Teppa	What Triggers Early Retirement. Results from Swiss Pension Funds
N° 36/04	Laurence J. Kotlikoff	Pensions Systems and the Intergenerational Distribution of Resources
N° 37/04	Jay Ginn	Actuarial Fairness or Social Justice? A Gender Perspective on Redistribution in Pension Systems
N° 38/05	Carolina Fugazza Federica Teppa	An Empirical Assessment of the Italian Severance Payment (TFR)
N° 39/05	Anna Rita Bacinello	Modelling the Surrender Conditions in Equity-Linked Life Insurance
N° 40/05	Carolina Fugazza Massimo Guidolin Giovanna Nicodano	Investing for the Long-Run in European Real Estate. Does Predictability Matter?
N° 41/05	Massimo Guidolin Giovanna Nicodano	Small Caps in International Equity Portfolios: The Effects of Variance Risk.
N° 42/05	Margherita Borella Flavia Coda Moscarola	Distributive Properties of Pensions Systems: a Simulation of the Italian Transition from Defined Benefit to Defined Contribution