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MEASURING THE SUSTAINABILITY OF PENSION SYSTEMS THROUGH A MICROSIMULATION MODEL

THE CASE OF ITALY

FLAVIA CODA MOSCAROLA

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Measuring the Sustainability of Pension Systems through a Microsimulation Model
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ENEPRI Research Report No. 66/January 2009

Flavia Coda Moscarola*

Abstract

Many countries have recently enacted radical reforms to their pension systems to recover long-term financial sustainability. One measure has been to introduce an actuarially fair pension rule. A system that grants actuarially fair benefits is not only fair across individuals and generations, i.e. it grants equality of treatment, but is also sustainable in the long run. In this paper, we take Italy as a case study and use a microsimulation model – an instrument able to monitor actuarial fairness of the pension rules in a less conventional approach – to analyse the phasing-in of the reforms and their ability to recover the long-term sustainability of the system.

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1. Introduction

In the last few decades, the sustainability of pension systems in developed countries has been threatened by population ageing and by the slowdown of the growth rate of the economy. For this reason, many countries have recently enacted radical reforms, which are currently being implemented.

In particular, many reforms have aimed at re-designing the social security schemes to impose or to stimulate individuals to undertake the transfer, under a life-cycle perspective, of resources from an active period to an inactive period and to assist them in this endeavour, offering the possibility to access an efficient system, both on the whole and in its single components. The new social security system is meant to be an instrument that *insures* the basic consumption of goods in old age more than a form of *assistance* given by an active population to the inactive classes. Assistance is still certainly included, but only in favour of less fortunate persons who, because they had a less prosperous and an inconsistent working life, could not accumulate sufficient pension savings to guarantee an adequate annuity.[1]

The new approach involves assimilating social contributions into a form of saving, meant to satisfy the needs of old age and to do it in an *efficient* way, i.e. through a good contributions/benefits ratio.

In this spirit, it will be natural to refer to the concept of actuarial fairness in order to evaluate the effects of the reforms, as first pillar pensions were life assurance products. A system that grants actuarially fair benefits is, by definition, fair across individuals and generations, i.e. it grants equality of treatment, and it is sustainable in the long term.

Accordingly, in this paper we show that microsimulation models, normally used to analyse the distributive properties or adequacy properties of the pension system, can also be used to monitor the phasing-in of the reforms and their ability to recover the long-term sustainability of the system.

For that purpose, we use Italy as a case study. The Italian pension system has undergone many important reforms during the last few years. Reforms have sought to recover financial sustainability by shifting towards the adoption of an actuarially fair pension rule and all of them have been characterised by a very gradual phasing-in.

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[1] The term 'accumulate' in the text does not refer in any way to financing by the funding instead of the pay-as-you-go mechanism. In the latter case, it is sufficient that the benefits are in some way correlated to contributions, according to the so-called 'Bismarckian' system, or that they are the actuarial equivalent, according to the 'notional capitalisation' system (known by the acronym NDC – notional defined contribution) that was the basis of the Italian and Swedish reforms in 1995, as well as the reforms in various Eastern European countries.

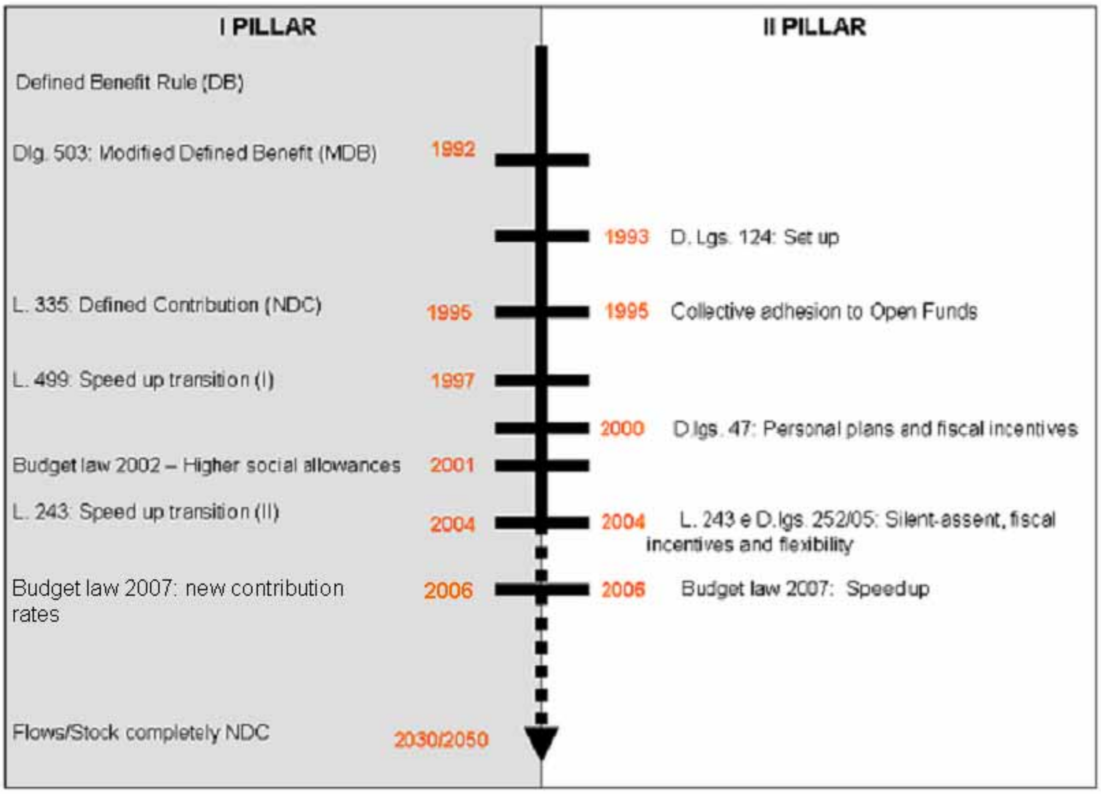
The analysis is accomplished by using CeRPSIM, an ad hoc microsimulation model, capable of accommodating both a fair amount of individual heterogeneity and the complex structure of time-varying pension rules. To fulfil the goal we simulate the money's worth of participation in the system for six cohorts of workers (born from 1945 to 1995) under the pre-reform and post-reform rules.

Section 2 describes how the different reforms implemented since the 1990s will affect different groups and cohorts of workers. Section 3 introduces the measures of sustainability used. Section 4 provides a short description of the microsimulation model. Results are presented in section 5. Section 6 concludes.

2. The transition of the Italian pension system

Italy represents an optimal case study for our purposes. Three main reforms and several minor ones have taken place since 1992, shifting the Italian pension system, which has previously applied a defined benefit (DB) formula, towards the adoption of a notional defined contribution (NDC) formula and a multi-pillar structure. Reforms have also been committed to the progressive harmonisation of rules across working schemes (for a detailed description of the Italian social security system and its recent reforms, see also Castellino & Fornero (2001), Brugiavini & Fornero (2001) and Brugiavini (1999)). The chronology of the reforms up to 2007 is reported in Figure 1.[2] As a consequence of their slow phasing-in, the working population can be characterised in different clusters according to the seniority accrued at the time the reforms were introduced.

Figure 1. The transition of the Italian pension system



[2] After this paper was completed, a new reform was introduced in 2008.

As for the first pillar, the subject of sustainability concerns and reforms to address them, three separate segments of the working population can be identified:

1. workers who had at least 18 years of service at the end of 1995 (modified defined benefit (MDB) workers), whose pension benefits are computed according to the DB system as modified by the 1992 reform;
2. workers who entered the labour market before 1995 but had less than 18 years of service at that date (pro rata regime workers), whose pension benefits are computed according to a pro rata *temporis* mechanism (PR). The part of the benefit related to the seniority accumulated before 1995 is computed as for the MDB group. The second part, related to the post-1995 years of work, is computed with the NDC formula; and
3. workers who have entered the labour market since the beginning of 1996 (NDC workers), who will be fully subject to the NDC system.

For the three above-mentioned groups, eligibility requirements and contribution rates have been set by the 2004 and 2007 reforms respectively. MDB and PR workers still benefit from the more generous minimum pensions (which can be claimed at retirement by low-income pensioners), while NDC workers can only claim the means-tested old-age allowance when they turn 65.

3. Measures of sustainability[3]

As in the case of inflation, which is normally measured not through a single index but through several indicators, to evaluate the sustainability of social security systems a number of indicators can be constructed, each one reflecting a particular aspect of the issue (and the same aspect through different viewpoints).

Macroeconomic indicators – such as the ratio of pension expenditure to GDP, the equilibrium tax rate, the coverage index and the ratio of deficit to GDP – are built starting from the aggregate amount of entrances into and expenditures of the social security system. These are projected into the future within reasonable demographic and economic scenarios, under the hypothesis of the constancy of the average payroll taxes paid by individuals in their active age and of the average benefits received by the retired.

The micro-economic indicators are constructed by focusing on the individual level and fully accounting for the individual's heterogeneity in lifetime contribution and benefits profiles. This can be done by reconstructing the observed individual's contribution and benefits profiles and simulating, under plausible economic scenarios, their future evolution. This approach is needed to be able to apply to the pension system some concepts used for the financial evaluation of a savings scheme, as the measures of the economic advantage of participating in the scheme (Castellino & Fornero, 2001). Long-term sustainability in fact coincides with actuarial fairness, i.e. with a granted internal rate of return on contributions equal to the long-term growth rate of the overall contributions paid.

In particular, in the following analysis we use the present value ratio (PVR). The PVR is a 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 is able to capture the expected money's worth of participation in the pension system with respect to the opportunity cost of a lost alternative that is exogenously fixed (represented by the discount rate used in the calculations). When computed at the equilibrium rate of interest of the pay-as-you-

[3] This section draws on a speech prepared by Elsa Fornero for the Conference "Ageing and pensions – Pension schemes confront the demographic challenge", organised by the Italian Ministry of Welfare for the Italian presidency of the EU, Bologna, 18 September 2003.

go system, it allows immediate evaluations of the actuarial fairness and then of the long-term sustainability of the social security rules: in a system granting the equilibrium interest rate (i.e. the rate of growth of the total amount of contributions), a PVR greater than one suggests that the individual is going to receive in terms of social security benefits more than s/he would be entitled to on the basis of the payroll taxes paid.

4. The microsimulation model

The tool we use to evaluate the sustainability of the social security system is a microsimulation model, CeRPSIM, designed to analyse the transition of the Italian pension system towards the new, steady state regime, after the major reform process that started in the 1990s. Its original core was built by Borella & Coda Moscarola between 2004 and 2006, and it has been successively updated according to legislative innovations and modified to include the second pillar benefits and taxation.

Using the taxonomy proposed by O'Donoghue (2001), CeRPSIM can be defined as a stochastic dynamic microsimulation model by cohorts. In contrast with cross-sectional models, the simulated population is representative of a limited number of living cohorts; these, however, are followed throughout their lives from birth to death with respect to the main economic events that have determined their retirement position. As typical with multiple cohort populations, individuals belonging to different cohorts do not interact with each other. These kinds of models are widely used in the analysis of intergenerational transfers and equity issues (Nelissen, 1994; Caldwell et al., 1999; O'Donoghue, 2001). With respect to the other available tools, microsimulation better allows the modelling of a wide range of economic processes and an emphasis on the linkages between economic outcomes (Emmerson et al., 2004).

CeRPSIM computes the pension benefits and several adequacy, sustainability and distributive measures for simulated workers retiring from the year 2000 onwards, in both net and gross terms. It is specifically designed to accurately account for the effects of the changes in the normative framework and of the income dynamics characterising different individuals of various cohorts. The normative transition of the Italian social security system towards the new steady state regime has been reflected in detail, including all the reforms from 1992 to 2007. A high degree of flexibility enables the implementation of one reform at a time and the testing of alternative policy solutions.

Furthermore, great effort has been employed in the estimation and forecast of income profiles. Earnings profiles have been estimated for a long panel of administrative data (the National Institute of Social Insurance – INPS – archive '*Estratti Conto*') for employees and self-employed workers, men and women, and white- and blue-collar workers, respectively. The unobserved component of the income-generating process has been modelled as the sum of an individual specific random effect and an AR(1) component.

At this stage of its development, however, the model is not behavioural, meaning in particular that workers are supposed to retire as soon as they reach the minimum requirements. Indeed, recent econometric estimations on retirement choices have shown evidence of forward-looking behaviour: the individual in fact seems to react to financial incentives proposed by pension rules (Spataro, 2005). In the DB regimes, no incentives to postpone retirement at the minimum mandatory age were in place and performing work beyond the age of 60 was strongly discouraged through implicit taxation.[4] Yet, the issue clearly becomes more relevant as the NDC rule is applied.

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[4] The distribution of ages at retirement deriving from the model is in fact quite similar to the one actually encountered in INPS administrative data.

CeRPSIM is made up of three modules: a population module, a pension module and a tax module. The most relevant events of individual lives are simulated in the population module according to a set of deterministic and stochastic rules. When an individual is born, s/he is assigned a birth date, a gender and a region of residence. Then the module simulates the education level attained, the marital status, the age of entrance into the labour market, the working scheme and the career profile. The simulated working schemes are public employees, private employees and the self-employed, separately divided into tradesmen, craftsmen and agricultural workers. Stochastic treatment of the events is realised throughout Monte Carlo simulations.[5] Transition probabilities are estimated on the bases of national statistical data and two micro data sets: the Bank of Italy survey (Survey of Households' Income and Wealth, SHIW) and the INPS archive *Estratti Conto*.

The pension module calculates the benefits of the first and second pillars according to the evolution of the normative setting (fully accounting for all the floors and ceilings on pensions and contributions, exit windows, etc.).

The tax module – aimed at better analysing adequacy issues and not used in the present analysis – simulates the imposition on wages and benefits, according to the personal income taxation rules (IRPEF) by applying the appropriate deductions. It accounts for the differential taxation of second pillar benefits introduced in 2007.

A discrete time perspective is adopted and the main macroeconomic variables (such as GDP growth rate and interest rate) are taken at their real historical value until 2002, while from 2003 they are supposed to reach and maintain their steady state values. A detailed description of the modules making up the model is provided in the appendix.

5. Defining cohorts and setting parameters

To account for the fact that the reforms being phased in have varying effects on different cohorts of workers, we simulate six cohorts of individuals, born between 1945 and 1995 with a 10-year gap from one to another. This choice enables us to study the evolution of the long-term sustainability of the different regimes outlined in the previous section (for MDB, PR and NDC workers).

Each cohort is made up of 12,000 heterogeneous individuals. As shown in Figure 2, in the first cohort, born in 1945, virtually all workers receive benefits computed according to the MDB rules (MDB workers). In the second cohort, born in 1955, about 60% of the individuals receive benefits computed through the MDB formula, while about 40% of them fall into the pro rata mechanism (PR workers). In the third cohort, representing individuals born in 1965, almost all workers receive benefits computed with the pro rata mechanism. In the fourth cohort (born in 1975), about 60% of individuals are PR workers, while all the others receive benefits entirely computed with the NDC system. Cohorts 5 and 6 are completely under the NDC system, with the difference between the two being that for some categories of workers the steady state values of the payroll tax are reached only in cohort 6. Participation in the second pillar is assumed to involve, from 2007 onwards, all private employees and self-employed persons, representing about 60% of the simulated working population.[6]

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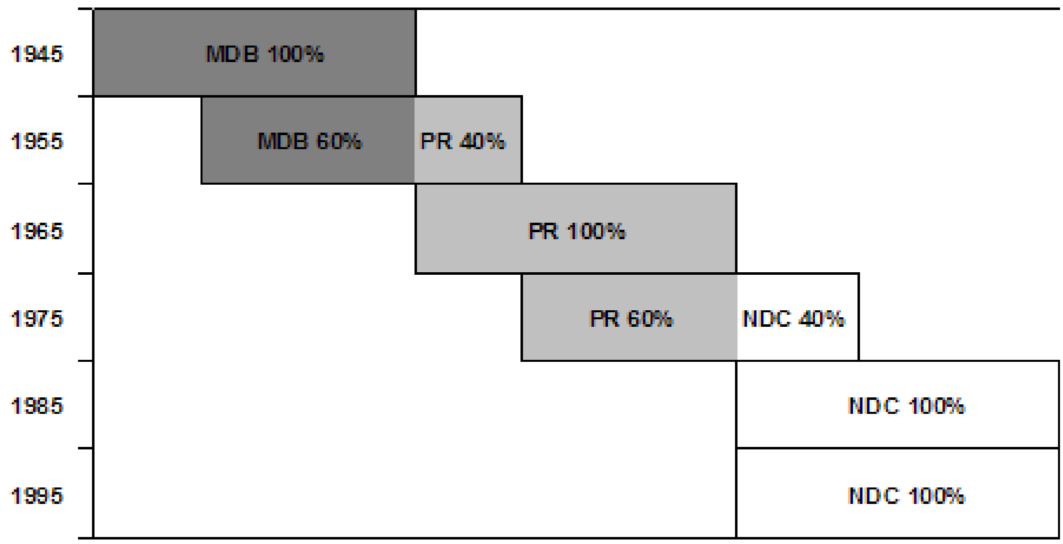
[5] They are evaluated by taking a random draw from a uniform distribution and comparing it with the relevant probability taken from the available socio-demographic surveys or from national statistical data. If the value of the draw is higher than the sample probability, the individual changes his/her status. If not, the individual remains in the initial state.

[6] Since most of the workers of the 1945 cohort are already retired at that date, participants in the second pillar are only 7% of the working population.

Figure 2. Percentages of workers under different schemes by cohort



Notes: MDB = modified defined benefit rule; PR = pro rata *temporis* rule;
NDC = notional defined contribution rule

Throughout all the calculations presented in this paper, we use historical values for the real GDP growth and the inflation rates as far as they are available (i.e. up to 2003). From 2003 onwards, we set the real GDP growth rate equal to 1.5% and the inflation rate equal to 1.6%.

All the simulations are based on RG48 cohort mortality tables updated for survival evolution by shifting the survival rate by age of one year each ten. The annuity rates for the NDC formula are upgraded to the evolution of mortality according to the ISTAT 2000 survival tables. The tables are shifted to account for the progressive increase in longevity. The RG48 tables are more optimistic on longevity than the ISTAT 2000 and are normally adopted by insurance companies. Since the process of updating the first pillar annuity rates is the object of bargaining among the government and the social parties, we assume that the applied rates are always slightly more generous than the ones fully incorporating the real evolution of life expectancy.

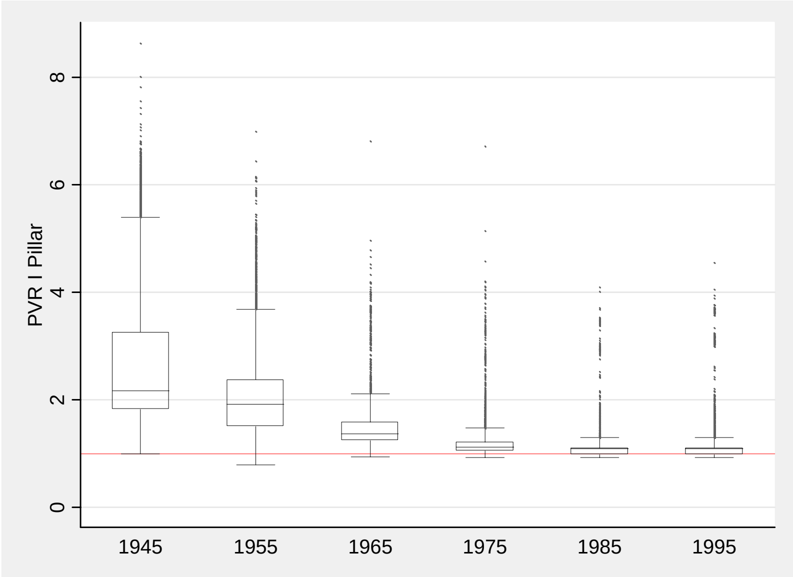
Minimum pensions, minimum contributions and ceilings are indexed to nominal GDP growth.

6. Results

The box plot in Figure 3 shows the median and the interquartile range (i.e. the distance between the 75th and the 25th percentiles) of the PVR by cohorts. The money's worth of participating is highly variable for the earliest cohorts while the heterogeneity decreases sharply for the last ones.

In particular, the cohort 1945 has a median PVR of around two, while for the cohorts 1985 and 1995 – which are completely under the NDC rule – it decreases to a value of around one. This means that the post-reform system almost recovered long-term sustainability and that reforms help to gradually stop further debt accumulation. The problem of repaying the accumulated debt is instead left unresolved.

Figure 3. PVR of the first pillar by cohort – Box plot



Notes: All reforms are included. The PVR is the present value ratio, the ratio between the present value of future pension benefits and the present value of the contributions paid, both valued at retirement.

Source: CeRPSIM simulation.

The microsimulation model also allows us to disentangle the effects of each reform at a time.

Table 1 reports the average PVR for each cohort before and after each additional reform. Each successive reform not only changed the benefit formula but also the payroll tax rates. As a consequence, both the present value of benefits and the present value of contributions at retirement differ for each cohort according to which reform is applied.

As for the pre-1992 regime, we do not report results for the first two cohorts, as under this system workers could retire at young ages, while the simulation model starts computing pension benefits only in the year 2000. For individuals born since 1965, the average PVR in the pre-1992 system is above 3, showing that the pension system was very generous and unsustainable given the actual growth rate of the economy[7] (and the one forecasted for the future).

After the introduction of the 1992 reform, which raised the minimum eligibility requirements for retirement and gradually extended the period over which pensionable earnings were to be computed, the PVR on average gradually decreases for all cohorts. For the last two cohorts, whose pensionable earnings are computed over the entire working history, the PVR reaches a value of around 2.

The 1995 reform affected both the oldest individuals, by further raising the minimum eligibility requirements, and the middle/younger cohorts, through a progressive introduction of the NDC formula. For cohorts born in 1985 and in 1995, the average PVR is equal to 1.05, meaning that the system (almost) stops accumulating new implicit debt, recovering long-term financial sustainability.

[7] That depends on the rate of growth of productivity and on the rate of growth of the population.

Table 1. PVR, by cohort and reform, first pillar – Baseline scenario

	Pre-1992	1992	1995	1997	2002	2004
1945	–	2.805	2.685	2.689	2.743	2.742
1955	–	2.650	2.165	2.165	2.224	2.081
1965	3.297	2.166	1.436	1.436	1.539	1.473
1975	3.379	2.022	1.138	1.138	1.254	1.225
1985	3.325	2.057	1.050	1.050	1.153	1.121
1995	3.373	2.078	1.052	1.052	1.164	1.130

Notes: Scenario with a 2% real interest rate; the PVR is the present value ratio, the ratio between the present value of future pension benefits and the present value of the contributions paid, both valued at retirement. The microsimulation model cannot compute the PVR in the pre-1992 system for the two oldest cohorts. Cohorts born in 1945 and 1955 under the pre-92 system would have been already retired in 2000, the starting year of our simulation.

Source: CeRPSIM simulation.

The 1997 reform intervened only to speed up convergence on the new eligibility requirements set by the 1995 reform. Its effects mainly concern individuals born in 1945.

The introduction of a means-tested old-age allowance in 2002 raises the average PVR for all cohorts: in particular, the NDC cohorts display an average PVR of around 1.15. This is mainly owing to a higher number of the self-employed becoming eligible for the means-tested old-age allowance, given that their payroll tax rate is much lower than that of employees.

The further tightening of eligibility requirements implemented by the 2004 reform affects all cohorts born since 1955: longer working careers on average correspond to higher pensions and to a lower probability of being entitled to the supplementary old-age allowance introduced in 2002. Hence, the PVR slightly declines for all cohorts.

What are the residual sources of actuarial ‘unfairness’ in the NDC system?

First, annuity coefficients are undifferentiated by age outside the range of 57-65. The coefficient for the age of 57 (65) is applied to workers retiring before 57 (after 65) without any further actuarial correction. This results in a higher (lower) pension than the one due on the basis of actuarial fairness principles.

In addition, for amounts above a certain level, benefits are only partially indexed to prices.

Finally, the NDC annuity rates are only updated every 10 years and the updating process is the object of bargaining among political parties instead of being automatically linked to the evolution of longevity.[8]

7. Conclusions

This paper offers an illustrative example of how microsimulation models can be used to analyse the long-term sustainability issues of pension systems. It uses Italy as a case study. The Italian system has undergone several reforms that have changed the pension formula from one of defined benefits to defined contributions and introduced a second pillar financed through funding.

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[8] Since this report was written, the frequency for the updating process has been reduced from 10 to 3 years (Law 247/2007).

The contribution patterns of individuals of several cohorts that are differently affected by the reform process are simulated to derive a measure of actuarial fairness of the benefits.

The new NDC system seems to be effective in stopping the process of debt accumulation. Cohorts that fall completely under the new system accrue present value ratios calculated at the 1.5% real interest rate of around 1 on average. This finding means that the system grants to them an internal rate of return equal to the estimated long-term rate of growth of the contributions, i.e. the equilibrium rate of a pay-as-you-go system in steady state. It has, however, a very slow phasing-in and sustainability is still threatened by the lack of an automatic approach to the process of updating the annuity rates.

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Appendix. The microsimulation model

The microsimulation model CeRPSIM is made up of three main modules: the cohort population module, which simulates the lifetime patterns of individuals; the pension module, which computes pension benefits according to Italian legislation; and the taxation module, which accounts for the effects of the differential taxation on different pillars. Most of the content of this appendix has been drawn from Borella & Coda Moscarola (2006).

A1. 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 are simulated from birth to death, and do not interact with each other.

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

A1.1 Data sources

In addition to the information available from national statistical data, we obtain the relevant probabilities (and the labour income profiles) from two micro data sets: the Bank of Italy 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 persons (craftsmen, tradesmen and farmers). The available sample is formed by all individuals born on the 5th of March – so that the theoretical sample frequency is 1:365 – and it 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 the labour income earned each year.

As is 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 in the Bank of Italy survey (SHIW), which was conducted about every two years from 1989 to 2002.[9]

A1.2 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 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 throughout the year of birth: this feature of the programme permits the

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

accurate modelling of the moment at which a worker is eligible for pension benefits 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 (ISTAT, 2003a).

A1.3 Mortality

In each period, every individual enters the mortality subroutine, which determines whether s/he will survive 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 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.

A1.4 Education

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

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

Once the individual decides to start a cycle of study, it is completed (in other words, there are no dropouts); 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.[10]

A1.5 Participation

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

Participation rates are specific for cohort (born before or after 1968), gender and region, and refer to the year 2002 (ISTAT, 2003b).

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

A1.6 First job

When an individual first enters the labour force, s/he enters the first job routine, in which there is success in finding his/her first job in the current year according to a certain probability. If the person is not successful, then s/he is recorded as not employed; in the subsequent periods, the individual will re-enter this routine until there is success in finding an occupation. Once a worker finds the first job, s/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, i.e. the 1975 cohort); we are therefore assuming that there are no cohort effects in the probability of finding the first job.

The probabilities are computed according to age class (older or younger than 24), gender and 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 graduates enter the labour force after age 24).

A1.7 Kind of employment and social security scheme

Once an individual finds an occupation, that person is randomly assigned to a social security scheme and a professional qualification. The individual will not change these characteristics throughout his/her 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 that for the 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 worker belongs where relevant: ‘regular’ private-sector employees (86.7%) or agricultural workers (13.3%), if the main scheme is that for private sector employees; craftsmen (40%), tradesmen (40%) or farmers (20%) if the main scheme is for the 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 also a variety of different social security sub-schemes in the public sector, all the public workers are modelled as belonging to the main sub-scheme.[11]

A third random draw determines, where relevant, whether the individual is a white- or a blue-collar worker, conditional on the scheme to which s/he belongs. Individuals who start working before age 18 are registered as blue-collar workers; those who start working after that age face a probability of being blue-collar workers equal to 35% in the private sector and 10% in the public one. 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.

It should be noted that owing to the lack of data, we do not model the new forms of temporary jobs that are covered by a dedicated scheme characterised by a reduced payroll tax rate (‘*Gestione Separata INPS*’). As this scheme was introduced in 1995 and its legislation is continuously updated, projections of contributions and pension benefits are very difficult to implement and highly dependent on discretional hypotheses.

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[11] This sub-scheme is also that used for local government employees (CPDEL).

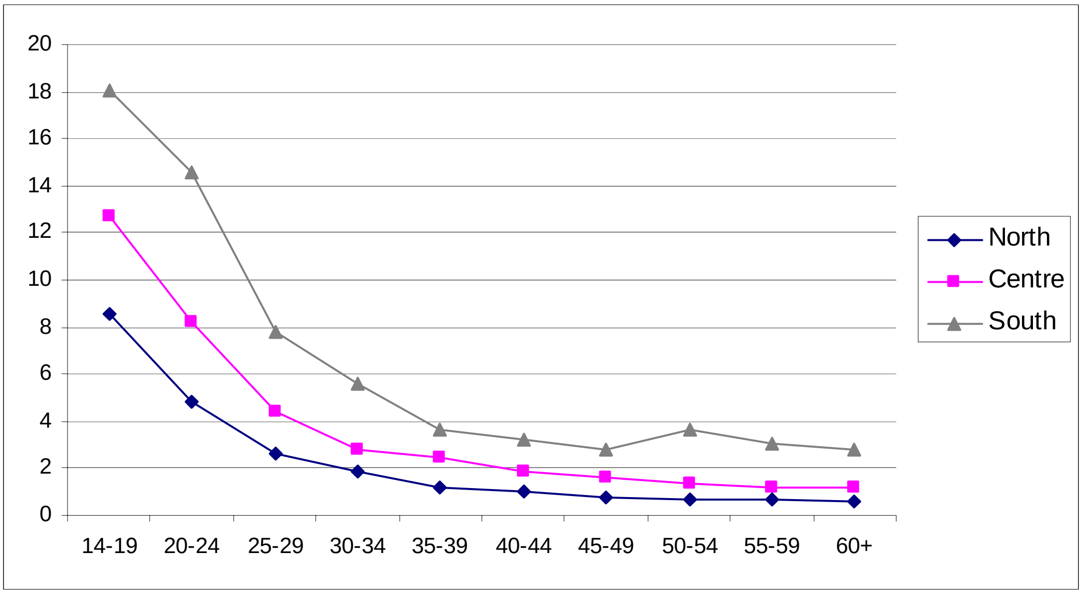
A1.8 Number of weeks

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.

The probabilities of being unemployed if in the previous year the worker was employed, and of being employed if in the previous year the worker was unemployed have been computed using our administrative sample – for private employees, employees in the agricultural sector and the self-employed, respectively.[12] These probabilities vary according to age (in classes), gender and region of residence.[13]

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 also been computed from administrative data for the two groups of workers, and they vary according to age and gender. Self-employed workers are assumed, if working, to do so for a full year.[14]

Figure A.1 Unemployment rate – Men, blue-collar workers, by region and age class



Source: Author's calculations from INPS archive *Estratti Conto*.

[12] 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 hand, it seems a reasonable assumption given the stability of work relationships in the Italian public sector.

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

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

A1.9 Earnings

Earnings profiles have been estimated from administrative data for private sector and self-employed workers, men and women, and white- and blue-collar workers, respectively.[15]

The estimated equation is

$$\ln y_{it} = x_{it}\beta + \gamma_i + \varepsilon_{it}$$
$$\varepsilon_{it} = \rho\varepsilon_{it-1} + \eta_{it}$$
$$\gamma_i \sim (0,\ \sigma_\gamma^2)\ ; \qquad \eta_{it} \sim (0,\ \sigma_\eta^2)$$

where x_{it} is a vector of individual characteristics, including a constant, a polynomial in age (third degree for the self-employed, fourth degree for employees), cohort dummies (cohorts 1935, 1945, 1955, 1965 and 1975), regional dummies (north, centre or south) and time dummies, which are assumed to sum up to zero and be orthogonal to a time trend.[16]

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. The AR(1) process plus the individual random effect has been found to be a good characterisation of the unobserved component of earnings in Italy in previous work (Borella, 2004).

In the microsimulation model, each individual is given his/her average log earnings profile for that person's 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 to which 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 A.1 Estimates for the unobserved error component

	Men			Women		
	Blue collar	**White collar**	**Self-employed**	**Blue 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

Source: Author's estimates from SHIW, various years.

[15] The self-employed are further distinguished among the categories of craftsmen and tradesmen, excluding farmers. In our administrative sample, the share of farmers who do not report zero income is less than 5%, resulting in a sample size too small to enable an estimate of the income profile. The zero-income report mainly stems from the pension legislation that 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.

[16] We also experimented with the estimation of cohort-specific profiles, by adding some age–cohort interactions, but could not find evidence of differences across cohorts in the shape of the age profiles, given the presence of cohort effects. The same result was obtained by Gosling, Machin & Meghir (2000) with UK data.

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 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, an individual faces the possibility of becoming divorced (probabilities also in 1991 census data) or a widow(er) according to the mortality table used in the programme.

We assign a marital status to each individual, although we take an individual perspective, as this influences the present value of benefits at retirement.

A2. 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 benefits for a number of schemes and for different regimes. Pension benefits are computed for individuals who retire from the year 2000 onwards. The programme flexibility enables the user to implement one reform at a time, starting with that in 1992 up to the reform in 2004.

When all the reforms are active, the regimes covered in the programme are

a) the modified, defined benefit regime, applying to those workers who had contributed to their scheme for at least 18 years in 1995;

b) the pro rata regime, which applies to workers who started contributing to their scheme before 1996 but had less than 18 years of service in 1995; and

c) the notional defined contribution scheme, which applies to workers who started contributing to their scheme in or after 1996.[17]

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 are those for private sector employees, employees in the agricultural sector, public sector employees and the self-employed, distinguished among craftsmen, tradesmen, farmers and farmers in disadvantaged regions. All these schemes differed in eligibility rules, payroll taxes and formulae for the computation of benefits before the 1995 reform. This reform set the principle of the uniformity of rules, confirmed then by the subsequent reforms, and since that year a convergence process has been taking place, which is at present almost complete. Differences in the definition of pensionable earnings (or income) and in payroll-tax rates have nonetheless been maintained, and will also be retained in the future

As retirement behaviour is not modelled, individuals are assumed to claim their pension benefits as soon as they are eligible: this requires not only that they meet the minimum eligibility requirements but also that they wait for an 'exit window' to be active.[18]

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[17] See section 2 for a more detailed description. When no reforms are active, all workers are under the same rules, regardless of their seniority; when only the 1992 reform is active, there are two groups of workers (depending on their seniority being greater or less than 15 years in 1992). From the application of the 1995 reform onwards, there are the three groups described in the text.

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

This module additionally computes, for each individual at the point 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. These two quantities are the building blocks for the various measures of money's worth used in the analysis.[19]

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

A3. The taxation module

Earnings, net of payroll taxes paid, are taxed according to the personal income taxation (IRPEF) rules. The taxation rules on personal income from 1999 to 2007 are implemented; from 2007 onwards the rules are instead kept constant. Deductions are allowed to workers on the basis of their working scheme and household charges. Because of the lack of data on complete household composition, deductions for household charges are not taken into account.

First-pillar pension benefits are also taxed according to IRPEF, but a special deduction is accorded to pensioners. Second-pillar pension benefits are subject to independent taxation (where the tax rate depends on the seniority accrued in the fund).

Taxation follows the scheme labelled 'Exemption-Taxation-Taxation' (ETT): contributions are exempt if they are less than €5,164.57 or less than two times the severance payment (TFR) flow; returns on funds' assets are taxed at the rate of 11% (returns on financial activities are normally taxed at a rate of 12%); annuities are taxed at a rate of 15%, progressively reduced by 0.30 percentage points for each year of contribution from the 15th to the 35th.

[19] The formula for the evaluation at retirement of the present value of the social security benefits is available from the author on request.

About AIM (Adequacy & Sustainability of Old-Age Income Maintenance)

The AIM project aims at providing a strengthened conceptual and scientific basis for assessing the capacity of European pension systems to deliver adequate old age income maintenance in a context of low fertility and steadily increasing life expectancy. The main focus is on the capacity of social security systems to contribute to preventing poverty among the old and elderly and more generally to enable persons to take all appropriate measures to ensure stable or "desired" distribution of income over the full life cycle. In addition it will explore and examine the capacity of pension systems to attain broad social objectives with respect to inter- and intra generational solidarity.

Furthermore it will examine the capacity of pension systems to allow workers to change job or to move temporarily out of the labour market and to adapt career patterns without losing vesting of pensions rights. The project will also address the specific challenges with respect to providing appropriate old age income for women.

A general objective of the research project is to clearly identify and analyse the potential trade-offs between certain social policy objectives and overall stability of public debt.

AIM is financed under the 6th EU Research Framework Programme. It started in May 2005 and includes partners from both the old and new EU member states.

Participating institutes

- Centre for European Policy Studies, CEPS, Belgium, coordinator
- Federal Planning Bureau, FPB, Belgium
- Deutsches Institut für Wirtschafsforschung (German Institute for Economic Research), DIW, Germany
- Elinkeinoelämän tutkimuslaitos, (Research Institute of the Finnish Economy), ETLA, Finland
- Fundación de Estudios de Economía Aplicada , FEDEA, Spain
- Social and Cultural Planning Office, SCP, Netherlands
- Instituto di Studi e Analisi Economica (Institute for Studies and Economic Analysis), ISAE, Italy
- National Institute for Economic and Social Research, NIESR, United Kingdom
- Centrum Analiz Spolleczno-Ekonomicznych (Center for Social and Economic Research), CASE, Poland
- Tarsadalomkutatasi Informatikai Egyesules (TARKI Social Research Informatics Centre), TARKI, Hungary
- Centre for Research on Pensions and Welfare Policies, CeRP, Italy
- Institute for Economic Research, IER, Slovak Republic
- Inštitut za ekonomska raziskovanja (Institute for economic research), IER, Slovenia