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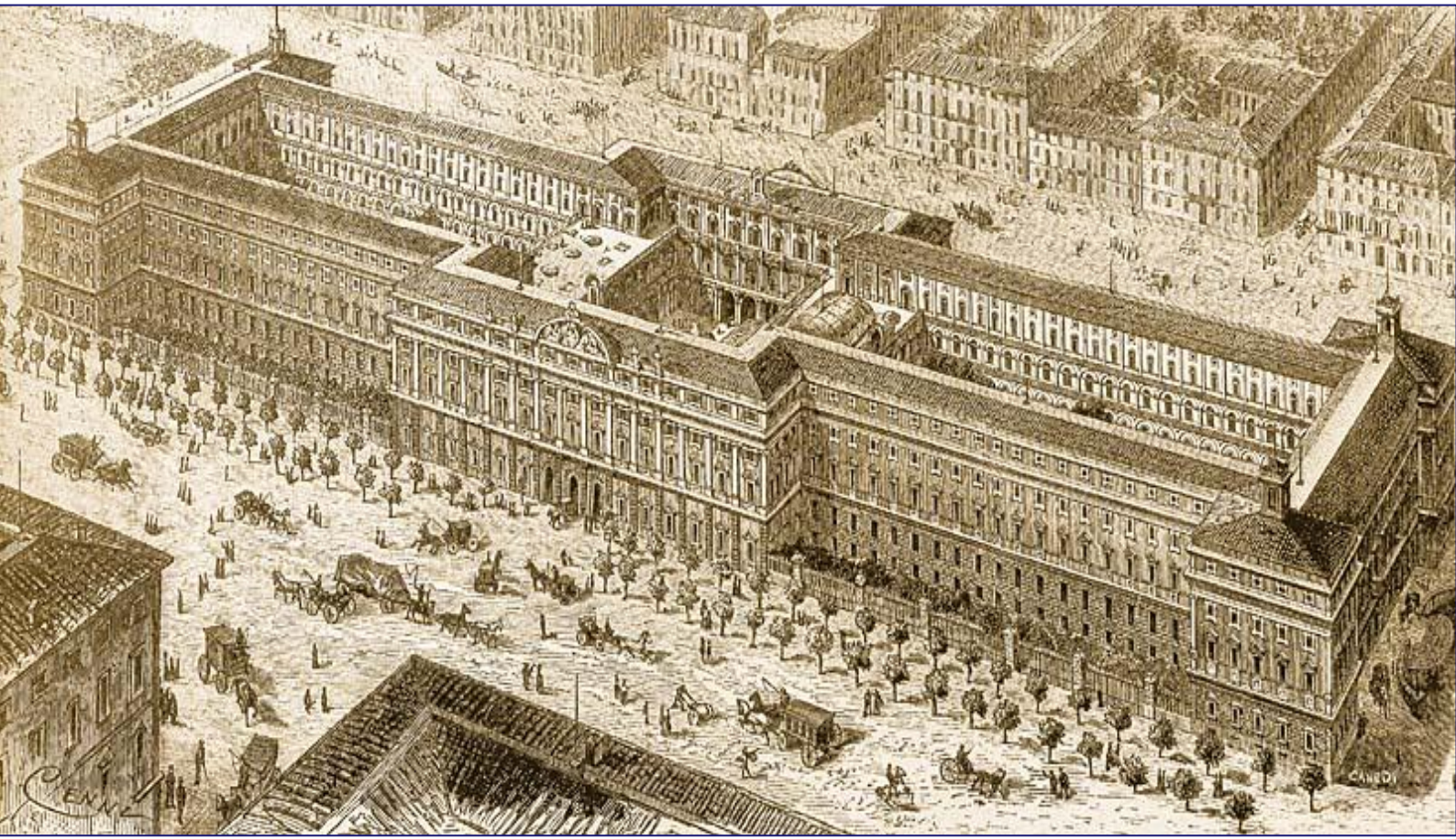
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# Measuring intra-generational and inter-generational redistribution in the reformed Italian social security system

Carlo Mazzaferro, Marcello Morciano



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# Measuring intra-generational and inter-generational redistribution in the reformed Italian social security system<sup>1</sup>

Carlo Mazzaferro (\*), Marcello Morciano (\*\*)

## Abstract

Reforms to the Italian social security system, carried out from 1992 onwards, will dramatically change its structure in the long run. So far, empirical research has devoted more attention to their macroeconomic and financial effects while relatively less attention has been paid to analysing their redistributive implications.

We present this line of research using CAPP\_DYN, a population-based dynamic microsimulation model. The model stochastically simulates the socio-demographic and economic evolution of a representative sample of the Italian population over the period 2010-2050. The initial sample is subjected to a large number of demographic and economic events such as partnership formation/dissolution, birth, education, work, retirement, health and disability and death. While acknowledging the rather complex phasing in of the Notional Defined Contribution system, introduced into the Italian social security system from 1995, a set of indexes (net present value ratio, Gini index, replacement ratios etc.) is used to evaluate the distributional properties of the reformed pension system in each of the simulated years as well as in a life-time/cohort perspective. Two main critical distributional aspects will emerge. Firstly the model predicts an increase in the old-age pensions dispersion in the transitional phase (2015 – 2030) due to the coexistence of different pension regimes and rules in calculating pensions. Moreover, a problem of adequacy in the public pension system from 2035 emerges as the NDC system will be almost completely phased in.

JEL classification: H20, H30, H55.

because the gap from the technological frontier is too large. In the case of Middle-tech sectors, FDI benefits can be substantial since an increase of one standard

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(\*) University of Bologna, CHILD and CAPP. E-mail: [carlo.mazzaferro@unibo.it](mailto:carlo.mazzaferro@unibo.it)

(\*\*) University of East Anglia, ISER and CAPP. E-mail: [M.Morciano@uea.ac.uk](mailto:M.Morciano@uea.ac.uk)

## **1. Introduction**

The reform of the Italian pension system started in the nineties and in the political domain it is not yet considered finished. Under the pressure of the 1992 financial crisis, a first parametric reform increased revenues and abruptly reduced perspective expenditure (and future benefits) which was deemed to be unsustainable. A second major reform that was approved by Parliament in 1995 introduced a Notional Defined Contribution (NDC) system, maintaining the pay-as-you-go financing method. Other changes in the legislation followed in 1997, 2004, 2007, 2009 and 2010, aimed mainly at homogenizing computation rules across (public) schemes; restricting eligibility criteria for early retirements, increasing the legal retirement age and introducing a second (private) reserve based pension pillar.

This intense legislative activity has encouraged economists to study a number of issues such as the evolution of pension expenditure in the medium-long term (RGS 2009), and the effects of these reforms on the allocation of the burden of public pension expenditures between living and future generations (Sartor 2001); on labour supply and retirement decision (Brugiavini and Peracchi 2004), and on the welfare of different cohorts of Italian workers evaluated with money's worth measures (Borella and Coda Moscarola 2006).

The recent EU Green Paper on pensions highlighted the importance for the EU members of drawing a pension system which ensures adequate and sustainable pensions to current and future pensioners, in the light of the prevailing ageing-population phenomenon and the recent financial and economic crisis (EU, 2010). In this context, the long-term analysis of the effect of Italian pension reforms cannot be considered only as a case-study, in the country with the most intense ageing process in Europe. Italy, together with Sweden and Latvia, was the first country that replaced the traditional Defined Benefit (DB) system with a NDC type. Other countries, notably the Kyrgyz Republic, Poland, Mongolia, Russia adopted such a system, while Spain, China, Belarus are discussing whether to move in this direction. From a theoretical point of view NDC systems, differently from DB systems, are

financially sustainable as long as the internal rate of return on contributions is strictly related to the real growth of earnings and actuarially fair since they deliver an expected amount of pension benefits equal to the amount of contributions paid during lifetime. A simulation approach in evaluating the long term distributive effects of the adoption of a NDC system will help to test its capacity to guarantee adequacy, neutrality and intergenerational fairness.

In this paper we jointly study the inter-generational and the intra-generational distribution of resources under the reformed Italian pension system. Our simulations are carried out using CAPP\_DYN, a discrete time, dynamic microsimulation model that stochastically projects the socio-economic evolution of an initial representative population up until 2050. Starting from the base year, new sample members are added in each of the simulated years as a result of the flow of new births and new immigrants; whereas others will be removed due to the simulation of annual deaths, according to demographic scenarios used by the Italian National Statistics Institute to project the likely evolution of the Italian population up to 2050 (ISTAT 2008). We model educational attainments for current young individuals and their entry in the labour market. For those in the labour market we model their transition into different occupational states, the labour income formation process, the retirement decision and we project future old-age pension benefits taking into account legislation in force in June 2010.

In order to measure the inter- and intra-generational effects of the reformed system, we focus on a set of indexes such as the (gross) replacement ratio expected to be delivered by the reformed statutory scheme, the Gini index on old-age pension benefits, and a measure of the Net Present Value Ratio between pension benefits and social security contributions. In this paper we focus on old-age pensions which currently represent about 70% of the total pension expenditure in Italy<sup>2</sup> and are the main source of income among older people.

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<sup>2</sup> According to the Italian National Institute of Statistics (ISTAT), in 2008 old-age pension expenditure amounted to 168 billion Euros. In the same year, total pension expenditure was equal to 241 billion Euros.

The paper is organized as follows: Section 2 briefly sketches the main changes occurred in the Italian pension system from 1992 to June 2010. Section 3 describes the model. Section 4 reports our results and section 5 concludes.

## 2. *The Italian pension system*

The (theoretical) long-term characteristics of the Italian pension system have been radically modified during the reform process started in 1992. Before the reforms, the system was based on a DB mechanism: old-age pension benefits were determined by multiplying pensionable earnings by the number of working years and by an accrual rate. Numerous schemes - each one with its own rule- were in place at the same time producing great heterogeneity in pension treatments. The system was unanimously considered financially unsustainable and unfair from a distributional viewpoint. To the contributions paid by workers, it granted an internal rate of return that was on average greater than the growth rate of the taxable base. Moreover, internal rates of return were higher for those retiring early and for workers with steep lifetime earnings profiles. Civil servants, the self-employed and workers in some minor schemes were guaranteed more generous rules with respect to the main scheme, the one in force for private dependent workers. Although the legal retirement age was set at the age of 60 for men and 55 for women, early retirements (seniority pension) were allowed on reaching a minimum period of contributions of 35 years (for the main scheme).

Under the pressure of the financial crisis of the Italian currency (Lira) and of the urgency to cut the public deficit, the first step of the reform process was a standard parametric one (the so-called "Amato reform") which starting from 1993: *i)* increased the legal retirement age, *ii)* increased the number of years over which pensionable earnings were to be calculated; *iii)* cut accrual factors in the pension formula; *iv)* modified indexation of pension benefits linking their growth to inflation in lieu of earnings. Furthermore, the reform began a gradual harmonization of pension rules among categories.

Three years later, the Italian Parliament approved a law (L.335/95) that introduced a NDC system which more closely linked individuals' contributions with pension benefits, and credited future benefits with a sustainable rate of return. Contributions are (fictitiously) accumulated in an individual fund, and are revaluated in line with a moving average of GDP growth. Pension benefits are calculated by multiplying the revaluated contributions with a conversion coefficient conditional on life expectancies at retirement. Such coefficients, uniform by sex and dynamically updated in order to take into account life-expectancy forecasts of new and future cohorts, allow the system to be (on average) almost actuarially fair among individuals belonging to the same sex and cohort. Retirement age was made flexible from 57 to 65 years conditional on a matured pension benefit higher than 1.2 times the minimum old-age allowance. The speed of convergence to the NDC system was very slowly designed. Current and future workers were divided into three different groups with substantially different pension expectations. For people already contributed into their scheme at least for 18 years on the 1<sup>st</sup> January 1996, the pension level will continue to be calculated according to the old DB method. Pensions for workers who started contributing to their scheme before 1996 but had less than 18 years of service on the cut-off date are calculated on the basis of a mixed formula: the periods before the 1<sup>st</sup> January 1996 are counted as earnings-related and the periods thereafter as contribution-related. The NDC system only applies completely to those who started working after the 1<sup>st</sup> January 1996.

The 1997 reform further reduced the heterogeneity of treatments between private and public employees, and posed additional restrictions for early retirement. In 2004 and 2007, governments tightened the eligibility conditions of retirement by raising the minimum retirement age to 60 for women and 65 for men, and by increasing the age and years of contribution requirements for seniority pensions. As a result, retirement age is no more flexible between the age of 57 and 65 in the long run, but it will be governed by a mechanism that allows early retirement<sup>3</sup>.

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<sup>3</sup> Early retirements are possible if a set of conditions on age and seniority is respected. Such conditions will be tightened in the future.



Starting from 2007, the Italian legislation formally requires the transfer of new flows of TFR (a severance payment that employers of the private sector have to pay to their employees<sup>4</sup>) from companies' book reserves to a pension fund, unless the employees explicitly forbid it. This rule, together with a strong fiscal incentive package for pension saving, was introduced to develop the tiny private pension pillar in Italy. Starting from 2010, the legal retirement age will also gradually be increased for women employed in the public sector to bring it in line with the age for men in 2012.

According to a number of studies and empirical exercises on representative individuals and microdata (see among others Franco 2002; Castellino and Fornero 2001; Borella and Coda Moscarola 2006), the change from a DB to a NDC scheme has made the system more equitable by closely linking individual's contributions with pension benefits making the system fairer from an intertemporal perspective. Nevertheless, two problems are still not yet well explored from the distributional point of view: the long-term adequacy of the reformed Italian pension system and the medium-term consequences of the slow transitional path designed by Parliament.

In order to ensure financial sustainability, the NDC system has sharply reduced prospective replacement ratios. This effect can be only partially counterbalanced by the increase in retirement age. Expected theoretical replacement ratios under the reformed system have been reduced by about 15%-25% for a dependent worker with a contributions record of 40 years and who will retire at 65. The reduction is expected to be significantly higher for workers who will retire earlier, for workers with discontinuous careers and for the self-employed (EU 2009). Retirement income adequacy could be regained through the expansion of a complementary private pension pillar. Empirical evidence on the actual development of a private pension pillar in Italy after the 2007 reform is still controversial. However, it should be noticed that although the participation rate in private pension schemes has

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<sup>4</sup> Upon termination of employment for any reason, employers have to pay a termination indemnity (*Trattamento di fine Rapporto* or TFR) to all employees. In Italy the TFR serves as a backup in the event of redundancy or as an additional pension benefit after retirement. Severance pay is calculated as 6.9% of each year's annual salary, revalued on the basis of 75% of inflation plus a fixed rate of 1.5% during the period of accrual, and is paid as a lump sum.

increased substantially in the recent years as effect of the 2007 reform, only about 26% (3.8%) of workers in the private (public) sector and 18.7% of self employed are enrolled in such schemes (COVIP 2010).

The slow transitional path from the DB formula to the reformed one complicates the picture further, since important cohort effects arose because of the application of the NDC formula only to those who entered the labour market after 1995. Moreover, the decision made in 1992 to abandon the indexation of pension benefits to real earnings will result in the gradual impoverishment of existing pensioners, compared with new pensioners and workers<sup>5</sup>.

The length of the reform process also generates uncertainty, impairs the beneficial microeconomic effects of the NDC system on the labour market, and pushes workers to retire as soon as possible in order to avoid likely future cuts in benefits (Franco 2002). The same author points out a remarkable continuity in the “Italian policy-making style”, before and after the 1992. In particular, reforms would have been introduced without adequate analysis of their implications. If this appears questionable as far as analysis of the long term sustainability of the system is concerned<sup>6</sup>, it is certainly true for the long term distributional analysis. From this point of view, a population-based dynamic microsimulation model is a tool that - unlike static or cohort based models - allows a joint analysis of both inter-generational and intra-generational effects within a consistent framework.

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<sup>5</sup> Since the mid nineties, growth in labour productivity and real wages have been particularly poor in Italy, meaning that the indexation rule applied to pension benefits may not have had an important effect in explaining the distribution of the national product between active and retired individuals. Notwithstanding, we consider this point important from a long-term perspective where labour productivity is also expected to increase in the face of a shrinking working population projected in the coming decades.

<sup>6</sup> Since 1991 the Ministry of Treasury has developed a cell-based macroeconomic model able to estimate the medium and long-term dynamic of the pension expenditure / GDP ratio. Results of these estimations are published each year. Latest projections are available in RGS (2009).

### 3. The Model

Results discussed in this paper are obtained using an updated version of CAPP\_DYN (Mazzaferro and Morciano 2008), a population-based dynamic microsimulation model, specifically designed to analyse the long-term economic well-being of a relatively large and representative sample of the Italian population until 2050<sup>7</sup>. Starting with the seminal contribution of Orcutt (1957), the application of microsimulation techniques has been extensively used in policy analysis (Citro and Hanushek 1991; Harding 1993; O'Donoghue 2001; Bourguignon and Spadaro 2006). Despite their complexity and limitations (Klevmarken, 2005), dynamic models have been commonly used to analyze the long-term perspective of social security systems in North America, North Europe and Australia (See Zaidi and Rake (2002) for a review). The dynamic approach used in CAPP\_DYN implies that the main socio-economic processes are explicitly simulated, accounting for the effect of changes in the socio-demographic population structure, labour supply and reforms of the Italian pension system<sup>8</sup>. The initial population is taken from the 2002 wave of the Bank of Italy Survey of Households Income and Wealth (SHIW), a dataset comprising 8,001 households and 21,400 individuals (Bank of Italy, 2004), which has been expanded by sampling weights and re-aligned using census data. All individuals in the sample are involved in a considerable number of demographic and economic events, such as birth, education, (re)marriage and divorce, work, retirement, disability and death<sup>9</sup>. The events, which are being used for the current version of CAPP\_DYN, and the sequence with which they are being executed, are given in figure 1. Economic and

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<sup>7</sup> A more detailed description of the model is presented in the appendix.

<sup>8</sup> The model is based on a nationally representative sample of the Italian population and it makes use of dynamic-ageing procedures to simulate transitions among states. Therefore, re-weighting procedures are not required. Despite its complexity, the advantage of this technique is that, at the end of a simulation, we are able to observe a lifetime pattern of education, work, career, personal and family income, and so on, for each individual in the sample.

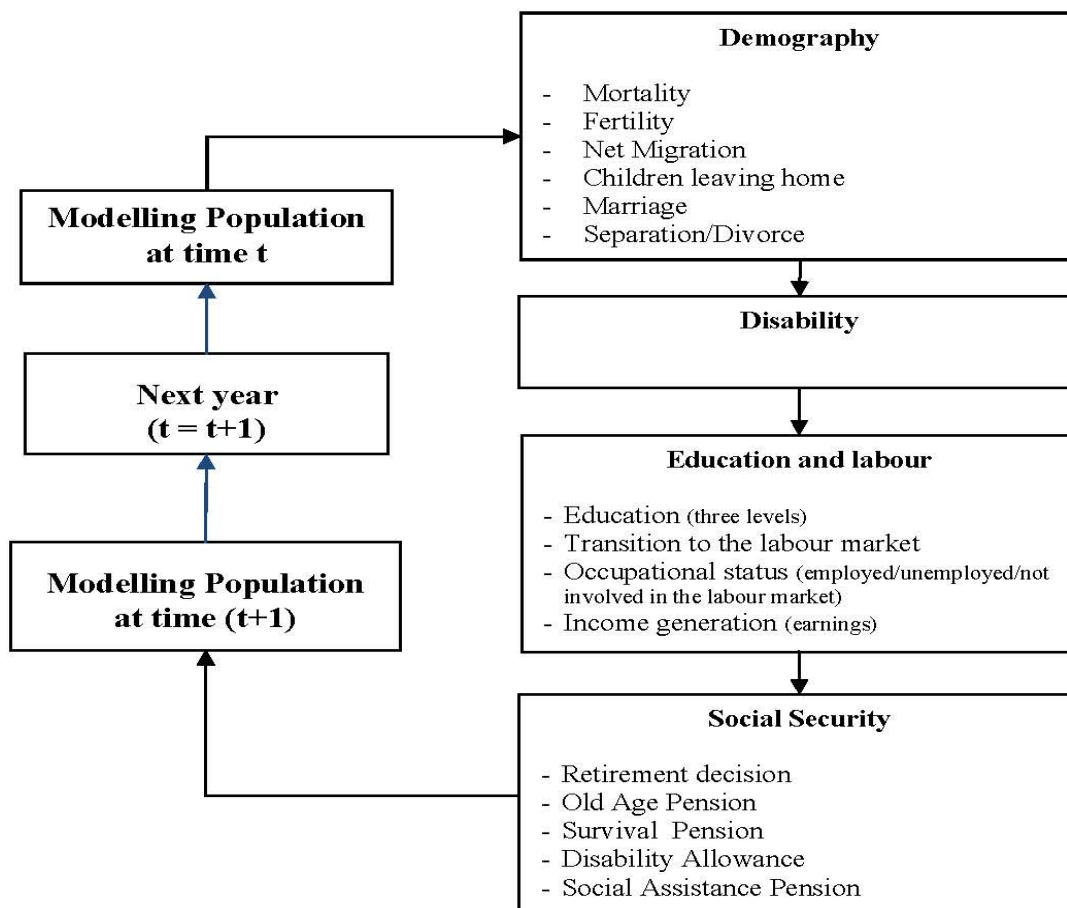
<sup>9</sup> While the unit of simulation is the individual, we nevertheless keep information on family structure and any changes this may be subjected to over the course of time.

demographic transitions among states are simulated in discrete time (annual cycle) using event-specific Monte Carlo processes. Thus, to model a change in the socio-economic characteristic of a sample member from one year to the next we first fit to the data statistical models that capture all relevant aspects of the individual's transitions; then, we simulate change in the individual status by making random drawings from the estimated models. Transition probabilities depend on a set of individual characteristics and are obtained from a range of available data source. Each annual cycle starts running a set of "demographic" modules (mortality, fertility, net migration) which, in line with the demographic projections of the National Statistics Institute (ISTAT), determines the size and structure of the population in each simulated year. Household formation/dissolution modules (parental house living decision, (re)marriage and divorce) allow the definition of the family structure in which each sample member is allocated<sup>10</sup>. The second set of modules allows the simulation of individuals' educational choices, job decisions and earnings. In each of the simulated year, individuals incur in the probability of changing occupational status (full-time, part-time, out of the labour market, unemployed). For employed people, gender and sector-specific earning equations are used to compute cross-sectional age-earning profiles, making some assumptions regarding the treatment of the unobservable individual effect and expected earnings growth rate over the simulated period.

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<sup>10</sup> Health status and disabilities profiles are simulated using a procedure described elsewhere (Baldini, Mazzaferro and Morciano (2008) and Mazzaferro and Morciano (2008)). Health status is not a direct outcome of this paper but we recognize that indirectly affects other economic dimensions (i.e. labour market position, earnings and receipt of disability benefits).

Figure 1  
The dynamic ageing process in CAPP\_DYN



### 3.1 The Social Security Module

The third block of CAPP\_DYN models Social Security and pension entitlements. Individual retirement choices and the computation of old age, seniority and survivors pension benefits, as well as of social allowances, social assistance increases (*maggiorazioni sociali*) and supplements (*integrazioni al minimo*) are simulated in this module.

The individual old-age pension depends on the following variables:

- the life-cycle profile of labour earnings;

- the total number of years he/she contributed contributed into his/her scheme;
- the contribution rate applied during the working life;
- the - exogenous - macroeconomic growth experienced during the period of accruing pension rights;
- the pension scheme;
- the retirement age.

The first four variables are endogenously determined within the “demographic” and “education and labour market” modules. In particular, the individuals’ life-cycle profile of gross earnings depends on how the set of socio-economic characteristics which acts as covariates in the earning regressions evolves over time and the exogenous assumption on the productivity over the whole working life (see appendix for details). The seniority at retirement depends on the total number of years individual accrued pension rights, assumed to be equal to the number of years the individual received a positive labour earnings. Due to the fact that individuals may transit to/from different employment/unemployment statuses during the working life, a share of sample members may incur in periods without contributions.

Retirement is simulated yearly following a two-stage procedure. In the first stage, all individuals fulfilling age and seniority conditions to claim a seniority pension are identified. For those eligible, the model checks the inter-temporal convenience of the retirement. In practice it compares two options: keep working another year or retiring immediately; if the net social security wealth is greater under the second option, the retirement choice is effectively simulated only if the replacement rate the individual would have in this option exceeds a certain threshold, set at 60%. Otherwise, the sample member will remains one more year at work<sup>11</sup>.

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<sup>11</sup> In practice, all those who retire with the DB formula respect this constraint. In the new NDC regime an individual will be “neutral” since the NDC insure quasi-actuarial equity between the present value of paid contributions and the present value of expected pension benefits (see later in the paragraph). It follows that all sample members cannot stay in a working condition after the age of 65.

Therefore, the model allows for two relevant aspects in the anticipated retirement choice: the first is an evaluation of inter-temporal convenience; the second relates to the adequacy of the pension benefit provided by the social security system<sup>12</sup>.

The second way for retirement is the achievement of the statutory age. Once conditions for an old age pension are fulfilled, then individuals are supposed to retire, irrespective of the evaluation in terms of inter-temporal convenience and adequacy of the pension benefit. Table 1 synthesizes requirements for the attainment of seniority and/or age pensions currently available for Italian workers.

Table 1  
*Retirement rules in the Italian reformed system*

Start working:	Requirements for:	OLD-AGE PENSION	SENIORITY PENSION
Before 1995		Women: aged 60 Men: aged 65 Women and men: at least 20 years of seniority	Women and men: age at least 59 seniority at least 35 years age + seniority: at least 95 or seniority at least 40 years irrespective of age
After 1995		Women: aged 60 Men: aged 65 Women and men: at least 5 years of seniority	Women and men: age at least 59 seniority at least 35 years age + seniority: at least 95 or seniority at least 40 years independently on age

Note that requirement of age and seniority will be progressively tightened with the age requirement increasing from 59 in 2009 to 61 in 2013. Requirements for the self-employed

<sup>12</sup> The choice of the particular threshold value adopted is clearly sensitive with respect the determination of the actual mean age of retirement. The value of 60% seems to be a “reasonable” option which in practice restricts the seniority retirements only in the second part of the simulation period when the NDC system is phased in.

are one year higher. Old-age pension for women employed under the public sector is also progressively increasing and is expected to reach the age of 65 in 2017.

We compute old-age pension benefits taking into account, as far as possible, the rules in force in Italy in June 2010.

Below we describe the different rules prevailing under the DB, the mixed and the NDC schemes. The population in the model has been divided into three groups according to seniority in 1995: DB, mixed and NDC<sup>13</sup>.

The computation rule for pension benefit of those workers who are under the DB system is summarized by the formula:

$$P_{DB} = r * (N_1 W_1 + N_2 W_2) \quad (1)$$

where  $r$  is an accrual rate,  $N_1$  and  $N_2$  represent the years of contribution before and after 1992 respectively,  $W_1$  and  $W_2$  represent the pensionable earnings used for computing pension installment, for the contributions paid before and after 1992 respectively.

The terms  $r$  and  $W$  in the DB formula vary according to pension scheme and to the amount of pensionable earnings. In particular,  $W_1$  is equal to the last yearly-earning for employees in the public sector; the average of the last five or ten pensionable yearly-earnings for those employed in the private sector and self-employed workers respectively.  $W_2$  is the mean computed over the last ten years of positive earnings for public and private sector employees and over the last 15 years for self-employed workers. The accrual rate  $r$  is equal to 2% for the pensionable earnings bracket between 0 and 42,111 Euros (2009 prices) and it decreases with earnings level down progressively to a value of 1.1% for the pensionable earnings bracket over 55,976 Euros (2009 prices).

Pensioners who have paid at least 20 annuities of contributions, but did not reach the minimum pension amount, are supplemented up to the minimum level<sup>14</sup>.

<sup>13</sup> See section 2.

<sup>14</sup> In 2009 the yearly minimum pension level was fixed at 5,950 Euro.



For workers under the mixed regime, the old age pension benefit is determined as the sum of two components:

$$P_{mixed} = P_A + P_B \quad (2)$$

where the general rule for determining  $P_A$  is similar to the formula used in the DB regime for the contribution paid before 1995, while the second,  $P_B$  is computed according to a NDC rule on the contributions paid after 1995. Nevertheless, in the “mixed” regime the pensionable earnings for the contributions paid between 1992 and 1995 is determined differently, as the average yearly earnings indexed to 1% yearly rate according to a simple compounding rule. The  $P_B$  term of the mixed pension is figured according to the NDC rule of equation (3).

Pensioners who have paid at least 20 annuities of contributions but have not reached the minimum pension amount are topped up to the minimum level.

Old-age pension in the NDC system is computed as:

$$P_{NDC} = D_X * MC \quad (3)$$

where  $D_X$  is a conversion factor that varies with retirement age ( $x$ ) so as to guarantee a quasi-actuarial equity between the present value of paid contributions and the present value of expected pension benefits<sup>15</sup>.  $MC$  is the total of contributions accrued during the whole working life in proportion to

<sup>15</sup> The conversion factor has been computed as the result of the following simplified formula:

$$D_X = \sum_{t=0}^{w-x-1} \frac{I_{x+t}^V}{I_x} (1+i)^{-t} + \beta \sum_{t=0}^{w-x-1} \left( \frac{I_{x+t}^V}{I_x} q_{x+t}^V a_{x+t+1}^F (1+i)^{-(t+1)} \right)$$

found in Caselli et al (2003) where  $w$  is the maximum life span (set equal to 100 years);

$\frac{I_{x+t}^V}{I_x}$  is the pensioner's probability at age  $x$  of being alive at age  $x + t$ ,  $i$  is the annual real discount rate (set equal to 1.5 per cent, assumed to be equal to the long-run annual growth rate of Gross Domestic Product in real terms);  $\beta$  (set equal to 0.54 for a male pensioner and 0.42 for a female one) is the fraction of the pension paid out the surviving spouse (if there is any);  $q_{x+t}^V$  is the probability of dying between age  $x + t$  and age  $x + t + 1$ ;  $a_{x+t+1}^F$  is the expected present value of a real annuity of one dollar paid to the surviving spouse (if there is any) after the pensioner's death at age  $x + t + 1$ .

gross earnings (33% for employees and 20% for self-employed), capitalized at the rate of growth of nominal GDP. The yearly contribution is computed as a share of the gross wage for employees and gross income for the self-employed. The contribution rate is set at 33% for employees and 20% for self-employed workers. A contributory cap is set at 91,507 Euros (2009 prices). At least five years of contributions are required to claim an old age pension if the corresponding pension installment exceeds the amount of social allowance increased by 20%. The latter condition is not applied for those who will retire after the statutory retirement age. For the pensions provided under the NDC scheme, a supplement up to the level of social allowance can be provided<sup>16</sup> but a supplement up to the minimum is no longer allowed.

Several supplementary benefits are provided to individuals older than 70 years. The aim of this rather complex set of transfers is to guarantee a minimum income level which, for a 70-year-old individual without previous contributions, is equal to 8,500 Euros (2009 prices). This amount increases progressively with the number of years of contributions and decreases in the 65-70 age bracket.

#### 4 Empirical results

In the coming decades, Italian society and its economy are expected to experience important structural changes, in line with trends already taking place. Table 2 presents a range of demographic and economic statistics - obtained using CAPP\_DYN- at the beginning, in the middle and at the end of the simulated period (2010, 2030, 2050). Column (1) reports also historical data referred to 1990, showing that there is a fair degree of uniformity in the future trends simulated with the observed ones.

The first four rows of Table 2 give a broad picture of some implications of the ageing process. Changes depicted and simulated by CAPP\_DYN are the result of important cohort effects already at work in Italy and expected to continue into the future. The central scenario of the

<sup>16</sup> In 2009 the yearly level of the social allowance (*assegno sociale*) was fixed at 5,317 Euro.

latest demographic projection to 2050 (ISTAT 2008), used in CAPP\_DYN as reference, assumes a further reduction in mortality, in particular among the elderly and new cohorts, a slight recovery of the fertility rate and a constant net inflow of immigrants. Important cohort effects are at work both in the educational and labour participation decisions. In particular young individuals in the model will continue the trend of increasing the time spent in acquiring education (mainly among women). As far as the participation rate is concerned, the recent trend of an increase of adult women participation is projected for the next decades too.

As result of these hypotheses, the average age of the population, that was 38.2 years in 1990, will increase from 42.9 years in 2010 to 48.9 years in 2050. The share of individuals aged 65 and over with respect to the whole population will nearly double in the next four decades; the percentage of 80+ over 65+ is expected to increase from 27.4% in 2010 to 42.3% in 2050. The percentage of partnered people will reduce drastically due to the combined effect of the expected increases in divorce rates and widowhood, as women are expected to live longer than men. Besides, projecting in the future observed trends in individuals' educational level (see appendix for details on the econometric framework), the model predicts a steadily reduction in the share of workers with a lower level of education in favour of an increase in the share of those with university degrees (mainly women). Finally, the constant net inflow of immigrants consistent with those projected by the National Statistics Institute implies a steadily growing share of the foreign-born population, particularly in the central age classes. Having started from nearly 1% of the population in 1990 that share will reach 15.1% in 2050.

**Table 2**  
*Descriptive statistics of the Italian population in 1990, 2010, 2030 and 2050*

Year	(1) 1990	(2) 2010	(3) 2030	(4) 2050
Average age	38.2	42.9	46.9	48.9
>=65 /Population	14.7%	19.6%	28.0%	33.5%
>=80 / >=65	21.4%	27.4%	31.3%	42.3%
Share of aged 25+ who are married/cohabiting	71.7%	57.7%	49.2%	45.6%
Highest educational attainment by population in paid employment				
<i>Primary school</i>	53.6%	43.9%	37.5%	33.5%
<i>Secondary school</i>	36.4%	44.6%	41.2%	32.8%
<i>University degree</i>	10.0%	11.5%	21.3%	33.6%
<b>Immigrants/whole population</b>	<b>0.6%</b>	<b>4.7%</b>	<b>10.5%</b>	<b>15.1%</b>

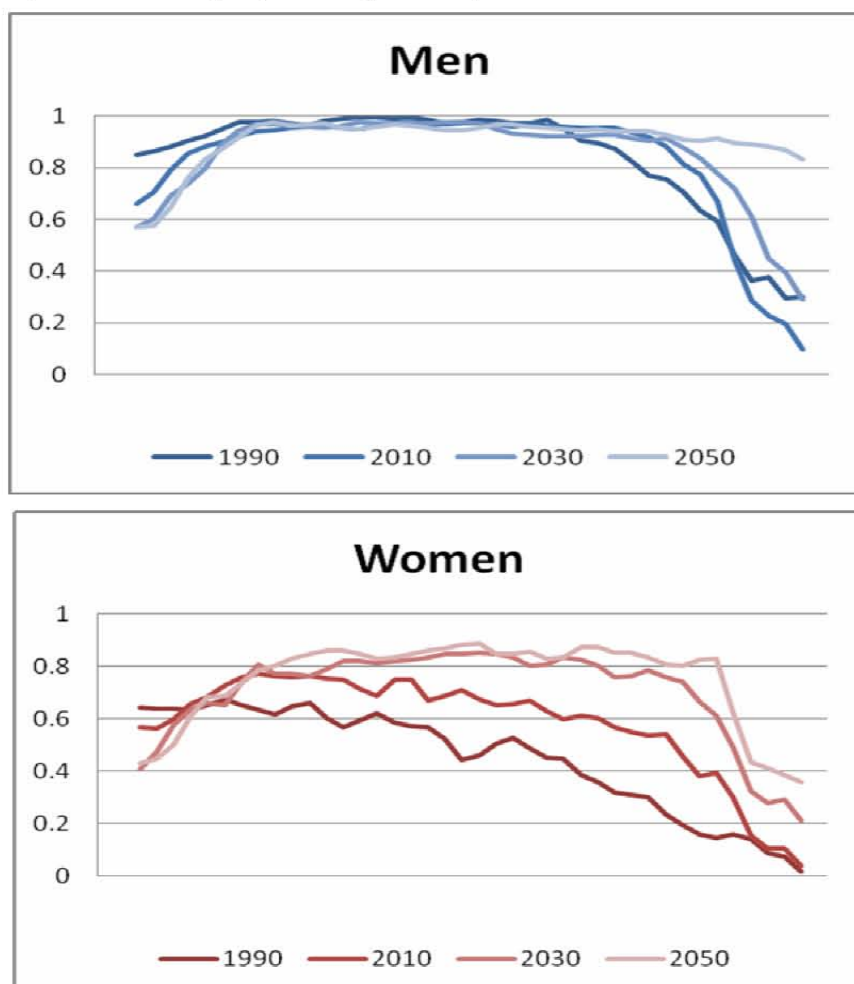
Source: (1) ISTAT (1990) and SHIW data 1991. Column 2 to 4 elaborations are obtained using CAPP\_DYN.

The increase in the number of years individuals spend in acquiring education together with the increase in the retirement age will radically modify the age and gender composition of the labour force over the coming decades.

As Figure 2 reports, the participation rates by age and gender estimated by CAPP\_DYN in 2010, 2025 and 2050 are rather different in particular at the beginning and at the end of the active lifetime. In continuity with the past twenty-years trend, moving from 2010 to 2050, the participation rate at younger ages will decrease for both men and women, given the younger cohorts' propensity to remain at school longer. Participation rate increases for women in the central part of their active lives as result from positive cohort effects and their propensity of acquiring high-level education. Finally, the participation rate increases in the final part of active lifetimes as a consequence of the rising legal and effective retirement age.

Figure 2

*Participation rate by age and gender, years 1990, 2010, 2030 and 2050*

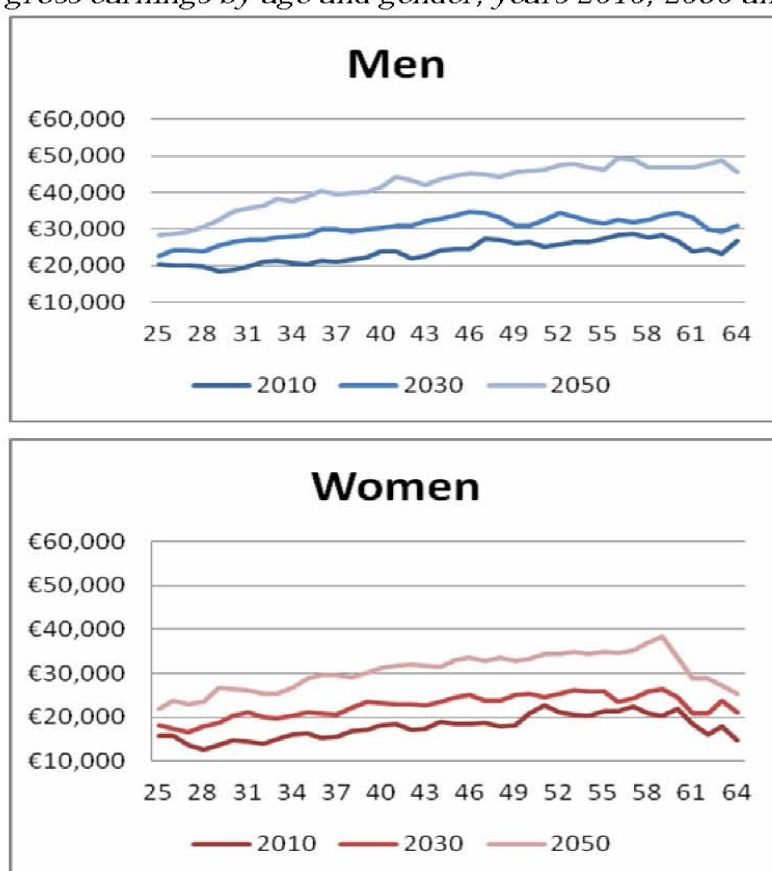


Source: (1990) SHIW data 1991. Estimates for 2010, 2030 and 2050 are obtained using CAPP\_DYN. The participation rate is the number of people in the labour force (occupied, unemployed) divided by the size of the adult population by age.

Figure 3 shows the median real gross earnings for men and women in paid employment at three points in time. The assumed path of earnings, estimated using the procedure discussed in the appendix, takes into account the assumption on the real growth in productivity used by the cell-based official RGS model and reported also in the appendix. The pro-quota distribution of the exogenous real growth among workers produces the shifts of the median gross earnings at all ages and simulated years, which is higher (in nominal terms) for those who earn more. Modifications from the initial

path are mainly due to the expected changes in the socio-economic characteristics of workers, mainly their level of education, the share of population working part-time and the increasing role of immigrants. Women in paid employment earn substantially less than men at all ages, although the estimated gap is partially explained by a larger incidence of part-time jobs amongst them.

Figure 3  
*Median real gross earnings by age and gender, years 2010, 2030 and 2050*



*Source:* Age profiles estimated using CAPP\_DYN. *Notes:* See appendix for details on the econometric procedure in use to estimated gross earnings. Value expressed in € 2009 computed amongst those with positive earnings.

Our projections clearly depend on the assumptions that current observed trends will continue throughout the simulated years and that socio-economic and policy changes will not produce significant “second round” effects not fully depicted within the model. Finally, it should be pointed out that the likelihood of future outcomes moving along our predicted trends

increases as the simulated time horizon increases. As one would expect, simulations obtained for the youngest cohorts of individuals might be affected by a high degree of uncertainty resulting from the broad set of events which need to be simulated.

With this precaution in mind, we move on now to assess the characteristics of the population of old-age pensioners, the main focus of this paper. Table 3 reports some summary information on their characteristics in 1990, 2010, 2030 and 2050.

It was 42.5% in 1990 and it is projected to be 62.8% in 2050. This result is the product of different trends. Secondly, on the denominator of the ratio, two opposite forces will be at work: on the one side, the active labour force is expected to fall as result of the present and future decline in fertility rates among women; on the other side, the increase in participation rate of these cohorts will move in the opposite direction.

Table 3

*Descriptive statistics calculated among pensioners, various years.*

Year	1990	2010	2030	2050
Old age pensioners / Employed	42.5%	49.8%	58.5%	62.8%
Share of DB pensions	100%	97.5%	40.8%	4.2%
Share of mixed pensions	0%	2.3%	50.5%	30.8%
Share of NDC pensions	0%	0.1%	8.8%	65.1%
Share of men	54.0%	54.5%	56.1%	52.8%
Share of old age pensioners < 65	37.6%	23.4%	16.1%	5.9%
Share of old age pensioners >=65 & <80	51.8%	54.6%	56.3%	53.2%
Share of old age pensioners >= 80	10.6%	22.0%	27.6%	40.9%
Average age of old age pensioners	68.1	72.0	73.9	76.9
Average age of retirement of new pensioners	56.9	60.4	62.6	63.3
<i>men</i>	57.6	60.2	63.1	64.9
<i>women</i>	55.5	60.5	62.0	61.4

Authors' analysis from: SHIW 1991 (reference period 1990) for numbers in the first column; CAPP\_DYN for the others.

The ratio between the number of old-age pensioners and the employed is expected to increase substantially. It was 42.5% in 1991 and, according to our projections, it will be 63.8% in 2050. This result depends on different trends. Firstly, the ageing process of the baby-boom generations

(which are expected to live longer) will increase the numerator, particularly after 2020. Secondly, on the denominator of the ratio, two opposite forces will be at work: on the one side, the active labour force is expected to fall due to the current demographic scenario, which has accounted for the present and future decline in fertility rates among women; on the other side, the increase in participation rate of these cohorts will move in the opposite direction.

Old-age pensions in the future will be much more heterogeneous as far as the computation rule of their benefits is concerned. In 1990 all of them were under the DB system. The share of DB pensioners however is still 97.5% in 2010 and 40.8% in 2030 because of the slow transition to the NDC system designed by the 1995 reform. As a consequence, only at the end of the simulation period pensions under the DB system will disappear. As a matter of fact, in 2050 roughly 2/3 of pensioners will be under the NDC system whereas 1/3 will be still under the mixed regime.

With respect to their age composition, old-age pensioners will become increasingly older. The share of them aged 80 and over is projected to increase continuously up to 40.9% at the end of the simulated period. On the other hand, the share of younger pensioners (aged below 65), which was an important component of the total in 1990, will nearly disappear at the end of the simulation.

Finally, under the law in force in 2010 the average age of retirement of new pensioners is expected to increase from 1990 to 2050 by 6.4 years (+7.3 years among men; +5.9 years among women).

#### ***4.1 Inter-generational/lifetime redistribution***

In the economic literature the NDC system is considered "actuarially fair". For a representative individual of each cohort, this system equalizes the present value of benefits with the present value of contributions thereby granting a constant internal rate of return independently from the age of retirement or the category of work. By increasing uniformity of treatment



among different categories of workers, the new system will reduce both the perverse and the good redistribution of the old DB Italian system (Borella and Coda Moscarola 2006). A measure widely used to consider the intergenerational fairness of a pension system is the Net Present Value Ratio (NPVR): this is defined as the ratio of the present value of benefits received to the present value of contributions paid during an individual's lifetime, each of which is evaluated at retirement age. The denominator of this indicator is the premium an individual pays in order to purchase an annuity which lasts for the individual's lifetime (Brown 2002). NPVR for individual  $i$  at time  $t$  can be written as:

$$NPVR_{i,t} = \frac{\sum_{t=1}^T \frac{P_{i,t} S_{i,t}}{(1+r)^t}}{\text{premium}} \quad (4)$$

where  $P_{i,t}$  is the pension benefit of individual  $i$  at time  $t$ ,  $S_{i,t}$  represents the probability of living to period  $t$ , while  $T$  is the maximum life span and  $r$  is the real discount rate. The interpretation of (4) is straightforward: if NPVR equals 1, in actuarial terms the individual receives the same amount of money that he/she has paid in as social security contributions. If NPVR is higher (or lower) than 1, the individual faces an expected gain (or loss).

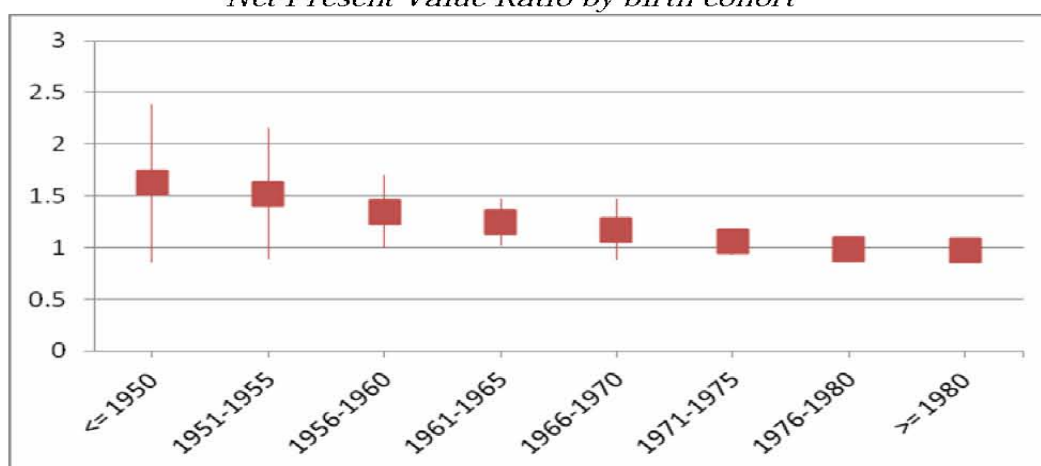
Figure 4 shows our estimates of NPVR by cohort of births. From the figure we are able to highlight two important patterns.

Firstly, the “average” value of the NPVR calculated from new pensioners by cohort shows important reductions when moving from older to younger cohorts. On average, NPVR is equal to 1.5 for individuals born before 1950, i.e. those completely belonging to the DB system. It progresses to values assuring actuarial neutrality for younger cohorts<sup>17</sup>. When looking at the trend of the average value of NPVR, the reduction appears quite important. This may be explained by the fact that the DB formula, prevailing

<sup>17</sup> After 2040, in actuarial terms a new pensioner in the model would expect to receive on average a smaller amount of money than he/she has paid in as social security contributions. This result depends on the fact that the accrual coefficient used in the NDC system is calculated so as to take into account life expectancy of the partner, who will be eligible for a survival pension. In the figure presented here we do not account for survival pensions.

among individuals of older cohorts, is far from being fair from an actuarial perspective, while at least on average the NDC formula is calculated so as to guarantee this aim. As our model depicts the complete distribution of the individuals NPVR, so we calculate the confidence interval around the mean values projected in each year of the simulation<sup>18</sup>. The dispersion of the NPVR values around its mean will also be dramatically reduced once the NDC is completely phased in. Once again, this result is explained by the introduction of an NDC system that ensures the same internal rate of return to each scheme's participant, regardless of the category and age of retirement in the Italian social security system. (Coda Moscarola and Borella, 2006).

Figure 4  
*Net Present Value Ratio by birth cohort*



Vertical lines identify 95% Confidence interval. Source: CAPP\_DYN.

Summing up our simulation depicts a scenario where in the long run the phasing in of the NDC formula moves the Italian pension system towards financial sustainability, granting at the same time intergenerational fairness. The fulfilment of the actuarial equity is an important result of the reform process. However, actuarial equity and system adequacy do not always

<sup>18</sup> All our confidence intervals are of the usual normal form. For a  $(1 - \alpha)$  100% significance level the interval is  $\hat{\theta} \pm c_{\alpha/2} \sqrt{V}$  where  $\hat{\theta}$  is the estimated quantity,  $c_{\alpha/2}$  is the appropriate two-sided critical value for the normal distribution, and  $V$  is the simulated sampling variance of  $\hat{\theta}$ .

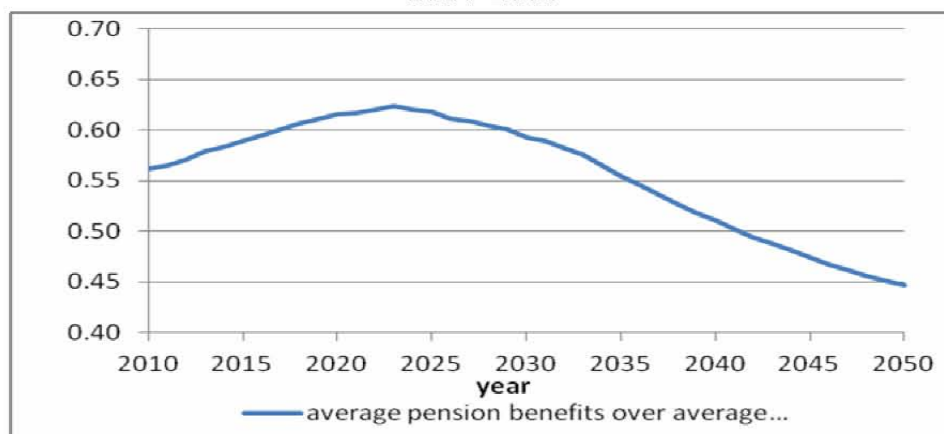
overlap. On the contrary, the two aims may conflict if the first is obtained by a sharp reduction in generosity of the treatments, holding the level of contribution fixed.

## 4.2 Adequacy

Adequacy of the public pension system is a complex issue. We measure adequacy by comparing average pension benefits with average earnings, and by measuring different definitions of replacement ratios between pension benefits and earnings. In the first case, we look at the living conditions of the population of (old-age) pensioners with respect to the active population. In the second, the analysis focuses on the ability of the pension system to guarantee pensioners living conditions similar to those achieved at the time of retirement.

Figure 5 shows the evolution of the ratio of average old-age pensions to average earnings over the period under observation. The ratio increases up to the year 2023 and decreases afterwards. At the end of the period it is 10% lower than at the beginning. Two factors are jointly at work in explaining the evolution depicted. On one hand, the absence of an indexation of pension benefits to real earnings tends to reduce the relative value of the former, with respect to the latter. On the other hand, the slow transition towards the less generous NDC system and the increase in legal retirement age produce a more ambiguous effect which helps to explain both the initial rise and the reduction of the ratio in the second part of the period under observation. More generally, Figure 5 draws a scenario where the average risk of poverty for the older part of the population is likely to rise in the distant future, exacerbated by the fact that individuals will live longer as a result of the huge anticipated increase in life expectancy. However, a full judgement of the repercussions that the reformed pension system might have on poverty would require detailed information about the disposable household income distribution; a task that is beyond the aim of this paper.

Figure 5  
*Ratio between average old-age pension benefits and average earnings.  
 2010-2050*



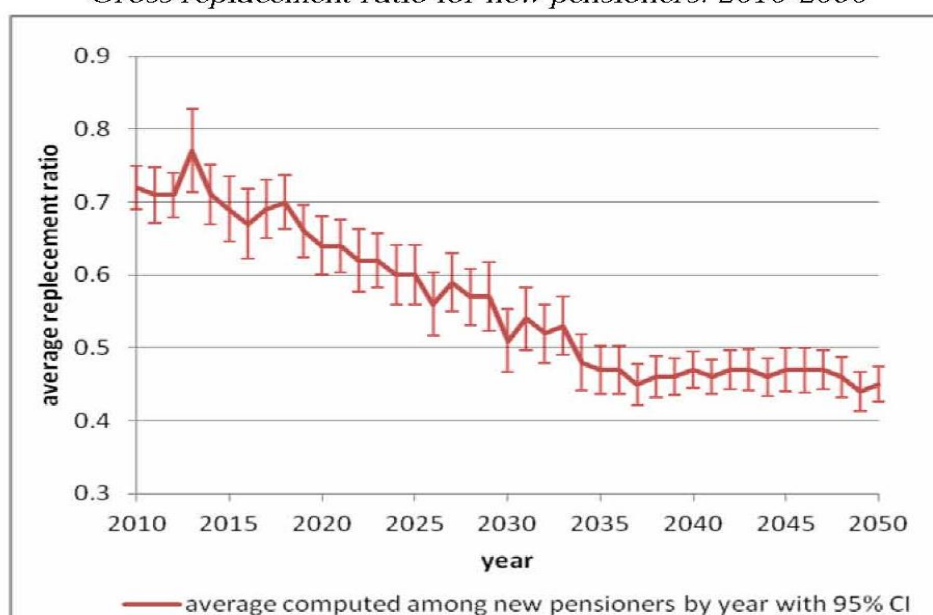
Source: CAPP\_DYN

Regarding the second measure of the adequacy of the public pension system, we explore the time trend of the gross replacement ratio of new retirees, calculated as the mean between individuals' ratio of accrued gross pension in the first year of retirement and their last gross earning. Although this index does not give a full picture of all the distributional characteristics of a pension system, it does provide an idea of the degree of the welfare loss associated with retirement decision and a brief indication of the private asset accumulation required to sustain consumption during retirement.

Figure 6 highlights the sharp reduction of this index, especially in the second part of the period when the NDC system will be completely phased in. The average replacement rate, slightly above to 70% at the beginning of the estimated period, decreases dramatically to about 45% at the end of it. The variability of the replacement ratio around its mean also decreases over time as a result of the reduction in the heterogeneity in both the retirement age and the computation rule of the old age pension. As far as the distribution of replacement ratios is concerned, it is worthwhile to notice that pensioners in the lowest decile of the replacement ratio distribution are projected to experience particularly low values for this indicator after 2030 (Table 4). This implies that in the future, and particularly under the NDC

system, the old-age pension might not be able, by itself, to guarantee individuals from falling into poverty.

Figure 6  
Gross replacement ratio for new pensioners. 2010-2050



Source: CAPP\_DYN

Table 4 splits the whole pensioners' population in subgroups and shows that, as one would expect, current young individuals, the self-employed and women will be the most hurt by the reform process.

Table 4  
Gross replacement ratio for different categories of pensioners

	Simulated Year				
	2010	2020	2030	2040	2050
DB	75.1	74.3	//	//	//
Mixed	47.6	66	60.9	58.5	//
NDC	//	//	37.8	47.3	45.2
Previous Self employed	73.2	52.5	41.2	38.1	35.8
Previous Employees	72.5	67.7	56.7	50.6	49.1
Men	75.6	69.4	60.5	51.1	49.5
Women	64.8	60.8	43.9	40.7	39.8
10 percentile	58.0	45.5	34.6	32.1	30.5

90 percentile	83.1	78.2	69.2	61.8	60.4
All	72.3	64.5	51.2	47.6	45.4

Source: CAPP\_DYN

A more in-depth analysis of the pension system's adequacy can be performed by calculating the ratio between pension benefits provided since a certain year and the average value of earnings after a time interval of 10, 20, 30 and 40 years. This exercise is useful since it allows an evaluation of the adequacy for pensioners retired in time  $t$  even after  $s$ -years into retirement. Table 5 reports these ratios for those retired in 2010, 2020, 2030 and 2040 for  $s=\{0,10,20,30,40\}$ . Results prove that the indexation mechanism chosen in 1995, by excluding any form of link between pensions and earnings growth, causes a progressive and intense reduction of the real value of the former, with respect to the latter<sup>19</sup>. This reduction increases with time and reaches troubling values: for example average (new) pension benefits paid in 2010 are worth 87 % of the average value of earnings in the same year, while the benefits received by the same individuals will be equal to only 54% of average earnings if measured 30 years later. At the same time, analysing data by columns we can measure the progressive reduction of the value of pensions as time passes and the introduction of the NDC system is phased in.

Table 5

*Ratio between the average pension benefit provided in year  $t$  and average earning (in the current year ( $r_{t-1}$  and  $t_{-1}$ ) and after 5, 10, 15 e 20 years*

Pension provided in year:	r_1	r_10	r_20	r_30*
2010	87.3%	78.9%	65.7%	54.1%
2020	80.7%	68.6%	57.7%	46.4%
2030	58.5%	49.2%	41.6%	//
2040	54.9%	45.8%	//	//

*Notes:* sample used in computing  $r_1$ ,  $r_{10}$ ,  $r_{20}$  and  $r_{30}$  is progressively reduced because of the simulation of mortality. The reduction of the sample not only reduces the precision of the estimates but may introduce bias due to the gradient of mortality with individuals' socio-economic status (SES) and health status (HS). Therefore, when mortality is simulated

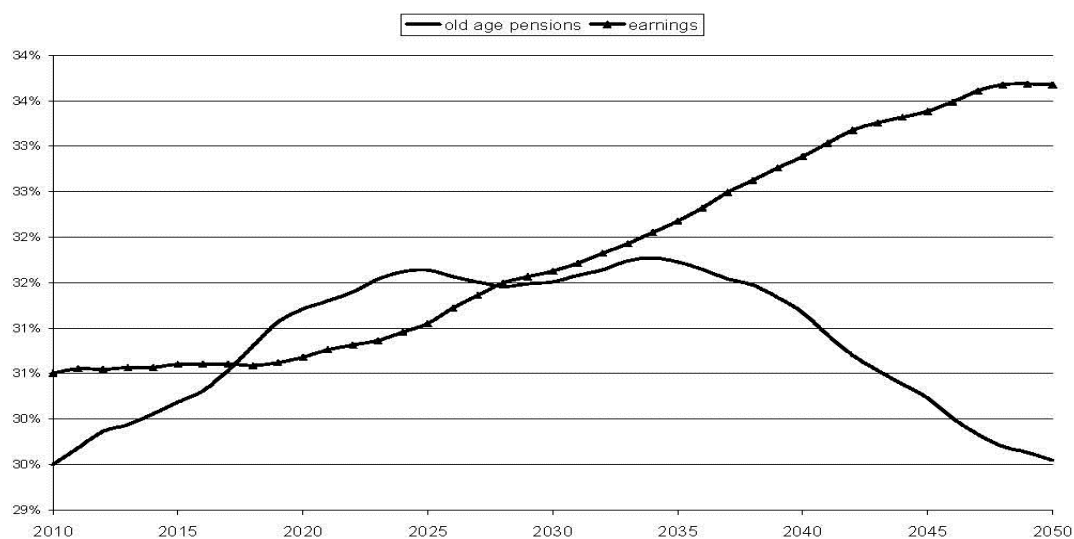
<sup>19</sup> Of course, the magnitude of this reduction is influenced by the assumption regarding the growth rate. We assume that earnings in CAPP\_DYN will grow in line with projection of RGS (on average 1.8% in real terms over the period 2009-2050).

without taking into account its relation with SES and HS (as in this case) we might incur in a sample selection problem. *Source:* CAPP\_DYN.

### **4.3 Intra-generational distribution**

Figure 7 compares the evolution of the Gini indexes calculated among old-age pensions and earnings. Both concentration indexes are calculated from pre-tax values, in order to deparare results from the redistributinal role of the tax system. The Gini index calculated from earnings steadily increases from 29.5% in 2008 to 33.5% in 2050. Many factors may affect earnings dispersion in the future: the increasing participation rate of women in the labour market as well as the increasing share of immigrants and highly-educated workers in the second part of the simulation are the more likely candidates. On the other hand, the trend of the Gini index concerning pensions is both due to the dynamic of earnings and to the effect of reforms implemented in the nineties. Of course, the heterogeneity arising from the calculation of old-age pensions by the slow transition phase to the NDC system has a stronger impact on the Gini index. This is because its value increases in the central part of the simulation, and decreases thereafter when the share of the NDC benefits becomes prevalent (see Table 3). The same trend is followed by the evolution of the interquantile ratio i.e. the ratio between the average old-age pension of the first and the tenth decile. The ratio is equal to 6.36 in 2010, it increases until 2031 when it scores 7.79, and decreases thereafter reaching a value of 6.00 in 2050.

**Figure 7**  
*Gini index on earnings and pension benefits: years 2010-2050*

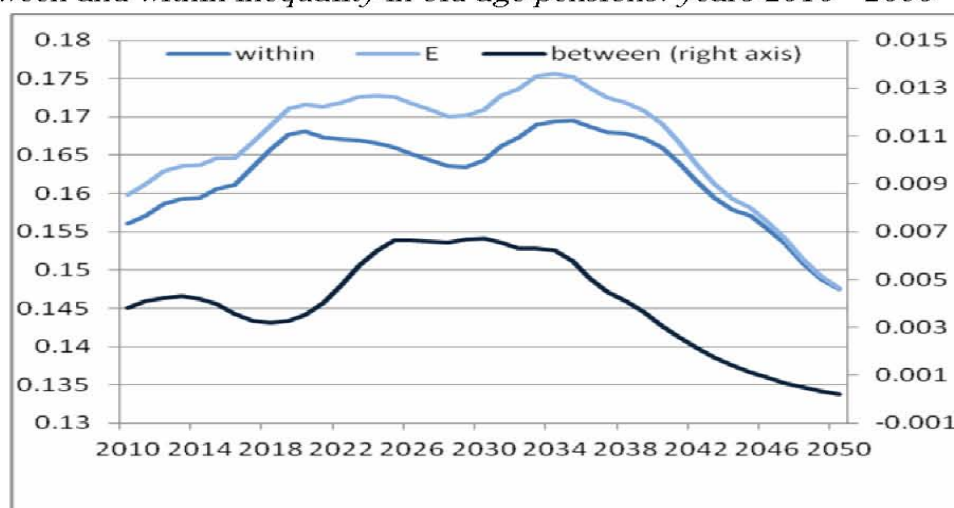


Source: CAPP\_DYN

In other terms, the dispersion in the old-age pensions distribution reaches its maximum in the central period of our simulation (2025-2035), when the heterogeneity in the composition of pensioners (according to the calculation of their benefits) is expected to reach the highest rate (see again Table 3). In order to test this hypothesis, Figure 8 calculates an index defined as the half of the coefficient of variation that, differently from the Gini index, has the advantage of being completely decomposable by subgroup into ‘within-’ and ‘between-’ group inequality components. Figure 8 shows that between-group inequality explains a non negligible part of the dispersion in the period 2025-2040, roughly the same time period that experiences the maximum value of the Gini index.



Figure 8  
*Between and within inequality in old age pensions: years 2010 - 2050*



Source: CAPP\_DYN

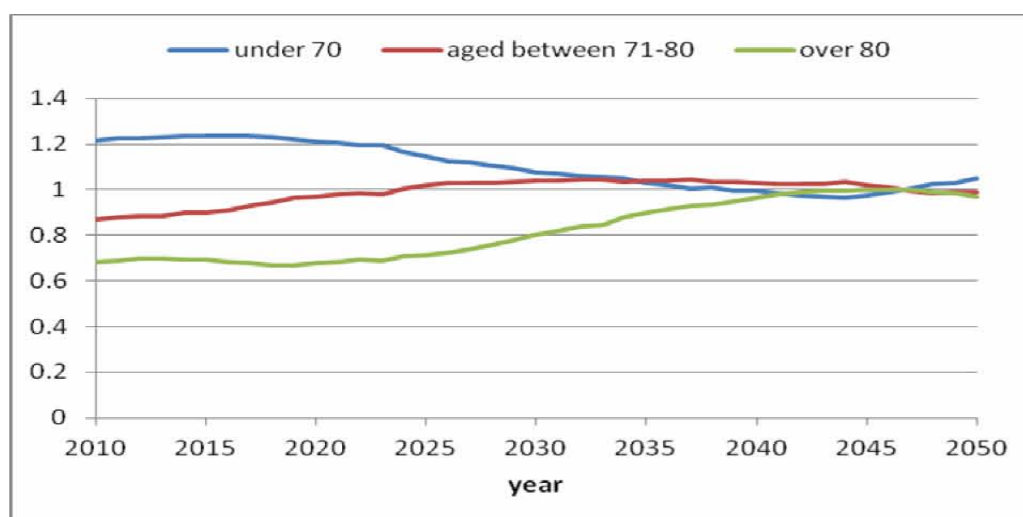
In order to better understand the forces at work that determine the distribution between old-age pensions, we divided pensioners into three different age groups: those less than 70 years old, those in the age bracket 71-80 and those older than 80 years old. Subsequently, we calculated the ratio between the average value of the old-age pensions of each subgroup with respect to the general yearly average value of old age pensions. As Figure 8 shows, there is a monotonic trend that reduces the differences among pensions in these three groups. If the relative position of pension benefits by age group appears to be the usual one at the beginning of the simulation<sup>20</sup>, things are rather different at the end of it, and generally in the second part of the simulation period. It is interesting to try to disentangle the forces that drive such a movement, bearing in mind that at the same time the average value of pension benefits decreases with respect to the average value of earnings (Figure 5). Starting from “younger” pensioners, we notice that their average pension is larger than the general average until 2035. Particularly in the first part of this period, this subgroup is composed of pensioners belonging to the old, generous DB system. Over time, “younger”

<sup>20</sup> In a steady state pension system, younger pensioners’ benefits are higher than those of older pensioners because they incorporate recent earnings growth.

pensioners will belong to the NDC system that will reduce their expected benefits. With regard to the opposite end of the age distribution scale, the condition of “older” pensioners increases over time. Two competing forces are at work in this case: the transition to the NDC system and the indexation rule. If the first explains the fact that older pensioners at the end of the period (which are mainly DB) will be better off than younger (mainly NDC) pensioners, the second applies to the opposite end of the age distribution scale, as it reduces the real value of benefits over time.

Figure 9

*Ratio between age group specific average pensions and the average calculated among the whole population of old-age benefit recipients*



Source: CAPP\_DYN

## 5 Conclusion and future work

This paper has set out projections for inter- and intra-generational features of the reformed Italian public pension system to 2050 using CAPP\_DYN, a dynamic microsimulation model that stochastically projects the socio-economic evolution of a representative sample of the Italian population forward through time. We model as far as we can the rather

complex phasing in of the NDC system and changes in the regulation of the social security system up to (June) 2010 over a representative population that evolves accordingly the latest demographic projection (by gender, age and year) published by the Italian National Statistics Office and assuming that past and current observed trends in educational choices and labour market participation will continue throughout the simulated years and that socio-economic and policy changes will not produce significant “second round” effects. We focussed on old-age pensions which currently cover about 70% of the total pension expenditure in Italy and represent the main source of income among current older people.

Results of our estimations show that reforms of the system, in particular the one approved by the Parliament in 1995, improved sensibly the intergenerational fairness. However, moving to an analysis of the adequacy of the system and of its intra-generational distribution the picture is more troubling.

Two main points appear still to be resolved according our estimates. Firstly, we project an increase in the dispersion of the old-age pension distribution in the transitional phase (2015 – 2030) due to the coexistence of different pension regimes and rules in calculating pensions. Moreover, a problem of adequacy in the public pension system from 2035 emerges as the NDC system will be almost completely phased in. All indexes used in our simulations (replacement ratios, Gini coefficient, decomposition of inequality, etc.) confirm this results.

Results presented in the paper, however, are still preliminary and need to be enhanced in the following directions. Firstly, our projections are valid under certain assumptions about the evolution of a number of (macro) exogenous variables. Given that, sensitivity analysis might be desirable. In addition, results rely on the quality of the data upon which CAPP\_DYN is constructed and the econometric models used in estimating transition probabilities. For the time being, we employ SHIW 2002 to draw the CAPP\_DYN base population while new waves of the dataset are released and new surveys (i.e. the Italian component of EU-SILC) are initiated. Such data may contribute in enhancing the current version of the model.

Secondly, the effects of the policy change should be further developed and analyzed, in particular with reference to some reforms under discussion (i.e. tightening the eligibility conditions of retirement by linking the age of retirement of all workers to the gain in life expectancy). Moreover, it would be interesting to combine this analysis with the one which enable us to consider differences in life-expectancy among people with different socio-economic status. Such topic has already, although separately, been considered using CAPP\_DYN, unveiling another regressive dimension of NDC systems (Mazzaferro, Morciano and Savegnago 2011).

## *APPENDIX*

### *The microsimulation model CAPP\_DYN<sup>21</sup>*

According to the taxonomy proposed by O'Donoghue (2001), CAPP\_DYN is a closed, discrete time, probabilistic, time-based dynamic microsimulation model. It takes a cross-sectional sample of the Italian population and forecasts their socio-economic characteristics forward through time to 2050.

#### *Base population*

The initial population is drawn from the 2002 Survey of Households' Income and Wealth (SHIW) (Bank of Italy, 2004). The SHIW has been widely used for the empirical analysis of income distribution and wealth at individual and household level. It collects a rich and detailed set of socio-economic characteristics of a random sample of non-institutionalized individuals (in the 2002 study 21,148 individuals within 8,011 household units were sampled)<sup>22</sup>. Particular attention has been devoted to the analysis of the representational accuracy of the initial population, since non-ignorable non-response behaviours, under-reporting and misreporting (especially with regard to the financial circumstances) may bias the long-term results<sup>23</sup>. In building the base year population in use by CAPP\_DYN, we applied a post-stratification procedure to the original sample weights, using information provided by the 2001 census data, allowing to an alignment of the survey distribution according the administrative one<sup>24</sup>. Finally, we expanded the initial dataset using the new vector of weights calculated. As far as the size of the initial population is concerned, there is a trade-off between, on the one hand, improving the heterogeneity of the simulation by using a larger sample, thus reducing estimation variance (Orcutt *et al.*, 1976), and on the

<sup>21</sup> A more detailed description of CAPP\_DYN can be found in Mazzaferro and Morciano (2008).

<sup>22</sup> A detailed description of sample design, data collection process and post-stratification adjustment procedures can be found in Bank of Italy (2004).

<sup>23</sup> See Cannari and D'Alessio's (1992) and Brandolini (1999) discuss non-response and miss-reporting behaviours in the SHIW.

<sup>24</sup> A detailed description of the procedure in use can be found in Morciano (2007).

other hand, the technological constraints involved in processing a set of sample members which, by the end of the simulation period, can number several million. Current analyses are carried out using a base year population of around 270,000 individuals within 107,000 households. In order to calculate future pension entitlements for those already in the labour market at the time of interview (2002), we reconstruct the past working history of each active individual present in the base year since his/her entry into the labour market, using all the retrospective information collected in the SHIW<sup>25</sup>.

### *Assumptions*

CAPP\_DYN makes projections on the basis of specific assumptions about the evolution of a number of (macro) exogenous variables. Table 6 displays the list of these exogenous variables, together with the data sources from which the values used in the simulations are drawn.

The latest demographic projection (ISTAT, 2008, central scenario) are used in predicting the number of deaths, births and net immigrants at each of the simulated year. The same demographic scenario is employed by the *Ragioneria Generale dello Stato* (RGS) macro-model to make forecasts of the future GDP growth and earnings, which in turn represent the benchmark of our macroeconomic scenario. Therefore, the choice we make insures internal consistency of our assumptions, in the light of the fact that demographic dynamics and macroeconomic variables are not independent.

### *The Demographic modules*

The general functioning of the demographic modules is as follows: each yearly simulation ages the population by one year; then, the simulation goes on to establish the number of observations that exit the model due to the death (according to age, gender and year-specific survival probabilities provided by ISTAT). This is followed by the simulation of new entrants in

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<sup>25</sup>We mainly exploit information regarding contributory seniority, professional attainments and sectors (actual and previous) taken from the SHIW. The life-cycle profile of past earnings is built using the same procedure in use for forecasting earnings. Individual earnings are then discounted by an annual variable rate amounting to the growth of real earnings observed in the period 1952-2001 (Golinelli, 2002).

without taking into account its relation with SES and HS (as in this case) we might incur in a sample selection problem. *Source:* CAPP\_DYN.

### 4.3 *Intra-generational distribution*

Figure 7 compares the evolution of the Gini indexes calculated among old-age pensions and earnings. Both concentration indexes are calculated from pre-tax values, in order to depurate results from the redistributive role of the tax system. The Gini index calculated from earnings steadily increases from 29.5% in 2008 to 33.5% in 2050. Many factors may affect earnings dispersion in the future: the increasing participation rate of women in the labour market as well as the increasing share of immigrants and highly-educated workers in the second part of the simulation are the more likely candidates. On the other hand, the trend of the Gini index concerning pensions is both due to the dynamic of earnings and to the effect of reforms implemented in the nineties. Of course, the heterogeneity arising from the calculation of old-age pensions by the slow transition phase to the NDC system has a stronger impact on the Gini index. This is because its value increases in the central part of the simulation, and decreases thereafter when the share of the NDC benefits becomes prevalent (see Table 3). The same trend is followed by the evolution of the interquantile ratio i.e. the ratio between the average old-age pension of the first and the tenth decile. The ratio is equal to 6.36 in 2010, it increases until 2031 when it scores 7.79, and decreases thereafter reaching a value of 6.00 in 2050.

Table 6  
*The range of events simulated by CAPP\_DYN: data source, methods and set of socio-economic observable characteristics*  
*Method and set of covariates*

Events	Data source	Method and set of covariates
Mortality rates by age, gender, cohort and area of residence (central scenario)	ISTAT official projections 1/1/2007,	Official projections applied to all sample members
Fertility rates by age (central scenario)	ISTAT official projections 1/1/2007; ISTAT "Famiglie, Soggetti Sociali e Condizioni dell'Infanzia" 2003	Official projections applied to married women aged 16-49
Net Migration (central scenario)	ISTAT official projections 1/1/2007; Bank of Italy, SHIW (2002); ISTAT "Permessi di soggiorno" [ <a href="http://demo.istat.it/altridati/permessi/">http://demo.istat.it/altridati/permessi/</a> ]	Official projections. New entrants are aged 16-65
Leaving parental' home (Re)marriage Divorce	ISTAT "Famiglie e Soggetti Sociali" (2003, 2005)	Transition probabilities by age group, gender and area of residence, (Re)marriage simulated using propensity score matching technique according age group, gender, area of residence, education and previous marital status of the candidates.
Disability	ISTAT "Indagine sulle Condizioni di Salute" (2003)	Ordered probit where level of disability is regressed on splines of age, gender, area of residence, marital status, education, cohort dummies
Education	ISFol PLUS (2003)	Ordered probit. Set of covariates: Parents' characteristics (i.e. education), gender of the pupil, area of residence, cohort dummies.
Entry into the labour market Transitions between labour and non labour statuses Transitions between contractual types	ISTAT, RTFL (1993-2003)	Gender specific multinomial logits where transitions from/to states are regressed on polynomial of age, area of residence, cohort of birth, marital status, education, contributory seniority, professional qualification, sector, work time (part time/full time).
Earnings	Bank of Italy, SHIW (2002)	and contributory seniority, gender, area of residence, citizenship, education, professional qualification, work time (part time/full time), sector.
Real GDP growth Productivity growth	RGS - Ragioneria Generale dello Stato 2007	Official projection



### *Education and labour market modules*

Once the socio-demographic structure of the population has been simulated, the model moves on to simulate decisions regarding participation in education and the labour market. All individuals aged 16 are deemed to have completed their compulsory education. At that age, we simulate the probability of individuals continuing full-time education (up to upper secondary school or higher education) using estimates of an ordered probit model where the educational level attained by an individual depends on a set of observables including family background indicators, and taking into account as far as possible - the presence of cohort effects<sup>26</sup>.

Formally, defining  $y_i$  as the observed and achieved educational level, and  $\tilde{y}_i$  the corresponding latent variable, we model the alternatives in an ordinal form which implies the following general structure:

$$y_i = j \quad \text{iff} \quad c_{j-1} \leq \tilde{y}_i < c_j, \quad r = 1 \dots J$$

$$\tilde{y}_i = \beta' x_i + \varepsilon_i \quad (5)$$

where  $J$  is the number of categories for  $y_i$ : 0 compulsory education, 1 secondary school, 2 undergraduate education, 3 postgraduate education,  $X_i$  is the vector of individual (gender, geographical area and cohort dummies) and household (parents' presence and educational level<sup>27</sup>) characteristics;  $c_{j,r}$  are threshold parameters estimated jointly to the column vector of  $\beta$  coefficients. Estimated coefficients and the cut-off parameters are then used for predicting the probabilities that individuals aged 16 will reach level of education  $j$ . The simulation of the individual educational attainment is finally obtained

<sup>26</sup> Estimates are based on the 2004 ISFol PLUS survey (ISFOL, 2006) which collects information about respondents' educational attainments and their families' socio-economic conditions when the respondent was 15 years old. See Mazzaferro and Morciano (2008) for a discussion on the pros and cons in using available Italian datasets for the empirical analyses of educational choice.

comparing the vector of  $J$ -probabilities with a random number drawn from an uniform distribution with support  $[0,1]$  (i.e. *Monte Carlo* Technique).

A higher educational level delays entry into the labour market until individuals achieve the simulated educational attainment. Then, individuals incur in the probability of entry into the labour market. Inputs/outputs into/from the labour force, together with changes in employment, are then simulated making use of estimates obtained using the *Rilevazione trimestrale sulle forze di lavoro (ISTAT, various years)* – herein after *RTFL*. Occupational attainments and sector are assumed to be time-invariant over the whole simulation period for each individual, whereas employment status and contractual arrangements are allowed to change over time. Concerning the number of transitions into the labour market, *CAPP\_DYN* allows for four employment statuses and, and in keeping with other dynamic microsimulation model, it assumes that employment decisions depend solely on individual characteristics, and are thus independent of demand-side factors. Individuals aged 16 to 64, excluding pensioners and students, can be classified as:

- full time workers (those working at least 31 hours);
- part-time workers (those working less than 31 hours);
- unemployed;
- outside the labour market (unemployed/ inactive);

Transition probabilities are estimated on a pseudo-panel *RTFL* 1993-2003 by using gender-specific multinomial models, assuming that, controlling for a set of observable characteristics and cohort effects, the individual status at time  $t+1$  depends on the state observed in  $t$ . Given the initial status of individual  $i$  at time  $t-1$ , the conditional probabilities of transition or immobility in the following year ( $J=j$ ) are modeled as<sup>28</sup>:

$$P(J = j | I, X_h) = \frac{\exp(X_h B_j)}{1 + \sum_{j=1}^4 \exp(X_h B_j)} \quad j = 1, \dots, 4. \quad (6)$$

<sup>28</sup> The multinomial logistic model is valid under some condition. The most important, known as Independence of Irrelevant Alternatives (IIA), imposes errors  $\varepsilon_{ij}$  which are independents of  $j$ , i.e. the odds-ratios are assumed to be constant between two alternatives, even if number of alternatives increases.

where  $j$  is one of the four feasible statuses,  $X_i$  is the covariates vector (see table 6) and  $\beta_j$  is the vector of coefficients varying according to each state. Finally, a Monte Carlo process enables a definition of the individual's job status in each of the simulated years. Consistent with previous works (Creedy et al, 1993; Disney and Emmerson, 2005), mobility between industries, occupations and sectors are not currently modelled.

Once a position in the labour force is simulated, the yearly-earning will be generated using separate estimated earning equations for employees and self-employed workers. The group of employees is in turn divided by educational level and gender<sup>29</sup>. The econometric model specification is the following<sup>30</sup>:

$$\log y_{it} = \beta' x_{it} + \varepsilon_{it} \quad (7)$$

where  $\ln y_{it}$  is the log of individual labour income gross of personal taxation<sup>31</sup> and the  $X$  vector contains observed individual time-variant and time-invariant observable characteristics and  $\varepsilon_{it}$  is a random disturbance term. Parameters of equation 7 are used to predict the deterministic component of the individual earnings in every year of the simulation. However individual income differs because of the presence of unobserved individual effects and a yearly component which can be thought of as the increase in productivity distributed to all workers in each simulation period.

Unobserved individual effects can be estimated using longitudinal data. Using cross-section data prevents  $\varepsilon_{it}$  from being split into the individual specific effect  $\alpha_i$  and the orthogonal error term  $\xi_{it}$  which have zero mean and variance  $\sigma_\alpha^2$  and  $\sigma_\xi^2$  respectively. Assuming that the orthogonal error term is equal to zero in the initial sample SHIW 2002 ( $\xi_{i0} = 0$ ), the prediction of the individual's earnings level in period  $s$ , is made using the set of information available  $y_{i0}$ ,  $x_{i0}$  and  $x_{is}$  together with the estimated  $\beta$ . Under normality, the conditional expectation of  $y_{is}$  is:

<sup>29</sup> The limited availability of observations for graduated independent workers prevented us from disaggregating data by gender. For the same reason we decided not to decompose the subsample of self-employed by gender and education.

<sup>30</sup> Errors are assumed to be normally distributed with zero mean and  $\sigma^2$  variance.

<sup>31</sup> SHIW collects net income variables. Net to gross conversion is obtained using MAPP, a static tax-benefit microsimulation model disposable at CAPP (Baldini, 2000).

$$E(y_{is} | y_{i0}, x_{i0}, x_{is}) = \beta' x_{is} + (y_{i0} - \beta' x_{i0}) \quad (8)$$

where the first term  $\beta' x_{is}$  is the deterministic part calculated using coefficient estimated in (7) by the vector of updated characteristic  $x_{is}$  whereas the second corresponds to the composite error term  $\varepsilon_{i0}$  in the base population.

Equation 8 specifies that, if we choose to generate earnings stochastically for the simulated period we must take into account the difference between the observed and fitted earnings in period  $t$  when a prediction for period  $s$  is made. A further problem in stochastically generating earnings in  $s$ -period is that  $\varepsilon_{i0}$  is not available for those to whom the information on earning is not available at the time of interview (in work and not respondent; temporarily not in work). Assuming normality we calculate this term extracting a random number from a normally distributed function with mean zero and variance  $\sigma_\alpha^2 + \sigma_\xi^2$ .

Finally,  $y_{is}$  is multiplied by a factor  $(1+\tau_s)$  allowing the individual earning in  $s$  to be linked to the medium-long term productivity growth, calibrated through the “scenario” block. Again there is one point which needs to be made clear: the demographic evolution and the increase in the stock of human capital in the coming decades increase the average earning level, since age and education have a positive effect on average labour earnings<sup>32</sup>. However, in this model, endogenous growth is lower than the growth forecasts according to RGS, since it does not allow for the expected increase in productivity. In order to avoid over/under-estimations of earnings’ growth rates for the coming decades, the following procedure is adopted: every year, a *pro-quota* growth factor  $\tau$  - equal to the difference between the exogenous earning growth fixed in the “scenario” and the earning growth estimated by the model - is added to the endogenous growth due to the socio-demographic evolution.

The term  $\tau_s$  is given by:

$$\tau_s = m_s - \left( \frac{E(y_s)}{E(y_{s-1})} - 1 \right) \quad (9)$$

<sup>32</sup> Other factors could have a negative effect, for instance the increase of female participation in the labour market, the increase of immigrants and the diffusion of part-time contracts.

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where  $m$  is exogenously determined in the “scenario” while  $\frac{E(y_s)}{E(y_{s-1})}$  describes the endogenous growth rate generated by the model.

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**Ministry of Economy and Finance**

**Department of the Treasury**

**Directorate I: Economic and Financial Analysis**

Address:

Via XX Settembre, 97  
00187 - Rome

Websites:

[www.mef.gov.it](http://www.mef.gov.it)  
[www.dt.tesoro.it](http://www.dt.tesoro.it)

e-mail:

[dt.segreteria.direzione1@tesoro.it](mailto:dt.segreteria.direzione1@tesoro.it)

Telephone:

+39 06 47614202  
+39 06 47614197

Fax:

+39 06 47821886