VALIDATION AND POLICY ANALYSIS USING DYNAMIC MICROSIMULATION MODELLING: EVIDENCE FROM EXPERIMENTS IN THE ITALIAN CASE.

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Abstract

The recent literature – including among others Redmond, Sutherland and Wilson (1998), Gupta and Kapur (2000) Mitton, Sutherland and Weeks (2000) – has highlighted model alignment and validation as crucial issues to be tackled when microsimulating the consequences of public policies. The main aim of this paper is to deal with these issues and to present new evidence on the effect of different policy options relative to fiscal and social security reforms on inequality and poverty in the case of Italy. Its analytical framework is based on MIND (Micro Italy National Dynamics), a dynamic ageing model, similar to the one developed in Cannari and Nicoletti-Altimari (1998, 1999), that incorporates behavioural analysis of individual choices of retirement age, derived from the Stock-Wise (1990) option value model.

This dynamic model has already being used to simulate pensioners' inequality trends in Italy by Bianchi, Romanelli, Vagliasindi (2000). Its main advantage consists in its ability to examine behavioural changes along the pension reform path. In this way, we test the appropriateness of dynamic micro-simulation to describe the evolution of income and wealth distribution, as well as inequality and poverty trends.

The paper discusses some validation experiments performed on the model inputs, procedures and simulation results. The MIND's input consists mainly of microdata derived from the 1995 Bank of Italy's households' survey. It is widely recognised that self-selection and underreporting can seriously affect the quality and reliability of the data included in the survey. In order to tackle these issues we calibrate the sample with respect to the actual population, attaching appropriate household weights, according to several dimensions, such as the demographic structure, the education level of workers, sex and geographic areas. The validation process that we use involves external checks such as the ex-post comparison (from 1996 since 1999) of grossed up aggregation of the key macro variables (e.g. dependent workers' incomes, and demographic variables) with official data (e.g. supplied by the Italian National Institute for Statistics ISTAT) at national and at regional level (North, Centre and South).

We test the appropriateness of the main assumptions and specification of the model and policies' effectiveness also using Monte Carlo simulations. Specifically, our analysis allows us to test MIND's ability in forecasting demographic and economic trends, in capturing socio-economic dynamics for regional areas and in assessing the effects of current fiscal and social security reforms on inequality and poverty trends.

A particular focus of our analysis is to compare the evolution of income concentration and poverty indices in the short and long run, also taking into account differences along regional dimensions. The simulation experiments show that in general:

i) recent fiscal reforms only partially alleviate inequality and poverty problems,

ii) inequality and poverty tend to increase among pensioners' families, notwithstanding greater disincentives to anticipated retirement, lower unemployment and more regular careers

iii) the recently proposed increase and the possible indexation of social and lowest pensions to per capita income, by reducing poverty, reduces inequality issues in the short and long run.

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1. Introduction.

The recent literature – including among others Redmond, Sutherland and Wilson (1998), Gupta and Kapur (2000) Mitton, Sutherland and Weeks (2000) – has highlighted model alignment and validation as crucial issues to be tackled when microsimulating the consequences of public policies. In particular, to analyse the effects of social security policies, it is important to study the evolution of: (a) demographic and family structures, (b) incomes and pension treatments considering the main sectors: private and public dependent workers and self employed workers. For these purposes, the use of dynamic microsimulation models[1] is particularly effective and allows us to examine the increase in the pensioners/workers ratio, determined by the present demographic evolution in Italy, and the pension/wage ratio, that may cause strains in the social security budget, both in the short and the long run. Microsimulation models, once validated, allow us to carefully consider the effects of social policies on the distribution of individual and family incomes and to tackle issues related to inequality and poverty.

The main aim of this paper is to deal with social security issues and to present new evidence on the effect of alternative policy options relative to fiscal and social security reforms on inequality and poverty in the case of Italy. Its analytical framework is based on MIND (Micro Italy National Dynamics), a dynamic ageing model, similar to the one developed in Cannari and Nicoletti-Altimari (1998), that incorporates behavioural analysis of individual choices of retirement age, derived from the Stock-Wise (1990) option value model.

The paper discusses some validation experiments performed on the model inputs, procedures and simulation results. The MIND's input consists mainly of microdata derived from the 1995 Bank of Italy's households' survey. [2] It is widely recognised that self-selection and underreporting can seriously affect the quality and reliability of the data included in the survey. In order to tackle these issues we calibrate the sample with respect to the actual population, attaching appropriate household weights, according to several dimensions, such as the demographic structure, the education level of

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[1] For the Italian case this micro-analysis is complementary to the one that estimates aggregate consequences of reforms as discussed in Baldacci and Lugaresi (1996) and Baldacci and Tuzi (2001).

[2] The model (jointly developed in the Universities of Parma and Pisa) is based on annual periods, mainly because the official data, involved in the building and use of the model, are supplied on an annual basis. Starting from the SHIW (see Banca d'Italia, 1997) data, we build alternative samples and use them to microsimulate the MIND (Micro-Italy-National-Dynamics). The software developed is written in FORTRAN95 and includes about 9000 code lines. The model simulates 50 years (1996/2045) in about an hour on a PC using an initial sample of 40.000 individuals.

workers, sex and geographic areas. The validation process that we use involves external checks such as the ex-post comparison (from 1996 since 1999) of grossed up aggregation of the key macro variables (e.g. dependent workers' incomes, and demographic variables) with official data (e.g. supplied by the Italian National Institute for Statistics ISTAT) at national and at regional level (North, Centre and South).

We test the appropriateness of the main assumptions and specification of the model and policies' effectiveness also using Monte Carlo simulations. Specifically, our analysis allows us to test MIND's ability in forecasting demographic and economic trends, in capturing socio-economic dynamics for regional areas and in assessing the effects of current fiscal and social security reforms on inequality and poverty trends.

We microsimulate the future evolution of pension treatments, that in the '90^s have been substantially modified by the introduction of two new laws.[3] In this framework we will tackle the issue of adjusting (or indexing) the lowest pension treatments to real wages (or per capita income).[4] Indexation to prices, introduced before the 1992 reform, has a number of drawbacks.[5] First, it transforms social and minimum lowest pensions from a social minimum into a biological one and it reintroduces differences between pensions depending on the year of retirement (the so called "vintage pensions") setting the premises for future discretional interventions aimed at eliminating such problems, on an equity basis.[6] Considering behavioural reactions to changing incentives, we

[3] The Amato law (L.503/92), raised the old age pension retirement age, lowered future pensions for workers subject to the old defined benefit regime (called "retributivo" and based on final wages, i.e. received in the last years of the working period), modified the indexation rule. The Dini law (L.335/95) introduced a new defined contribution regime (called "contributivo" and based on social contributions) for the new entrant workers and a long transition phase (the so called "mixed regime") for mature ones It also suppressed minimum pensions, shifting vertical redistribution outside the pension system and implying a larger role for welfare benefits (i.e. the social pensions) in the future. Moreover, it envisaged some sort of wage indexation of the lowest pensions from 2009.

[4] In particular we consider the two lowest types of Italian pensions; the "assegni sociali" (i.e. the social pensions) and the "pensioni integrate al minimo" (i.e. minimum pensions that received a social integration to reach a minimum threshold, which is slightly above the level of social pensions). In this way we strongly restrict the application of indexation to wages and reintroduce an automatic vertical redistribution inside the pension system. This put us out of the wider debate on the issue of price versus wage indexation of pensions, that has taken place even before Italian reforms and dates back at least to Aaron (1966). Several contribution to this subject, highlight the risk that a full wage indexation may turn out politically unsustainable. For a brief review of this topic and the related one (of a passage from a PAYG system to capitalization) we refer to Visco and Vagliasindi (1992) and Gronchi and Aprile (1998).

[5] In 2001 the indexation rule has been modified. A larger number of pensions is now fully indexed to price dynamics. In our simulations we consider this new indexation regime and apply it to the new indexed lowest pensions, without considering the discretional benefit increase taking place from 2001 onwards.

[6] Non-welfare pensions have different purchasing power depending on the year of retirement (since they depend on the past wages) and (differently from future wages) do not grow in real terms, during the retirement period. Starting from "high" individual pension treatments, trade unions accepted a partial indexation to prices. In this way, since wages and incomes grow in real terms, there is no certainty about the future value of the pensions during the retirement period. This uncertainty stems from the inflation level, normally incorporated in nominal wage and incomes growth. In the transition phase, this mechanism is expected to consistently reduce the relative purchasing power of "privileged" pension treatments when real wages grow. However, by lowering the purchasing power of ongoing pension it creates "vintage pensions" and a periodical stimulus to rise the level of pensions a few years after the retirement.In the seventies and the eighties the vintage pensions reflected also other factors.

will appraise the intra generation and inter-generation consequences on inequality and poverty as well as on the cumulated average values of wages and pensions of the new defined contribution system, and the restoration of wage indexation for the lowest (welfare) pensions.

The paper is organised as follows. In section 2 we describe the structure of the model, its modules, their interrelations and the basic hypotheses that we adopted. Section 3 discusses validation experiments on MIND's inputs and outputs. We consider the demographic and economic trends (i.e. incomes from 1996 to 1999), comparing our results with national accounts tables and with IRP forecasts from 1996 to 2045. In section 4, using a Monte Carlo experiment, we study the consequences of the demographic-evolution (e.g. family structure) and social security reforms on inequality and poverty. Section 5 concludes with some final remarks on the relevance of the dynamic microsimulation experiments.

2. The MIND dynamic ageing model: a brief description.

The MIND model considers both the national socio-demographic dynamics and the different Italian regional geographical areas (North, Centre, South and Islands).[7] Similarly to other models currently developed for other countries, the MIND structure is organised in modules, which simulate the evolution of: (***a***) demographic and family structures, (***b***) socio-economic phenomena related to work incomes and (***c***) optimal retirement choice and pension treatments.[8]

The "demographic" module includes the subsections on mortality, marriage, divorce, singles, and birth. First of all, based on the observed data on the population in the base year 1995, the demographic modules determines the number of deaths; subsequently, on the basis of different transition rates, survivors can get married, divorce or become single. Finally, it simulates births. Marriage-rates, birth-rates and divorce-rates depend on the geographical area and individuals' age.[9]

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[7] The main differences between our models and the one developed by Cannari and Nicoletti Altimari (1998) refer to the inclusion of a geographically differentiated demographic evolution and a retirement choice based on the option value model.

[8] See, for example, NEDYMAS by Nelissen (1994), DYNAMOD by Antcliff, Grusskin, Harding e Kapuscinski (1996) and DESTINIE built at INSEE (1999). Transaction probabilities (e.g. related to death) are constant overtime as usual in these type of models, even if a decrease of mortality can be assumed. MIND demographic structure is however validated along a 50 years period, based on IRP (1995) forecasts. For more specific demographic microsimulation methods see Bongaarts et al. (1987) and Hammel et al. (1990).

[9] Every year the model attributes to each individual a probability of death, depending on his sex, age and living area. We generate a random number r with uniform distribution in the interval 0-1. If r is greater than the relevant probability the individual lives and his age is increased, otherwise he is taken out of the database. In this case, if he was married, the civil state of the partner is modified; if was head of the family, the partner (or the eldest

The "work and incomes" module is organised as follows: the first sub-module simulates the entry in the labour market and the second one derives workers' incomes. The choice between the three different categories of work is stochastic, depending on the probabilities to be dependent workers (private or public) or self-employed. The education degree (years of education, EDU) is also given through a stochastic procedure which simulates the probability of completing a first degree, for individual older than 24 years.[10] Following Andreassen, Fredriksen and Ljones (1993), the estimation of income levels, based on cross sectional data, has the standard log-linear specification suggested by Mincer (1974).[11] For the individual *i*, the forecast value ($\hat{y}_{it}$) at time *t* is obtained by replacing the values assumed by the characteristics of the individual in the vector $\mathbf{x}_i$ of the equation $\hat{y}_i = e^{(\boldsymbol{x}_i b + \hat{u}_i)}$ where, to avoid biases, the estimated residuals $\hat{u}_i$ are also included.[12]

Finally, the "social security" module determines the retirement age and pension treatments using a reaction function based on the option value (OV) model from Stock and Wise (1990). In this way workers are allowed to choose to postpone retirement when the expected value of their utility to retire is growing over time. As in Stock and Wise, individuals, given the available information, calculate the expected values of the utility of retiring today and in future. The differential benefit $OV_t(t)$ of postponing the retirement to the next year is then considered. If OV is positive the retirement will be postponed otherwise (negative OV) the worker retires immediately. OV is estimated each year until the maximum age of retirement is reached. In the calculation of OV we

relative) is the new family head and inherits his wealth; the number of family components is decreased. The marriage is simulated in two phases. In the first one MIND selects candidates (aged between 17 and 48), based on a given probability table. In the second phase, each female candidate gets married to the best candidate (for whom the difference between the extracted random number and the theoretical probability is minimised). Inside each marriage, births depend on the mother's age, the geographical area and the number of existing children. The new individuals enter the database modifying the characteristics of their families. Each partner can divorce on the basis of a probability table. Children and 2/3 of the family wealth (half in the absence of children) go to the wife with a 92% probability, as in Cannari and Nicoletti Altimari (1998). Individuals aged between 28 and 35 become singles with a probability equal to 20% of their probabilities of marriage. Transaction probabilities are derived from ISTAT data and from the SHIW sample. All demographic probability tables are reported in Vagliasindi (2002).

[10] The relative probabilities are derived from ISTAT data on the 1999 labour force and from the SHIW sample.

[11] In particular we consider a structure diversified for AGE, AGE^2, SEX, EDU and HOURS worked in a week for three occupational sectors (dependent, self-employed, public) and geographical areas (North, Centre, South). Almost all the coefficient are of the right sign and statistically significant at the 99% confidence level. For more details, see Bianchi, Romanelli, Vagliasindi (2001).

[12] Real income at period *t* is derived from: $\hat{y}_{it} = \hat{y}_i \ (1 + g)^{t-t_0}$, where *g*, the real growth rate of incomes, is assumed to be to 1% after 2000 and t_0 is the initial simulation period. The number of hours worked by entrants (HOURS) are estimated on the basis of the average number of hours worked (HOURSA) and of the respective standard error (STDERR), depending on the sector and the geographical area: HOURS = HOURSA (AGE, SECT, AREAGEO) + (STDERR(AGE, SECT, AREAGEO) × ***rd***) where ***rd*** is a random number with normal standard distribution which introduces a stochastic element.

consider the different computing procedures (defined benefit, 'mixed' or defined contribution)[13] depending on the characteristics and contribution of each individual and on the benefits and requisites related to workers' type and period.

In our simplified specification of the model, in each period t workers calculate the differential benefit $OV_t(t+1)$ of postponing retirement to time $t+1$ and decide to retire if $OV_t(t+1) \leq 0$.

$$OV_t(t+1) = E_t V_t(t+1) - E_t V_t(t) = \alpha Y_t - B_t(t) + \sum_{s=t+1}^{S}(1+r)^{t-s} \cdot (B_s(t+1) - B_s(t))$$

where $V_t(t)$ is the value to retire at time t and depends on the actualised flows of incomes Y_s[14] and pensions $B_s(t)$[15] and α is the marginal rate of substitution between income from wage and pensions.

$$V_t(t) = \sum_{s=t}^{R-1}(1+r)^{t-R} U_y(Y_s) + \sum_{s=R}^{S}(1+r)^{t-s} U_b(B_s(t)) = \alpha\sum_{s=t}^{R-1}(1+r)^{t-R} Y_s + \sum_{s=R}^{S}(1+r)^{t-s} B_s(t)$$

Given our simplifying assumptions, each worker derives the age that maximises the value of retiring (V). In fact, the differential benefit monotonically decreases, reaching the maximum when it becomes null, since the variation, Δ_t, of the option value from time t to time $t+1$ is:[16]

$$\Delta_t = \alpha(Y_{t+1} - Y_t) - \left(\frac{2+r}{1+r}\right)(B_{t+1}(t+1) - B_t(t)) + \sum_{s=t+2}^{S}(1+r)^{t-s}[(1+r)(B_s(t+2) - B_s(t+1)) - (B_s(t+1) - B_s(t))]$$

Assuming that the absolute increment of the pension benefit $(B_{j+1}(s)-B_j(s))$ rises at a rate equal or less then the discount factor $(1/(1+r))$,[17] Δ_t is negative when: $\alpha \leq \frac{2+r}{1+r}\frac{B_t(t)}{Y_t}$

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[13] In the Italian PAYG system future treatments are based: (i) on final wages in the old ***defined benefit*** regime ("regime retributivo"), (ii) on social contributions in the future new ***defined contribution*** regime ("regime contributivo" introduced by the Dini law L.335/95) for the new entrant workers and (iii) on a mixture of final wages and social contributions in the so called ***mixed*** regime ("regime misto") for mature workers, during a long transition phase leading towards the new contributive regime. For an overview of future trends of the the Italian PAYG system see Ministero del Tesoro (1998). For an interesting reform proposals see Visco Vagliasindi (1991), Baldacci Peracchi (2000) and De Santis (2001).

[14] In order to reconstruct the history of wages and social contributions of each worker in our database, necessary to calculate his pensions, we used the following simplifying hypothesis: 1) a future real rate of discount, equal for all to 2.5%, 2) a real rate of per capita growth of 1%, 3) absence of individuals that temporarily suspend the payment of their contributions, 4) payment of pension and incomes at each end of year, 5) indexation of pensions to the rate of inflation 1.8%: total (i.e. 100 %) if inferior to the double of the value of the social pension (equal to 6.500.000 – € 3357 - in 1999), partial at 90% if inclusive between the double and the triple of this value and at 75% otherwise, 6) workers face a social constraint to retire set at 66 for dependent workers, 67 for public and 68 for self-employed (in this way we generate a corner solution). However in the present work we realise also additional simulations using different sets of hypotheses; in particular: ***a***) a future real rate of discount equal to 4%; ***b***) a real rate of per capita growth of 2%: ***c***) a future rate of inflation equal to 2.5%. The first two are discussed in the appendix, while the increase in inflation is skipped because it produces only very minor consequences.

[15] The indirect utility specification of labour and pension incomes are respectively $U_y(Y_s) = \alpha Y_s + \omega_s$ $(0 \leq \alpha \leq 1)$ and $U_b(B_s(t)) = B_s(t) + \xi_s$, with ω_s and ξ_s zero mean random variables whose variance can be estimated as in Stock and Wise (1990). For recent work in this area see Gruber and Wise (1999) and Peracchi (1999).For related studies on SHIW data see also Di Pino Mucciardi (2001) and Spataro (2000). In our paper the comparison involves flows of gross incomes. Obviously, being individual interested to disposable incomes, the tax system and the income tax progressivity may affect the results, but it is quite impossible to envisage how these will evolve in the next 45 years.

[16] We consider real quantities, so $B_{t+1}(t) \leq B_t(t)$. In what follows, we assume that equality holds. In fact, *a fortiori* the results still hold if strict inequality is supposed.

Hence, being r relatively small, this condition becomes $\alpha \leq 2$ ($B_t(t)/Y_t$) and is satisfied by a ratio $B_t(t)/Y_t = 50\%$ (independently from the value of α).

3. The database and validation of demographic variables.

The recent literature has highlighted model alignment and validation as two crucial issues to be tackled when microsimulating the consequences of public policies.[18] This section discusses some validating experiments performed on the model inputs, procedures and simulation results. In particular, we test the ability of the model to accurately forecast the evolution of the demographic and socio-economic phenomena. Accordingly, we verify the forecasting precision of the variables interacting with pension policies (such as the evolution of the demographic structures, workers' characteristics and the dependent worker incomes) mainly focusing on demographic trends. Specifically, our re-sampled data and simulation results are compared with the ISTAT and SHIW data, as well as the IRP's forecasts and the output obtained using the national tables (NA), as in Cannari and Nicoletti Altimari (1998).

In order to reach our aims, we apply the usual validation procedures discussed in Caldwell (1993) and in Redmond et al (1999). First, we consider the single modules correcting possible discrepancies, forcing outputs to replicate historical values, calibrating probability tables and using statistical indicators to verify internal and external microdata compatibility. Then, we examine the different modules jointly in order to validate the whole model, comparing aggregated variables (or simulated frequency distributions) with official ones or with forecasts derived using alternative methods.

3.1 Validation of demographic inputs.

The MIND's input consists mainly of microdata derived from 1995 SHIW database. It is widely recognised that self-selection and underreporting can seriously affect the quality and reliability of the data included in the survey.[19] In order to tackle these issues we calibrate the initial sample to be

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[17] In this way we have $(1+r)(B_s(t+2) - B_s(t+1)) - (B_s(t+1) - B_s(t)) \leq 0$.

[18] In our case, alignment consists in adjusting the probabilities, derived in the demographic module, to bring them closer to the corresponding historical value (ISTAT data) and forecasts (IRP projections) considering a period of 50 years. Validating the model we verify the reliability of the databases and the model specifications and their suitability for policy purposes. On these issues, see, among others, Pudney and Sutherland (1994), Redmond, Sutherland and Wilson (1998), Gupta and Kapur (2000) and Mitton, Sutherland and Weeks (2000).

[19] As already emphasised by Brandolini and Cannari (1994), given the reluctance of interviewed families to provide actual income data, estimations of income (from financial activities, owned residences and secondary works) are lower than the aggregated values of the national accounts and Census data. See also Atkinson and Micklewright (1983) and Brandolini (1999). The average number of hours worked during the week is instead higher than the corresponding

used in simulation with respect to the actual population, attaching appropriate household weights, according to several dimensions, such as the demographic structure, the education level of workers, sex and geographic areas.

To get microdata as close as possible to the universe of the Italian population, we considered ISTAT data for age structure, level of education and occupational sector (because of their impact on the income generation process).

Table 1, for Italy (It), North (N), Centre (C), and South (S) includes the mean age and the quota of population over 65 supplied by ISTAT (on the whole population) and is estimated by using both the Bank of Italy weights and our re-calibrated weights $MIND_E$. Despite the previous caveats, the sample with the original weights approximates reasonably well the demographic structure, even if it underestimates the first and the last classes of age. Serious differences appear in occupational data, that underestimate self employed.[20]

Table 1: Indexes of structure and distribution of the labour force (in 1995)

	ISTAT				Bank of Italy				$MIND_E$			
	It	**N**	**C**	**S**	**It**	**N**	**C**	**S**	**It**	**N**	**C**	**S**
Mean age	40.30	42.20	41.90	37.30	38.90	39.90	39.80	37.20	40.90	42.90	42.10	37.89
Quota of population over 65	16.80	18.20	18.50	14.30	16.45	17.70	15.90	15.23	19.03	20.75	20.43	16.15
Dependent	71.2	36.9	14.3	20.0	74.8	39.2	14.6	21.0	73.6	38.8	14.5	20.3
Self-employed	28.8	14.6	5.8	8.4	24.9	12.6	4.8	7.5	26.4	13.3	5.2	7.9

The $MIND_E$ values have been constructed considering 19 classes of age, 7 different levels of education and 6 different professional positions. Microdata weights have been recalculated taking into account the demographic structure, the level of education, the professional position, the sex and the geographical area.

Given the frequencies of individuals (with characteristic x = age class , y = sex, z = geographical area) relative to three variables - age (***e***), education (***s***) and profession (***l***) - the ratios

ISTAT values. Cannari and D'Alessio (1992) calculate the bias due to self-selection, estimating the real probability of inclusion in the sample. The 1987 aggregate income increases by 5% but there is still a strong discrepancy with ISTAT surveys, because of fiscal evasion, estimated by Cannari and Viola (1991) at a level greater than 20%. Cannari and D'Alessio (1993) show that the self employed, the elderly, and the less educated heads of the family are more likely to under-report financial activities. In relation to the secondary residences, Cannari and D'Alessio (1990) show that only one out of six rented houses is declared and underreporting increases with the number of owned residences. According to Cannari and Gavosto (1995), it is difficult to correct the strong underestimation of secondary works, as it depends on several reasons. Similarly, the overestimation of hours worked in average during the week (in the principal or only activity) is not easy to be addressed, as individual, during the interview, may disregard periods of vacations or illness.

[20] Also pensioners are underestimated. On demographic trends and aging see in general De Santis (1997) and Golini (1997) for recent European tendencies.

$\boldsymbol{I_{ei}}, \boldsymbol{I_{si}}, \boldsymbol{I_{li}}$ (ISTAT on Bank of Italy) are calculated and attached to each individual $\boldsymbol{i}$ of the SHIW survey.[21] We proceed to calculate average ratio at family level $\boldsymbol{I_{ef}}, \boldsymbol{I_{sf}}, \boldsymbol{I_{lf}}$ (taking the geometric mean of individual components indices $\boldsymbol{I_{ei}}, \boldsymbol{I_{si}}, \boldsymbol{I_{li}}$). We then derive three normalized family weights $\boldsymbol{W_{ef}}, \boldsymbol{W_{sf}}, \boldsymbol{W_{lf}}$ multiplying each average family ratio ($\boldsymbol{I_{ef}}, \boldsymbol{I_{sf}}, \boldsymbol{I_{lf}}$) for the weight that the Bank of Italy has attached to each $\boldsymbol{f}$ family $\boldsymbol{w_f}$ and normalizing the results (so that family weights sum up to one). Once we normalize the geometric mean of these three weights ($\boldsymbol{W_{ef}}, \boldsymbol{W_{sf}}, \boldsymbol{W_{lf}}$) we finally get our new family weight $\boldsymbol{W_f}$, through which the original sample is expanded.

The SHIW survey includes 8.135 families and 23.294 individuals; setting the minimum weight equal to one we get an initial expanded sample $\mathrm{MIND_E}$ of 104.017 families and 271.208 individuals. The $\mathrm{MIND_E}$ sample (proportional to the new weighted one) can be used for dynamic microsimulations, and also to validate the socio-economic and demographic modules of the MIND model, but is too large to perform Monte Carlo experiments on future inequality trends for a period of 50 years.

Accordingly, we need to reduce the size of the expanded sample.[22] Using the original Bank of Italy weights, we get the sample $\mathrm{MIND_1}$ or the sample $\mathrm{MIND_2}$ using our modified weights. Finally, we also consider the sample $\mathrm{MIND_3}$ (of 41.941 individuals and 15.068 families), which maintains the maximum observed heterogeneity as it includes, at least once, all the interviewed families.

3.2 Validation of demographic simulated results and procedures.

The validation of the demographic output is carried out, first, up to 1999, comparing it with the ISTAT resident population data and then, up to 2045, using IRP projections; these data, like ours, do not include migrations but assume a gradual increase in average life up to 2018.[23]

To validate our model in the short run (1995-1999), we consider the birth-rate n_t and mortality-rate m_t with respect to ISTAT and IRP data. Table 2 shows how the microdata bias already existing

[21] For instance, considering the educational level $\boldsymbol{s}$, we associate each individual with characteristics x = class of age, y = sex, z = geographical area to the index $\boldsymbol{I_{si}} = \boldsymbol{s}_{\mathrm{ISTAT}}/\boldsymbol{s}_{\mathrm{SHIW}}$, where $\boldsymbol{s}_{\mathrm{ISTAT}}$ is the proportion of individuals with attribute $\boldsymbol{s}$ in Italian population (ISTAT data) and $\boldsymbol{s}_{\mathrm{SHIW}}$ is the analogous proportion in the SHIW survey. A similar procedure is used in INSEE (1999), see p. 19.

[22] In order to generate the initial sample used in the Monte Carlo experiments, for each household H_i (with weight w_i) we generate a random number r_i (the times we duplicate H_i in the database) following a binomial distribution, with parameter w_i and p (a constant which determines the size of our database). As discussed in Cannari and Nicoletti Altimari (1998), this procedure ensures proportionality with respect to the original expanded sample.

[23] A more sophisticated analysis is based on the degree of dissimilarity of frequency distributions in the various age classes (in Appendix A) estimated by Δ_1, the average difference, dissimilarity indexes of the first order, using our separate tables for each geographic area GA or Cannari and Nicoletti Altimari (1998) national tables NA. For a more detailed explanation, see Vagliasindi (2002).

in 1995 (caused by the high weight given to elderly aged above 65 years) is still present in the short run. This explains the greater mortality indexes that we get in comparison to ISTAT, whereas the differences in birth rates indexes are small.

Table 2: Crude birth and mortality rates by geographical area (‰ population).

NORTH	**1996**			**1997**			**1998**			**1999**		
	GA	Istat	NA	GA	Istat	NA	GA	Istat	NA	GA	Istat	NA
birth-rate	8.88	8.29	10.13	8.22	8.54	10.52	7.96	8.57	10.42	7.71	8.48	10.72
mortality	11.07	10.51	12.62	11.80	10.56	13.1	12.22	10.75	13.71	11.95	10.69	13.78
CENTRE	**1996**			**1997**			**1998**			**1999**		
	GA	Istat	NA	GA	Istat	NA	GA	Istat	NA	GA	Istat	NA
birth-rate	9.50	8.26	8.08	8.81	8.36	9.354	8.66	8.28	9.979	8.46	8.45	9.931
mortality	11.15	10.09	12.21	11.12	10.39	12.04	11.22	10.58	12.71	11.91	10.37	12.73
SOUTH	**1996**			**1997**			**1998**			**1999**		
	GA	Istat	NA	GA	Istat	NA	GA	Istat	NA	GA	Istat	NA
birth-rate	11.37	11.20	15.00	11.27	10.97	8.851	11.26	10.60	9.489	11.02	10.15	9.639
mortality	8.99	8.52	18.16	9.11	8.61	9.319	9.47	8.83	9.988	10.01	8.45	9.961

Note: GA = our own estimates, with rates specific by Geographic Area; Istat = official data;
NA = estimates taken from Cannari and Nicoletti Altimari (1998), with uniform national data.

Birth rates estimated with the national tables differ from regional ones considering five years periods from 1999 to 2045. In fact, table 3 shows that the birth rate is overestimated in the centre-north regions compared to the national tables (while it is relatively underestimated in the South).

Table 3: Crude birth and mortality rates by geographical area (long run)

	NORTH						**CENTRE**						**SOUTH**					
	b			***m***			***b***			***m***			***b***			***m***		
	GA	IRP	NA	GA	IRP	NA	GA	IRP	NA	GA	IRP	NA	GA	IRP	NA	GA	IRP	NA
2004	7.35	7.62	10.15	12.69	10.96	13.96	8.18	8.15	10.02	12.18	10.64	13.25	10.67	12.31	9.79	10.28	8.21	10.35
2009	5.97	6.60	8.44	14.56	11.44	14.83	7.10	7.19	9.46	14.01	11.23	14.39	9.85	11.35	9.65	11.25	8.42	11.43
2014	4.93	5.59	7.06	15.74	12.19	15.40	6.08	6.23	7.95	15.34	12.02	15.46	9.06	10.31	8.99	12.15	8.88	12.23
2019	4.31	5.07	6.20	17.18	13.52	16.35	5.30	5.69	6.48	16.27	13.22	15.99	8.33	9.62	8.13	12.75	9.50	12.99
2024	4.36	4.99	6.75	18.11	15.15	17.13	5.24	5.57	6.60	16.87	14.58	16.34	8.21	9.36	7.59	13.15	10.34	13.40
2029	4.52	5.04	7.59	19.72	16.64	18.11	5.72	5.59	7.54	17.85	15.81	17.24	8.29	9.28	7.68	13.70	11.06	14.13
2034	4.42	4.94	7.93	20.57	18.10	18.59	5.71	5.48	8.08	18.66	17.06	17.63	8.19	9.11	7.72	14.29	11.82	14.92
2039	4.15	4.65	7.37	21.85	19.59	19.47	5.20	5.20	7.66	20.03	18.40	18.45	7.97	8.80	7.75	15.69	12.73	16.18
2044	3.66	4.32	6.72	23.76	21.14	20.49	4.83	4.89	6.97	21.24	19.94	19.40	7.67	8.49	7.42	17.03	13.78	17.45

The comparison of mortality data is more difficult, since IRP assumes a decreasing mortality up to 2014-2018 while the GA and NA data are constant. Such difference in the hypotheses influences the demographic results, especially for the elderly classes.

In the long period, we can also compare the trends of each age class (of the $MIND_E$ database simulated with the GA and NA table) with the IRP forecasts, as show in figs. 1, 2 and 3.

Fig 1. Fraction of total population in various age groups (North in %)

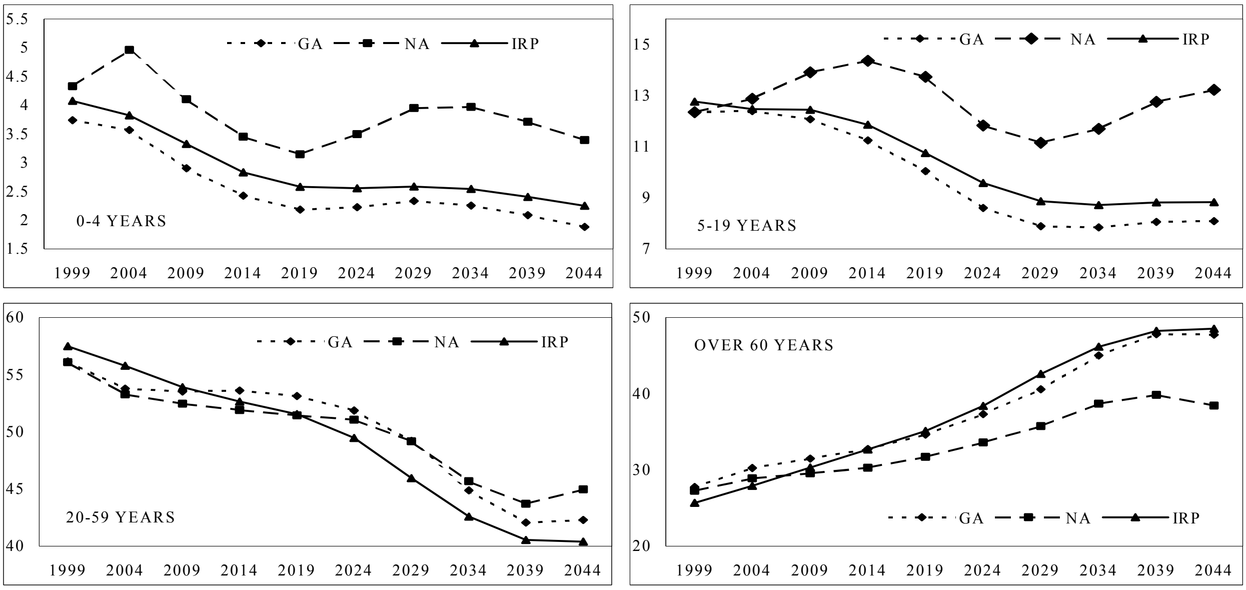


Fig 2. Fraction of total population in various age groups (Centre in %)

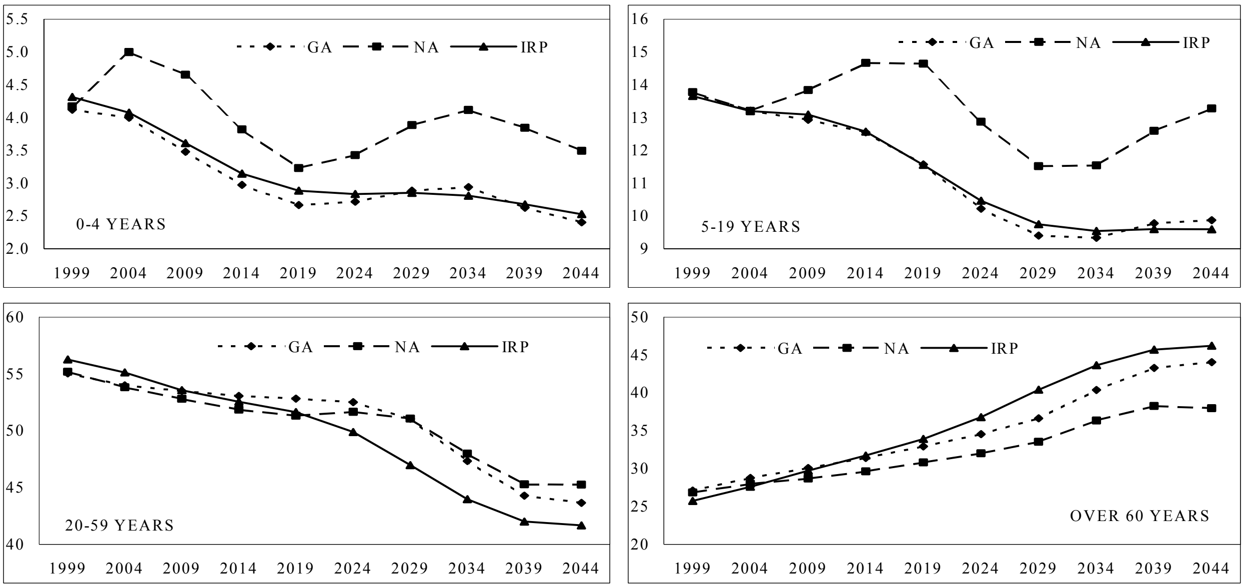
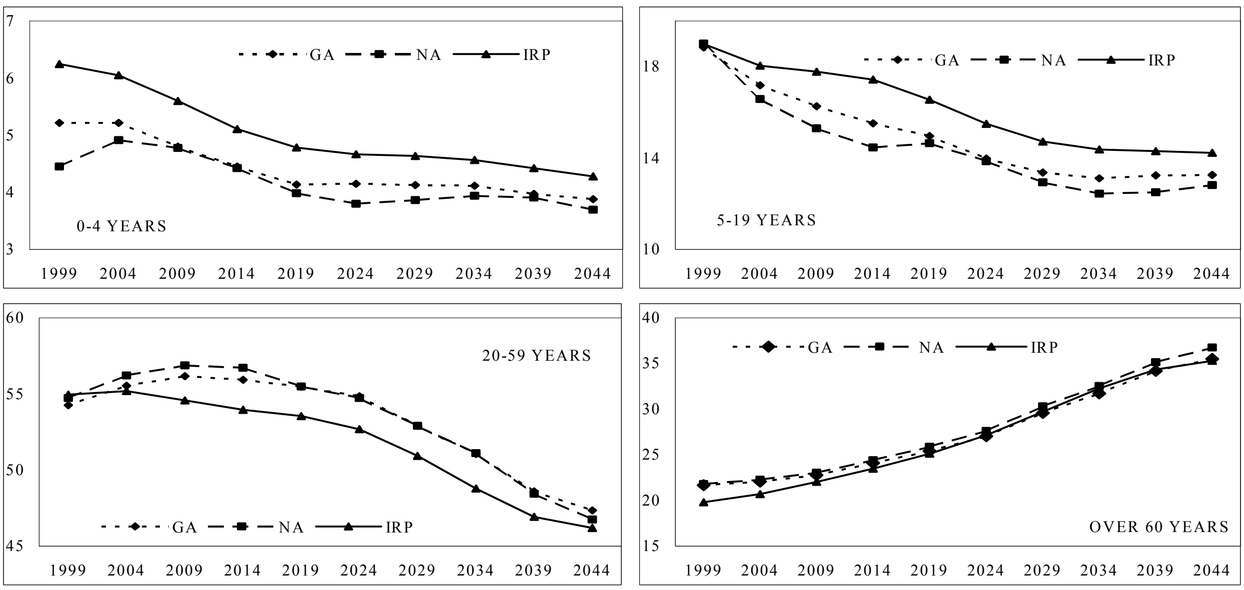


Fig. 3 Fraction of total population in various age groups (South in %)



In central Italy the trends and values derived with regional specifications are closer to the IRP ones. In southern Italy, due to the greatest birth rate, the decreasing trend of the young is less evident and as before the GA divergence is reduced.

For each geographical area, using the data included in figs. 1-3, the R^2 coefficient shows the high correlation between the relative frequencies of our simulation (for every age class) with IRP ones. Furthermore, table 4 shows the superiority of the regional estimates obtained using GA.

Table 4: R^2 for different age classes

R^2						
Age class	**NORTH**		**CENTRE**		**SOUTH**	
	GA	**NA**	**GA**	**NA**	**GA**	**NA**
0-4	0.99	0.61	0.97	0.52	0.99	0.79
5-19	0.99	0.27	0.99	0.46	0.94	0.87
20-59	0.95	0.96	0.93	0.93	0.92	0.93
+60	0.99	0.98	0.98	0.98	0.99	0.99
+80	0.98	0.97	0.90	0.81	0.92	0.92

Among socio-economic variables the most important ones are represented by the aggregated incomes. Restricting ourselves to dependent workers' aggregated income Y (net of social contributions), we multiply the sum of incomes (y_{Dep}) by the ratio of number of dependent workers estimated by ISTAT ($TotDep_{ISTAT}$) to that of our database ($TotDep_{MIND}$). Hence:

$$Y = \left[\sum_{Dep} y_{Dep} \right] \cdot \frac{TotDep_{ISTAT}}{TotDep_{MIND}}$$

Table 5: Dependent worker's aggregated income (million current euro)

	1996	**1997**	**1998**	**1999**
ISTAT	290,105	302,336	313,193	325,084
$MIND_E$	290,113	301,016	313,723	325,400

Table 5 shows that the differences between the two aggregates are really minor, so that the alignment of 1995 incomes has overcome *self-selection* problems. This is confirmed for all incomes when we consider the personal income tax revenues *IRPEF* estimated multiplying the sum of family liabilities ($Irpef_i$) by the ratio of number of families estimated by ISTAT ($TotFam_{ISTAT}$) and the ones present in our database ($TotFam_{MIND}$).

$$IRPEF = \left[\sum_i Irpef_i \right] \cdot \frac{TotFam_{ISTAT}}{TotFam_{MIND}}$$

From table 6 we see that the differences are negligible (less than 2%), a really satisfactory result if we consider that, given the information available in the SHIW database, it is not possible to exactly attribute individual incomes and deductions.

Table 6: IRPEF revenues (million current euro)

	1996	1997	1998	1999
Bank of Italy	86,724	94,305	103,404	114,566
$MIND_E$	88,709	92,523	105,599	112,064

Note: IRPEF revenues is reported in Bank of Italy's "Relazione generale sulla situazione economica del Paese".

Similar results are obtained using $MIND_1$, $MIND_2$ and $MIND_3$. This shows that the model has a reasonable and relatively stable structure, so that when performing Monte Carlo replications we can also use small samples. In particular, the R^2 values reported in Table 7 (computed as in Table 4) show that the smaller samples $MIND_2$ and $MIND_3$, with the GA tables, correctly reproduce IRP forecasts for young and elderly people (this is true also for the other relevant variables, not reported here for space reasons).

Table 7: R^2 for different age classes, with alternative databases

AGE CLASS	NORTH			CENTRE			SOUTH		
	$MIND_E$	$MIND_2$	$MIND_3$	$MIND_E$	$MIND_2$	$MIND_3$	$MIND_E$	$MIND_2$	$MIND_3$
0-4	0.99	0.99	0.99	0.97	0.94	0.94	0.99	0.97	0.93
5-19	0.99	0.99	0.99	0.99	0.97	0.98	0.94	0.97	0.96
20-59	0.95	0.96	0.96	0.93	0.93	0.94	0.92	0.88	0.93
+60	0.99	0.98	0.99	0.98	0.98	0.98	0.99	0.99	0.98
+80	0.98	0.98	0.99	0.90	0.92	0.97	0.92	0.89	0.97

In what follows, we will use small well-aligned samples (such as $MIND_3$ with respect to elders) to perform the Monte Carlo experiments.

3.3 Validation of "social security" procedures.

Once the initial input and the demographic procedures are validated, we need to calibrate the social security module. For this purpose, we want to set the parameters of the module as to reproduce, at least in the short term, the official dynamics of the socio-economic phenomena.

Given the difficulties in comparing our database with the entire universe of pensioners (e.g. as it is difficult to introduce new families etc. to correct remaining biases), our goal is simply to see whether our database evolves along the same lines of reality.[24] Accordingly, we try to mimic the

[24] The official data used for the analysis are supplied by *Casellario INPS* and from ISTAT.

trend of the percentual change in the quota of workers retired between 1996 and 1999. In order to gain this result, we change the parameter's value of the retirement choice function till the simulated output fits as good as possible with the official data.

As reported in Section 2, the reaction function included in our model is based on the comparison between the present value of the expected utility of the flow of the pension benefits obtained by an agent opting for an immediate retirement with the one obtained postponing it to the next period. However, when retirement is postponed, the problem arises whether (and to which extent) we should take into account the wage income earned in the following period. It's important to consider the functional form of the indirect utility functions and in particular the chosen value of α.[25] In particular, we assume for the same amount of money, the utility of income from labour is lower than the utility gained from pension benefits. This justifies a value of α less than one.

The validation of the social security module is carried out trying different values for the parameter α until reaching the lowest distortion between simulated output and official data. In particualar we consider the time period between 1996 and 1999 and compare the simulated and official percent change in the quota per age class of the individuals retired and still alive in 1999. In performing our analysis we also try to disaggregate the results, as far as possible, by considering sex and occupational sector (dependent, self-employed, public) of the agents.

As the small samples - $MIND_1$, $MIND_2$, $MIND_3$ - are well-aligned, we use these databases to perform the analysis. For simplicity's sake we report the following values of α used in the study:

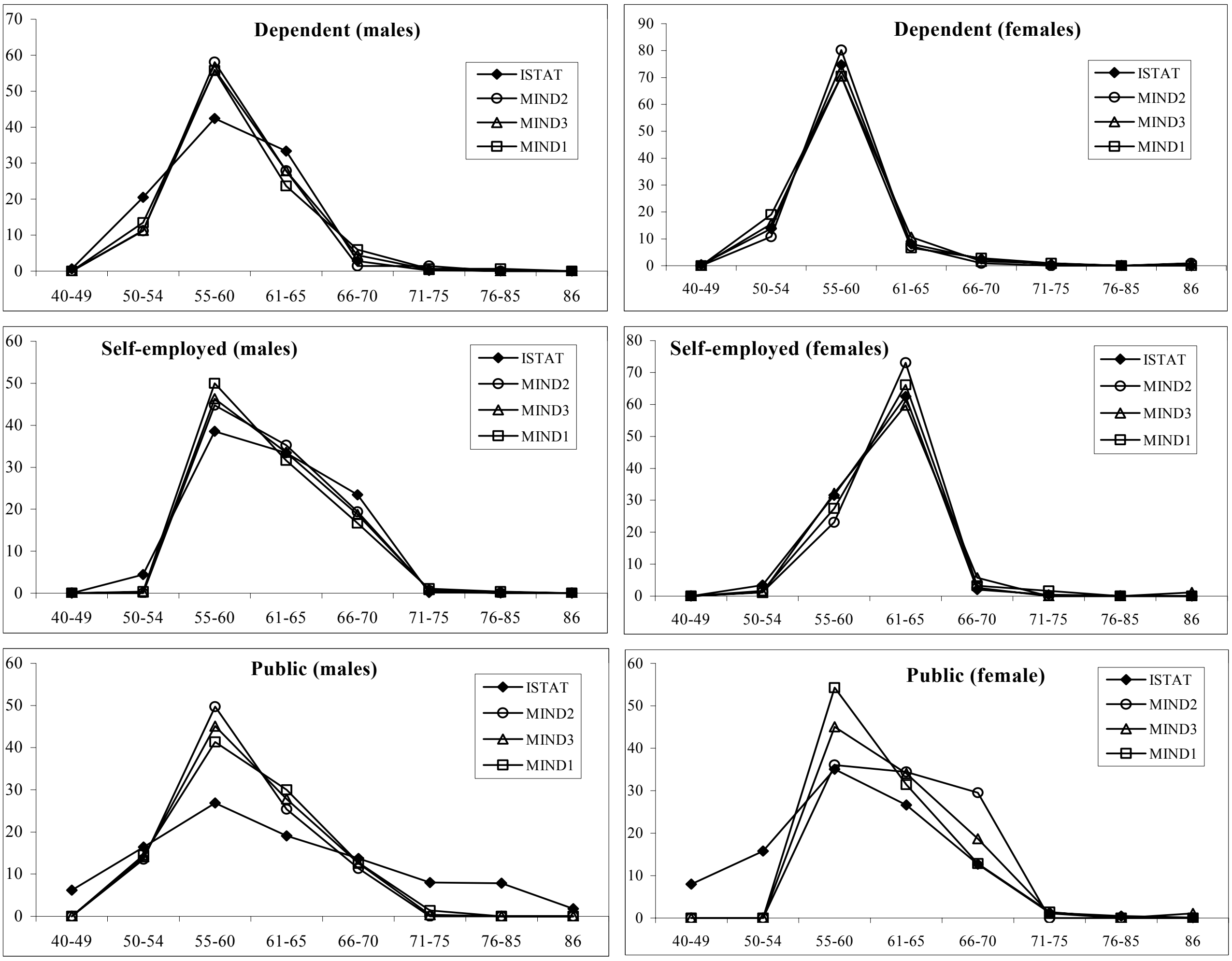
α	0.000	0.125	0.250	0.375	0.500	1.000

From the analysis of the results, $\alpha = 0.0$ seems to be the value that grants the simulated output to best fit the data. In the present work we'll show the whole results only for this value of α (figure 4).

In the figure 4 we report the simulated results and official (dark diamond) data per age class and for all the categories. Usually the simulation produces profiles very similar to the ones supplied by the INPS and ISTAT statistics, except for the case of the public sectors (especially for females). This may be due in part to the tendency, in a period perceived as uncertain, to retire early in order to avoid future restrictions as well as to take advantage of economies of scope of the family and of possibilities offered by the informal sector.

[25] We remember that the indirect utility specification of labour and pension incomes are respectively $U_y(Y_s) = \alpha Y_s$ $(0 \leq \alpha \leq 1)$ and $U_b(B_s(t)) = B_s(t)$.

Figure 4: change in quota (%) for different sectors (workers retired between '96 and '99). α=0.0



Our model seems to concentrate the values around the modal classes. In particular the model doesn't replicate completely the phenomenon of "young pensioners" (workers who decide to retire before the age of 50). We ascribe this discrepancy to the common sense of uncertainty coming from the approval in 1995 of the Social Security System reform, which characterises the temporal interval used in our validation process and probably represented an accelerating factor towards the choice of retirement. However, we can assume that this feature disappears after the early phase of the reform.

Similar conclusions can be drawn if we consider the results disaggregated at the regional level (figure 5 reports the results obtained using the three small samples). Setting the parameter equal to zero is still the choice that better assures the simulated results to mimic the official data. The regional profiles produced by the model are quite similar to the national ones except for some categories in the South[26] where they reveal some slight differences.

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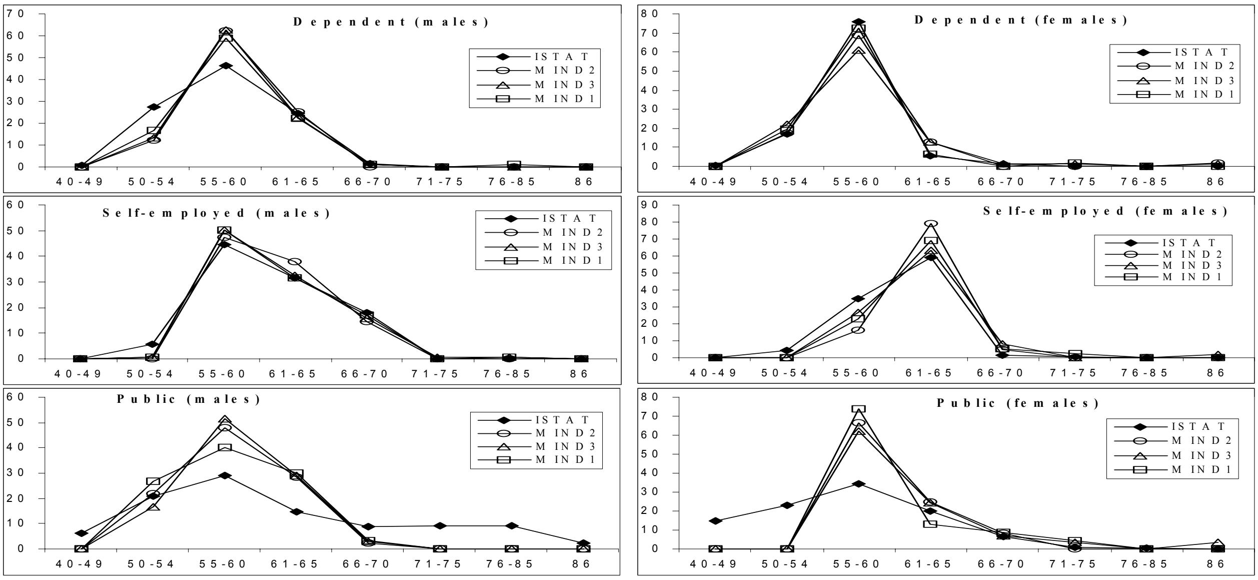
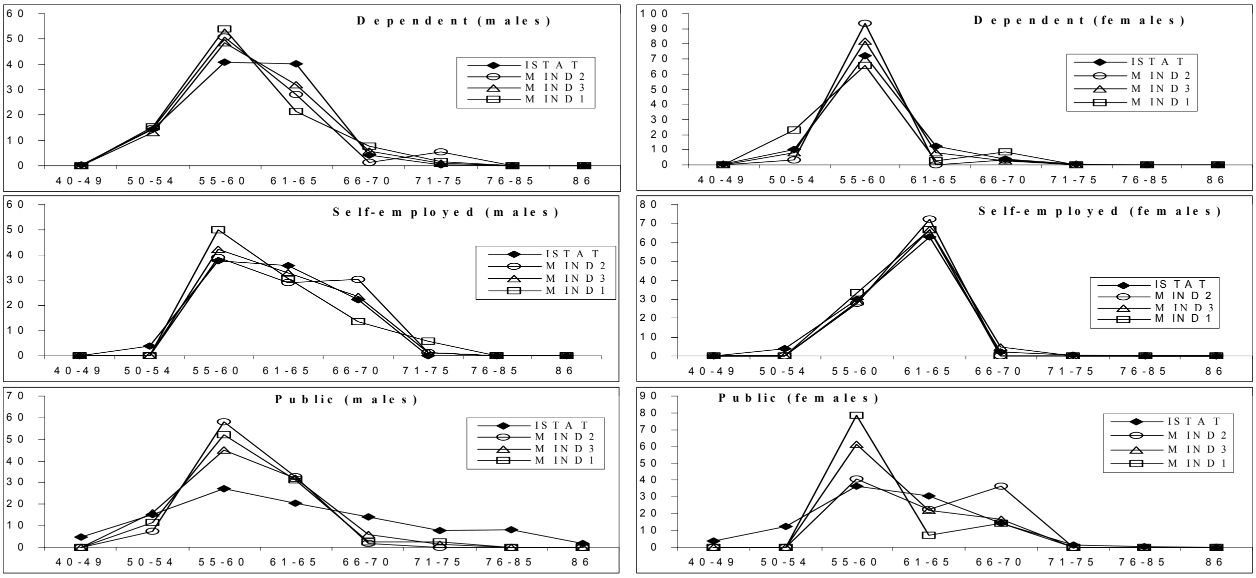
[26] In particular in three cases (dependent and self-employed males and public females) the results show different modal classes with respect to the INPS and ISTAT statistics.

Figure 5: change in quota (%) for different sectors and regional areas

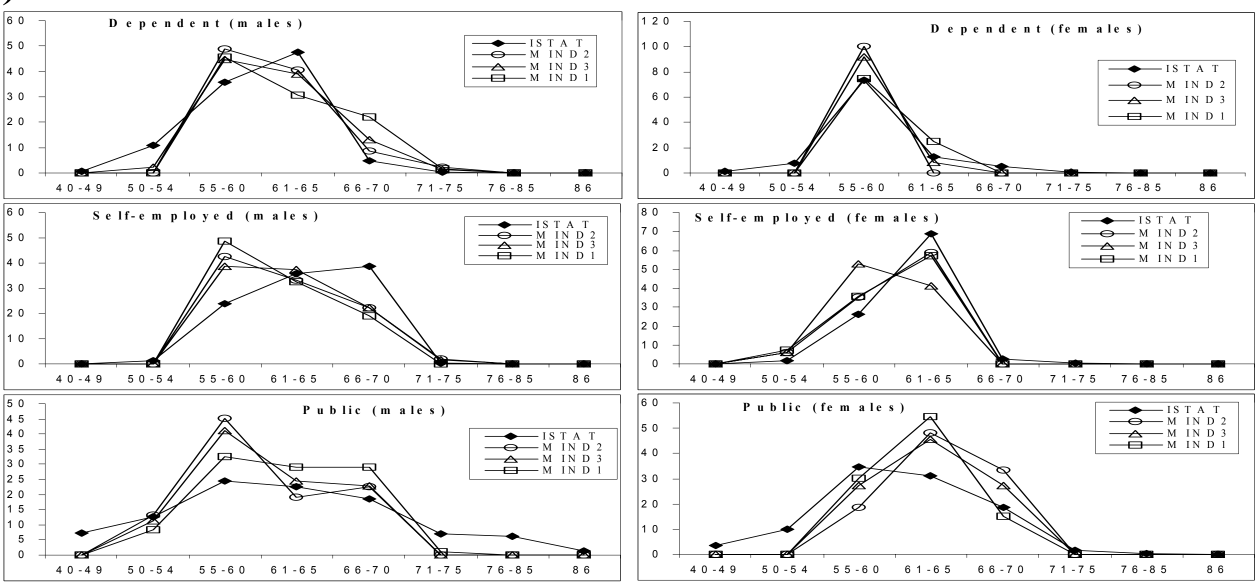
a) NORTH



b) CENTRE

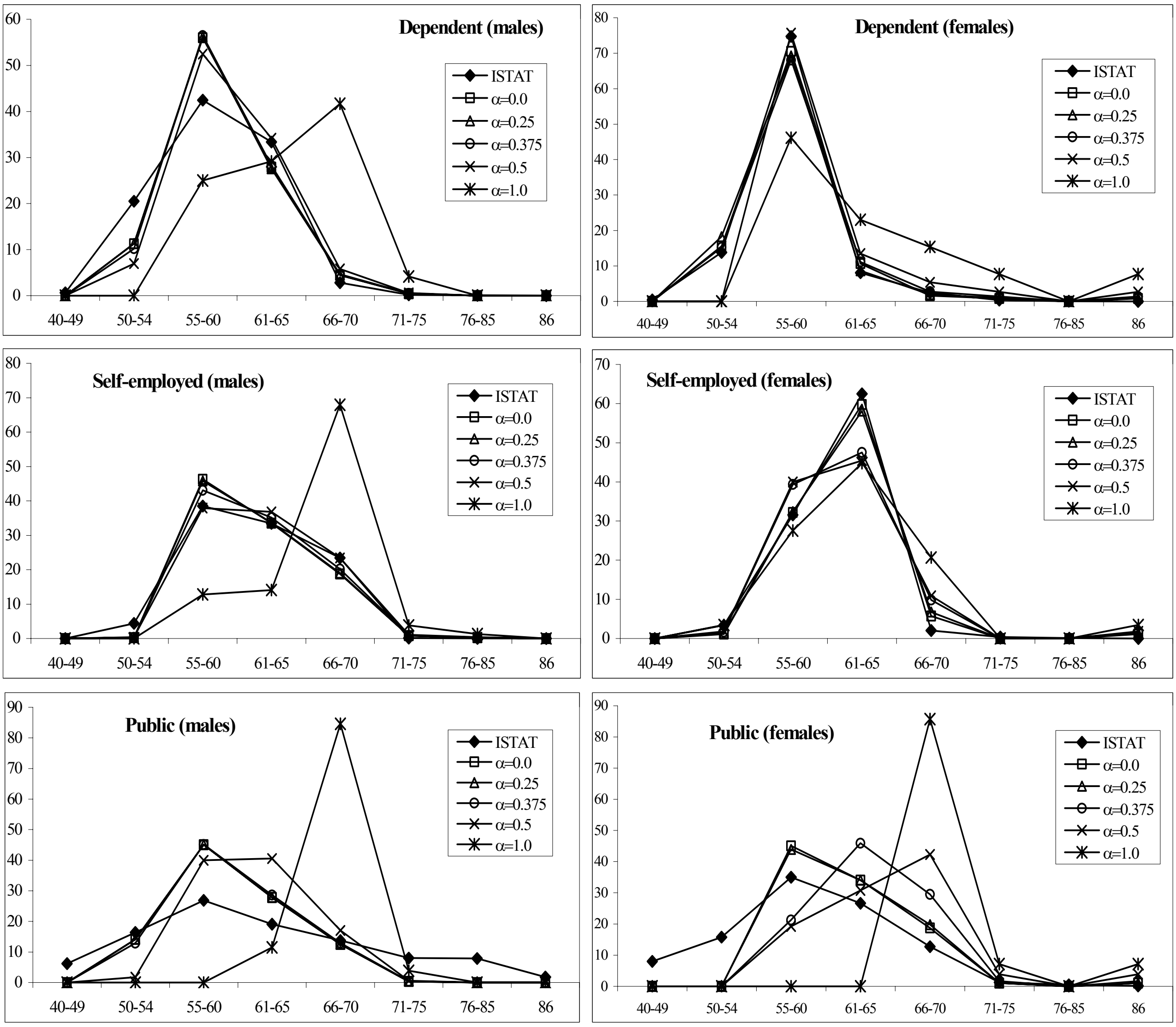


c) SOUTH



In figure 6 we report all the profiles obtained using the sample $MIND_3$ (the best-aligned small sample with respect to elders) and different values of the parameter. The following seems to emerge: lower the value of α the better the fit.

Figure 6: change in quota (%) for different sectors - $MIND_3$



In table 8 we report the R^2 coefficients calculated comparing the results achieved using different value of the parameter with the ISTAT and INPS data.

Table 8: R^2 for different values of α

α	MALES			FEMALES		
	D	SE	P	D	SE	P
0.00	0.90	0.96	0.92	0.99	0.99	0.82
0.125	0.90	0.96	0.92	0.99	0.98	0.81
0.25	0.89	0.96	0.91	0.99	0.98	0.81
0.375	0.89	0.98	0.90	0.99	0.91	0.47
0.50	0.89	0.98	0.71	0.95	0.89	0.28
1.00	0.20	0.24	0.01	0.72	0.85	0.003

Our results show a high correlation between the simulated output and the official data. They also illustrate that the R^2 is decreasing with respect to α in almost all the cases considered, reaching its maximum when the parameter is equal to 0. For the category of formerly self-employed males, this is not the case: the best choice is for $\alpha = 0.5$ even if the lower values of the parameter don't produce strong distortions with respect to the official data.

4. Inequalities and poverty among pensioners' families: a counterfactual experiment.

The MIND model allows to examine the evolution of poverty and the concentration of gross incomes (net of capital incomes) among families with at least one pensioner, highlighting the differences between the indexation policy adopted by the past government and an alternative one, aimed at alleviating poverty and inequality issues. In this counterfactual analysis, we employ the indexes suggested in the recent literature.[27] Around 15% of pensioners are entitled to wage indexation but also other pensioners may indirectly benefit due to the pressure of higher indexation to prices (e.g. 100% instead of 75%).

The poverty threshold, anchored to incomes, is equal to 14.9 million liras (7.7 thousand euros) in 1999 for families with 2 components and we use in the basic case the ISTAT equivalence scale. Considering five-year intervals in the period 2000-2045,[28] the results (shown in figures 7 up to 11) represent the mean values of 20 Monte Carlo replications. [29]

By using mean values of 20 Monte Carlo replications, we reduce the uncertainty introduced by the dynamic ageing approach. 20 replications seem to be enough to ensure reliable results. In fact, considering mean values of 20 replications we substantially reduce the variance by 95%[30]; using a single simulation the model output can assume configurations very unlikely for the whole population and highly undesirable when using a policy model.[31] In our analysis we use Monte Carlo

[27] For a brief discussion, see Appendix B. On demography and poverty see De Santis and Livi Bacci (1999). More technical references on these indexes are in Atkinson (1970), (1971), (1983) and Champernowne and Cowell (1998).

[28] One should also keep in mind that: a) between 2000 and 2020 the system of retributive calculation prevails, b) subsequently mixed calculation takes over (coexisting with pensions already liquidated with the retributive one), c) finally, after 2035 only the contributive calculation survives (persisting however retired "mixed" and retributive). Similar results and trends are obtained with the other samples $MIND_E$, $MIND_1$ and $MIND_2$.

[29] Replication *i* differs from replication *j* only because of the random numbers used in the simulation of the model.

[30] According to Wolf (2000) "in survey-data item-imputation applications of the multiple-imputation technique, a small number (say 3-6 replications) has been viewed as sufficient" (cf. p.24).

[31] Namely, the dynamic ageing approach has the advantage to avoid the well known "curse of dimensionality", associated with cell-based models like MIND, but has the drawback of introducing a greater variance in the simulated results. Assuming that N individuals of the sample have a transition probability p to be involved in a given event, we will expect $N p$ outcomes with a standard error given by $\sqrt{Np\,(1-p)}$. From the previous formula, it is evident that

replications, because this procedure, even if costly in term of computational time, allows to (***a***) quantify the uncertainty of outcomes conditional to given assumptions (or policies) and (***b***) improve the precision of the sensitivity analysis of the results with respect to alternative policies.[32]

Our counterfactual experiment follows the distributive consequences along the two alternative paths.[33] Dealing with concentration and poverty indexes[34] - varying between 0 (equality) and 1 (maximum inequality) - we assume the family as the unit of comparison, and an absolute (or relative) poverty threshold anchored to per capita income or constant in real value, initially in z_n = 7.64 thousand € with n= 2 components and the ISTAT equivalence scale.[35] Alternatively, we also consider the 30 equivalence scale.[36]

Table. 9 ISTAT and 30 equivalence scales: a comparison

Componenti n =	**1**	**2**	**3**	**4**	**5**	**6**	**7**
ISTAT relative **eq.scale**	0.60	1.00	1.33	1.63	1.90	2.15	2.40
ISTAT absolute **eq.scale**	0.67	1.00	1.42	1.80	2.27	2.61	2.95
30 equiv.scale	0,70	1,00	1,30	1,60	1,90	2,20	2,50

The analysis considers all the families with at least a retired individual, (generally the head of the family or the consort) from 2000 till 2045 each five years[37] and compares the consequences on income concentration and poverty of the following policies:

a) actual system: new indexation of pensions (modified in 2001) to prices (***B***);

b) our proposal: indexing lowest pensions to wages without the new indexation to prices (***A***).

The distribution of incomes and its evolution is analysed using Gini's inequality index. As shown in fig. 7, in the whole period the inequality increases (from 0.35 to 0.39, i.e. by 11%, under ***B***, i.e. pension benefits' maximisation, only. to 0.37, about 6%, under indexation to wages ***A*** dotted

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for small values of N the relative error N$p/\sqrt{Np\ (1-p)}$ is very large. Hence, in dynamic ageing, using a different sequence of generated random numbers we can get completely different results.

32 The reduction of variance can be performed either considering the mean values of Monte Carlo replications, or using "ad hoc" techniques. Unfortunately, the use of "ad hoc" techniques - such as *selective sampling* and *side walk* methods – to reduce the variance may have some drawbacks, e.g. altering the probabilities of the events (see Gupta Kapur, 2000, ch. 17 and 18).

33 We assume a probability to find occupation of 8% in the Centre-North and 6% in the South and the same career profiles in the Centre-South. It is not possible to estimate the possibility to lose or change occupation, as this information is not included in the SHIW database.

34 Cf. Atkinson (1970), (1971) and (1983), Champernowne Cowell (1998) and Mervyn (1983).

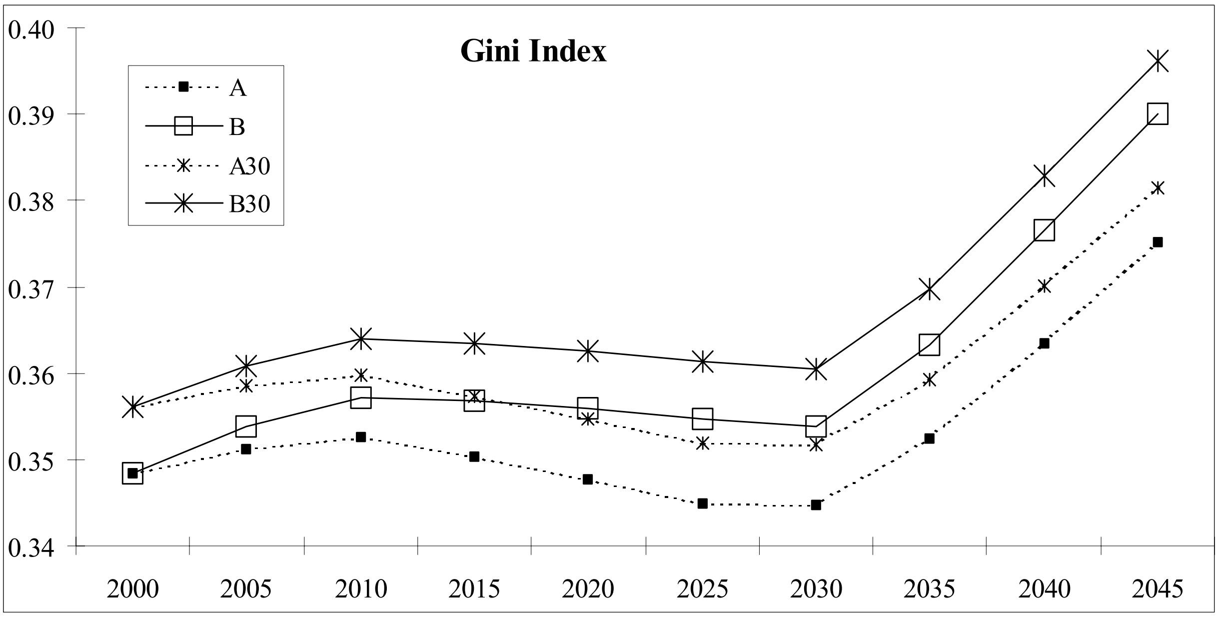
35 These series of coefficients, increasing with the number of individuals, is aimed at eliminating the heterogeneity of incomes due to the different numerousness of family units.

36 The "30 equivalence scale", was already proposed in Vagliasindi (1997). It discriminate less than the "ISTAT relative eq. scale" against single-families.

37 Between 2000 and 2020 the defined benefit system of calculus prevails and the mixed one begins. Subsequently the defined benefit comes to an end and the defined contribution takes over (even if pension treatments already liquidated with the previous system survive for a while). After 2035 only the defined contribution calculus survives (persisting however pensioners retired under the mixed and defined benefit treatment).

lines); between 2010 and 2030 the concentration remains quite stable with ***B*** whereas in the same period indexation (***A***) reduces it. With the new regime (***B***) the inequality is increasing especially after 2030 as the integration to the minimum disappears. The gap between the two hypotheses (G_B-G_A) is increasing (with a difference that reaches 3.8 %).

Fig. 7 Gini's inequality index for pensioners' families



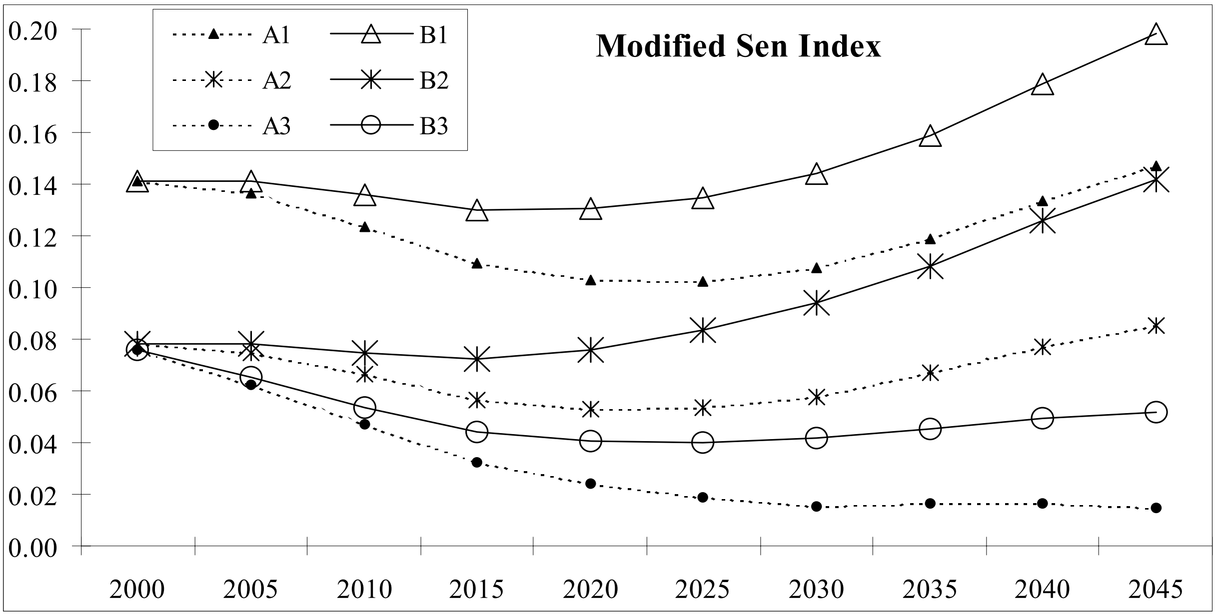
Deviations from the basic trends with 30 equivalence scale are given by an upward divergent shift (ranging from 2.2% to 1.7%, with ***A30*** and from 2.2% to 1.6% with ***B30***) slowly converging especially under the new regime (***B***).

The strongly increasing trend in concentration may be due by the current partial (full) indexation of (lowest) pensions to prices, that: (***i***) creates differences between pensions depending on the year of retirement (the so called "pensioni d'annata", or vintage pensions) increasing poverty over time, (***ii***) transforms the lowest pensions from a social minimum into a biological one, increasing poverty intensity and inequality over time. Therefore, increasing poverty trends would support our hypothesis on the negative impact of the current indexation in the short and long term.

To investigate this possibility we consider poverty tendencies summarised by the trend of the Sen index, modified according to Shorroks (1995), considering (***1***) a relative poverty threshold and an absolute poverty threshold (***2***) anchored to per capita income or (***3***) exogenously given in real term.

The trend of the modified Sen index shows a sharply increasing poverty trend (except, obviously for case ***3***), especially after 2030 due to a faster increasing of poverty intensity. This process involves a progressive reduction of poverty until 2025, that is before the introduction of the defined contribution regime. However, our proposed indexation to real wages could have the effect of slowing down this phenomenon (with an evident decrease until 2025).

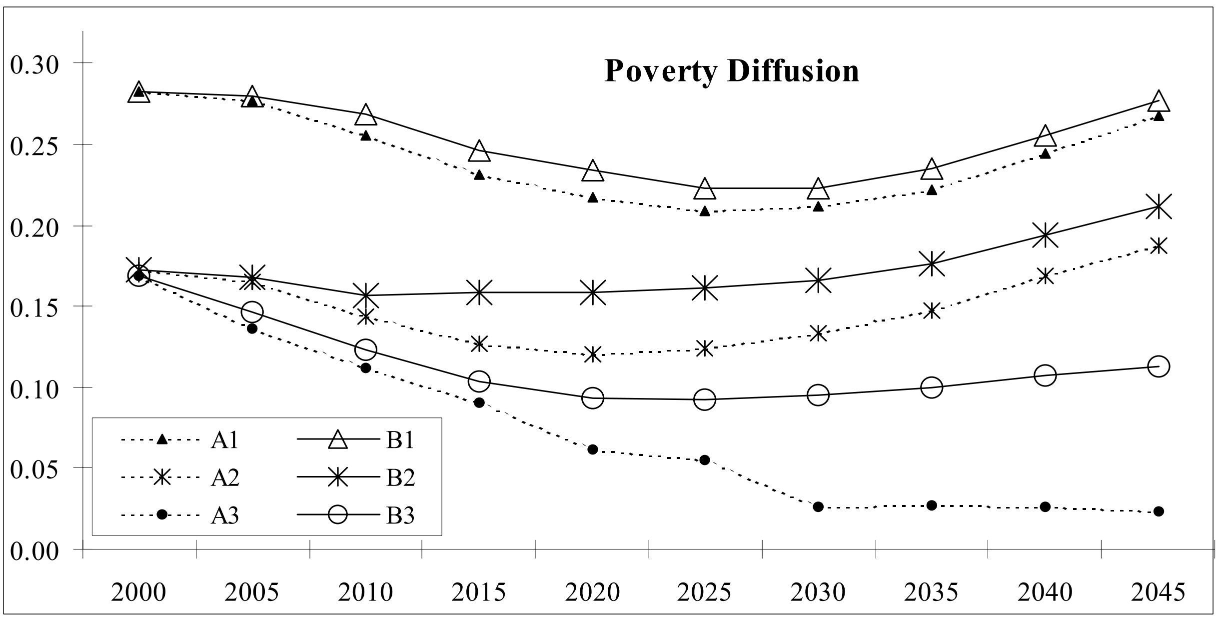
Fig. 8 Modified Sen index for pensioners' families



For simplicity sake's we do not report deviations from the basic trends with 30 equivalence scale but we would have seen an upward divergent shift (with ***A30*** and ***B30***) with differences always below 0.01.

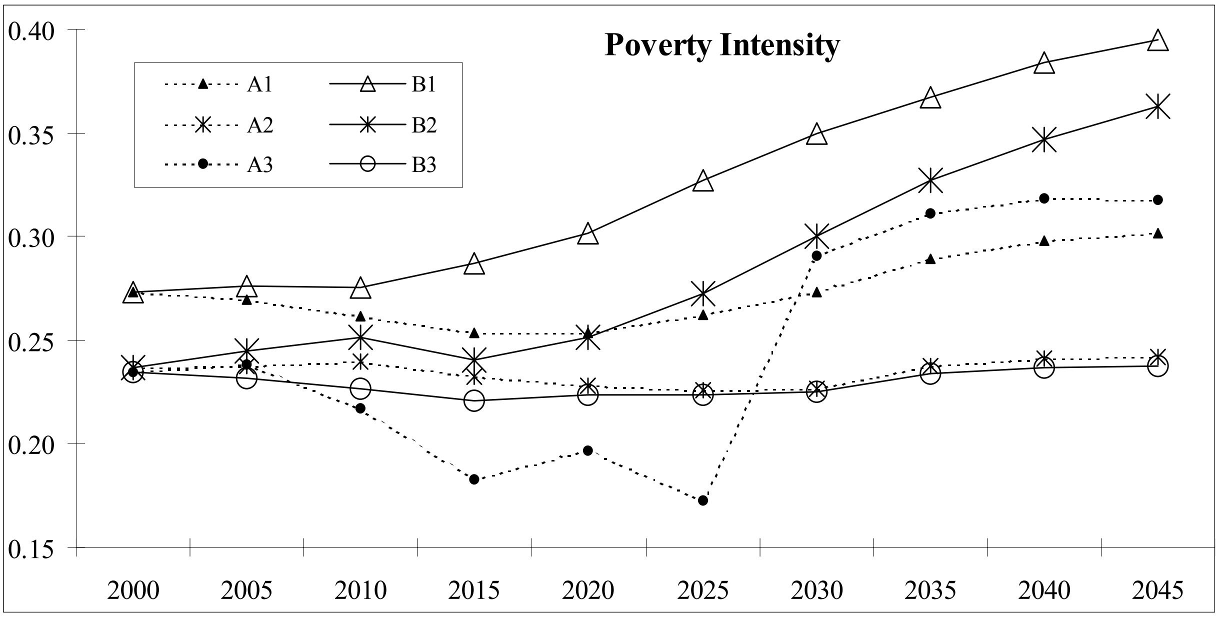
These increasing poverty trends may be decomposed in a decrease (case ***1*** and ***3*** where the final value is lower than the initial one) or very slightly increase (case ***2***) in poverty diffusion, shown in figure 9, and in a quite sharp raise of intensity reported in figure 10.

Fig. 9 Poverty diffusion index for pensioners' families



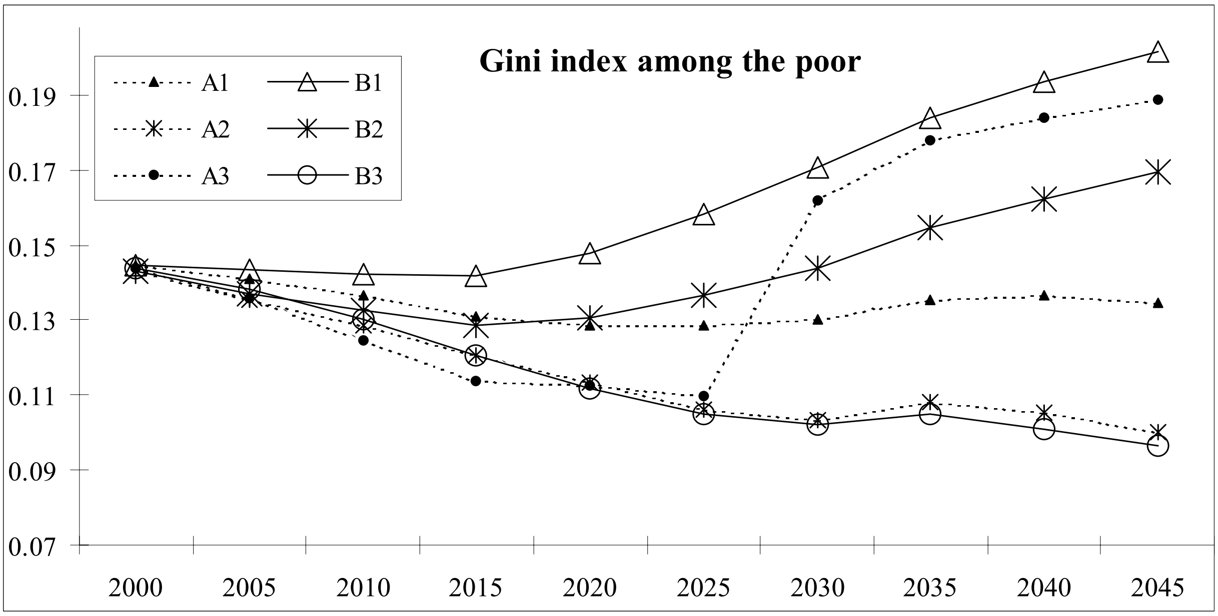
As shown in figure 10, poverty intensity is stable or slightly increasing in case ***B3*** and ***A3***, i.e. with an absolute poverty threshold exogenously given, but increases after 2025 under ***A3***, i.e. indexing social pensions to wages.

Fig. 10 Poverty intensity index for pensioners' families



The trend of Gini's inequality index for the poor is very similar, apart from the initial constant (or decreasing) values, due to a proportional reduction of resources among the poor (or a to a smaller reduction of resources among the poorer). In particular, the difference in the distribution of resources available to poor pensioners is reduced introducing a real indexation of the lowest pensions, if we do not consider an exogenous absolute poverty threshold. In fact, this case only shows the presence of some residual cases, that deserves a particular attention.

Fig. 11 Gini's inequality index among the poor for pensioners' families



In sum, (***i***) inequality and poverty increase among pensioners' families also due to the reforms (which neglected poverty issues) but (***ii***) the increasing inequality trend could be strongly reduced indexing lowest pensions to wages, i.e. fighting the increasing intensity of poverty among pensioners. This could have represented an effective policy till 2030 when different inequality problems could arised, due to the introduction of the defined contribution regime by the Dini pension reform. The presence of this indexation policy against poverty slows down substantially the increasing trend of inequalities (reducing substantially the Gini index in 2045) alleviating poverty (reducing the Sen index even more than 40% in 2045), in particular decreasing poverty intensity and disparities. Thus, our sensitivity analysis supports the hypothesis that the increasing trends of inequality and poverty among pensioners are mainly owed to the price-indexation system.

The former analysis uses Monte Carlo methodology to ensure: (***i***) more reliable results, since they are not based on one experiment, but are derived by the average values of 20 experiments, and (***ii***) the differences (even if small) are 'robust' and can be distinguished on the basis of the adopted indexes.

First of all, the reliability of these results is confirmed by the standard errors (computed over the 20 Monte Carlo replications – table 10), which are very low and oscillate on average between 1% and 3% of the mean value of the calculated indexes. From the analysis of these figures it emerges the relative stability of the results and the absence of increasing trend in stochastic components.

Table 10 Indices standard errors in percentage

year	**Gini**		**Diffusion**		**Intensity**		**Gini of poor**		**Sen modified**	
	A	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
2000	0.70	0.70	1.72	1.72	1.47	1.47	1.72	1.72	1.89	1.89
2005	0.66	0.66	2.04	2.06	1.47	1.46	1.80	1.70	2.54	2.50
2010	0.73	0.74	2.29	2.27	1.51	1.48	2.12	1.74	2.45	2.21
2015	1.04	0.99	2.29	2.69	2.22	1.93	2.94	2.14	3.26	2.67
2020	1.28	1.26	2.22	2.27	2.11	1.33	3.26	2.04	2.92	2.47
2025	1.48	1.45	2.00	1.90	2.07	1.57	3.00	1.79	3.18	2.39
2030	1.45	1.15	2.41	2.19	1.75	1.46	3.17	2.17	2.75	2.21
2035	1.01	0.94	1.87	1.71	1.79	1.06	4.20	2.05	2.67	1.84
2040	0.90	1.04	1.50	1.70	1.98	1.37	4.14	2.07	2.68	2.05
2045	0.97	0.82	1.65	1.55	1.60	1.29	3.94	1.08	2.44	1.81
mean	***1.02***	***0.98***	***2.00***	***2.01***	***1.80***	***1.44***	***3.03***	***1.85***	***2.68***	***2.21***

Using replicated Monte Carlo simulations, we analyse the sensitivity of the results to the partially unavoidable stochastic component present in our dynamic micro-simulation. Since we don't know the form of the probability density functions (pdf) of the indices, we cannot test the significance of the difference between the two means. In our case the pdf are unknown and we can use the following simple n-sigma criterion. Given the mean value of an index I and its standard error σ the n-sigma confidence interval is given by $I \pm \boldsymbol{n}\sigma$. Considering two regions, we have an upper I_U and a lower value I_L and the related standard errors σ_L and σ_U, so that we can build the associated confidence intervals. We are interested to the maximum value of ***n*** for which the two confidence intervals are still separated, that is: $I_L + \boldsymbol{n}\,\sigma_L = I_U - \boldsymbol{n}\,\sigma_U$ and hence $\boldsymbol{n} = (I_U - I_L)/(\sigma_U+\sigma_L)$. In general, the larger ***n***, the more significant the difference between the two mean values of an index is. Without knowing the distribution of the indexes, we can fix two thresholds ($\boldsymbol{n}° = 1$ and $\boldsymbol{n}^* = 2$) considering indexes ***sufficiently distinct*** (when $\boldsymbol{n} > \boldsymbol{n}°$) and ***clearly distinct*** when the more stringent criterion is satisfied (i.e. $\boldsymbol{n} > \boldsymbol{n}^*$).

For each single index we consider the maximal ***n*** values for which such intervals are still separated. The benefits arising from the use of Monte Carlo approach are evident from the results reported in table 10 where for each index there are two values of ***n***, one associated to a single replication and the other to the mean value of 20 replications. From the results of the table we can conclude that a clear distinction of the effects of the two policies (***A*** and ***B)*** systematically emerges only when using the variance reduction procedure.

Table. 10 Values of n for concentration and poverty indices.

year	**Gini**		**Diffusion**		**Intensity**		**Gini of poor**		**Sen modified**	
	1	**20**	**1**	**20**	**1**	**20**	**1**	**20**	**1**	**20**
2005	0.57	2.54	0.53	2.35	1.03	4.61	0.32	1.45	0.98	4.40
2010	0.87	3.91	1.81	8.10	1.58	7.05	0.74	3.30	2.68	11.99
2015	0.92	4.12	4.40	19.70	0.82	3.67	1.29	5.79	4.20	18.77
2020	0.92	4.10	6.07	27.14	2.84	12.70	2.64	11.82	6.70	29.98
2025	0.95	4.26	6.76	30.25	5.20	23.25	5.31	23.73	7.99	35.73
2030	1.01	4.50	4.75	21.24	8.75	39.11	6.19	27.70	9.84	44.03
2035	1.55	6.91	4.91	21.94	11.55	51.64	5.95	26.62	10.97	49.07
2040	1.81	8.08	4.42	19.78	11.04	49.36	7.25	32.42	10.54	47.13
2045	2.16	9.66	3.72	16.64	14.09	62.99	11.76	52.61	12.23	54.68
mean	***1.19***	***5.34***	***4.15***	***18.57***	***6.32***	***28.27***	***4.61***	***20.60***	***7.35***	***32.86***

5. Conclusive remarks

At the beginning of the '90s, the panel of the National Academy of Science (US) on microsimulation models highlighted the crucial importance of the validation of such models, formulating (see Cohen et al. 1991) explicit research recommendations on validation methods and on the criteria to evaluate the uncertainty of simulation outputs. Nevertheless, as observed by Wolfson (2000), in the last ten years such recommendations have been neglected, maybe also because of the high costs involved in validation experiments. Accordingly in this paper, we validate the demographic and the socio-economic input and output of our microsimulation dynamic model (MIND), at a national and regional level, using ISTAT, IRP and SHIW data.

Considering the Italian case, our analysis allowed us to validate:

a) socio-economic and demographic trends, in the short and long run and

b) the different demographic and socio-economic dynamics for geographical area.

Given the intrinsic complexity of the model, its construction and validation required the involvement of different types of expertise.[38] By validating microdata and sharpening the model specification, we obtained a reliable tool for simulating, at a disaggregated level (for instance for geographical areas), the evolution of the distribution of incomes and pensions and for highlighting the redistributive consequences of pension reforms.[39]

The model allowed us to analyse the evolution of gross incomes and pensions using the traditional concentration and poverty indexes, emphasizing the differences among geographical areas.

In particular, demographic trends and the adopted reforms increase income concentration and poverty intensity among pensioners, whereas they reduce inequalities among the different geographical areas. Furthermore, the Monte Carlo analysis confirmed the reliability of our results and in particular that the increase of inequality and poverty is largely due to the current indexation system.

The development and validation of MIND allowed us to use alternative ways to represent

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[39] Our dynamic microsimulation results encourage us to face the future challenges to incorporate and to verify the heuristic value of individual "reaction functions" (e.g. in the family, in the processes of creation and distribution of the wealth and in the labour market). This modelling strategy seems to be supported by recent research in the field. As observed by Harding (2000) transition probabilities are being replaced by hazard models.

individual abilities in problem-solving and decisional processes, which are at the basis of individual "reaction functions" to the policies. In this context, we plan to undertake future research, incorporating and corroborating behavioural functions – such as the ones which endogenise retirement choice (the base of the option value) - to sharpen the model's forecasting abilities with respect to policy changes.[40] A more accurate specification of the Italian reality would also require the introduction of a "migration" module, but, as far as we know, the data that would allow us to model the phenomenon accurately are not yet available.

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[40] In particular, it could be worthwhile to examine in more detail the individual choices in family setting, not merely as a stochastic process, but dependent also on socio-economic variables. In this way, the decision to get married and to have children could be related to other characteristics (e.g. social status, life styles) or choices (e.g. the decision to work or not, or to ask for special working conditions, such as part time). On these issues, related to fertility decline, interesting considerations and evidences can be found in De Sandre, Pinnelli, Santini (1999) and De Sandre (2000).

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