INEQUALITY AND POVERTY AMONG PENSIONERS: MICRO SIMULATING THE ROLE OF INDEXING LOWEST PENSIONS TO WAGES.

Carlo Bianchi, Marzia Romanelli and Pietro A Vagliasindi
A few years after the introduction of the Amato and Dini laws a renewed debate on reforming the Italian pension system and on modifying its structure and technical parameters is taking place. The present work distinguishes between the different typologies - dependent workers (private and public) and self-employed - and simulates individual reactions to systemic changes. This approach allows us to carry out a general micro-analysis of the effects of past reforms on individual and family pension-income and pension-wealth distribution. Furthermore, it allows us to assess the consequences of legislator’s choices such as indexing the lowest pensions (“assegni sociali” and “pensioni integrate al minimo”) to wages or just to inflation. Finally, a Monte Carlo analysis underlines future inequality and poverty trends with a remarkable accuracy and allows to verify the robustness of our results.

1. Introduction.

In a few years, pension treatments, have been deeply modified by the introduction of two new laws: (a) the Amato law (L.503/92), that lowered future pensions for workers subject to the old "retributivo" regime (based on final wages, i.e. received in the last years of the working period), and (b) the Dini law (L.335/95), that introduced a new “contributivo” regime (based on social contributions) for the new entrant workers and a long transition phase (the so called “mixed regime”) for mature ones. In spite of these changes new reforms are still needed in Italy. In fact, the evolution of the demographic structure may introduce tensions in the pension system and in the public budget. In this framework, the issue of adjusting (or indexing) the lowest pension treatments to real wages (or per capita income) has become a very actual problem, and different opinions emerged in the Treasury, the Ministry of the Labour and in the opposition parties (e.g. Forza Italia and Rifondazione Comunista). It is therefore necessary and of great actuality to carefully consider the effects of reforms on pension-income and pension-wealth

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* Suggestion and comments can be addressed to Pietro Vagliasindi, Istituto di Economia e Finanza, via Università, 12, 43100 Parma (e-mail: pvagli@unipr.it). We thank: Massimo Matteuzzi, Valeria De Bonis, Daniele Guidi, Alberto Niccodemi for observations and suggestions. We are grateful to all the participants to the seminar “Quale futuro per il sistema pensionistico italiano”, held at the Department of Statistical Sciences of the University of Padova, on June 9 2000 and to the Congress “Giornate di studio sulla popolazione”, of the Italian Society of Statistics, held at Università Milano-Bicocca on February 20-22 2001. Notwithstanding the strong interaction between the authors, this work is fruit of individual contributions. Particularly, Bianchi is responsible of section 4, Romanelli of sections 2, 5 and of the appendix, Vagliasindi of sections 1 and 3.

1 In fact the relationship between retired persons and workers is substantially increasing. The increase of transfers to the elders is contrasted by a diminution of contributions, from young working people, especially if politics remains favourable to the elderly, the most numerous voting class. To solve this problem, different indications, at times even divergent, have already come from many sides (political parties, Confindustria, FMI, OCSE and the usual experts).

2 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).
distribution, also in relation to economic policies aimed at increasing lowest pensions’.³

This note has an operational origin, which goes back to the Committee on the Welfare State at the Italian Ministry of Finances. It aims at assessing the consequence of linking the lowest pensions to current wages through an explicit indexation mechanism, distinguishing between the rules applied to dependent workers (private and public) and to self-employed ones.⁴

Probably, the partial (full) indexation of (lowest) pensions to prices has been the only real immediate saving of pension expenditure due to the reforms. However, it has at least three negative consequences: (i) it transforms the lowest pensions from a social minimum into a biological one, (ii) it recreates differences between pensions depending on the year of retirement (the so called “pensioni d’annata”), with expected conflicts among pensioners and (iii) it sets the premises for future discretionary interventions aimed at eliminating such problems, on an equity basis. Our analysis follows: (a) the evolution of the distribution of life incomes, i.e. the wealth that could be cumulated from wages and pensions as well as (b) inequality and poverty trends in the pension system. It compares the distributive consequences of indexing lowest pensions to wages (hp.A) rather than to prices (hp.B) in a period of 50 years.⁵

The slow transition implies that in an initial period pensions are “privileged”, maintaining a relevant “social security gift”, compared to social contributions and new pensions under the “contributivo” regime. This gift depends on the year of retirement and decreases during the transition period (in the next 30 years). Starting from “high” individual pension treatments, trade unions have accepted a partial indexation to prices. In this way, since wages and pensions grow in real terms, there is no certainty about the future value of the pensions during the retirement period. When nominal wages grow this mechanism is expected to consistently reduce the relative purchasing power of “privileged” pension treatments in the

³ Beyond the different sectors of affiliation, one must considers - according to the generation - three categories: elderly workers, disciplined from the rules of the past based on final wages (“retributivo”), the mature workers a generations subject to transition (the so called "mixed regime") and the new entrant workers subjects to the new regime based on social contributions “contributivo”.

⁴ The distinction is the same adopted from Istat, cf. Baldacci-Inglese (1999). At the computationale level we developed the Bianchi-Guidi-Niccodemi-Vagliasindi model (1999).

⁵ Departing from Bank of Italy sample investigation on the budgets of the Italian families, the technique of dynamic micro-simulation allows, in fact, to modify the demographic, social and economic characteristics of each unity of the sample by means of stochastic processes. At the moment, this is the more adjourned and reliable fonts of information on the demographic and economic characteristics of the Italians, considering 24.000 individuals (belonging to 8.135 families, representative of the universe from 19.600.000 Italian families at December 31 1995).
future. However, by lowering the purchasing power of ongoing pension it creates a periodical stimulus, during the transition phase, to rise the level of pensions a few years after the retirement. In this way not only savings on public expenditures but the very same profile of the reform path toward the new regime may be at risk. However, for the lowest pensions (which contain a social element), there is not a privileged initial purchasing power to be reduced as time passes by, in relationship to social contributions. Hence, a mechanism of revaluation anchored to the growth of wages (or to the per capita income) could be immediately applicable, respecting the principle of “guaranteeing a full indexation to whoever has not privileges”.

Considering behavioural reactions to changing incentives, we intend to appraise the intra generation and inter-generation consequences on inequality and poverty of:
(i) the “retributive” system, without “pensioni integrate al minimo” and indexation to wages and (ii) the restoration of indexation for the lowest pensions.

The hypothesis that we want to test is: “indexation to wages and salaries - without increasing consistently the average treatment - can significantly reduce inequality and poverty, by increasing the purchasing power of pensioners near to the poverty threshold”. Furthermore, our analysis also verifies in methodological terms the heuristic value and possible role of dynamic micro-simulation models in the field of social security.

In particular, starting from Cannari and Nicoletti Altimari (1998) dynamic micro-simulation model, this paper tries to extend micro-simulation potentialities by looking at the dynamics at the regional level and incorporating a behavioural analysis related to individual choices; such as the Stock-Wise (1990) “option-value” model, in order to analyse individual decision about retirement age. In practice, each individual compares the expected utility from an immediate retirement with respect to a delayed one. Finally, the effects of the uncertainty (due to the intrinsic stochastic component of the microsimulation procedure) on the evolution of the model will be detected by means of Monte Carlo experiments. Given

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6 Moreover, with a low inflation other discretionary measures are needed to reduce expenditures.
7 In the model, the individual decides the year of retirement from the labour market by comparing expected individual utilities (\(V(c)\)), calculated for the current age \(c\) and for each possible future age \(f\) of retirement (\(V(f)\)). Thus the \(f^*\) age that maximizes the value \(V(f)\) is determine. \(V(f^*)\) is therefore the maximum value and it is compared with the expected value at age \(c\). If it is superior, the individual decides to postpone retirement. Econometric applications to the Italian case have been recently provided in Peracchi (1999) and Spataro (2000).
the previous framework of reference our main objectives are the following:

- to simulate the effects of reforms on the gross wage and pension wealth and on the poverty and inequality in the distribution of the gross incomes of families with at least one pensioner;
- to appraise the redistributive consequences of the choice to index lowest pensions to wages (hp.A) instead than to inflation only (hp.B);
- to analyse the results sensitivity, considering the distribution of replicated Monte Carlo experiments, to verify the robustness of the outcomes.

In what follows, we first focus on theoretical and practical issues of dynamic micro-simulation, highlighting its positive and negative characteristics and discussing its practical strength. Particularly, in section 2 we shortly describe the structure of the model, the individual modules, their hypotheses and interrelations, with particular attention to the social security system and to the behavioural model of choice of the retirement age (option value model). In the third section, considering a time period of 50 years, from 1996 to 2045, we will follow the evolution of the phenomena of distributive inequalities and poverty in the Italian families with at least one pension income recipient, discussing the indexation problem of the lowest pensions. Finally, in section 4 we will test, by means of Monte Carlo experiments, if the results are robust and significant, considering the mean values and variances of replicated dynamic simulations.

2. The micro-simulation model: the fundamental relationships and the ambit of application.

The dynamic micro-simulation modelling technique consists in replicating for each individual and family, present in the initial database, the decisional processes (reproducing the functioning of the considered system) on the base of definite behavioural models, as shown in figure 1.

**Fig. 1 A scheme of dynamic micro-simulation**

We consider families that differ with respect to the number of components and related characteristics (age, sex, education, income generation, etc.), allowing for a better evaluation of the: (i) reforms paths,
(ii) redistribution between families, generations, etc..

In particular, dynamic microsimulation modifies demographic and socio-economic structures starting from the evolution of individuals (birth, education, death, ...) and families (creation and dissolution of family unity: marriages, procreations, separations, divorces, ...).\(^8\) Beyond studying a socio-economic system with heterogeneous individuals, dynamic micro-simulation allows us to model a non ‘ad hoc’ demographic and socio-economic evolution and to insert simple individual and families reaction-functions.

This model is inspired by Nelissen (1994) and Cannari-Nicoletti Altimari (1998). It is a modular dynamic ageing model,\(^9\) with temporal unity equal to the solar year. It is based on three modules: 1) “demographic”; 2) “occupation and income”; 3) “social security”.

The demographic part is articulated in subsections: mortality, marriage, divorce, singles, birth. Initially it determines who dies in the current year; then individuals who are still alive can (no the basis of different probabilities) get married, divorce or exit the original family nucleus. The last step consists in simulating births. The section on “occupation and incomes” is articulated in two subsections. They simulate the entry in the labour market and estimate initial incomes (of unemployed persons, aged between 25 and 45 years, who find new occupations)\(^10\) and update them as time goes by. Income estimation is based on cross-section data and has a log-normal specification (cf. Andreassen, Fredriksen and Ljones, 1993). It considers an age structure diversified for sex, education, occupational sector and geographical area.\(^11\)

Finally, in the “social security” part the age of retirement and pension benefits are determined, giving each subject the possibility of postponing retirement to a future period. This is done using an individual

\(^8\) In practice, micro-simulation dynamic derivates future scenarios, by modifying the demographic and socio-economic characteristics, using individual stochastic decision processes; cf. Orcutt (1957), Orcutt Caldwell Wertheimer (1976), Orcutt Merz Quinke (1986), Orcutt Greenberger Korbel Rivlin (1961). In our case, the FORTRAN90 code of our model includes about 6,000 lines-code. In a pentium II PC, one simulation runs over the period 1996-2045 in about one hour. Accordingly we need more than one day to perform 30 replications.

\(^9\) The proposed model is in the same line of the existing dynamic models such as DESTINIE (INSEE, 1999), DYNAMOD (Antcliff, Grusskin, Harding e Kapuscinski, 1996). See also Toso (1996).

\(^10\) A Monte Carlo process with uniform distribution individuates the subjects and the probability to find occupation (depending on geographical area 8% in the Centre-North and 6% in the South). Actually the possibility to lose or change occupation is not included. Occupational sector and weekly worked hours are attributed by a Monte Carlo process, on the base of probabilities extrapolated from the Bank of Italy sample, corrected with a casual error (that follows a normal distribution with variance equal to the one of the occupation sector and to the age of the individual).

\(^11\) Given the estimation problems met for the South, supposing that in the future wages’ trends will be similar to that of the Centre, we used for this area the coefficients of the population of the Centre.
reaction function based on the Stock and Wise option value (OV) model. The worker, in fact, given the available information, calculates the expected values of the utility of retiring today and in future. The difference constitutes the value of the option (OV) of postponing retirement (in our case to the following year). If OV is positive the retirement will be postponed otherwise (negative OV) the worker retires immediately.

The value of retiring at times $t$ depends on the flows of salaries $Y_s$ and pensions $B_s(t)$.

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

The differential benefit $OV_t(t)$ of postponing retirement to time $t+1$ is

\[
OV_t(t+1) = E_t V_t(t+1) - E_t V_t(t)
\]

For $OV_t(t+1) \leq 0$ the individual retires. More precisely, up to the maximum retirement age (e.g. 65 years), $OV_t$ is computed for each year, considering different norms and systems (‘retributivo’, ‘mixed’ or ‘contributivo’, given the age and the contributive characteristics of the subjects) within the three principal pension funds to which workers belong.

3. Economic hypothesis and resulting trends.

Our model delineates future scenarios, that can be described using different indexes. In particular, by considering the mean values of these indexes in 30 Monte Carlo replications we:

(i) compare the average gross wealth from wages and pensions (accumulated in the working life and retirement period by generations born between the ‘50 and the ‘80)

(ii) analyse the distribution of gross incomes and poverty in pensioners’ families.

Given the similarity of the characteristics of the sample we used as our starting point in the simulation

12 In practice, the indirect utility specification of labour and pension incomes are respectively $U_y(Y_s) = Y_s + \omega_s$ and $U_b(B_s(t)) = B_s(t) + \xi_s$ (where $\omega_s$ e $\xi_s$ are random variables with zero mean).

13 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 1.8%, 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% (ex L.41/86, art.24, paragraphs 4 and 5): total (i.e. 100 %) if inferior to the double of the value of the social pension (equal to 6,500,000 in 1999), partial at 90% if inclusive between the double and the triple of this value and at 75% otherwise.

14 That allows us to refer to the ‘retributivo’ system (considering the native until at 1959), to the mixture (considering those born between 1960 and 1976) and to the ‘contributivo’ (considering the individuals born from the 1977). Besides, the model considers 18 typology on the basis of three characteristics, geographical area (north, centre and south), sex (males, female), occupational sector (public dependent, private dependent, self-employed worker).
with the population structure the model should provide reliable information. For instance, considering the
demographic structure for classes of ages, fig. 2 shows the reliability of sample data with respect to the
whole Italian population (continuous line).

Fig. 2 Demographic Italian Structure for classes of age (in 1995)

3.1. Gross cumulated wealth from wages and pensions and inequalities.

Let us indicated the wealth from wages (sum of salaries $Y_{ij}$, capitalised in the contribution years
before retirement $p$) and from pensions (sum of pensions $B_s$, perceived up to the $S$ age) of individual $i$
be respectively:15

$$R_{ip} = \sum_{j=p-a}^{p-1} Y_{ij} (1 + r)^{p-1-j} \quad P_{ip} = \sum_{s=p}^{S} B_{is} (1 + r)^{S-s-1}$$

These values start from 1999 (for individuals born in 1950). They are made comparable referring
them to progressively increasing years, and discounting them for the real rate of growth of the per capita
GDP.16 Let us indicate with $WP^A_i$ and $WP^B_i$ ($WR^A_M$ and $WR^B_M$) male wealth from wages (pension),
respectively under $hp.A$ and $hp.B$, according to whether there is (or not) indexation to salaries. Table 1

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15 With $S$ equal to 74 years for men and 81 for women; the real rate of interest are until 1994 those on the
Ordinary Treasure Bill BOT (until at 1979 see Homer and Sylla, 1991); then equal to 2.5% cfr. note 13.
16 This procedure is related to the analysis of dynamic fiscal policy and of the intergenerational inequality
index. For a general reference, see Auerbach Kolikoff (1987) and (1991), for an application to the Italian
case see Franco Giovale Guiso Kotlikoff Sartor (1994), Sartor (1997) and for the pensions system Boll
Raffelhuschen Walliser (1994). Differently from intergenerational accounting, our comparison between
present and future generation doesn't imply the constancy of relative profiles, the satisfaction of the
intertemporal budget constraint, an equal general tax burden and a constancy of the relative discriminations
between groups for future generations (i.e. ratio between net tax burden). In fact, we have expressly
considered that behaviours change (in accordance with the OV hypothesis) as fiscal and contributive rules
are modified and that current deficits of the pensions system could not be postponed and paid by future
generations.
shows how the differences between sexes decrease (the female wealth is unchanged, while the male one decreases). On the other hand, wealth from pensions decreases, but slowly for males. Differences due to indexation are reduced (new pension treatments increase around 13 and 7%, respectively for males and females).  

**Table 1 Wealth from wages WR and pensions WP (hp.A and B mil. liras)**

<table>
<thead>
<tr>
<th>Generazioni</th>
<th>WR&lt;sub&gt;M&lt;/sub&gt;</th>
<th>WR&lt;sub&gt;F&lt;/sub&gt;</th>
<th>WR&lt;sub&gt;M&lt;/sub&gt;</th>
<th>WR&lt;sub&gt;F&lt;/sub&gt;</th>
<th>WP&lt;sub&gt;M&lt;/sub&gt;</th>
<th>WP&lt;sub&gt;F&lt;/sub&gt;</th>
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<th>WP&lt;sub&gt;F&lt;/sub&gt;</th>
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<tbody>
<tr>
<td>1950-4</td>
<td>1408171</td>
<td>905127</td>
<td>1411865</td>
<td>919766</td>
<td>173161</td>
<td>190840</td>
<td>161552</td>
<td>177519</td>
</tr>
<tr>
<td>1955-9</td>
<td>1279949</td>
<td>867758</td>
<td>1326591</td>
<td>909860</td>
<td>174596</td>
<td>183459</td>
<td>137028</td>
<td>148583</td>
</tr>
<tr>
<td>1960-4</td>
<td>1295665</td>
<td>844127</td>
<td>1413884</td>
<td>905922</td>
<td>191169</td>
<td>174381</td>
<td>101857</td>
<td>123487</td>
</tr>
<tr>
<td>1965-9</td>
<td>1149666</td>
<td>889791</td>
<td>1270631</td>
<td>972197</td>
<td>172895</td>
<td>181044</td>
<td>80599</td>
<td>102688</td>
</tr>
<tr>
<td>1970-4</td>
<td>1157405</td>
<td>872965</td>
<td>1228047</td>
<td>908342</td>
<td>150390</td>
<td>165989</td>
<td>102692</td>
<td>130725</td>
</tr>
<tr>
<td>1975-9</td>
<td>1094358</td>
<td>852049</td>
<td>1108413</td>
<td>854563</td>
<td>129568</td>
<td>157605</td>
<td>114808</td>
<td>147517</td>
</tr>
</tbody>
</table>

The previous analysis could be extended using indexes; e.g. the ratio between wealth from wages and pensions IR and IP. Comparing male and females at a national level we will have:

\[
IR_S = \frac{WR_m}{WR_f} \quad IP_S = \frac{WP_m}{WP_f}
\]

By comparing these indexes a diminution of the relative advantage of the males emerges.

Females seems to enjoy less social security privileges under hp.A, the index being less than unity (**table 2a**). The decreasing trend is quite strong. Under hp.B, it explains around the 40% of the whole variability considering three years moving average values. The reduction of ratios is concentrated in the late '60es as shown by percentage changes (**table 2b**).

**Table 2 Ratios of wealth from wages IR and pensions IP and percentage changes.**

<table>
<thead>
<tr>
<th>Generations</th>
<th>Table 2a</th>
<th>Table 2b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IR&lt;sup&gt;A&lt;/sup&gt;</td>
<td>IR&lt;sup&gt;B&lt;/sup&gt;</td>
</tr>
<tr>
<td>1950-4</td>
<td>1.565</td>
<td>1.546</td>
</tr>
<tr>
<td>1955-9</td>
<td>1.477</td>
<td>1.461</td>
</tr>
<tr>
<td>1960-4</td>
<td>1.539</td>
<td>1.566</td>
</tr>
<tr>
<td>1965-9</td>
<td>1.298</td>
<td>1.314</td>
</tr>
<tr>
<td>1970-4</td>
<td>1.330</td>
<td>1.356</td>
</tr>
<tr>
<td>1975-9</td>
<td>1.285</td>
<td>1.298</td>
</tr>
<tr>
<td>1950-79</td>
<td>-12.88%</td>
<td>-9.87%</td>
</tr>
</tbody>
</table>

It depends on the faster growth of female education and of salaries and on the accumulation of

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17 However, absolute values could greatly reflect critically approximations and hypotheses based on the working of the model.
pensions’ wealth in a longer retirement period. The reduction for the whole period (last line of table 2b) is greater in absence of indexation to salaries. Therefore, despite the increase in the number of contribution years, the reform causes a notable reduction of gross wealth from pensions and increases female “privilege” (but reduces its increasing trend). Indexation of social and lowest pensions increases significantly wealth from pensions, but decreases the female privilege in relative terms.

### 3.2. Distribution of gross incomes and poverty among families of pensioners

Dealing now with concentration and poverty indexes18 - varying between 0 (equality) and 1 (maximum inequality) - we assume the family as the unit of comparison, and an absolute (relative) poverty threshold anchored to per capita income, initially $z_0 = 14.8$ (20) million with $n=2$ components and the ISTAT (30) equivalence scale.19

<table>
<thead>
<tr>
<th>Componenti</th>
<th>$n =$</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonaro</td>
<td></td>
<td>0.60</td>
<td>1.00</td>
<td>1.34</td>
<td>1.63</td>
<td>1.91</td>
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<td>2.40</td>
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<td>ISTAT eq.scale</td>
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<td>0.67</td>
<td>1.00</td>
<td>1.42</td>
<td>1.80</td>
<td>2.27</td>
<td>2.61</td>
<td>2.95</td>
</tr>
<tr>
<td>30 equiv.scale</td>
<td></td>
<td>0.70</td>
<td>1.00</td>
<td>1.30</td>
<td>1.60</td>
<td>1.90</td>
<td>2.20</td>
<td>2.50</td>
</tr>
</tbody>
</table>

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. Moreover, we consider the average values of 20 Monte Carlo replications.20 The whole distribution of these family incomes and its evolution could be analysed, as usual, by means of the Gini index.

As shown in fig. 3, in the whole period the inequality increases (less with indexation to wages $hp.A$ in dark); it decreases between 2015 and 2030 with indexation. With the new regime ($hp.B$) the inequality is always increasing, especially after 2025 and 2030 as the integration to the minimum disappears. Deviations are increasing and indexation reverses from 2015 to 2030 the increasing trend of concentration.

19 These series of coefficients, increasing with the number of individuals, is aimed at eliminating the heterogeneity of incomes due to the different numerosness of family units. The “30 equivalence scale” (compared in the table with the “Carbonaro” one), was already proposed in Vagliasindi (1997). It discriminate less than the Carbonaro against single-families.
20 Between 2000 and 2020 the retributivo system of calculus prevails and the mixed one begins. Subsequently the retributivo comes to an end and the contributivo takes over (even if pension treatments already liquidated with the previous system survive for a while). After 2035 only the contributivo calculus survives (persisting however pensioners retired under the mixed and retributivo treatment).
By indexing lowest pensions to wages our main aim was to reduce poverty. In fact, considering the diffusion of poverty we notice initially a decreasing trend.

However this trend is reversed from 2020 as the diffusion of poverty increases, a phenomenon amplified by the absence of indexation (hp.B). The decreasing trend of poverty diffusion continue instead till 2025 with indexation and the final increase does not bring it back to its initial.
The poverty intensity decreases slowly indexing the lowest pensions to wages (hp.A), while it quickly increases (around 60%) with hp.B.

**Fig. 6 The Gini index among the poor for families of pensioners.**

Starting from 13%, the Gini index among the poor remains substantially stable till 2025 increasing afterwards till 15% without indexation. Instead, its value decreases sharply (around 50%) with indexation, from 13% to around 7%.

**Fig. 7 The modified Sen index for families of pensioners.**

Finally the modified Sen index (which synthesises the poverty trend)\(^{21}\) shows the evolution of poverty (reproducing the intensity index with a reduced oscillation band) and showing the divergent poverty trends with the two hypotheses: (a) decreasing indexing the lowest pensions to wages (hp.A), (b) increasing in absence of indexation (hp.B).

We may briefly synthesise the conclusion of section 3 as follows:

(i) inequality increases among the families of pensioners, due to the reforms,

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\(^{21}\) The Sen index phenomenon and it is calculated following Shorroks (1995).
(ii) the absence of indexation to wages (of the lowest and social pensions) speeds up the rising trend of inequalities hardening poverty problems, increasing its diffusion and intensity,

(iii) indexing pensions to wages we can slow down inequality increases and reduce poverty problems, decreasing concentration and reducing the diffusion and intensity of poverty.

### 4. Monte Carlo outcomes and their significance.

Previous results depend on the economic hypotheses and the working of the model (cf. sections 2 and 3). Being mean values of more experiments, our results are more reliable than those based only on one experiment. This represents an innovation and a methodological refinement.

We now need to establish whether the effects of the two indexation options (A and B) are ‘robust’ and can be distinguished on the basis of the adopted indexes. In fact, the inherent variability of stochastic processes may be so high that the results may lose significance, not allowing a clear discrimination between the effects of the two options. Therefore, such matters - dealt with by means of the Monte Carlo method - refer to the sensitivity of the results, compared to the relative weight of the stochastic component in the dynamic micro-simulation. In what follows we analyse the statistic properties of the sample values of our indexes drawing more accurate information on the distribution, variability and intervals of confidence of their estimated values.

<table>
<thead>
<tr>
<th>Table. 4 Indices standard errors (values $\times 10^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>year</strong></td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>2005</td>
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</tr>
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<td>2015</td>
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<tr>
<td>2020</td>
</tr>
<tr>
<td>2025</td>
</tr>
<tr>
<td>2030</td>
</tr>
<tr>
<td>2035</td>
</tr>
<tr>
<td>2040</td>
</tr>
<tr>
<td>2045</td>
</tr>
<tr>
<td><strong>mean</strong></td>
</tr>
</tbody>
</table>

22 For the precision sake 20 experiments dependent by the different random numbers generated used in the dynamic ageing.

23 A similar experiment consists in examining the consequences of the two options in alternative scenarios, varying for instance with stochastic processes also the values of the real rate of interest and of growth per capita.
From the observation of table 4 we deduce: (i) the relative stability of the results, (ii) the absence of increasing trend in stochastic components and (iii) a superior variability generally under hypothesis (B), which points out a greater volatility without indexation.

Case (iii) no longer holds for poverty indexes, if we instead refer to standard errors in percentages terms (see table 5). Observing these values, oscillating on average between 1% and 3%, we however confirm the results’ reliability. The standard errors of the Gini index, oscillating around 1%, deserve special consideration because they are referred to the whole family sample (with at least a retired person) not only to the poor ones.

<table>
<thead>
<tr>
<th>Table. 5 Indices standard errors in percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gini</strong></td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>2005</td>
</tr>
<tr>
<td>2010</td>
</tr>
<tr>
<td>2015</td>
</tr>
<tr>
<td>2020</td>
</tr>
<tr>
<td>2025</td>
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<tr>
<td>2030</td>
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<td>2035</td>
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<td>2040</td>
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<td>2045</td>
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<tr>
<td><strong>mean</strong></td>
</tr>
</tbody>
</table>

In order to be able to distinguish the two policies on the basis of the adopted indexes (despite their stochastic variability) we must appraise the probability that the value of a single index for a given year with option A could be attributed to B (and vice versa). With normal distributions of the Monte Carlo replications it would be easy to determine the confidence intervals at 99% or at 90% - simply by adding and subtracting the standard error times \( n \) (= 2.32 or 1.28) to the average values - and verify if they superimpose. When that is not true, the probability of the event would be inferior to 1‰ or 1% (or to 5% and to 10% with \( n \) respectively equal to 0.8 and 0.2).

Without imposing a particular constraint to the distribution of the indexes, obtained with the Monte Carlo analysis, we assume the two options as distinct when the intervals, calculated by adding and subtracting \( n \) times the standard error to the average value, are separated.

In the following table 6 we found, for each single index, the maximal \( n \) values for which such intervals
are separated. Assuming two thresholds ($n^\circ = 0.8$ and $n* = 2$), the indexes are sufficiently distinct ($n > n^\circ$ from 2005 or 2010, or from 2015 with the Gini index) and clearly distinct with the more stringent criterion only from the second decade ($n > n*$).

### Table 6  $n^*$ values for distinct intervals

<table>
<thead>
<tr>
<th>year</th>
<th>Gini</th>
<th>Diffusion</th>
<th>Intensity</th>
<th>Gini of poor</th>
<th>Sen modified</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>20</td>
<td>1</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>2005</td>
<td>0.19</td>
<td>0.866</td>
<td>0.312</td>
<td>1.395</td>
<td>1.141</td>
</tr>
<tr>
<td>2010</td>
<td>0.46</td>
<td>2.044</td>
<td>0.993</td>
<td>4.442</td>
<td>2.687</td>
</tr>
<tr>
<td>2035</td>
<td>7.28</td>
<td>32.541</td>
<td>11.433</td>
<td>51.130</td>
<td>19.816</td>
</tr>
<tr>
<td>2040</td>
<td>9.64</td>
<td>43.094</td>
<td>13.743</td>
<td>61.460</td>
<td>18.866</td>
</tr>
</tbody>
</table>

Considering instead mean values of indexes, variances are substantially reduced (already with just 20 replications) and maxima values of $n$, with separate intervals, grow notably as one can deduce from table 6. Differently from the case with a single observation also the more stringent criterion is already satisfied since 2005 (included the Gini index).

To conclude, the comparison between $hp.A$ and $hp.B$ results: (i) only partly satisfactory with respect to a single outcome, for poverty indexes (not very satisfactory for the Gini index), even if it is already unlikely to confuse the effects of the two options, (ii) good considering instead the average values of just 20 replications, with a clean distinction of the effects of the two options.

### 5. Concluding remarks.

In this note we have (i) substantially modified the hypothesis and demographic parameters of Cannari and Nicoletti-Altimari (1999) (looking at the dynamic at the regional level and simplifying the model in order to have a more manageable one to simulate) and (ii), introducing an endogenous choice of retirement age in the model. In fact, we devise an individual reaction function (based on the Stock-Wise option value model) able to adapt to behavioural changes along the pension reform path. Accordingly,

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24 The value of $n$ can be easily calculated, if we know the index mean values $A < B$ and related standard errors $\sigma_A$ and $\sigma_B$. In fact from the relation: $A + n \sigma_A = B - n \sigma_B$ we get $n = (B - A)/(\sigma_A + \sigma_B)$. 
we have verified the ability of dynamic micro-simulation to incorporate behavioural analysis in relationship to individual choices.

Such model allowed us to follow the evolution of the wealth distribution (from wages and pensions) as well as inequality and poverty trends for families of retired with partial indexation to the inflation. We also compared its redistributive consequences with those relative to the introduction of lowest and social pension indexation to the wages. Moreover, to generate more precise and representative results, the sample and the model, have been calibrated to the Italian universe (e.g. demographical-occupational structure and incomes).

In the Italian case, the analysis allowed us to verify how:

a) inequality problems (especially poverty ones) among pensioners' families tend to increase as time goes by, notwithstanding the greater disincentives to anticipated retirement, the decrease of unemployment, the presence of more regular careers and the emerging hidden economy;

b) the missing indexation (of social and lowest pensions to per capita income) by increasing poverty, speeds up the rising trend of inequalities and

c) our results are relatively stable and robust (stochastic influences being not strong) so that the mean values of poverty and concentration indexes allow meaningful comparisons.

Of course, there are still problems to be solved by further research in this area. First, to generate more precise and representative results, the reaction function (based on the option value model) can be validated along the initial pension reform path. If we want to consider incomes (and pensions) net of taxes (and contributions), we must estimate future taxes and contributions (in relation to different types of employment) and wealth arising from the accumulation of private pension funds inclusive of reformed TFR (cf. Vagliasindi 1999). Besides, it could be interesting to: (a) examine economic individual behaviours in more detail, setting family choices in connection to the labour market and (b) introduce immigration, creating a database of families and deepening relative behavioural differences to the various socio-economic and cultural choices.

7. References.


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