An agent-based microsimulation of labour force participation. Some results for Italy

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Roberto Leombruni, *LABORatorio R. Revelli – Centre for employment studies*
Matteo Richiardi, *LABORatorio R. Revelli – Centre for employment studies*

Abstract

Most Oecd Countries are experiencing a rapid population ageing. Italy adds to this picture a very low labour market participation of the elders, so that most projections about the impact of ageing on the labour market are rather pessimistic. However, there are other long run modifications currently underway that will presumably have a sizeable impact on the labour market, above all changes in the retirement legislation, in educational choices and participation behaviour. In this paper we present LaborSim, an agent based microsimulation model of labour supply, which offers new insights on the likely evolution of the labour force in the next decades in Italy. LaborSim integrates the current demographic projections with simulation modules modelling retirement rules, retirement behaviours, migrations, education and participation choices, plus a consolle to implement various policy scenario analyses. When all these factors are taken into account, projections for next decades are not that pessimistic. In most scenarios, the overall participation rate is expected to increase steadily for the next two decades, while shortages in the labour force supply and an unfavourable dynamics for the economic dependency rate are expected to show up in the late 20s, when the baby boom generations will arrive at their retirement ages.

1. Introduction

In the next decades most Oecd Countries will experience a rapid population ageing, because of the increase in life expectancy occurred in the second half of last century, and to a concurrent sharp decrease in fertility rates. This will have strong consequences both on the sustainability of social security systems – financed in most cases through a pay-as-you-go mechanism – and on the labour market, with possible labour supply shortages. Within this general picture Italy is no exception, having one of the oldest populations among Oecd countries. What is worse, Italy also has one of the lowest participation to the labour market is recorded, particularly for women and the elderly. Ageing and low participation, taken together, justify the very pessimistic projections that are currently made about the evolution of economic dependency ratios in the next decades.

Most projections, however, are based on a very simplistic extrapolation of cross-sectional participation rates as measured today. Oecd [2004], for instance, applies the participation rates measured in 2000 to the demographic projections, and estimates a dramatic reduction in the consistency of the labour force – dropping from 24 to 17 millions by 2050 – and an increase in the economic dependency ratio that is the second worst in all Oecd countries forecasts.

This kind of projections are unsatisfactory under many respects. First, participation choices should be viewed in a life cycle perspective. To extrapolate cross-sectional data observed today can produce paradoxical results for the pseudo-individuals belonging to the new cohorts simulated: they would participate little when they are young – since young people today generally go to school – and they will participate little when they get old – since today's elders have generally started working very early, and are willing to retire.

Second, existing low employment rates for people aged 50 and over, in Italy, are probably below their long run equilibrium. As regards women, many of those who are not participating to the labour market, actually never worked during their lives – again, in a life cycle perspective, they once and for all decided to "offer" their labour services within the family. In the data, however, a trend towards a higher participation is clearly detectable for new cohorts. Moreover, both men and women during the last two decades took advantage of the very generous early-retirement schemes available up to the Eighties. Such a "filtering out" of the labour force has a negative impact on the participation rates observable today for the elders, but will vanish in the future due to the major reforms of the pension system delivered in the last twelve years.

In this paper we present an agent based microsimulation model of labour supply, which offers new insights on the likely evolution of the labour force in the next decades in Italy. The main focuses of the model are on demography, migration, retirement rules, retirement behaviours, education and participation choices. All behavioural rules implemented are cohort specific, and have been estimated on Istat and Eurostat data over the years 1993-2003. The eligibility criteria implemented for the pension system carefully mimic the actual three-layer retirement rules in force in Italy. When all these factors are taken into account, projections for next decades are not that pessimistic. Even in the less favourable scenario – assuming that the positive trend in higher participation in education and in higher labour force participation for women will dry out – the overall participation rate is expected to increase steadily for the next two decades.

The paper is structured as follows. Section 2 deals with some background issues on participation. Section 3 presents the model. Section 4 discusses the simulation results in the standard scenario. Section 5 concludes.

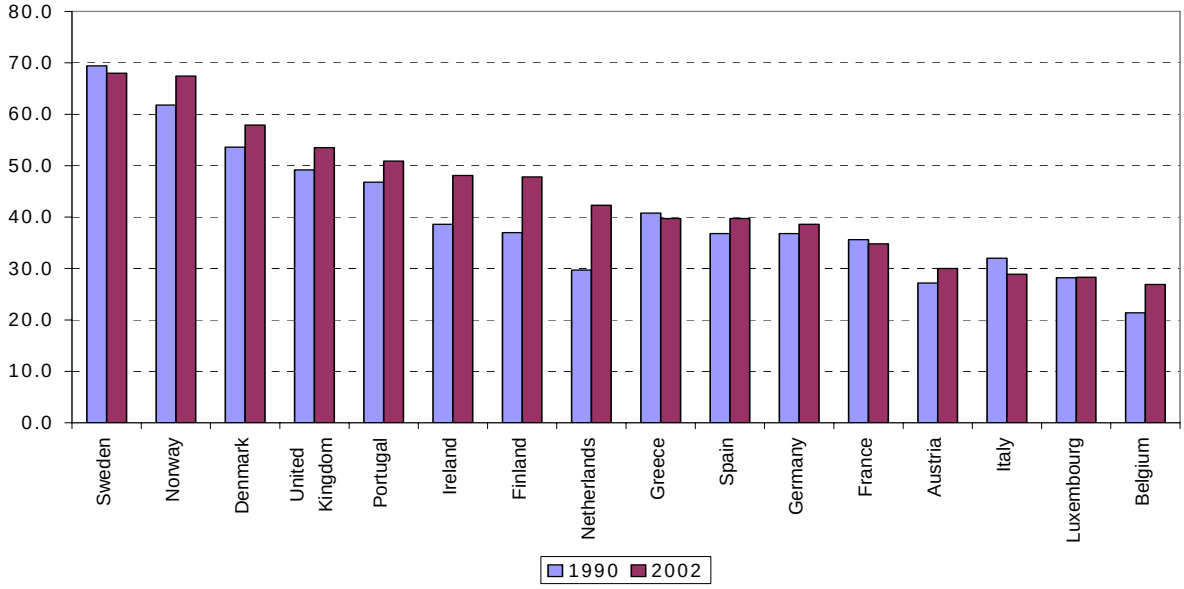
2. Some background issues on participation in Italy

The process of population ageing currently underway in Italy is more pronounced than in most other Oecd countries. In the last decades the total fertility rate has declined steeply, going below the

replacement rate of 2.1 as soon as at the beginning of the 80s, reaching 1.24 in 2000[1]. At the same time, life expectancy is among the highest among Oecd countries. Even though a slight recovery in fertility rates is expected for next years, the transition process to the new demographic regime will have a deep impact on the age structure. In the next two decades, the baby boom generations of the 60s and early 70s will enter in their retirement ages, and will be replaced by new labour force cohorts roughly half in size[2]. By 2050, more than one in three Italians will be over the age of 65.

An additional source of concern about Italy is the fact that the participation rates of the elders are peculiarly low. Figure 1 compares participation rates for people aged 55-64 in a selection of EU countries. Italy is 14th out of 16, and contrary to most countries has experienced a decrease in the participation rates during the Nineties.

Figure 1. Participation rates in 1990 and 2002, people aged 55-64, various EU countries.



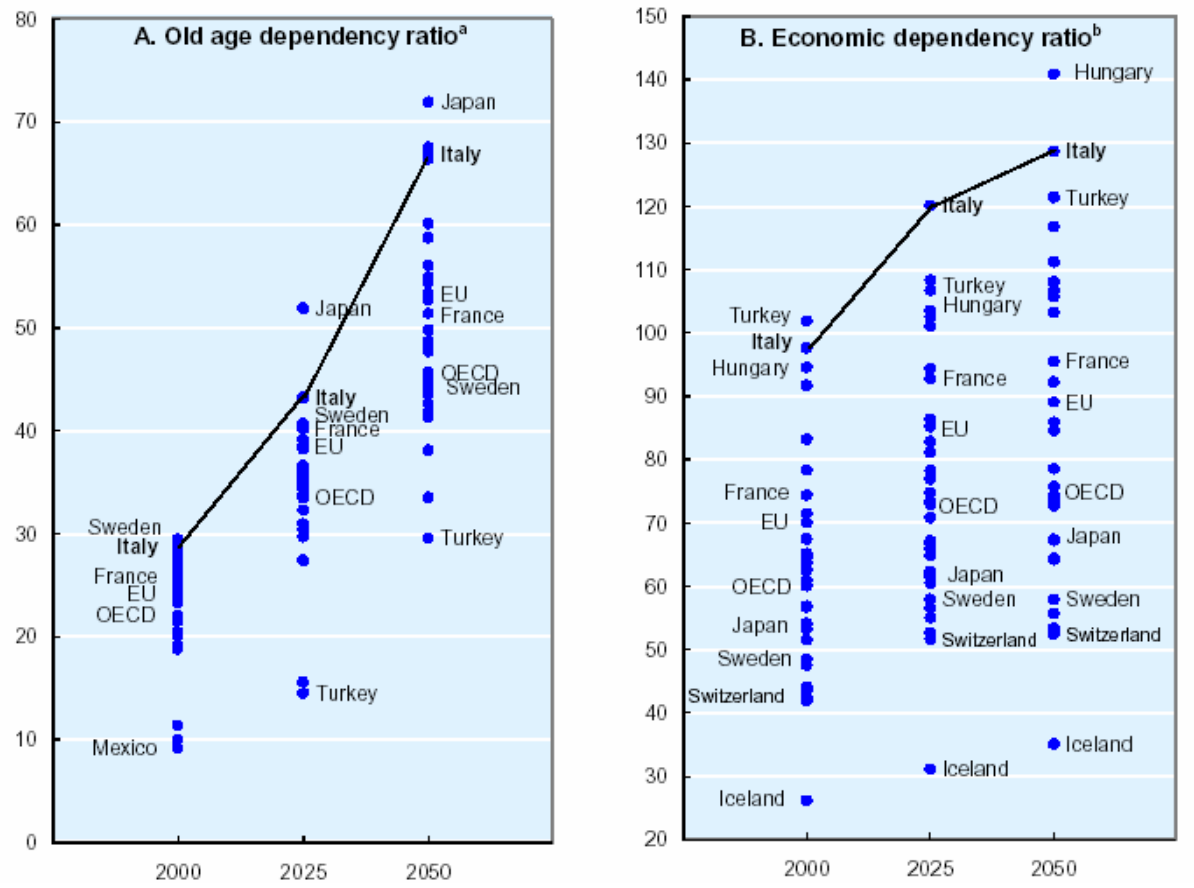
Source: Eurostat LFS 2002.

Putting together ageing and low participation of the elders it is straightforward to build future scenarios in which the economic dependency rate – the ratio of people out of the labour force on those who partecipate – will become hardly sustainable. Oecd launched in 2001 a tematic rewiew on this issue, and built projections about the future evolution of old age dependency rates in Oecd member countries (see for instance Oecd [2004]). They applied the participation rates measured in 2000 by gender and five-years age groups to the best available demographic projections, and compared the evolution of a demographic and an economic old age dependency rate (see figure 2).

Figure 2. Old age demographic and economic dependency rates, Oecd countries.

[1] Here and in what follows we refer to the "central" scenario of the population projections produced by the Italian Statistical Office (Istat), see http://demo.istat.it/index.html.

[2] New births averaged 950 thousands during 1960-69, and 890 thousands during 1970-1974. In recent years (1998-2002) they averaged 530 thousands per year (see Marano and Sestito [2005]).



Source: Oecd [2004].
Panel A, left: People aged 65 and over to people in the age bracket 20-64.
Panel B, right: People out of the labour force to those in the labour force, excluding under 20.

The most revealing comparison is about Italy and Japan. Both countries are facing the most rapid ageing in the population (left panel). In Japan, however, workers stay longer in the labour market, so that the share of those who are not active remains below the Oecd average (right panel). On top of ageing, Italy adds one of the lowest participation rates for people aged 50 and over, so that the economic dependency rate is expected to reach a record level of almost 130% by 2050.

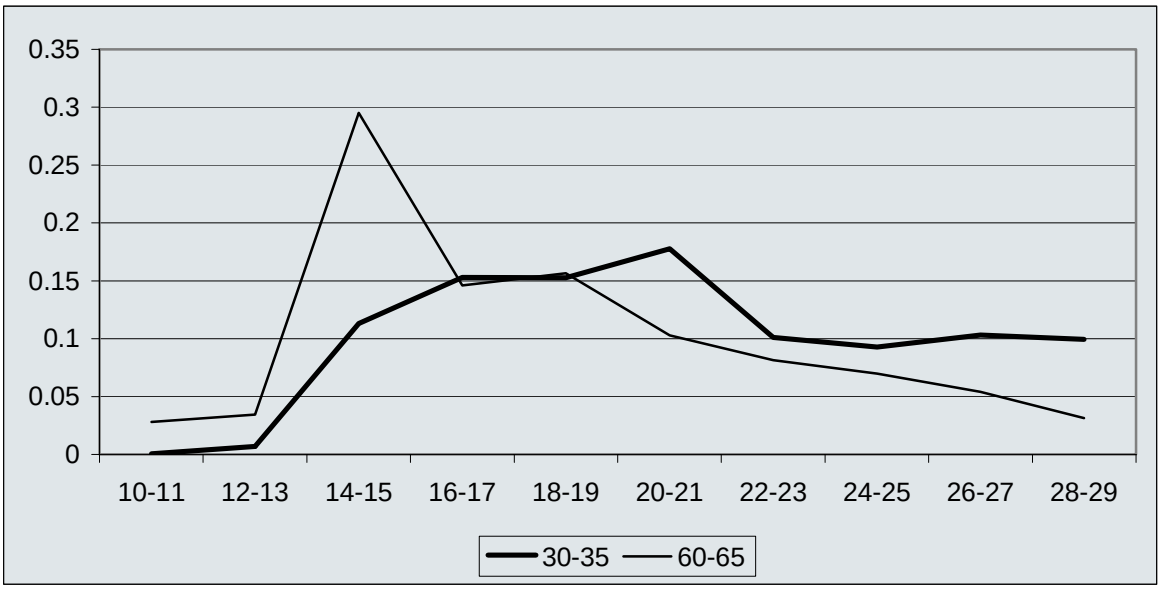
How reliable are these projections? While the future evolution of the population age structure reflects a secular change that can hardly be questioned, the use of cross-sectional participation rates by age and gender is unsatisfactory under many respects. The general argument is that participation choices should be viewed in a life cycle perspective, since the choices made by young people as regards education and the entry in the labour market have an impact on all their subsequent working career. The use of cross-sectional evidence mixes behaviours of young individuals with the behaviour of their contemporary elders, that as a rule are not coherent each other. For what concern the Italian case, this general argument goes together with the following points.

First, the legislation has changed. Actual low participation of the elders in Italy (both males and females) has to be linked with a retirement legislation that is no more in force. The old system was particularly biased towards early withdrawing from the labour market, both because it allowed seniority pensions, and because of the defined benefit rule used for the computation of pension entitlements, that most of the time provided a financial incentive to retire as soon as one became eligible. The retirement legislation in force today has higher age requirements, and – because of the introduction of a defined contribution rule – does not embed incentives towards an as-soon-as-possible retirement behaviour.

Second, the working careers of individuals has shifted forward in the life cycle. Actual low participation of the elders in Italy reflects working careers that on average started well before what

can be observed for new cohorts today. In figure 3 we considered two cohorts: those that in 2001 where aged 60-65, and those that will be in the same age bracket in thirty years. Plotting the declared age at which they began their working life, as comes out from the European Community Household Panel (Echp), the shift toward later entries in the labour market is clear. This means that individuals of actual cohorts will arrive to the retirement ages with shorter seniority in comparison with those who retired during the last decades[3], and this will contribute to postpone their retirement decision for two reasons. From one side, the seniority requirements in the eligibility criteria will be met later. From the other, shorter contribution spells mean lower pensions, and individuals will have the incentive or the need to withdraw later, in order to achieve a higher standard of living when retired.

Figure 3. Reported age at first job/business, two cohorts, 2001.



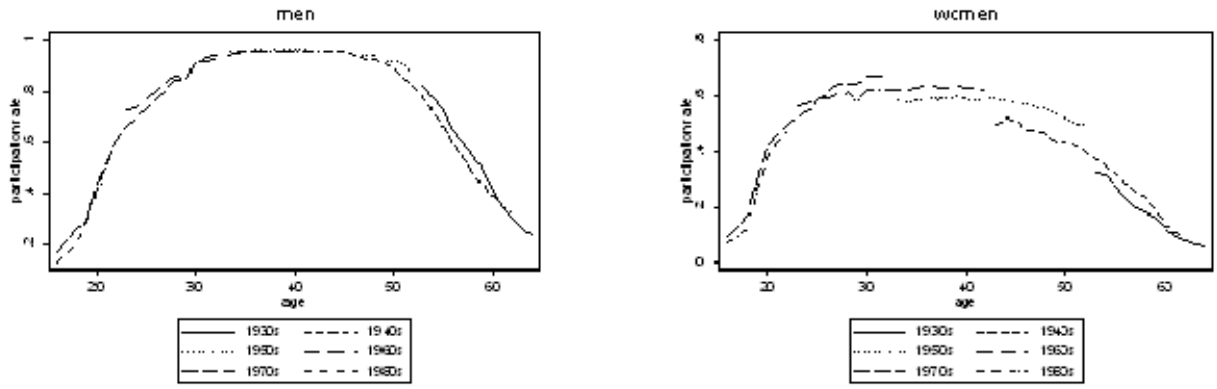
Source: Our elaborations on Eurostat data, ECHP, wave 6.
Note: Ages are grouped in 2-years classes in order to avoid heaping at even ages.

Strictly connected with the last point is the fact that newer generations have on average, in Italy, a higher level of education (see section on education below). Actually, later entries in the labour market can be explained by and large by higher participation to education. This will presumably have an additional, direct impact on the participation to the labour market of future elders, both because higher education has a positive effect on the employability of workers – that is, on their *capability* of retaining and finding a job – and on their willingness to do it, since high skill jobs usually bear a lower disutility of work.

Finally, actual low participation of elder women has to be linked with life cycle choices made many decades ago, when a large share of Italian women decided once and for all to "offer" their labour services within the family instead of within the labour market. A simple analysis of unconditional participation profiles of women by cohort reveal a trend towards a lower share of those who work within the family (see Figure 4). This is coherent with a decreasing average household sizes that goes together with decreasing fertility rates, and with a long run reduction in the gender differences as regards the attitudes towards the labour market.

Figure 4. Participation profiles by cohorts, males (left panel) and females (right panel)

[3] In the same direction goes the fact that youngsters today experience on average more and longer unemployment spells with respects to what happened to older cohorts.



Source: Our elaborations on Istat data, RTFL, 1993-2003.

To sum up, whilst the demographic trends will point in the future to scenarios where the elders will be a very large share of the population, this will not necessarily turn into a high economic dependency upon people in the labour force. There have been in the last decades many changes – in the retirement legislation, in educational choices, in the working careers, in the participation behaviours of women – that will have a long run impact on future participation to the labour force, and will probably countervail the demographic ageing of the population.

3. The model

LaborSim is a dynamic aging, discrete-event, probabilistic agent-based microsimulation model[4] of labour supply. The specification of a large model is always a compromise between the desire to include all relevant dimensions of the phenomenon under investigation – including all sorts of endogenous feedbacks, and the need to keep the model manageable and simple enough to allow an easy interpretation of the results.

Setting the focus of LaborSim we gave precendence to the phenomena pointed out in previuos paragraph, namely to the retirement legislation reforms, the process of seniority accumulation, the changes in the educational choices of young people and the participation behaviours of women. All these factors have been integrated with the best demographic projections available, with an additional focus on migrations dynamics.

What LaborSim is not. It is not a general equilibrium model. The demand for labour is not considered but for the analysis of unemployment differentials, while the overall unemployment rate is a scenario parameter. Monetary variables (wages and pensions) are not considered, although future extensions of the model could easily include them. Also, family structure is not considered. However, in estimating an upward trend in the participation rates of women, we implicitly take the evolution of family structure into account.

In what follows, we briefly discuss the technical implementation, the data used, and then proceed describing the overall structure of the model, and the modules it is composed of.

The technical implementation

The simulation model is written in Java, using JAS (Java Agent-based Simulation Library)[5], an open source platform for agent-based modelling that provides a number of libraries for the management of time, the collection of on-line statistics, on-line graphical widgets and database storage capabilities. Two databases are used to support the simulation. One contains all technical data, i.e. the initial population, the demographic projections and the estimated parameters, which are not supposed to be modified by the user unless when an update is required. The other one (the

[4] For a review of the microsimulation literature, see O'Donoghue (2001). For a review of the literature on agent-based modelling in economics, see Tesfatsion (2001).

[5] JAS is available from http://jaslibrary.sourceforge.net. See Sonnessa (2004) for details.

scenario database) contains the console to manage all scenario parameters. The console is organized in different forms:

- a *demography* form, to choose which demographic projections are to be used, both for natives and for immigrants;
- a *participation-to-education* form, to set the cohort after which the estimated trend towards higher participation to the schooling system is supposed to halt;
- a *probability-of-graduation* form, where the estimated probabilities for increasing one's own educational attainment can be varied, for instance in order to mimic the effects of a reform of the schooling system;
- a *participation-to-labor market* form, to manage the expected trend towards higher participation rates;
- an *unemployment differentials* form, for changing the estimated coefficients for the unemployment differentials among different groups of the population; this again can be used to mimic the effects of specific policies (e.g. aimed at reducing the negative effect on employability of previous unemployment spells);
- three forms for modifying the parameters governing *pension eligibility* requirements, one for each regime (defined benefit, defined contribution and mixed scheme); the default values being those currently considered by the legislation;
- three forms for setting the values of the parameters affecting the *probability of retirement*, given eligibility (one for each regime).

The output of the simulation consists of online graphics of the most relevant statistics disaggregated by gender and area. Moreover, whenever specified by the user all personal variables of all artificial individuals are recorded in each simulated year, and stored in a panel data structure in the same scenario database. LaborSim also supports a multi-run feature, to allow automatic multiple simulation runs with the same values of the parameters. The results of all simulation runs are stored with a specific run id in the same scenario database.

On a standard Mobile Intel Pentium 4 laptop with 1.8 GHz CPU and 360 MB RAM, simulating an initial population of 50,000 individuals up to 2050 takes 3.5 minutes with the online statistics only, and about 1 hour if the panel data creation option is specified (the resulting panel data has more than 2 million records).

The data used

All behavioral parameters have been estimated on waves 1993-2003 of the *Rilevazione Trimestrale delle Forze Lavoro* (RTFL), the Quarterly Labour Force Survey delivered by the Italian Central Statistical Office (Istat).

In particular, the initial population has been derived from the April 2003 RTFL wave, resampling it in order to have a database of about 50,000 individuals all with constant inflating factor. From this, at each run of the simulation a sample of variable size is extracted[6].

Unfortunately, RTFL data do not include information on seniority, which is relevant for pension eligibility. We recovered this variable with a two step process. First, we imputed the age when individuals started their work career by means of a standard regression imputation, using the European Community Household Panel as a donor (Echp, various waves). The variables common to the two datasets on which age at first job was estimated are age, education, area of residence, sector

[6] Actual simulation runs are generally based on 5,000 to 50,000 artificial individuals.

of activity, marital status and family dimension[7]. The difference between age and age at first job gives a sort of potential seniority.

In a second step, seniority was finally imputed assuming a continuing spell of participation between start of first job and end of last job, and discounting it by average yearly unemployment rates, conditional on individual characteristics.

The model structure

The simulation is made up of four modules: Demography, Education, Retirement and Employment (see Figure 5)[8]. The *Demography module* takes care of population ageing, determining the number and characteristics of newborn individuals and of individuals that leave the population, either because they migrate out of Italy or because they die. As regards individuals aged 14 and below and those aged 65 and over no other steps are needed, since they are out of the labour force.

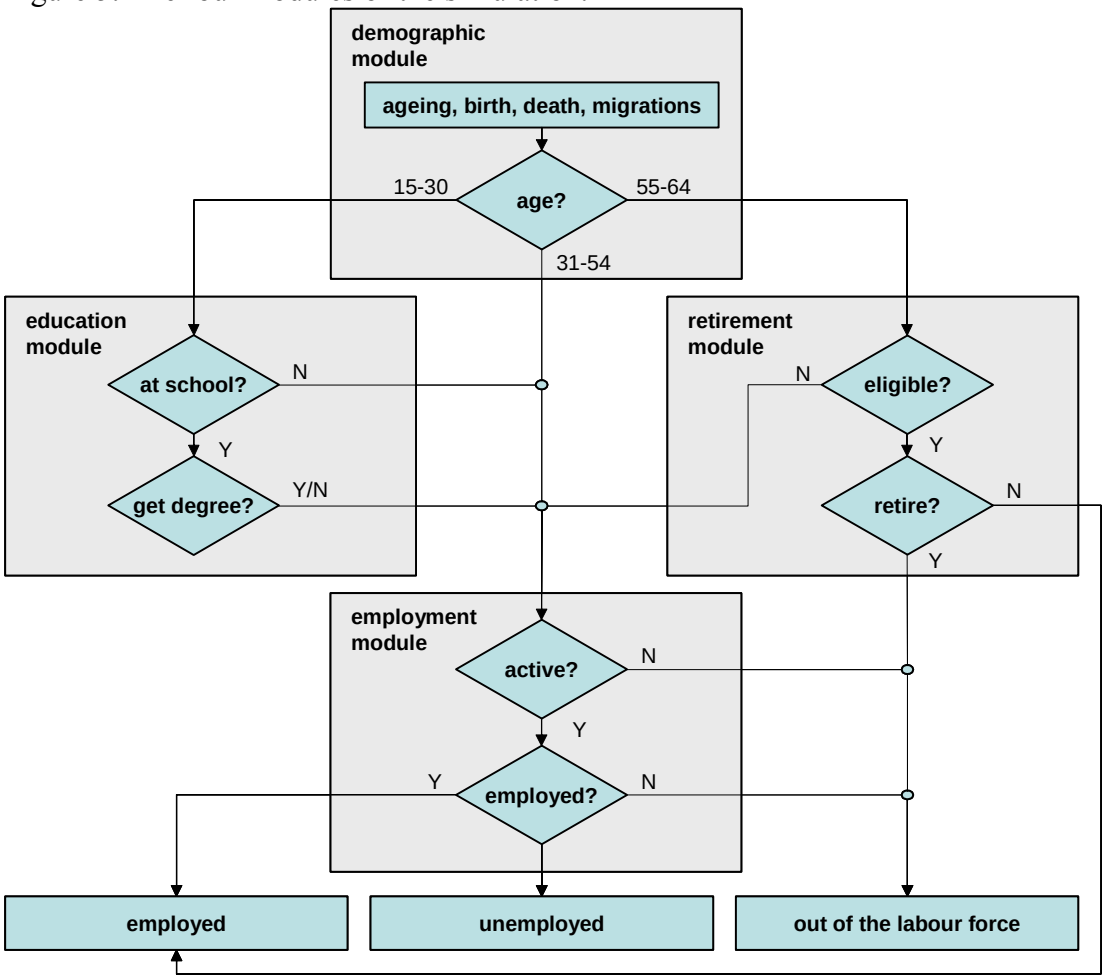
For those who are in the labour force age, we distinguish between three moments in their lifetime: youth (15-30 years), prime age (31-54 years) and old age (55-64). Young individuals decide whether to attend formal education, and – given enrolment – the event whether they get a degree is determined. This is accomplished by the *Education module*. The next module is concerned only with the elderly, and regards retirement choices (*Retirement module*). First, eligibility is checked. Eligible individuals then decide whether they want to retire or not.

Young people after 15, prime age individuals and elderly people who are not eligible enter the *Employment module* (thus, we explicitly model the case of working students). The first decision is whether to participate to the labour market. Conditional on participation, then, their employment status is determined. As regards eligible people who do not retire, we assume that they are active and employed.

[7] Pure regression imputation tends to underestimates the variance. Hence, as is standard, we added a noise term to the predicted values in order to avoid this problem.

[8] For more details on the data, model specification and estimation, and scenario parameters, see Leombruni and Richiardi (2005).

Figure 5. The four modules of the simulation.



The Demographic module

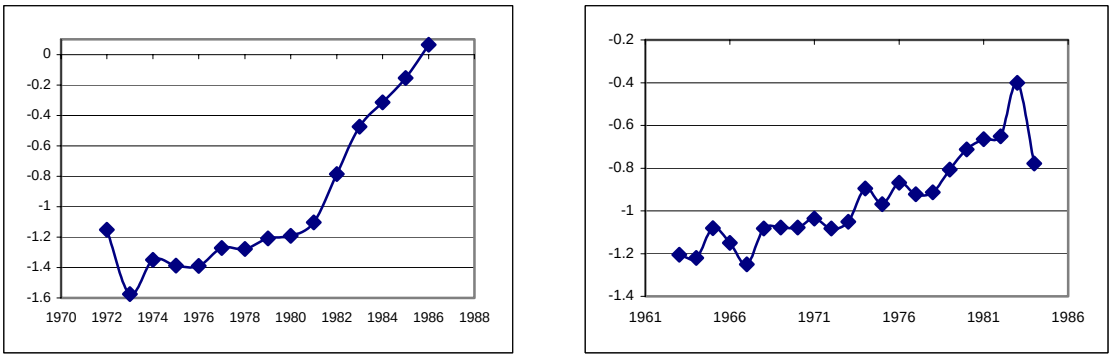
The demographic evolution of the simulated population is aligned with Istat projections by sex, age and geographic location. However, official forecasts only consider three scenarios – namely a low, central and high scenario, where all relevant variables (fertility and mortality rates, plus migrations) are changed. In order to allow for a richer scenario analysis, we extrapolated from the official

projections the separate evolution of natives and immigrants under the three hypotheses. We can thus run our experiments under nine different demographic scenarios. Our spatial analysis focuses on three macro-regions: North, Centre and South of Italy. New cohorts aged 0 identify newborn individuals. The consistency of the simulated population of natives in any sex, age and geographic class is aligned with the projections of the selected scenario by randomly removing or cloning individuals. This is equivalent to the assumption that people who move are *ex-ante* similar to those who do not move but *ex-post* similar to the people in the destination area[9], and allows neglecting the problem of internal migration. Since official statistics only provide projections on the flow of migrants form abroad, the same approach cannot be used for immigration from abroad. The flow of migrants is then evolved according to the mortality rates used by Istat. Immigrants are supposed to have the same average level of education as in the corresponding sex, age and geographical cell, and – given the level of education – to have the same probability to still attend school. We suppose that all immigrants older than 15 who are not students enter in the simulation as employed, and with a seniority of zero.

The Education module

This module is formed by two sub-modules, one for determining the status of student and the other for determining whether the individual gets his/her degree. We consider three level of education: basic, diploma and university degree. The first level is compulsory, and we model it as driven only by age. As Figure 6 shows, we detect an increasing trend towards higher participation rates, both for high school and for university. We model this trend linearly, and estimate the probability of being a student conditional on sex, age, geographical location, lagged status as student and cohort (Table 1 and 2). The reference group is composed by non-student males living in the South.

Figura 6. Cohort-effect in schooling participation rates, high school (left panel) and university (right panel). Coefficients of year-of-birth dummies in a logit regression reported.



Source: Our elaboration on Istat data, RTFL, 1993-2003

Table 1: Logit estimates for high school participation. Data: Istat, Rtfl, 1993-2003

Number of obs.	106,022			
Parameter	Estimate	Error	Chi-Square	Pr > ChiSq
woman	0.2950	0.0297	98.9079	<.0001
north	-0.1575	0.0323	23.7897	<.0001
center	0.2466	0.0428	33.1466	<.0001
lagged student	5.7608	0.0330	30411.2442	<.0001
age	3.1394	0.2329	181.6358	<.0001
age squared	-0.0919	0.00637	207.9202	<.0001
cohort	0.1137	0.00480	562.3682	<.0001
_const	-254.6	9.8287	671.1519	<.0001

[9] The alternative assumption that migrants keep their pre-migration behaviour is equally arbitrary. Note that there are extremely little data concerning the behaviour of individuals *before* and *after* migration.

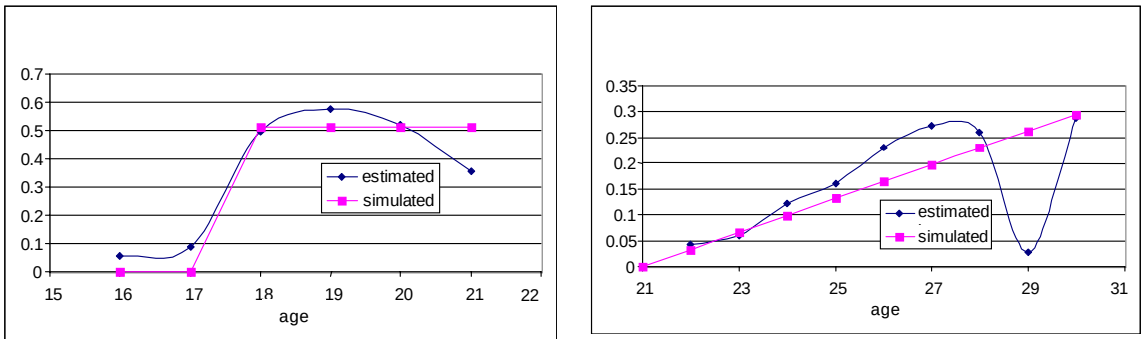
Table 2: Logit estimates for university participation. Data: Istat, Rtfl, 1993-2003

Number of obs.	167,564			
Parameter	Estimate	Error	Chi-Square	Pr > ChiSq
woman	0.2152	0.0198	118.4854	<.0001
north	-0.4721	0.0223	448.2335	<.0001
center	-0.1580	0.0272	33.7918	<.0001
lagged student	5.6032	0.0252	49629.8288	<.0001
age	1.8367	0.0475	1495.9943	<.0001
age squared	-0.0373	0.000995	1409.3989	<.0001
cohort	0.0336	0.00317	112.5205	<.0001
_const	-92.0507	6.3470	210.3386	<.0001

In the scenarios consolle we allow the user to choose a cohort after which the linear trend towards increasing participation comes to a stop.

The probability of graduating is also estimated on Rtfl data, in the period 1998-2003, conditioning only on age. Figure 6 shows the estimated probability and the approximation implemented in Labor Sim, which maintains the overall probability of getting the degree, over the age bracket considered, equal to the empirical one.

Figure 6: Probability of graduating, high school (left panel) and university (right panel).



Source: Our elaboration on Istat data, RTFL, 1993-2003

The Retirement module

This module is based on the distinction between eligibility and retirement choice. Given the Italian legislation, time, age and simulated seniority, eligibility is deterministically determined. In short, the legislation identifies three different regimes, according to seniority in 1995: the old defined benefit, pay-as-you-go scheme for workers who had more than 18 years of seniority in 1995, the new defined contributions, funded scheme for workers who started working after 1995, and a mixed scheme for workers who had less than 18 years of seniority in 1995. The detailed eligibility criteria up to the Maroni reform of August 2004 for these three regimes have been implemented.

On the contrary, the choice of postponing retirement can be affected by a number of issues. In the past, with an extremely generous welfare scheme for pension holders, most workers decided to retire as early as possible. This has in particular been true during the reform period, as workers were afraid to postpone retirement fearing that the rules could change against them. With the purpose of improving the balance of the system some proposals have been recently discussed, aiming at creating incentives to workers for postpone retirements. In order to allow the creation of flexible scenarios, we have modelled the retirement choice in an entirely parametric way: the user must specify the probability of retiring as early as possible (i.e. as soon as the individual becomes eligible) and the probability of postponing retirement until the age of 65. For These two parameters are sex, education and regime-specific. For each parameter, two values must be imputed: one for the base year, and one for the final year of the simulation. In each simulated year a linear interpolation of these two extremes is then used. The residual probability of retiring is distributed in the interval

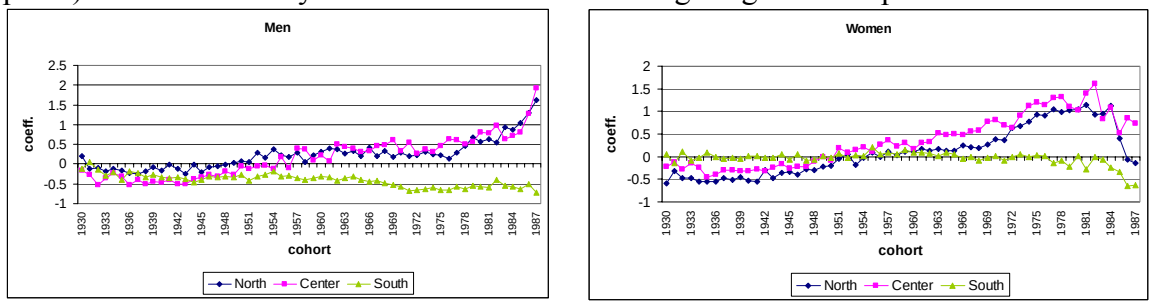
between age of eligibility and 65 according to a simple algorithm specifying that, given a cohort of individuals becoming eligible at the same age, the flow of retirement must remain constant.[10]

Employment module

The employment status of individuals is simulated in two steps: First, their participation to the labour market is decided; conditional on participating, then, the employment/unemployment status is simulated.

As already mentioned, labour market participation choices seem to entail a relevant cohort-effect, especially for women. We modelled participation as a function of lagged participation, a polynomial of age, year of birth, the status of student and the educational level, by conditioning on not being retired. The choice of a linear specification of the cohort-effect has been made after a preliminary analysis of the coefficients of specific year-of-birth dummies[11].

Figure 7: Cohort-effect in labour market participation rates, males (left panel) and females (right panel). Coefficients of year-of-birth dummies in a logit regression reported.



Source: Our elaboration on Istat, RTFL, 1993-2003

We estimated this model separately by sex and geographical area, and found significant cohort-effects in most subgroups (see Figure 7). The only exception is for the South of Italy, where the cohort-effect is less significant, and reversed. For the sake of brevity we omit to report all six sets of regression results. However, in order to give an intuition of the estimated dynamics we report the results of two additional logit regressions for the participation probability, for males and females, pooling together the three macro-areas (Table 3 and Table 4 below). The reference group is composed by non-students, low educated previously inactive individuals.

Table 3: Logit estimates for male labour market participation. Data: Istat, Rtfl, 1993-2003

```
Logit estimates                                   Number of obs   =     637423
                                                  Wald chi2(8)    =  108843.36
                                                  Prob > chi2     =     0.0000
Log pseudo-likelihood = -123089.77                Pseudo R2       =     0.5846

------------------------------------------------------------------------------
             |               Robust
       part. |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lagged part. |   2.968351   .0138102   214.94   0.000     2.941284    2.995419
         age |   .1215354   .0132734     9.16   0.000       .09552    .1475507
 age squared |   .0006595   .0003399     1.94   0.052    -6.58e-06    .0013257
   age cubed |  -.0000314   2.76e-06   -11.39   0.000    -.0000368    -.000026
     student |  -3.165786   .0284844  -111.14   0.000    -3.221615   -3.109958
     diploma |   .5887948   .0147846    39.82   0.000     .5598176    .617772
univ. degree |   .9996766   .0280698    35.61   0.000     .9446608    1.054692
      cohort |   .0040348   .0018856     2.14   0.032     .0003392    .0077305
       _const |  -11.34523   3.765515    -3.01   0.003     -18.7255   -3.96495
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[10] A more detailed description of the algorithm can be found in Leombruni and Richiardi (2005).

[11] Note that the interpretation of the dummy coefficients in Figure 7 as full cohort-effect is not straightforward, since we included the lagged participation status (which is correlated with the cohort-effect) as an explanatory variable.

Table 4: Logit estimates for female labour market participation. Data: Istat, Rtfl, 1993-2003

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Logit estimates                                   Number of obs   =     684238
                                                  Wald chi2(8)    =  230110.25
                                                  Prob > chi2     =     0.0000
Log pseudo-likelihood = -184363.12                Pseudo R2       =     0.6111

------------------------------------------------------------------------------
             |               Robust
       part. |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lagged part. |   4.354981   .0098822   440.69   0.000     4.335612     4.37435
         age |  -.2488898   .0134446   -18.51   0.000    -.2752407   -.2225389
 age squared |   .0071877   .0003326    21.61   0.000     .0065358    .0078395
   age cubed |  -.0000665   2.64e-06   -25.14   0.000    -.0000717   -.0000613
     student |  -2.109739   .0324601   -64.99   0.000    -2.173359   -2.046118
     diploma |   .8268708   .0111389    74.23   0.000     .8050389    .8487026
univ. degree |   1.586245   .0240933    65.84   0.000     1.539023    1.633467
      cohort |   .0139369   .0015227     9.15   0.000     .0109525    .0169213
      _const |  -26.74826   3.044314    -8.79   0.000    -32.71501   -20.78152
------------------------------------------------------------------------------
```

In the scenarios consolle we let the user specify the cohort after which the trend comes to a stop. However, since it is hard to believe that the weak but negative cohort-effect in the South will continue in the future, we removed the year-of-birth variable in the related regressions (both for males and females). We also added two additional convergence effects, one by gender and the other by area, that by default are set to zero. Setting them to a positive value one can choose to let participation rates in the South of Italy become closer to participation rates in the North, participation rates for women become closer to participation rates for men, or both. The user has to specify the fraction of the gap that has to be filled in each year of the simulation. This option becomes valuable for scenario analysis and policy evaluation, since it can be used to mimic the effects of specific policies aimed at increasing participation rates for subgroups of the population where they are particularly low.

Finally, we come to the employment status. As already mentioned, the microsimulation model does not model the demand side of the economy. Consequently, the employment module simply aims at reproducing the observed heterogeneity in unemployment rates across subgroups. The average unemployment rate in each simulated year is an exogenous parameter to be set by the user. To estimate the unemployment differentials we modelled the probability of becoming unemployed as a function of lagged unemployment, sex, age class (below 20, 20-50, over 50), educational level, geographical area and the average overall unemployment rate with a logit regression. We thus replaced the usual value of 1 for the constant with the average overall unemployment rate. The reference group is composed by prime age employed men living in the North with high school diploma.

Table 5: Logit estimates for unemployment. Data: Istat, Rtfl, 1993-2003

Number of obs. 860,172

Parameter	Estimate	Error	Chi-Square	Pr > ChiSq
unempl. rate	-36.4554	0.1095	110834.681	<.0001
female	0.7660	0.00872	7718.4177	<.0001
low education	0.1398	0.00912	235.2739	<.0001
univ. degree	-0.5715	0.0176	1053.8429	<.0001
center	0.2625	0.0125	444.2999	<.0001
south	1.0572	0.00962	12083.8515	<.0001
lagged unempl.	3.0731	0.00924	110652.437	<.0001
young	0.9247	0.00904	10466.5191	<.0001
old	-0.5818	0.0159	1331.7270	<.0001

4. Results

The standard scenario

Our standard scenario exactly replicates Istat central demographic projections up to 2050, i.e. we choose the central forecast both for natives and immigrants. We assume conservatively that the linear trend towards increasing participation to education ends for individuals entering high school and university in the base year, i.e. respectively born after 1990 and 1985. Analogously, we assume that the trend towards increasing labour market participation stops for individuals born after 1980. The additional convergence effects by gender and area are set to zero. The average unemployment rate is set to a constant value of 9% of the work force for all simulated years. We assume that 75% of eligible male workers in the defined benefit and mixed scheme retire as early as possible, while all remaining individuals' retirement age is distributed between eligibility age and 65 according to the algorithm explained above. This choice is motivated by what follows. The fact that the defined benefit scheme is not actuarially fair, and it is thus economically convenient to retire as early as possible, should suggest to set the share of early retirements to 100%, as done by most microsimulation models of the Italian pension system (Mazzaferro, yyyy, Vagliasindi et al 200x). However, the Maroni reform (august 2004) tried to counterbalance this bias by introducing monetary incentives in order to induce workers to postpone retirement. We suppose that these incentives are partly effective and accordingly reduce the share of early retirements to 75%.

The Maroni reform also allows women in the defined benefit and mixed scheme to retire earlier by switching to the defined contribution scheme, that is by accepting a lower pension. We suppose that only a few women will actually choose this opportunity and assume that only 30% of eligible female workers retire as early as possible. The probability of postponing retirement as much as possible is assumed to depend on education: 10% for women with low education, 20% for women with a high school diploma and 30% for women with a university degree.

Finally, the defined contribution scheme is roughly actuarially fair and thus does not provide incentives either towards early or towards late retirement. For workers belonging to this regime we assume that the probability of retiring as early as possible decreases with education, irrespective of gender: 50% for the low-educated, 40% for those with high-school diploma and 30% for those with a university degree. Correspondingly, the probability of postponing retirement as much as possible is assumed to increase with education: 10% for the low-educated, 20% for those with a high school diploma and 30% for those with a university degree. Table 6 summarizes. All these values are assumed to remain constant for all simulation periods.

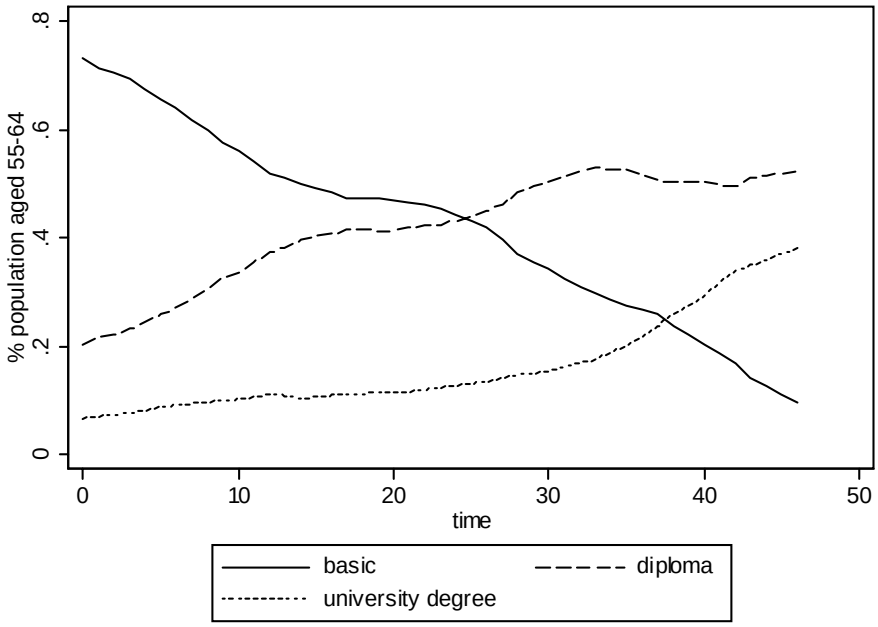
Table 6. Standard scenario parameters.

	Men			Women		
	Education					
	Basic	High-school	University	Basic	High-school	University
Defined benefit & Mixed						
% early retirement	.75	.75	.75	.30	.30	.30
% late retirement	0	0	0	.10	.20	.30
Defined contribution						
% early retirement	.50	.40	.30	.50	.40	.30
% late retirement	.10	.20	.30	.10	.20	.30

Education

The graph below shows the evolution of the distribution of educational levels in the standard scenario.

Figure 8. Evolution of the educational attainment distribution in LaborSim standard scenario, people aged 55-64.



Source: LaborSim standard scenario.

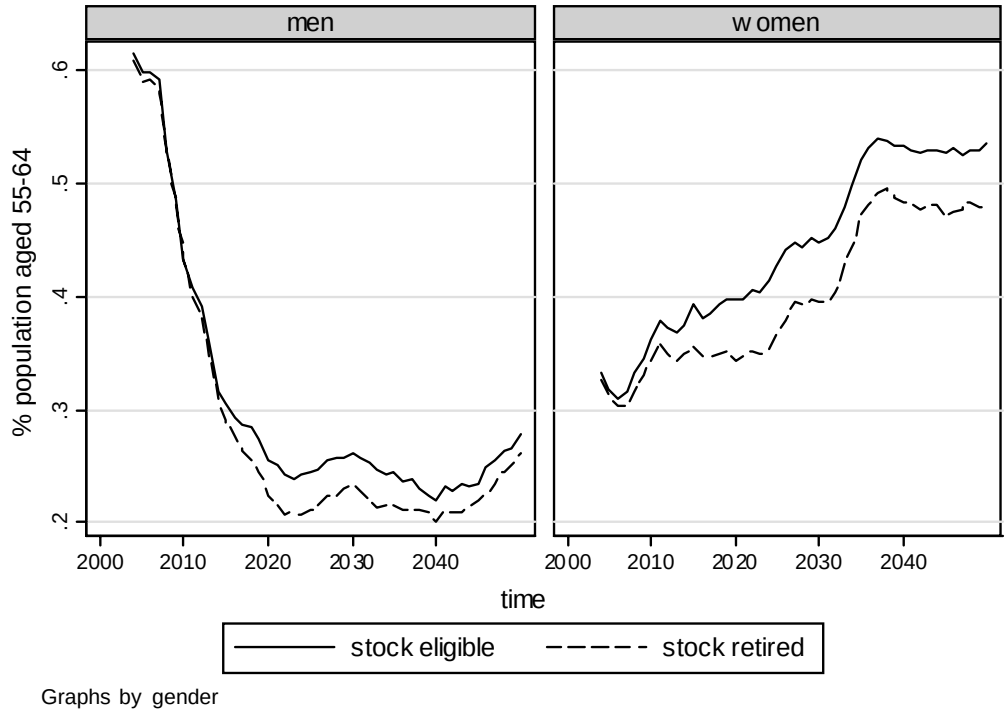
Even if the trend towards higher participation to the educational system has been stopped for the future, the simple demographic effects of younger cohorts replacing older ones with lower education are important. The share of people having attainted a university degree is expected to rise to over 20% of the population by 2040.

Retirement

The effects of the reforms of the pension system undertaken in the period 1992-2004 are clearly visible in the left panel of Figure 9, which depicts the share of eligible and retired workers in the age bracket 55-64. The different figure for women can be explained (a) with the differences introduced by the Maroni reform in the eligibility requirements for men and for women (more generous for the latter), and (b) with the increasing female participation rate that will be documented in the next section, which raises the number of women who can claim a pension. Note that as the share of workers belonging to the defined contribution scheme increases, the gap

between people who *can* retire and people who actually *choose* to retire increases. This is due to the different values of the parameters governing retirement choice for the two regimes (see table 2 above), which account for the waning of the bias towards early retirements implicit in the legislation.

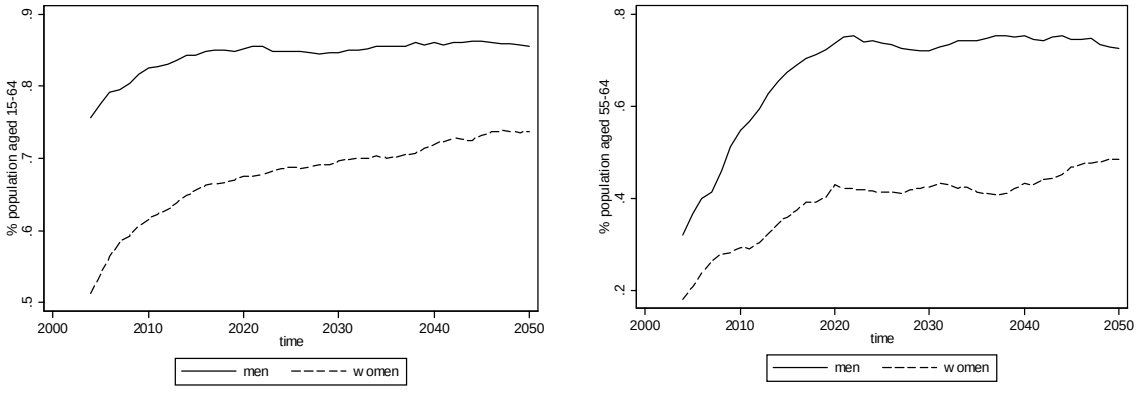
Figure 9. Share of eligible and retired workers in LaborSim standard scenario, people aged 55-64, by gender.



Participation

Higher education people tend to participate more to the labour market. Thus, the effects of the changes in the composition of the working age population described above, together with the effects of tightening requirements for retirement and the replacement of older cohorts with younger ones, imply higher participation rates. This holds even without extending the estimated trend towards higher participation rates beyond the level reached by younger cohorts in the initial population.

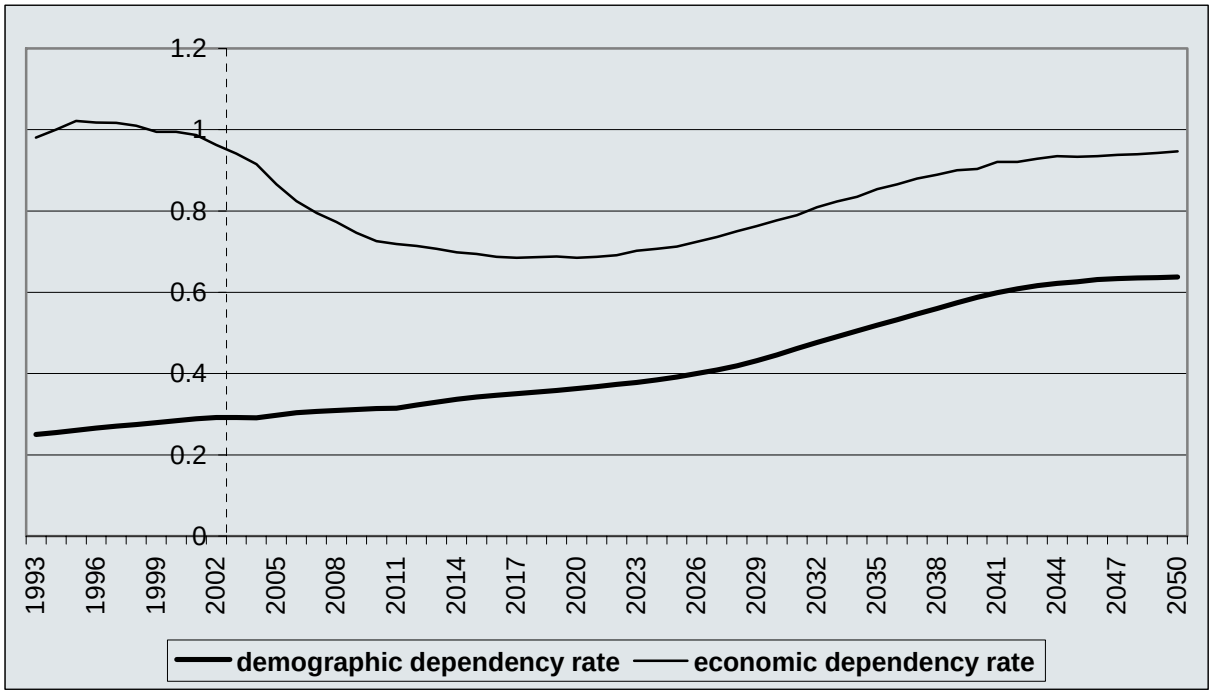
Figure 10. Projected participation rates as share of population in working age (left panel) and of population aged 55-64 (right panel) in LaborSim standard scenario.



Note that these projections, although based on conservative assumptions, are much more optimistic than those generally available in the literature. In particular, according to this scenario Italy will be able to meet the target of a female participation rate of 60% by 2010, set by the Lisbon (march 2000) and Stockholm (march 2001) European Councils , while the participation rate for men will be well above the target of 70%. The goal of an overall participation rate above 50% for workers aged 55-64 will not be met by 2010, due primarily to the legacy of a very low participation rate for elder women today. However, it is expected to be achieved by no later than 2015. Finally, the participation rate for elder women is expected to rise to almost 50% by 2050.

These forecasts have a clear implication for the evolution of the economic dependency rate, defined as the ratio between people not in the labour force and people in the labour force. Despite continued population ageing[12] we expect the economic dependency rate to *fall*, until the 'baby boom generation' of the 60s and early 70s enters retirement age.

Figure 11. Demographic and economic dependency rates, historical (left of dashed line) and in LaborSim standard scenario (right of dashed line).



Conclusions and further developments

In this paper we have presented Labor Sim, a dynamic ageing, discrete-event, probabilistic agent-based microsimulation model of labour supply, and an application to Italy. The Italian case is interesting because of the combination of rapid population ageing and low participation rates of the elderly. Due to these two causes, it is generally argued that Italy will experience a sharp decline in the labour force in the forthcoming decades, with a consequent increase in the economic dependency rate (the ratio of inactive to active people). In contrast, we showed that changes in the retirement legislation, in educational choices, in the working careers, in the participation behaviours of women will countervail the demographic ageing of the population, allowing Italy to broadly meet the Lisbon targets.

However, the welfare implications of these projections have not been addressed. Old people will work more in the future, and as a consequence they will impose a lower burden on younger

[12] measured for instance by the demographic dependency rate, defined as the number of people aged less than 15 or more than 64 over the number of people aged 15-64.

generations. However, these people could possibly be worse-off with respect to old people now, stay at work at later ages possibly reflecting both a choice and a necessity. That is, many people will choose to study more, thus delaying their entrance in the labour market. On the other side, due to a less favourable pension regime people will need to work more in order to sustain their income. Moreover, if the trends toward a reduction in family size and an increase in job precariousness that can be detected in the data will continue, intergenerational solidarity could be affected (in either way: from young to old people and vice-versa), with significant welfare implications.

In order to investigate these issues it is necessary to explicitly model income and family networks. We thus plan to include new modules in Labor Sim, to deal with wages, pensions and family evolution.

The modular structure of Labor Sim, as the separation between the code and the input data, allow for an easy application of the model to different national contexts. We thus plan to use Labor Sim for cross-country comparisons, and for the evaluation of policy proposals both at a national and at a EU level.

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