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DIFFERENTIAL MORTALITY AND REDISTRIBUTION IN THE ITALIAN NOTIONAL DEFINED CONTRIBUTION SYSTEM

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Abstract

In this paper we assess, through a financial measure (Net Present Value Ratio), the extent of the lifetime earning redistribution operated by the Notional Defined Contribution in a sample of individuals representative of the Italian population born from 1975 to 2000. Controlling mortality by the level of education we identify at least three channels of redistribution: among genders (from men to women), along educational lines (from low to high educated) and among income quintiles (from poor to rich). This happens because some groups systematically live less than average (men, low-educated and poor) while others live more than average (women, high educated and rich). This finding is not trivial: even if the NDC system assure long term financial sustainability, it harms the most disadvantaged groups like poor and low-educated people.

JEL classification: H55, J14

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1. Introduction

The 1995 reform of the Italian Social Security System introduced a notional defined contribution (NDC) system that will have important consequences both under the macroeconomic point of view, ensuring in the long run the system financial sustainability, and under the microeconomic point of view, affecting future both retirees' income distribution and individual's retirement decisions.

In the economic literature the NDC system is considered to be "actuarially fair" (or, fairer than a defined benefit one) [Castellino and Fornero 2001]: it should equalize, for each individual, the present value of benefits (PVB) to the present value of contributions (PVC). Once an individual reaches the retirement age, his/her cumulated contributions are converted into a stream of monthly benefits according to a conversion factor: under the Italian law (L. 335/95) this factor called "coefficiente di trasformazione" (common for both sexes and forecasted to change every ten years in order to compensate expected increase in life expectancies) takes into account the *average* life expectancy at retirement age. However, since the PVB depends on the *actual* life length at retirement, actuarial fairness, among individuals that belong to a certain generation, will occur only for those who happen to live as long as the average individual does. For the others, the system is "unfair": the pensioners who die earlier then the mean will incur in a "waste" of resources, while those who die later will have a "gain"[1].

Since life expectancy is affected by socio-economic determinants, like level of education, sex and occupational status, there are groups of individuals whose life expectancy is higher or lower than the mean. In a certain sense this should not be a surprise since the inherently insurance characteristics of the NDC system. However there might be systematic, even if unintended, redistribution of lifetime resources among different groups of

[1] Among losers, one has also to consider all individuals that paying contributions to the pension system occur to die before the age of retirement.

the population if life expectancy at retirement and lifetime income ranking happens to be positively correlated.

The aim of this article is to assess, through a financial measure, the extent of this phenomenon in a sample of individuals representative of the Italian population born from 1975 to 2000, whose pension benefit will be computed under the new regime (NDC) introduced in 1995. We will use CAPP_DYN, a dynamic microsimulation model developed at CAPP (Centro di Analisi delle Politiche Pubbliche – Center for the Public Policies Analysis): this model allows scholars to study the long-term redistributive effects of the pension system and its reforms (Ministero del lavoro e della previdenza sociale 2005, Ministero della solidarietà sociale 2008). Actuarial fairness will be evaluated applying a new demographic module which explicitly takes into account the estimated differences in mortality due to educational attainment.

A first contribution of the paper is the building of differential mortality tables for Italy.

Secondly in order to assess the redistribution of lifetime resources within the NDC system in the presence of differential mortality we compute the *Net Present Value Ratio* (*NPVR*), defined as the ratio between the PVB and the PVC for each individual of the sample.

Controlling for educational level and for quintiles of Average Indexed Yearly Income we find that the NDC system determines a substantial regressive redistribution of lifetime resources within each cohort and sex. These results pose a problem under the economic policy point of view, since the NDC system ends up transferring money from poor and low educated people to rich and high educated ones: a result that contradicts not only the progressivity of the system but also its claimed neutrality.

2. Education and Differential Mortality

Mortality can be differentiated provided many socio-economic indicators, such as income, wealth, education, professional status: we adopt education as our preferred indicator. That is because education is not correlated with health, so it is not affected by simultaneity problems (unlikely income: an individual can have higher mortality risk because of his poverty, but he can be poor because already in a bad health status). Moreover, since education and life-cycle income are positively correlated, educational level can be also interpreted as a proxy of the individual's lifetime resources. Additionally, unlikely professional status (blue or white collars, for example), education enables to study even individuals outside the job market. Under this point of view, educational level would have a mediate and indirect effect on mortality, due to the correlated variables like income and wealth. On the other hand, qualification synthesizes the human and cultural capital owned by individuals: "virtuous" behaviours (such as foresight, patience in delaying satisfaction, awareness of some dangerous habits like smoking) are more likely associated with high school attainments. These are direct effects, which must be considered with the indirect ones.

Empirically, there is large evidence that life expectancy is increasing in educational levels.

Coding schooling years in four classes (less than 7; 8; 9 to 12; more than 13), among those aged 65-74 mortality rate[2] is 4,23% for an American man in the bottom educational class, and 2,69% for the top class, while women's figures are respectively 2,36% and 1,45% [Preston and Elo 1995].

Brown [2002], after having computed *ad hoc* group-specific mortality tables, finds that the life expectancy at age 22 is 80,5 years for a white graduated man and 75,5 years for a white man with less than High School education. The same patterns are found even within the others racial groups: so the difference in life expectancy amounts to 3 years between the most and least educated white females, 6,5 years within black men and 4,5 years within black women.

[2] This indicator is the *crude death rate* defined as $m = \frac{n}{p} \cdot K$, where *m* is the rate, *n* is the number of events (in our case, deaths), *K* is a proportionality factor e *p* is the benchmark population.

It is a well-known point that in Italy there is not any national longitudinal survey on differential mortality across socioeconomic groups[3]. However, on 2002, the Italian National Institute of Statistics (ISTAT) published the second edition of a transversal study [ISTAT 2001]. This survey uses 1981 and 1991 census data and (although it does not provide differentiated mortality tables), estimates crude and standardised mortality rates depending on classes of age[4]. Taking a glance, the ISTAT study finds mortality differential for educational level to be very strong in Northern Italy and in the first class of age (18-59): let 100 be the average standardised rate, regardless of education, un illiterate man faces a rate of 188, while a graduate coetaneous only 47. For younger northern men, mortality rates at the bottom of educational level are four times as much as those at the top [ISTAT 2001, pp. 17 e ss.].

Giving a broader description, men's relationship between education and mortality is "regular": it favours degree or high school diploma holders (172 for illiterates, 102 per lower secondary school, 52 for graduates; elderly people show an analogous trend, with a smaller extent). The phenomenon among women is slightly different: gaps are far smaller (for example, the difference between degree and secondary school is very little for the younger, and negligible for the elderly)[5].

A first attempt to analyse life expectancy at certain age by level of education has recently been made by Maccheroni [2008]. He uses death certificate and census data as sources of information, and adopts econometric

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[3]There are only local longitudinal enquires, covering determined areas like Turin, Tuscany or Reggio-Emilia.

[4] Crude rates are calculated dividing deaths occurred in a class of age by the relative stock of population. However, it could be tricky to make comparisons among different countries or group, because of (possible) different demographic structure of the population. For example, if a population is older than another one, it will show higher mortality rates, partly due to the different demographic structure and partly to the actual conditions of life. In order to avoid this bias, standardised rates are used: they say what the mortality rates would have been if the population's age distribution was equal to a standard population's distribution, previously defined. Standardised rates allow comparisons across space and along time.

[5] The most accepted explanation calls the differences in the major causes of death in the two genders. Men's most common fatal disease, lung cancer, is negatively correlated with education, while women's one, breast tumour, is positively associated with educational level (probably because of the "renounce" to some protective factors, such as early pregnancy and breast-feeding [Candela S. *et al*. 2005]).

techniques to obtain differentiated mortality tables. Maccheroni finds that difference in life expectancy at 35 years between high and low educated people is 7,6 years among men and 6,5 among women, while at 65 years these values are respectively 5,5 and 5,3 years. According to Maccheroni, men's figures are consistent with those shown by the international literature, while differential mortality among Italian women appears to be higher than that previously supposed [ISTAT 2001; Candela S. *et al*. 2005].

3. Mortality, Progressivity and Redistribution

The most used measure to judge the intergenerational redistribution operated by a pension system is the Net Present Value Ratio (NPVR) defined as the ratio of the present value of benefits received to the present value of contributions paid during lifetime, each evaluated at retirement age. The denominator of this indicator can be seen as the premium an individual pays to purchase an annuity which lasts as long as the individual lives (Brown 2002). *NPVR* for a *i* individual at time t can be written as:

$$NPVR_{i,t} = \frac{\sum_{t=1}^{T} \frac{P_{i,t} S_{i,t}}{(1+r)^t}}{premium} \quad (1.1)$$

where $P_{,t}$ is the pension benefit at time t, $S_{i,t}$ represents the probability of living to period *t*, *T* is the maximum life span and *r* is the real discount rate. The interpretation of (1.1) is straightforward: if NPVR equals to 1, in actuarial terms, the individual receives the same amount of money that he/she has paid as social security contributions. If NPVR is higher (smaller) than 1, the individual faces an expected gain (loss). Another way to look at this measure is to interpret it as the return of each present value euro paid (i.e., if NPVR equals to 0,91, it means that the individual will receive 91 cents back each euro he/she has contributed for).

The relation between differential mortality and returns form the Social Security system has been studied above all in the U.S. The public pillar of the U.S. pension system is formally progressive: it combines a flat payroll tax with a benefit formula which replaces a higher share of earnings for workers with low lifetime earnings. However, part of this progressivity can be offset by differential mortality: once the latter is taken into account, is the system still progressive?

Liebman [2002] analyses the cohort born from 1925 to 1929 and estimates the internal rate[6] of return by sex, race and education. Main results of this work are displayed in Table 1.

Table 1
Impact of differential mortality on Internal Rate of Return, by race and education. USA.

INTERNAL RATE OF RETURN (%)		
	Including mortality due to race and education	*Omitting* mortality due to race and education
White	1,52	1,59
Black	1,64	2,19
Less than High School	1,63	1,88
High School	1,46	1,52
More than High School	1,46	1,35

Source: Liebman [2002].

With respect to the case of uniform mortality (second column), the introduction of differential mortality have significant effects on IRT of those people with higher mortality rates, such as blacks and low-educated

[6] The *Internal Rate of Return* (IRR) is defined as the rate that makes the present value of benefits equal to present value of contributions. *IRR* and *NPVR* provide the same information, since the *IRR* is the value of *r* that makes the *NPVR* in (1.1) equal to 1.

individuals. The former receive an IRT of 1,64% (it would have been 2,19% if differential mortality had not had effects), the latter have a return of 1,63% (instead of 1,88%). High-educated people are the only "winners" by means of differentiated mortality: their IRT increases from 1,35 to 1,46%. Liebman classifies individuals by Average Indexed Monthly Income, defined as lifetime earnings divided by the number of years with positive earnings, as well: he finds that top and bottom quintiles receive respectively a *Net Present Value Ratio*[7] of 0,86 and 1,41 with uniform mortality rates, while with group-specific mortality these figures are 0,87 and 1,38. Therefore, everything being equal, differential mortality ends up redistributing money from low-income-education people to those with both high income and education.

Brown [2002] focuses on the redistribution that occurs within a Notional Defined Contribution (NDC) system, very close to the Italian pension system introduced in 1995. Next table shows Brown's findings with an interest rate of 3%.

Table 2
NPVR by sex, race and education. USA (computing pensions under the Notional Defined Contribution System).

Population subgroups	Men	Women
All	0,920	1,076
Whites: All	0,927	1,084
Less than High School	0,865	1,044
High School	0,916	1,080
Degree	0,967	1,106
Blacks: All	0,862	1,022
Less than High School	0,800	0,976
High School	0,857	1,022
Degree	0,916	1,055

Source: Brown [2002].

7 In order to sterilize inter-cohort transfers, Liebman uses the cohort's internal rate of return (1,29%) as real interest rate to compute NPVR: see equation (1.1).

The first thing to note is the large resource transfer from men to women: because of different mortality, for every dollar paid to purchase the annuity, a man expects to receive 92 cents and a woman can expect $1,076. Large gaps arise even within racial groups: there are 10 points difference between top and bottom educated among white males, 6 points for white females, 11 and 8 points among, respectively, black males and females. Concluding, black men with less than High Schools are the largest "losers" (NPVR=0,800), while white graduated women are the largest "winners" (NPVR=1,106).

Outside U.S., Nelissen [1999] investigates Dutch case. Although Holland is among the countries with lowest differential mortality (along with Sweden, Denmark and Norway). He estimates that high-educated people have a life expectancy at birth 4,5 years higher than low-educated ones. Therefore, an individual with a low educational level, compared with the average individual, faces a loss of 6% in his permanent income (lifetime earnings and pension benefits).

Turning to Italy, Caselli *et al.* [2003] study the link between life expectancy and conversion factors at regional level. They compare legislated factors (which guarantee actuarial fairness on average) with those that would be necessary to assure actuarial fairness in each of the four regions considered.

A positive (negative) deviation means that estimated-regional factors are higher (smaller) than legislated-national ones: it follows that these individuals' pensions should be higher (smaller) than the actual, in order to achieve actuarial fairness. Therefore, "loser" regions are Campania and Lombardy (whose estimated conversion factors are respectively 4% and 1,5% higher than legislated ones); Calabria roughly reflects Italian mortality, so its pensioners neither gain or lose with legislated factors; Tuscany shows negative deviation percentages that make its retirees the "winners" in the current pensions system.

Table 3
Legislated (Italy) and estimated (Regions) conversion factors.
"*Deviation*" refers to the percentage difference between estimated and legislated.

Region	60 years old	65 years old
Italy	0,05163	0,06136
Lombardy	0,05240	0,06222
deviation	*1,5%*	*1,4%*
Tuscany	0,05096	0,06037
deviation	*-1,3%*	*-1,6%*
Campania	0,05359	0,06394
deviation	*3,8%*	*4,2%*
Calabria	0,05154	0,0629
deviation	*-0,2%*	*-0,1%*

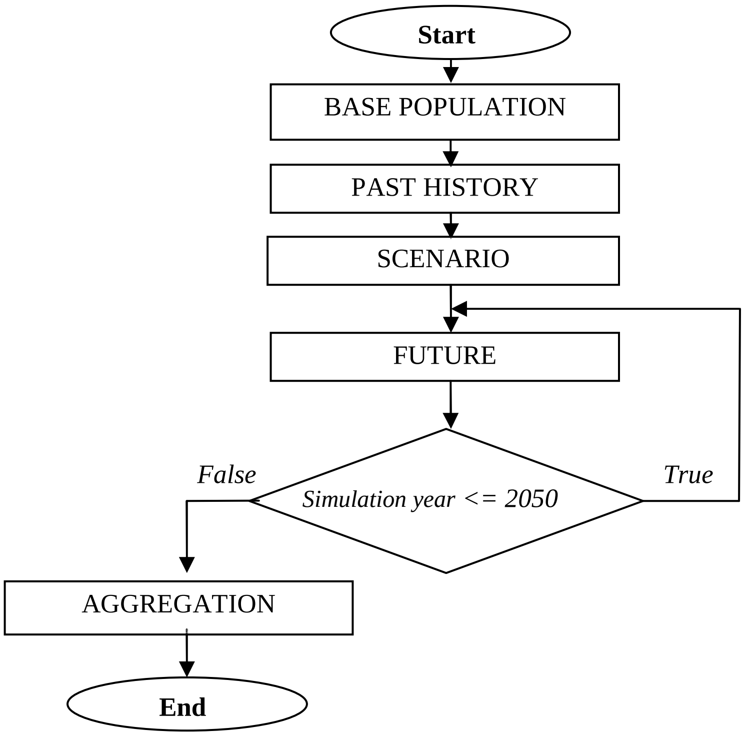
Source: Caselli *et al.* [2003].

4. The model

All the simulations presented in this paper are performed using CAPP_DYN (Mazzaferro and Morciano, 2008), a dynamic microsimulation model of the Italian population developed at the Centro di Analisi delle Politiche Pubbliche (CAPP), a joint research centre for the analysis of public policies, run by the Universities of Modena and Bologna. The model simulates the main characteristics of the Italian population from 2005 to 2050. Fig. 1 shows the structure of the model: there is an initial base population, a second block which estimates past earnings of the currently active population, a simulation cycle which determines the future evolution of the population, and a final output where all annual cross–sectional data are aggregated into a single panel.

Figure 1

The structure of the CAPP_DYN model



The initial population is taken from the 2002 wave of the Bank of Italy Survey of Households Income and Wealth (SHIW_02), a dataset comprising 8001 households and 21,400 individuals, which has been resampled and inflated. Any simulation randomly extracts a sample of 107,000 households and 270,000 individuals.

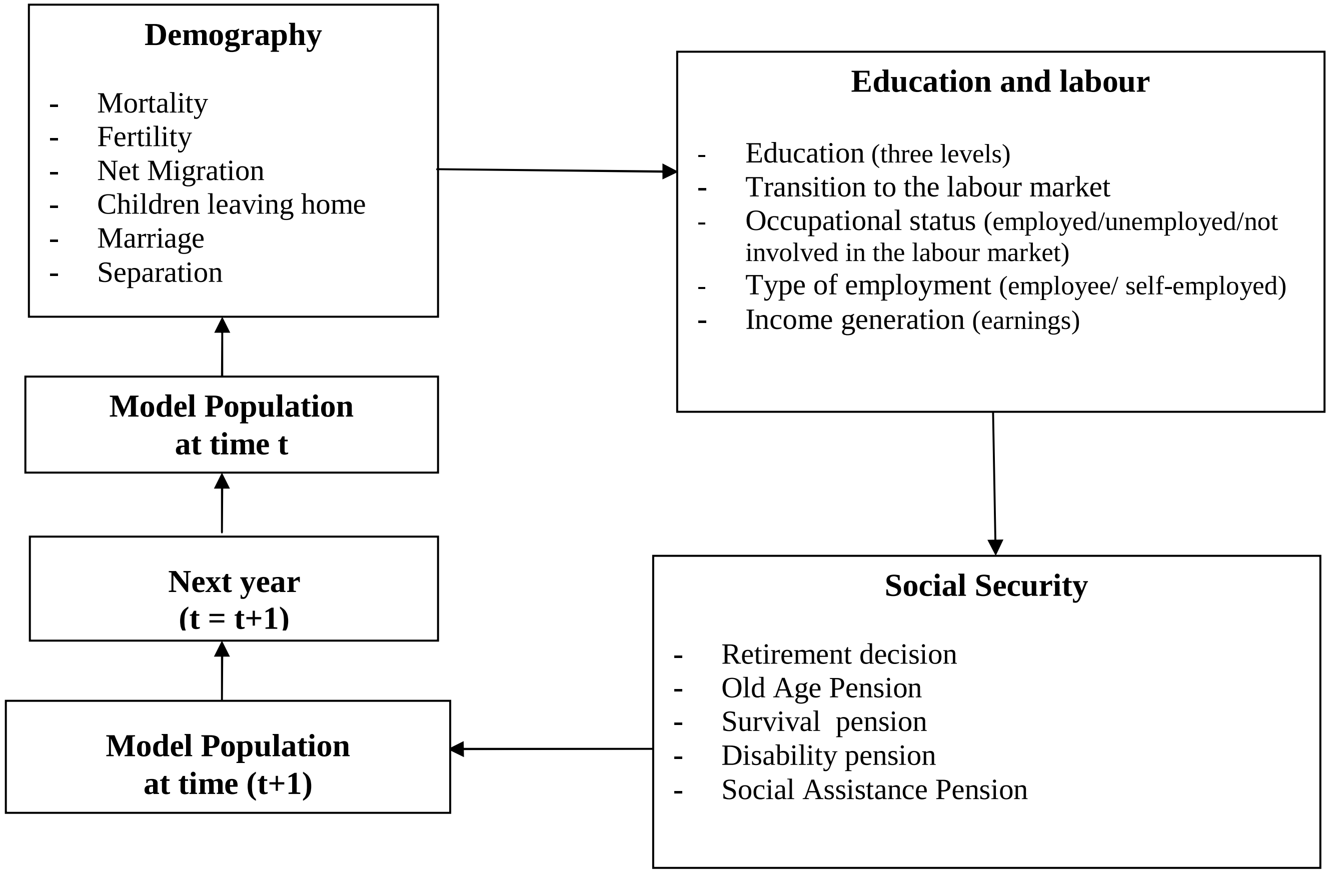
While the unit of simulation is the individual, we nevertheless keep information on family structure and any changes this may be subjected to over the course of time. All individuals in the sample are involved in a considerable number of demographic and economic events, such as birth, education, marriage, work, retirement and death. Economic and demographic transitions among states are simulated using Monte Carlo processes. A set of matrices and econometric models are employed to generate transition probabilities, so as to produce a lifetime pattern of education, work, career, personal and family income, and so on, for each individual in question.

The CAPP_DYN model has a recursive structure consisting in a set of modules executed in a predetermined order. The structure of these modules is shown in Fig. 2. The simulation starts with a set of demographic modules (mortality, fertility, net migration, household structure, divorce). These are followed by a module for educational choices. The next module deals with job decisions and the estimation of earnings. Each individual may change occupational status (full time, part-time, out of the labour market, unemployed) during his/her lifetime. Finally, each individual, on the basis of the current pension laws, of his/her accrued seniority and of the legal retirement age, moves towards retirement.

Individual income comes from employment or from the social security system. For employed people, an earnings equation is used to estimate lifetime labour income. For retired individuals we compute occupational, survival and social-flat rate benefits, taking into account the rather complex nature of the Italian pension system, as far as possible.

With respect to the standard version of the model the novelty of the estimations presented in this paper concerns the mortality module. The technical working of the mortality module is the following: as usual, given the year of simulation, age and gender, a random number drawn from a uniform distribution [0,1] is attached to each observation. If the random value is smaller than the age-cohort specific ISTAT death probability, then the model simulates death and consequently modifies the cohabitant's marital status. However, using differentiated mortality tables that we will describe in the next subsection, we are able to apply a different pattern of the mortality to individuals with respectively a low a middle and a high level of education.

Figure 2 The modules of CAPP_DYN



5. Differential mortality

Differential mortality tables are currently not available in Italy. This subsection describe the procedure adopted to estimate them from available data.

First, we compute group-specific crude mortality rates, using data from death certificates and labours surveys and controlling for sex and three different level of education; then, we estimate relative risks, dividing each group-specific mortality rate by the general mortality rate; finally, we obtain differentiated death probability multiplying our relative risks to the general age-related death probability. An important hypothesis has been introduced: mortality differentials, in relative terms, stay constant across all generations[8].

Let $\overline{q}_x$ be the death probability of a man[9] aged x, regardless of his education. We can write:

(1.2)
$$q_x^{\alpha} = RR_x^{a} \cdot \overline{q}_x$$
$$q_x^{\beta} = RR_x^{\beta} \cdot \overline{q}_x$$
$$q_x^{\gamma} = RR_x^{\gamma} \cdot \overline{q}_x$$

where RR_x^i represents the group-specific relative risk (for instance, the 70% more than average for an illiterate man, or the 30% less for a graduate) for the age *x*, and the apexes α, β, e γ refer respectively to an individual with low, middle and high education.

The first step is to compute group specific mortality rates. Mortality rates are expressed as

(1.3)
$$m_x^i = \frac{n_x^i}{p_x^i} \cdot K$$

where *n* is the number of deaths, *p* is the benchmark population, *K* is a proportionality factor (we set *K*=10.000), *x* refers to age and *i* to the

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[8] Roughly speaking, if a 40 years-old graduate man faces a death risk 30% less than average, this 30% difference will come out even for the 40 years-old born ten, twenty years later and so on.

[9] Women's procedure is identical. We deal with men for sake of simplicity and to avoid the abuse of apexes and subscripts.

educational level. The sources of data are the death certificates provided by ISTAT[10] (for the numerator *n*) and the Surveys on Labour[11] (for the denominator *p*). Since the classes of education in these two sources do not perfectly match, we have re-aggregated them to make our calculations consistent with the CAPP_DYN education module (Mazzaferro and Morciano 2008).

Each individual, in the model, can reach three different levels of education: compulsory education (formally achieved at 16 years old, but actually many pupils drop out earlier), high school, and university degree. Therefore, we aggregate available data according to these three levels, as it can be seen in the next table.

Table 4
Re-aggregation of classes of education of the ISTAT death certificates.

Our classification (CAPP_DYN)	Degree	High School	Less than High School			
Death Certificates	Degree	High School		Lower Secondary	Primary	Unknown
Survey on Labour	PhD, Degree	High School	Professional Institutes[12]	Lower Secondary	Primary, none	

Table 4 summarizes our classification. Data regarding death certificates contain about 15% of individuals whose level of education is unknown: we decide not to impute them to other levels, and to subtract these observations from the total[13].

We now have, for each sex, level of education and class of age (five-year classes from 15 to 74 years, and an open class from 75 onwards), the number of deaths and the respective stock of population.

[10] ISTAT (2005), *Decessi: caratteristiche demografiche e sociali. Anno 2001*, Roma.
[11] Rilevazione Continua sulle Forze di Lavoro - Media 2001.
[12] They usually last 3 years (instead of 5) and do not allow to enroll at University.
[13] For a discussion on how to treat unknown data, see Maccheroni [2008, pp. 3-6].

Table 5 shows crude mortality rates computed in this way.

Table 5
Crude Mortality Rates (per 10.000 persons), by education and class of age.

Class of age	Men				Women			
	< High School	**High School**	**Degree**	***Total***	**< High School**	**High School**	**Degree**	***Total***
15-19	4,99	6,70	0,00	*5,14*	1,96	2,29	0,00	*2,00*
20-24	12,18	4,63	8,86	*7,97*	4,18	1,56	2,36	*2,43*
25-29	12,23	4,45	3,64	*8,17*	3,89	1,79	1,54	*2,66*
30-34	11,45	4,45	2,40	*8,12*	4,52	2,54	1,40	*3,42*
35-39	14,26	6,10	3,60	*10,73*	6,17	4,21	2,28	*5,13*
40-44	18,83	8,60	6,23	*14,31*	9,52	6,79	4,07	*8,17*
45-49	29,39	13,99	12,03	*23,10*	14,72	10,01	8,00	*12,96*
50-54	46,83	23,56	19,49	*38,72*	22,88	15,62	12,43	*20,86*
55-59	75,23	40,60	31,88	*65,66*	34,37	20,28	18,92	*31,83*
60-64	117,52	56,83	44,12	*104,80*	51,72	33,63	21,14	*49,07*
65-69	194,14	98,61	85,23	*179,91*	86,94	51,07	37,12	*83,38*
70-74	317,31	175,13	172,48	*298,31*	152,09	90,55	57,07	*146,30*
75+	878,37	466,11	457,90	*828,44*	670,78	357,81	241,23	*650,03*
Total	*142,18*	*24,66*	*40,22*	*104,71*	*132,03*	*15,28*	*14,29*	*97,48*

Source: our calculation on ISTAT data.

Important differences arise when we take into account schooling years. A graduated 60-to-64 years-old man has a rate of 44,12, and a man who did not get the High School diploma 117,52 (more than double the amount of the former). Similar pattern are observed among women.

The second step is to derive relative risks, that is to say the *RR* terms in (1.2). For each gender and class of age, we divide the three group-specific mortality rates by the total population's rate. We do not consider the class 15-19, since no one can graduate by that age, and we ignore the open class 75+, because it covers too many years. Finally, for years from 100 to 120, we impute relative risks of 1: we assume that at very old age educational levels do not matter anymore, death being unavoidable. This assumption is consistent with the empirical findings presented above.

Relative risks we estimated are shown in table 6.

Table 6
Relative Risks by education and class of age.

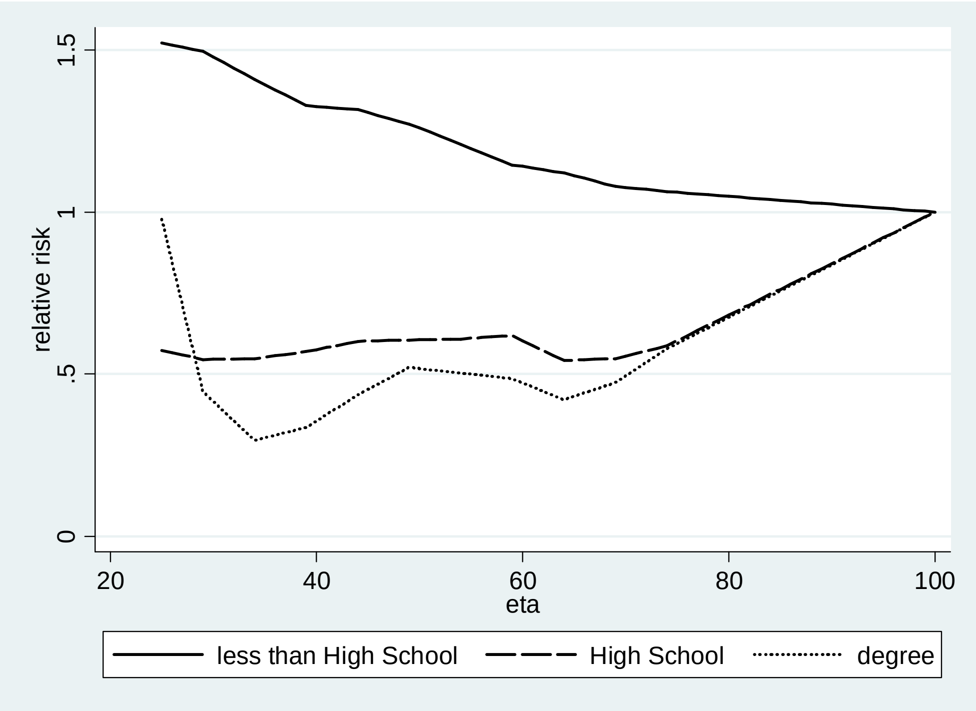
Class of age	Men			Women		
	< High School	High School	Degree	< High School	High School	Degree
20-24	1,528	0,581	1,112	1,717	0,642	0,970
25-29	1,497	0,545	0,446	1,461	0,671	0,578
30-34	1,410	0,548	0,296	1,320	0,741	0,410
35-39	1,329	0,569	0,335	1,203	0,821	0,445
40-44	1,316	0,601	0,436	1,166	0,831	0,498
45-49	1,272	0,605	0,521	1,136	0,772	0,617
50-54	1,210	0,609	0,503	1,097	0,749	0,596
55-59	1,146	0,618	0,486	1,080	0,637	0,594
60-64	1,121	0,542	0,421	1,054	0,685	0,431
65-69	1,079	0,548	0,474	1,043	0,613	0,445
70-74	1,064	0,587	0,578	1,040	0,619	0,390
100+	1,000	1,000	1,000	1,000	1,000	1,000

Source: our calculation on ISTAT data
Note: Ratio of subgroup male (female) mortality to general population male (female) mortality. Relative Risks of 1 are imputed for ages ranging from 100 to 120.

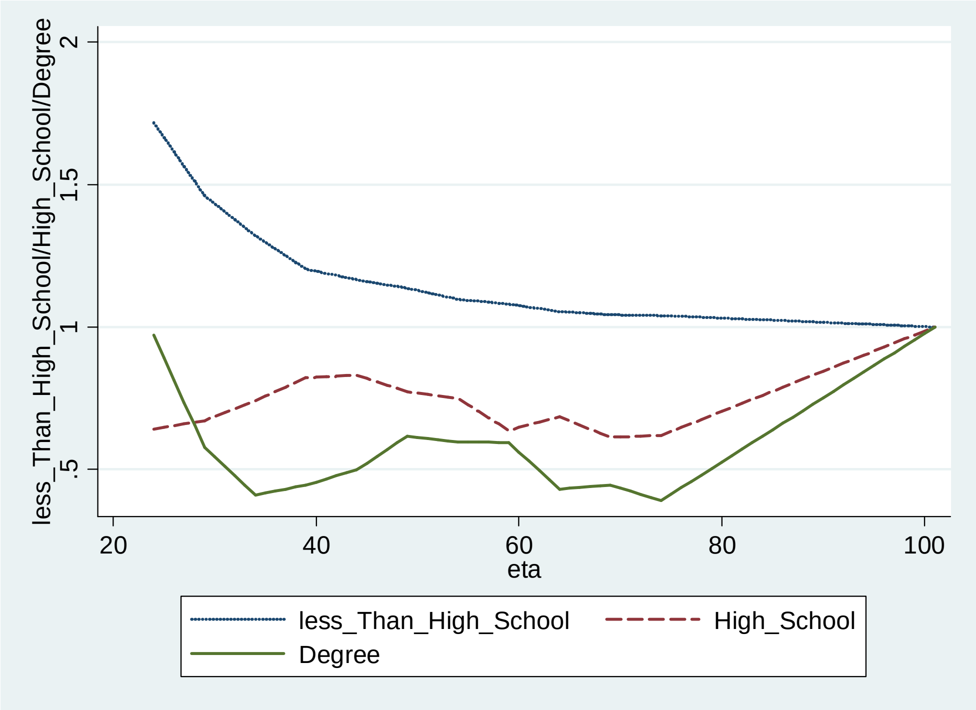
Each cell in table 6 says the subgroup percentage deviation from total population of a given age class in its mortality rate.

We now interpolate our data in order to obtain *annual* relative risks. Graph 1 and Graph 2 show these figures for both sexes.

Graph 1
Relative Risks, by education and age. Men.



Graph 2
Relative Risks, by education and age. Women.



We see a decreasing trend of the solid line (less than High School): the relative disadvantage of these people is stronger during youth. The dashed (High School) and dotted line (degree) are stable around 50% until 74 years, then approach 1 because of our interpolation. The second thing to note is that, from about 70 years onwards, graduate individuals and High School holders share the similar patterns. The great difference is between those who have studied until or more than secondary school, and those who have studied less.

The third step is to compute differentiated death probability, applying (1.2). This procedure enable us to take into account even the cohort effect, since $\overline{q}_x$ depends on birth year as well, and we have assumed that *RR* are equals for all the generations considered. Let's note that in the dynamic simulation the model exploits ISTAT death probability official forecasts (2005-2050).

Final step is purely computational, tough very important, and assures model's consistency. The point is that, year by year, the number of deaths simulated by the model *must* be the same whether differentiated or non-differentiated rates apply. Otherwise, the differential mortality would imply a "deny" of the whole population's rates, which *must* be still valid. Therefore, the model implements this algorithm: it simulates and counts the number of deaths with undifferentiated mortality, and compares the number of deaths after having applied the differentiated rates. The benchmark is, of course, the former, and the latter is calibrated to match the benchmark. The model calculates the difference between the scenarios: if difference is positive, it means that differentiation has made not enough deaths; if it is negative, the experiment has made too many deceased. CAPP_DYN, in the first case, randomly generates further deaths among the survived; in the second it randomly makes the dead in excess "live again".

Based on the procedure described above, we compute on our estimated differential mortality tables the theoretical life expectancy at birth and at 65 years old, by sex and education.

Table 7
Life expectancy at birth and at 65 years, by sex and education.
Calendar year 2008.

Education	**Life expectancy**			
	At birth		**At 65**	
	Men	**Women**	**Men**	**Women**
Less than High School	76,5	83,5	16,9	21,5
High School	82,0	86,6	20,4	23,9
Degree	82,6	88,3	20,7	25,3
Total	*77,6*	*84,0*	*17,3*	*21,7*

Source: our estimation on Istat data.

Life expectancy[14] varies greatly between and within genders. Irrespectively of education, life expectancy at birth is 77,6 years for men and 84 for women, while at 65 years old these values are 17,3 and 21,7. Considering education, a man can expect to live 76,5 years if he has a low level of education and 82,6 years if he gets a degree, with a difference of 6,1 years. A woman without secondary education on average lives up 83,5 years that rise to 88,3 if she has graduated, with a difference of 4,8 years. Obviously, gaps remain high even at 65 years old: between least and most educated there are 3,8 years of difference for both sexes.

These data roughly confirm those of Maccheroni [2001], whose findings are here summarized above.

6. Main results

In order to asses the effects of the introduction of differential mortality on the distribution of lifetime resources under the NDC system we run the

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[14] Data in Table 7 have been obtained applying the usual formula: $e_x = \frac{T_x}{l_x}$, where e_x is the life expectancy at age *x*, T_x are the person-years remaining for individuals of age *x* and l_x is the number of survivors at age *x*.

microsimulation model substituting the official mortality tables of ISTAT with those estimated as described in the former subsection. Our microsimulation involves all the individuals born from 1975 and 2000 who reach retirement age and whose pension will be computed under the new regime (NDC). This *panel* contains 13.857 individuals, 7.160 men and 6.697 women. All findings and comments that follow are now referred to *pensioners* and not to general population.

Table 8 shows average pensioners' death age in the panel.

Table 8
Average pensioners' death age, by sex and education.

Education	**Death age**	
	Men	**Women**
Less than High School	82,5	87,3
High School	86,0	89,0
Degree	85,9	90,0
Total	*84,8*	*88,9*

Source: CAPP_DYN.

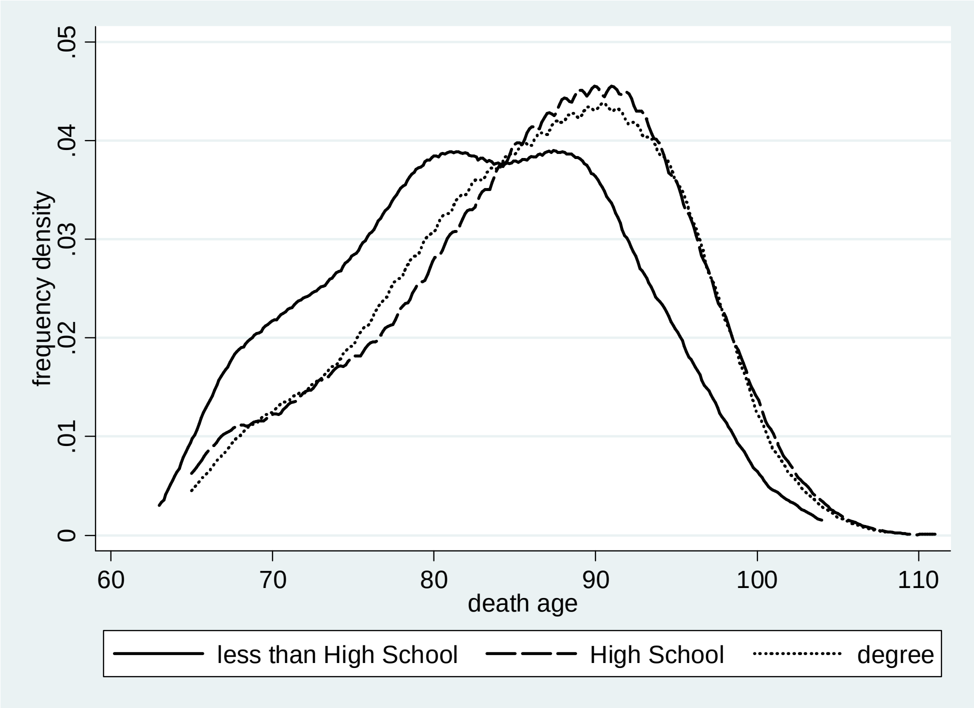
Results confirm figures of the table 7: life expectancy appears to be influenced both by sex and educational level. In particular a male pensioner born from 1975 to 2000 with less than High School expects to live on average 3,4 less than a graduate, while for women this difference is 2,7.

CAPP_DYN is based on a heterogeneous population so that we can focus not only on the average levels, but also on the whole distribution.

It can be useful to plot the frequencies of death age by educational level. Since the existence of differentiated mortality tables, we can expect that the proportion of individuals died at very old age is higher among the most educated ones.

Graph 3

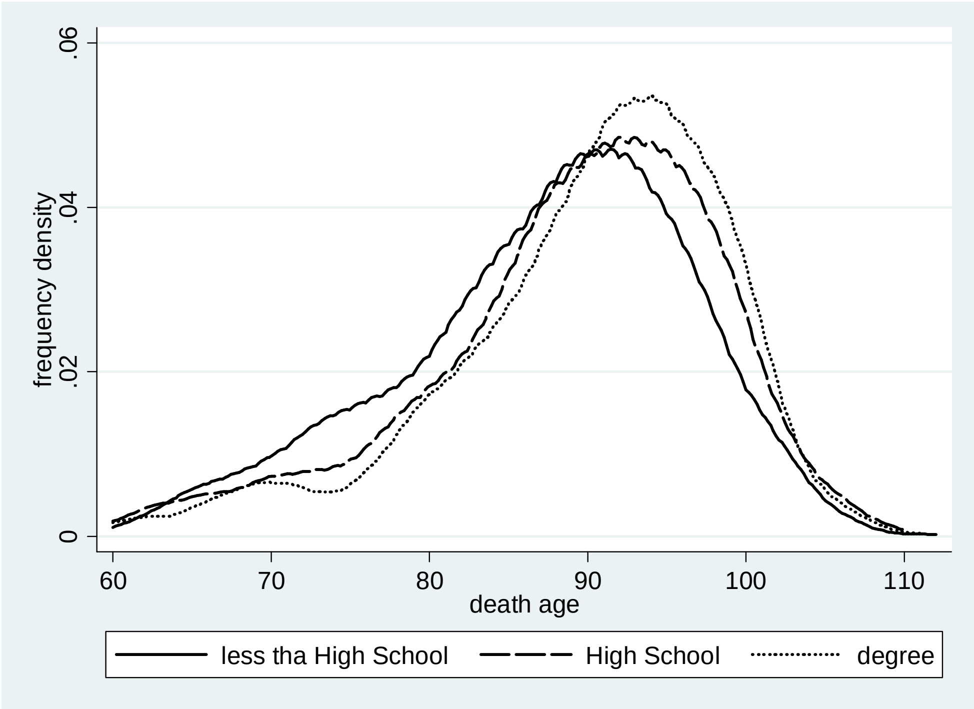
Death age frequency density, by education. Men born 1975-2000.



The graph shows that the low-educated frequency (solid line) is more left skewed and the high-educated frequency (dotted line) is more right skewed, meaning that the probabilities to survive after 85 years are higher among those with the highest levels of education. On the other side, percentage of individuals died before 85 years is higher among the least educated people. Again, dashed and dotted lines are very close, meaning that male graduated and High School holders have quite similar survival paths.

We provide the analogous female graph: this time the relation between education and death age is even clearer.

Graph 4
Death age frequency density, by education. Women born 1975-2000



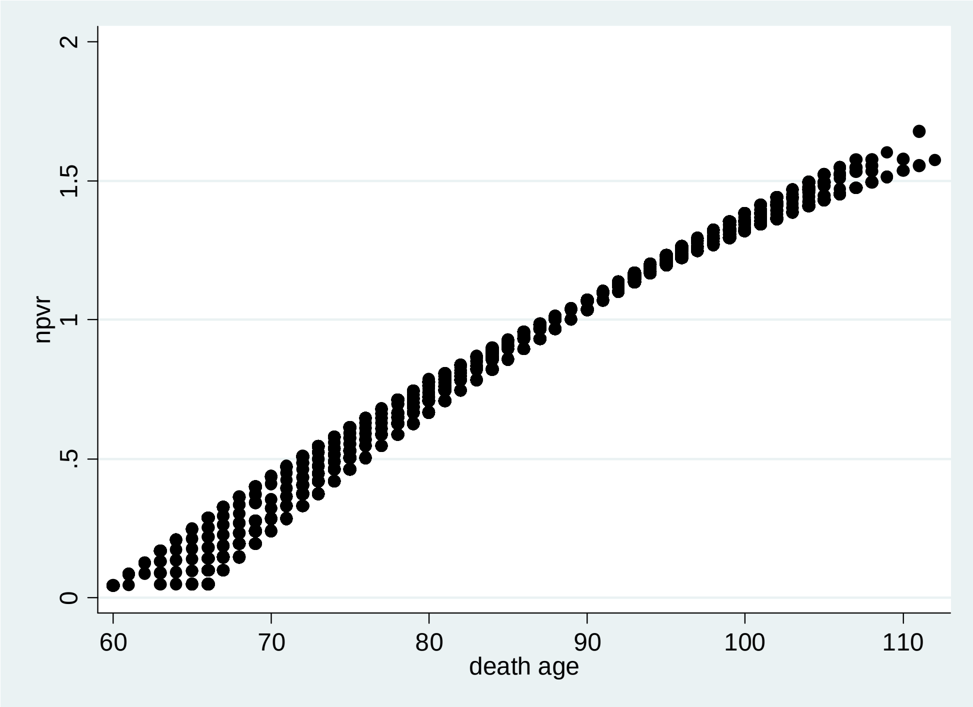
Unlikely Graph 3, here there is a certain difference even between High School and degree.

Moving to the analysis of the effects of differential mortality on the distribution of lifetime resources under the NDC system, Graph 5 plots, for the whole *panel*, the relation between NPVR and death age. As expected the NPVR displays a positive relation with the age of death.

It is interesting to notice that NPVR reaches the value of 1 at the age of 89, which is higher than the average life length. This can be explained by the fact that the transformation coefficients (used by the model to compute pension benefits) take into account the expected survival benefits, whereas our computations of NPVR do not[15].

[15] At this stage, we decided not to consider the distributive effects of survival benefits which can occur between married and single individuals.

Graph 5
Relation between Net Present Value Ratio and Death Age. Men and Women.



The whole panel, irrespectively of sex and education, receives a NPVR of 0,935. This means that the generations born from 1975 to 2000 expect a loss of 6,5 cents for every euro paid as contribution. This finding confirms that the NDC system is less generous than the previous defined-benefits system, and that the transition generates a burden weighting on the future pensioners (present students and workers)[16].

Since NPVR depends on life length (see Graph 5), and since life length is affected by educational level (as we have seen in Table 8), we can expect the NPVR to be different provided education and, obviously, sex.

[16] These results are consistent with those reported by Fornero and Castellino [2001].

Table 9 reports the main results of our simulation.

Table 9
Net Present Value Ratio, by sex and education.

Education	NPVR	
	Men	**Women**
Less than High School	0,781	0,956
High School	0,910	1,017
Degree	0,904	1,040
Total	*0,866*	*1,001*

Source: CAPP_DYN

The first thing to note regards the difference between average male and female NPVR. While a man expects to receive only 86,6 cents for every euro paid, a woman gets back the same amount she has contributed for, since her NPVR is 1,001[17].

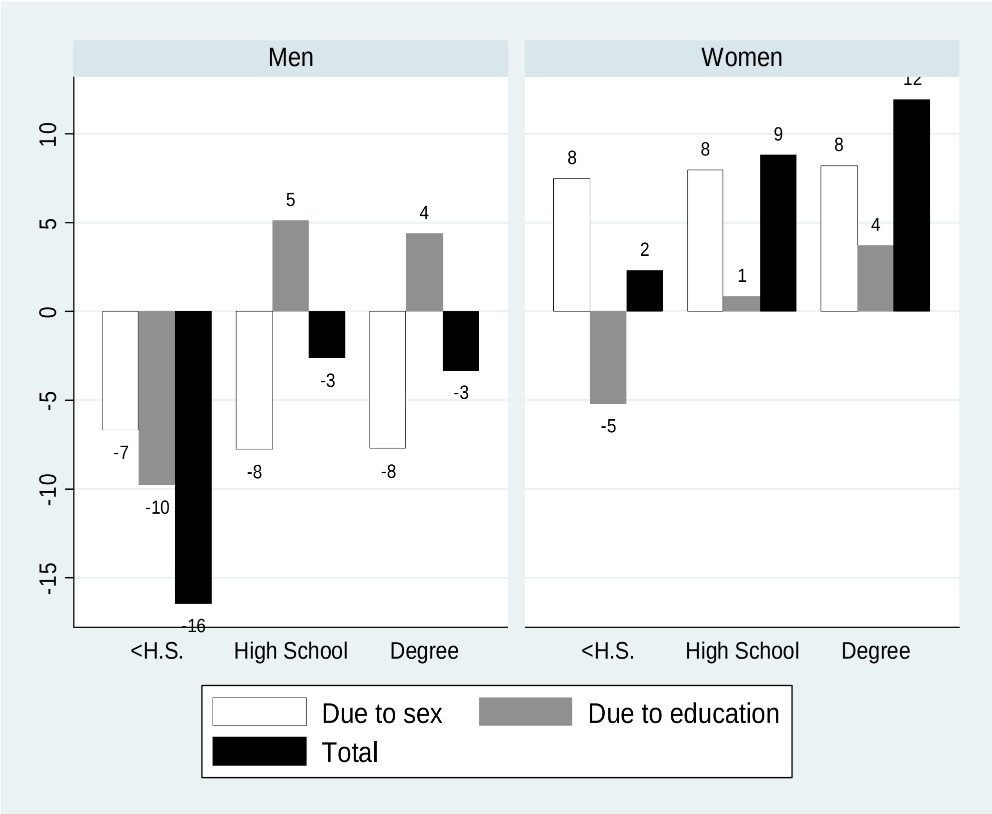
Looking within genders, we also see large differences along educational lines. Men with less than High School do particularly poor, having a NPVR of 0,781, about 10% less than average male NPVR (0,866) and 16% less than whole *panel*'s NPVR (0,935). On the other hand, luckiest group are graduate women: they have a NPVR of 1,040, about 4% more than average female NPVR (1,001) and 12% more than general NPVR (0,935).

We can identify two channels of redistribution: *between* genders (from man to women), and *within* genders (from low to high-educated people). These effects can go in the same way, as in the case of graduate women: their NPVR is higher than *panel*'s NPVR *both* because they are female *and* because they are graduated. However, these effects could offset each other, as in the case of male graduated: because of their sex, they should have a NPVR minor than average, but because of their education it should be higher. The total effect is the sum of these two distinct phenomena.

[17] In the simulation presented the discount rate is fixed at 1.5%. We run our simulation with interest rate of zero and 3%. In the former case, NPVR are extremely high, and in the latter extremely low but relive differences among educational level do not appear to be influenced by the choice of this parameter.

In Graph 6 we break down the total distribution in a part due to sex and in a part due to education[18].

Graph 6
Percentage deviation from general NPVR, due to sex and education.



Black bars refer to total redistribution from social security system: males with less than High School are the largest "losers", having the NPVR 16% less than general average. This large difference depends for a 7% by sex (white bar) and for a 10%[19] by low education (grey bar). Taking a broader view, se see that sex effect stays constant at 7-8%, while education effect differs among groups. It matters most for the above cited poorly educated males (-10%) and least for females with High School (+1%).

A complete description of distribution of NPVR, both for men and women, is supported in Graph 7 and Graph 8.

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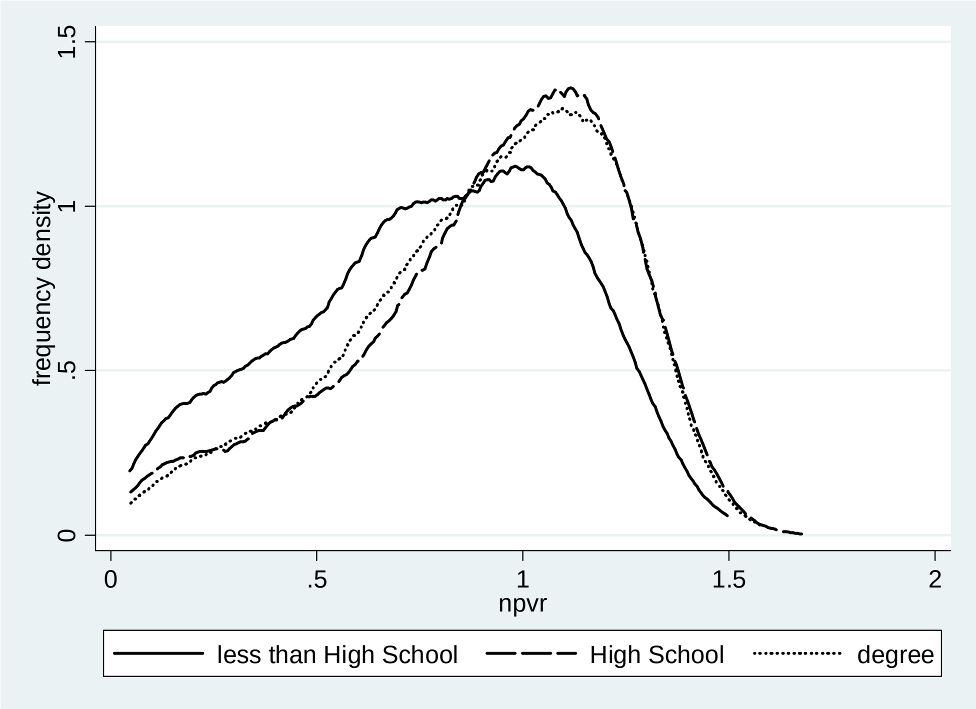
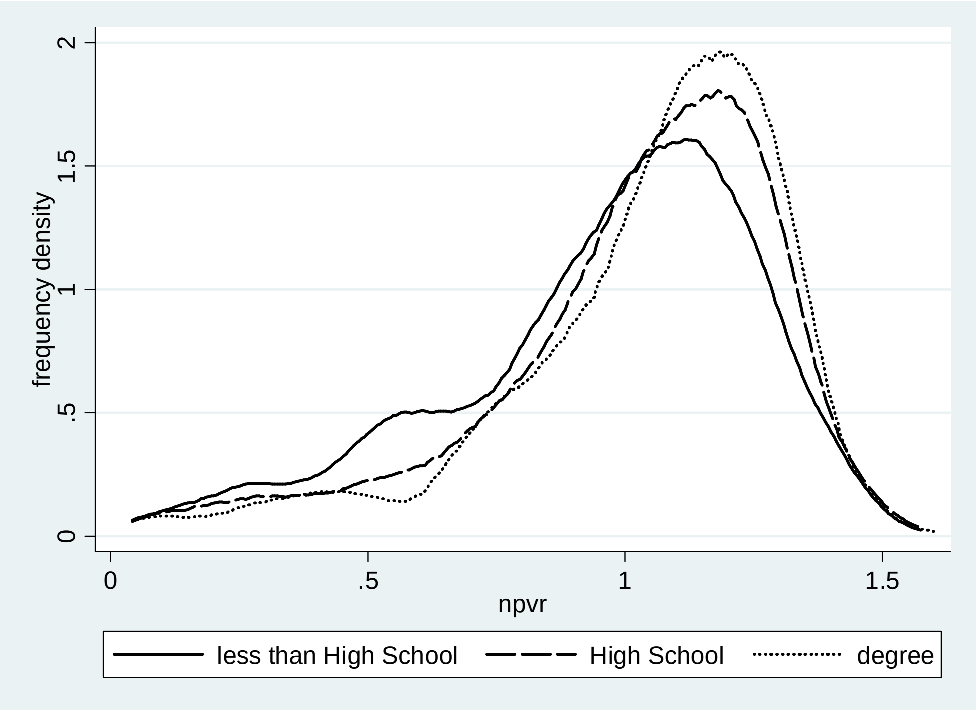
[18] Total distribution is obtained as the percentage difference between the individual NPVR and the *panel*'s NPVR. Distribution due to education is obtained as the percentage difference between the individual NPVR and the general male and female NPVR. Difference due sex is obtained by subtraction (total minus education)

[19] Because of rounding, total may not exactly be the sum of sex and education.

Graph 7
NPVR frequency density, by education. Men.



Graph 8
NPVR frequency density, by education. Women.



We can see that the paths of lines in Graph 7 and Graph 8 are very similar to those in Graph 3 and Graph 4 (death age frequency density). This appears obvious once equation (1.1) is considered and Graph 5 is looked at.

As we have found, there is a certain degree of redistribution from low to high-educated people. However, since education is positively correlated with income, it is likely that social security system ends up redistributing resources from poor to rich.

In order to measure the potential system progressivity/regressivity of the NDC system, we classify individuals with respect to the Average Indexed Yearly Earnings[20], defined as lifetime earnings divided by the number of years with positive earnings.

Table 10
Net Present Value Ratio, by sex and quintile of Average Indexed Yearly Earnings.

Quintile	**NPVR**	
	Men	**Women**
1st	0,843	0,987
2nd	0,842	1,001
3rd	0,867	1,015
4th	0,881	1,004
5th	0,894	1,028
Total	*0,866*	*1,001*

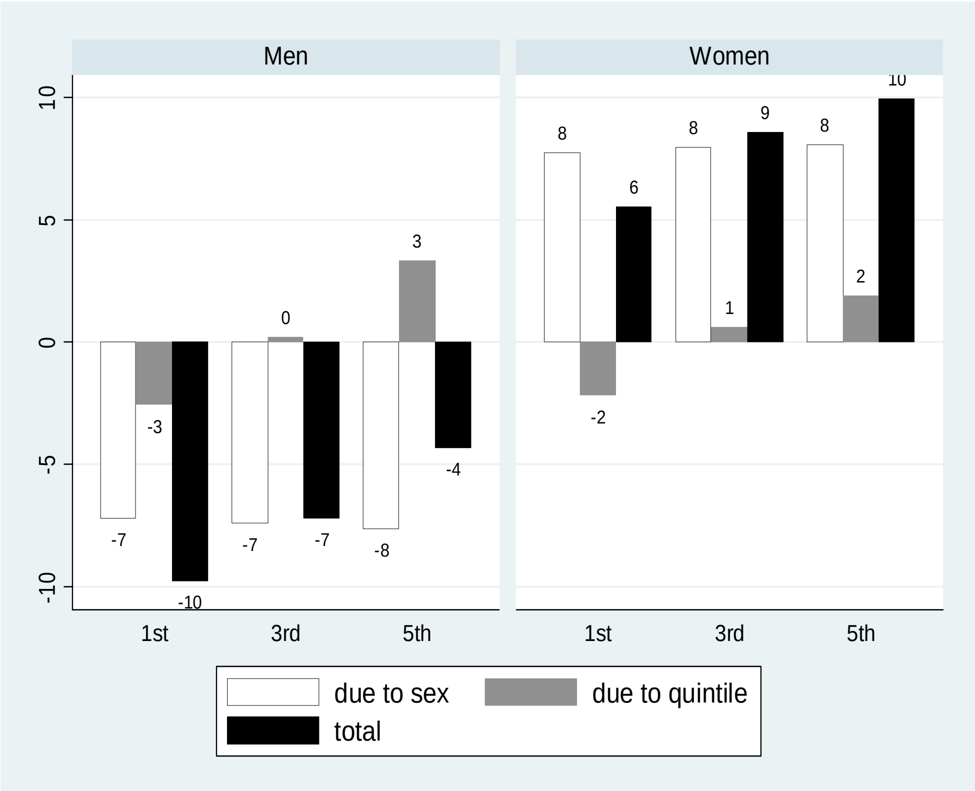
Source: CAPP_DYN

Table 10 confirms a regressive redistribution once individuals are classified by lifetime income, by means of the positive correlation between educational attainment and income. NPVR shows an increasing trend with income quintiles: between the 5th and 1st quintile there are, for both men and women, five points of difference in terms of NPVR. However, these gaps are

[20] *Average* because lifetime wealth is divided by the number of years with positive earnings. Wages earned in different periods have been indexed at 1995 values.

smaller than those observed classifying individuals by level of education (see Table 9). Even in this case, it is possible to isolate the effect due to sex and the one due to wealth, as we show in Graph 9.

Graph 9
Percentage deviation from general NPVR, due to sex and income quintile.



Analogously to Graph 6, white bars refer to redistribution due to sex, grey due to wealth and black bars represent the total percentage difference with respect general NPVR (0,935). The effect due to sex is constant at 7-8%, just like in Graph 6. We observe that wealth contributes for about 2-3% to the total percentage. For instance, poorest males have a NPVR 10% less than average: 7 points depends on sex, and 3 on standard of living. On the other hand, richest men have their NPVR 4% less than average: in this case the positive effect due to income (+3%) partly offsets the negative effect due to sex (-8%).

Conclusion

This work measured the magnitude the extent of redistribution among socioeconomic groups under the NDC pension system, for a *panel* of individuals born between 1975 and 2000. This redistribution arises because of the implementation of uniform coefficients of transformation, which cannot take into account the different life expectancy due to factor like gender, education or wealth.

For this aim we use CAPP_DYN, a dynamic microsimulation model able to forecast the long-term redistributive effects of fiscal policies.

After having reviewed the most important findings about the link between socioeconomic factors and differential mortality, and between differential mortality and actuarial fairness, we estimated mortality tables differentiated by sex and education. For example, we find that the average pensioners' death age was 82,5 years for a man with less than High School and 85,9 for a man with a university degree. Similar pattern were observed among women.

We identified at least three channels of redistribution: among genders (from men to women), along educational lines (from low to high educated) and among income quintiles (from poor to rich). This happens because some groups systematically live less than average (men, low-educated and poor) while others live more than average (women, high educated and rich).

For instance, for every euro paid at the social security system, a man can expect to receive 86,6 cents back, while a woman receives 100,1 cents back. These figures become 78 and 95 cents for respectively low-educated men and women, and 90 and 104 cents for graduated men and women. Therefore, even within genders, we saw a strong redistribution from individuals with less than High School to those with secondary school or more.

Moreover, since education is positively correlated with income, it is likely that social security system ends up redistributing resources from poor to rich. In order to measure the potential system progressivity/regressivity, we classified individuals with respect the Average Indexed Yearly Earnings, defined as lifetime earnings divided by the number of years with positive earnings. We found the system to be regressive. A men belonging to 1st quintile has a NPVR of 0,843, about 2,3 points less than average male NPVR (0,866) and 5 point less than the 5th quintile (0,894). Turning to women, the poorest ones have 0,987 while the most affluent people 1,028.

We can conclude stating that, along with redistribution across educational lines, we find a regressive transfer, which penalises poor people. Of course, this regressivity is unintended and is a necessary by-product of using uniform coefficients of transformation, which do not take into account sexual or social differences. However this finding is not trivial: even if the NDC system assures long run macroeconomic sustainability, it harms the most disadvantaged groups like poor and low-educated people.

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