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MORE EQUAL BUT LESS MOBILE? EDUCATION FINANCING AND INTERGENERATIONAL MOBILITY IN ITALY AND IN THE UNITED STATES

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ABSTRACT

More Equal but Less Mobile? Education Financing and Intergenerational Mobility in Italy and in the United States*

A state school system should be expected to reduce income inequality and to make intergenerational mobility easier. It is therefore somewhat surprising to observe that Italy, in comparison to the United States, displays less inequality between occupational incomes, but lower intergenerational upward mobility, not only between occupations, but also between education levels. In this paper we provide evidence on this empirical puzzle, and offer a theoretical explanation building around the idea that even if in Italy moving up on the social ladder is easier, the incentive to move may be lower, making mobility less likely.

JEL Classification: I22, J62
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NON-TECHNICAL SUMMARY

If one of the goals of a public education system is to favour equal opportunities of social mobility, the Italian schooling system has failed to achieve this goal. The centralized and egalitarian structure of education financing in Italy has indeed ensured a substantial uniformity of the quantity and quality of education offered to both rich and poor families; but despite this offer of equal opportunities Italy, in comparison to the United States, displays lower intergenerational mobility, not only in terms of occupations, but also in terms of education levels. For example, while in the United States having a father with a college degree increases by 6 times the probability of graduating from college, in Italy the same probability increases 25 times if the father is a college graduate. In addition, if in the United States the probability that a son is in a high-income occupational class depends more on his education level than on family background, in Italy the opposite is true: it is better to choose the right family than to get a college degree. Not surprisingly, Italy has one of the lowest shares of college graduates among OECD countries.

The fact that family background is a more important determinant of individual social fortunes in Italy than in the United States is particularly puzzling given that in the United States 98% of expenditures for education are financed locally. From the viewpoint of this paper, this is the distinctive feature that makes the US education system intrinsically *private*. Indeed, because of local financing the quality of pre-college education in the United States is significantly different in different neighbourhoods and it has an implicit price in the property tax paid by residents and in the higher housing price in the best neighbourhoods. The choice of the location of residence is clearly related to the choice of the education provided to the child. *A fortiori* this is true for college education where, in addition to local financing, 43% of funding is private in the United States. The fact that in such a system family background is less important than in a system in which education is centralized and granted equally to each pupil, is the puzzle that this paper describes and tries to understand, using representative samples of the population in the two countries.

The prevalence of non-competitive labour and financial markets and barriers to entry/exit into/from occupations can certainly explain part of the observed evidence, as suggested in the sociological literature. But in this paper we propose a complementary explanation that highlights a worrisome distortion of the incentives to human capital investment and to upward mobility generated by a centralized school system providing the same quality of education to everybody.

When the same quality of education, financed through income taxes, is offered to every potential student, the individual incentive to accumulate human capital is reduced for two reasons. The first is income taxation, which reduces the direct benefit to the person who decides how much effort to put in the schooling activity. The second is the impossibility for a dynasty to take advantage of the (potential) higher talent of their children by choosing a better education system even if this requires investing more resources in the accumulation of their human capital. While in a decentralized system parents who expects their children to be talented can provide them with better education out of their own income, in the centralized state school system their contribution is to a common fund, and has no direct benefit for their children.

In other words, a centralized system in which the same education quality is offered to everybody at the same price, makes the acquisition of human capital cheaper for poor students, but reduces the incentive to reach higher education levels in order to move up the social ladder. *Vice versa*, in a decentralized system (not necessarily private) offering better educational curricula only at higher prices (in terms of money and effort), the incentive to acquire human capital may overcome the corresponding cost making this option attractive even for a poor student. For this reason a decentralized and private education system like that in the United States may surprisingly foster more intergenerational mobility, in particular between education levels, than the Italian centralized public system.

From a policy viewpoint, the simulations performed in this paper suggest that neither of the two systems is necessarily superior in terms of stimulating greater intergenerational mobility. It depends on the features of the schooling system in the following way: the centralized system fosters more upward mobility when it is applied to those types (or levels) of schooling in which the education quality offered by the institution is relatively more important than the individual effort or talent of the student in order to achieve a successful human capital accumulation (e.g. in the case of primary education); on the contrary when an outstanding education quality is largely wasted in the absence of individual effort and talent (e.g. in the case of tertiary education) the crucial role of incentives is better enhanced by a decentralized education system.

1 Introduction

The Italian schooling system can be characterised as a prevalently public system financed by the central government through taxes levied on the family of origin and that provides the same quality of education to everybody. The US system, instead, can be characterised as a prevalently private system in the sense that public education is mainly financed at the local level and the share of students going to private school is substantially higher.

Indeed, while both countries spend a similar fraction of GNP on education,[1] the sources of funding are very different. In Italy 79% of the expenditures for compulsory education comes from the central government, whereas in the US 98% of these expenditures is financed locally. Such decentralisation of education financing in the US makes the quantity and moreover the quality of education available to a child heavily dependent on the locational choices and on the income of the family of origin. In addition to the possibility of choosing the quality of primary and secondary education "with their feet", US families have also the option of a well established private education system at the university level. While in Italy only 4.3% of university students is enrolled in private institutions[2] in the US the same proportion is more than five times higher (21.9%).[3] Furthermore, in the US the proportion of public sources in the expenditures for tertiary education is only 56.2% (in 1991); analogous figures for Italy are not easily available but given that the number of private Italian universities can be counted on the fingers of one hand, we suspect that the proportion of public funding for tertiary education is much higher in this latter country.

Given this characterisation, an Italian family at a low level of income (which can reflect a low level of acquired human capital) should have, thanks to the centralised state school system, the same level of education available as a higher income family. A US low income (and low human capital) family, instead, because of the mixed and decentralised structure of the school system, should have the additional disadvantage of a low expense in education decided by parents (as a result of a lower direct investment or because of locational choices in communities in which preferences are for lower tax rates and worse schooling institutions).[4] Within this framework it would seem natural to predict for Italy a more compressed distribution of human capital investments (and therefore of incomes) matched by a higher likelihood of upward mobility for poor families.

Comparative empirical evidence on Italy and the US, described in Section 2, suggests that this is not the case. While Italy seems characterised by less income inequality, standard measures of intergenerational mobility between occupations and between education levels indicate that poor and non-educated families are less likely (in relative or absolute terms) to invest in the education of their children and to move up along the occupational ladder.

In this paper we propose a theoretical model capable to shed some light on this empirical

[1] In 1992, the incidence of expenditures for primary and secondary education on GNP was 3.4% in Italy and 3.8% in the US. Data from OECD, *Education at a glance*, Paris 1993.

[2] Data published in ISTAT, *Annuario di statistiche dell'istruzione*, Roma 1995

[3] Data published in OECD, *Education in OECD countries*, Paris 1993.

[4] See Benabou (1996a).

puzzle and, more generally, on the relation between income inequality and intergenerational mobility.[5] The intuition goes as follows. Two characteristics of a state school system contribute to reduce the individual incentive to accumulate human capital. The first is the tax on income, which reduces the direct benefit to the person who decides how much effort to put in the schooling activity. The second is the altruistic motive: while in the private system a father can provide a better education to the son directly out of his own income, in the state school system his contribution is to a common fund, and has no specific effect for the son.

Now consider a son from a low income family, who is trying to decide whether to go to school or not. His answer will depend on the expected utility from the choice of going or not. And a society is more (upwardly) mobile, the more likely he is to choose to go. Independently of the schooling system his utility depends, in particular, on two critical factors: how important is his individual effort in the accumulation process and how important is the quality of education in determining his human capital.

If individual effort is relatively more important in the accumulation of human capital a private system should display more upward mobility because this system provides additional incentives to larger effort making people more willing to pursue the choice of education for a given level of confidence in their own ability. The importance of the quality of education goes, of course, the other way. This is the factor which is available to everybody in the state school system. So *ceteris paribus*, when the quality of education is relatively more important for the accumulation of human capital, a state system should display more mobility because the incentives to go to school rather than not are more similar across different income groups.

Within this framework, the evidence provided by the comparison between Italy and the US would suggest that the relative importance of individual effort, as opposed to the average quality of education, in the accumulation of human capital may create conditions that are unfavourable to a state school system. Of course in a more general model capable, for example, to incorporate the effects highlighted in Benabou (1996a) and (1996b) and in Fernandez and Rogerson (1996),[6] the balance would probably shift again in favour of a state school system. Indeed, a possible alternative interpretation of our results is that in order for a state school system to generate more mobility than a private system it has to be relatively more capable to select talents and reward individual effort.

This alternative interpretation hinges crucially on one additional ingredient of our theoretical framework: the role of self confidence in determining the likelihood of an investment in human capital. Surprisingly, in the 845 pages of their book on "The Bell Curve", Hernstein and Murray devote no time to the "self confidence" factor. Presumably, in their opinion, it is a purely psychological factor of no importance. But at the moment of making a critical decision about schooling, a person has, besides income and education already received by

[5] This relation has been surprisingly somewhat neglected in the literature. An important exception is represented by the work of Anthony Atkinson (in particular, Atkinson, 1980-81 and Atkinson, 1983) who takes up the challenge posed in Pen (1971) to "build a bridge between the figures on vertical mobility and income distribution".

[6] See also the insightful survey by Bertola and Coen-Pirani(1995).

the family, a fundamental uncertainty: how good she is. If she decides to go to school she will, a few years later, find out with some accuracy. If she decides not to, she will probably not find out. Now suppose that you give some credit to the idea that talent (here defined as generic ability to succeed in school) is in some measure hereditary. It does not matter really, at this point, how much this hereditary component is genetic, or environmental. If you do, then it is reasonable to assume that an additional fundamental difference among individuals is the degree in which their family history affects their belief on their own ability.

In the model that we present below, this belief is a critical factor in each person's decision; this is a perfectly rational consideration, since this belief summarises in the best way information available about each person own talent. This belief becomes an important way in which family background affects the decision of a child. Even in a hypothetical state school system in which parental human capital had no direct effect on the child's human capital, family background would still matter because of the self confidence (in the form of the belief on her own ability) that the child has. A family may be stuck at low levels of education for a sequence of periods because the previous family experiences have given a "low confidence". As a consequence, school as a sorting mechanism only works for those who try. At the high end of the income scale every person with talent achieves a high level of human capital. At the low level, on the contrary, a fraction of the population has high talent, but does not use it, *because* of the "adverse" belief.

At the moment of deciding about schooling, each person learns about his talent from his family history, but not from his performance in the early stages of his education. This is clearly an extreme assumption. We have two reasons to defend it. The first is that some of the important decisions about schooling are already made at the very early stages of the education. For instance, the *quality* of the elementary education is important, and has sometimes decisive influence on future choices. The second reason is that we can easily think of a richer model where, say, each agent makes successive choices in education, and receives at each step a signal correlated with his talent from his performance. This model would yield the same results as ours (provided, of course, this signal is not too precise). In other words: we want to focus here on the effect of past family experiences on the choice of a person, and we claim that our model and its results are robust to the introdution of the possibilty of learning from personal experience.

After the description of the motivating facts concerning mobility in Italy and in the US provided in section 2, in sections 3 and 4 we present the model, the implied equilibria and the steady state distributions. In section 5 we propose an unconventional measure of mobility suggested by the theoretical model. In section 6 we describe and comment the results of numerical simulations of the possible equilibria under the two schooling systems. Concluding remarks follow.

2 An Empirical Puzzle?

Occupational mobility

Social mobility is defined and measured in many different ways in the literature. Among economists, some authors focus on transitions between income classes or between percentiles of the income distribution (Atkinson (1980-81)) while others look at the speed of mean regression of incomes across generations (Becker and Tomes (1986), Solon (1992), Zimmerman (1992)); among sociologist, instead, the attention is concentrated on transitions between occupations ranked according to social prestige (Treiman and Ganzeboom (1990)) or on the transitions between social classes (Erickson and Goldthorpe (1992)). In general while economists tend to study mobility in terms of incomes, sociologists are more likely to focus on occupations.

Our approach can be characterised as a sort of intermediate third way that we adopt partly because of data limitations[7] but also because it offers some advantages from the point of view of achieving a meaningful international comparison and complements in an hopefully interesting way the existing literature. Sociologists have since long argued that because of temporary income fluctuations and measurement error, mobility in terms of yearly income is a misleading upwardly biased indicator of mobility if the goal is to measure transitions between long term economic status. Casting this argument in an econometric framework, Solon (1992) and Zimmerman (1992) propose averages of individual incomes on subsequent years as measures of long term status, but we cannot follow their suggestion because we do not have the necessary information for Italy. We take instead a road more familiar to sociologists and focus on occupations as indicators of economic status; but, we also depart from the sociological literature because we do not rank occupations according to social prestige nor we aggregate them according to subjectively defined social classes.

Given the information contained in our datasets the concept of social mobility that we can measure is represented by mobility between occupations ranked according to the median income paid by each occupation in the generation of children in each country. The reader should therefore keep in mind that in this study, a dynasty is classified as mobile only if the occupation of the son is different from the occupation of the father. Take the case of a father and a son in the same occupation, which is highly paid in relative terms when the father is observed but that is paid less than average when the son is observed. According to our definition this dynasty is classified as immobile even if, in terms of individual incomes, it experiences downward mobility. Income changes that take place within the same occupation but across generations cannot be measured in our datasets and do not imply mobility according to our definition. Viceversa, the case of a father and a son possibly earning the same incomes but working in two different occupations is considered here as a case of intergenerational mobility.

Therefore, intergenerational mobility in this study has to be interpreted as mobility between occupations even if occupations are ranked on the basis of incomes. With this caveat

[7] See the Appendix 8.1

in mind a preliminary graphic glance at the evidence on inequality and mobility in Italy and in the US is offered by Figure 1 and 2. In Figure 1 the 1050 US dynasties considered in this study have been ordered on the horizontal axis according to fathers' occupational incomes measured by the continuous non decreasing line in the Figure.[8] On the vertical of each point on the income line of fathers, a point indicates the income of the corresponding son. To the extent that the points for sons do not lie on the income line of fathers there is evidence of occupational mobility in the US.

Figures 2, based on Italian data, offers a term of comparison. Also in Italy the fact that sons do not work in the same occupation of their fathers appear to be the rule rather than the exception. Yet, in addition to the fact that the distribution of occupational incomes appears to be more concentrated, most of the observed mobility seems to be taking place between occupations that pay similar incomes.

The existence of greater labour income inequality in the US in comparison to Italy, has been already documented in the literature[9] and is confirmed in the datasets used in this study: as shown in Table 2, within each generation all the most common indicators of income inequality proposed in the literature are clearly larger in the US sample.[10]

Less documented, is instead the comparative evidence on intergenerational social mobility for Italy and the USA. Tables 3 and 4 present the matrices of transition between the quartiles of the distributions of occupational incomes in the two countries. At first sight these matrices appear similar, but if one computes on the basis of these matrices the most standard scalar indicators of mobility that have been proposed in the literature,[11] the USA appear unambiguously characterised by greater intergenerational mobility (see Table 5 and the Appendix 8.3 for a description of these indicators).

Even larger differences in mobility patterns seem to characterise Italy and the US if one looks at transitions between more homogeneous occupational income classes than the ones defined on the basis of the quartiles of the distributions. Indeed, any given transition between quartiles means quite different transitions in terms of occupational incomes in the two countries. This is evident in the left panels of Tables 6 and 7: for example, going from the median of the first quartile to the median of the third quartile implies an income change of 52% in Italy as opposed to a change of 81% in the US. Therefore, the transitions between occupations in the first three quartiles of the Italian distributions imply smaller

[8]Figures 1 and 2 contain representations of the occupational income distribution according to the so called "Penn's Parade" proposed in Penn (1980). In order to allow for a comparison between the two countries the lowest occupational income has been normalised to 100 in both countries. Please note that, as already mentioned (see the Appendix 8.1), the income attributed to each individual is the median income of the individuals in the generation of children that work in his occupation. Therefore, in both countries the dispersion of these occupational incomes is smaller than the dispersion of original individual incomes.

[9]See, for example: Gottshalk and Smeeding (1995) and Erickson and Ichino (1994).

[10]See the appendix 8.2 for a description of these indicators. Given that in each country occupational incomes for both generations are computed on the distribution of children, inequality differs across generations only because of intergenerational changes in the distribution of dynasties across occupations.

[11]See: Boudon (1974), Atkinson(1980-81), Atkinson et al. (1981), Atkinson (1983), Bartholomew (1982), Sommers and Conlisk (1979), Shorrocks (1978), Geweke et al. (1986), Conlisk (1989), Conlisk (1990) and Dardanoni (1992).

income changes than the analogous transitions in the US. In addition, within each country, quartiles may group together occupations that pay very different incomes: for example, in Italy the fourth quartile spans over a percentage income change of 103%; the transition from the median occupation of the third quartile to an occupation of the fourth quartile may imply a 7% income change if the arrival occupation is the lowest in the fourth quartile, as well as a 116% income change if the arrival occupation is at the top of the quartile. Similarly in the USA these two transitions imply, respectively, income changes equal to 4% and 83%. Therefore, within each country, the fact that a dynasty goes from the third to the fourth quartile may mean very different events in terms of occupational incomes according to the ranking of the arrival occupation within the quartile of destination.

This evidence suggests that transitions between quartiles (and percentiles in general) are misleading if one is interested not so much in the probability of an inversion of dynastic rankings, but more so in the probability with which different *social distances* are covered by mobile dynasties. In the right panels of Tables 6 and 7 we propose a different aggregation of dynasties according to income classes defined as proportions of equal size of the (log) difference between the highest and the lowest occupational incomes in the two countries. According to this aggregation strategy income classes in both countries span over the same percentage increase in occupational incomes, allowing for a more meaningful comparison of transitions within and between countries.

The transition probabilities between these income classes are presented in tables 8 and 9. Differences between the two countries are now more evident even from the simple inspection of the transition matrices: in particular, the probabilities of persistence along the main diagonal are larger in Italy for the three upper classes. Looking at the scalar indicators presented in table 10 intergenerational mobility appears greater in the US than in Italy and the difference between the indicators for the two countries is substantially larger for interclass matrices than for interquartile matrices (compare table 10 and table 5).

In order to determine whether intergenerational mobility is significantly different in a statistical sense in Italy and in the USA, we aggregate the four income classes defined above in two groups and we estimate a probit model of the probability that the son is in the highest of these two groups. We define the *highest group* as the union of the classes 3 and 4 that were described in tables 6 and 7). Hence, the dependent variable of our probit models takes value 1 if the son is in income class 3 or 4, i.e. if his occupational income is greater than the income corresponding to one half the percentage difference between the maximum and the minimum of the distribution of occupational incomes. We estimate this probability as a function of a dummy indicator for the income group of fathers (that takes value 1 if the father is in income class 3 or 4) and of two dummy indicators for the education levels of fathers and sons. In both generations and in both countries the education indicators take value 1 if the individual has a college degree. Age controls are also included in the regressions.

The results of this exercise are presented in table 13 that reports, for each regression, the change in the probability that the son is in the highest group due to a change from 0 to 1 of each independent dummy variable.[12] These effects are evaluated at sample averages.

[12]For the age controls the reported effect is the effect of an infinitesimal age increase.

In model 1 only the family background variables are included as regressors: while the effect of father's education is equal in the two countries, the effects of father's income class is significantly larger in Italy.[13]

In model 2 the education dummy for the son is introduced, and the effect of fathers' education disappears in both countries: this is a well known result in the literature[14] and suggests that most of the effect of parental education on sons' occupational achievements works indirectly through the effects on son's education. The effect of the occupational income class of fathers, however, remain significantly different from zero in both countries, and significantly larger in Italy than in the US. While in the US the effect of sons' education is larger than the effect of parental income, in Italy the opposite is true.

Coming to the comparison between model 2 and model 3, in both countries a likelihood ratio test rejects the hypothesis that family background is irrelevant. Yet, while in Italy the value of the test (3 degrees of freedom) is 98.1 in the USA it is equal to 38.1: i.e. the null hypothesis of no background effect is rejected with greater confidence in Italy. Furthermore, adding parental characteristics to sons characteristics (i.e. going from model 3 to model 2) increases the predictive capacity (pseudo R2) of the model by 150% in Italy; in the USA the increase is much lower being equal to just 19%.

The probit estimates presented in Table 13 confirm that intergenerational mobility between occupations is significantly lower in Italy than in the USA: in both countries the occupational class of fathers is an important determinant of the occupational class of sons, but in Italy the effect is much stronger than in the USA in absolute terms and relatively to the effect of sons' education levels.

We turn now to the evidence on intergenerational mobility between education levels in which the relative lack of upward mobility in Italy appears even more striking given the prevalently public and centralised structure of the Italian schooling system.

Educational Mobility

The comparison across countries of educational mobility patterns is certainly not an easy task given the enormous differences between national education systems.[15] One strategy that seems to us reasonable consists in comparing the probabilities of reaching the highest educational degree offered by the schooling system of each country. Disregarding post graduate studies, that both in Italy and in the USA concern a very small fraction of the population, we consider the college degree (*laurea in Italy*) as the relevant highest educational degree[16] We therefore begin our analysis of educational mobility by considering the probabilities of dynastic transitions between the following two educational categories: all the individuals

[13] Here and for the rest of this table, differences between coefficients have been tested using appropriately constructed t-tests; the null hypothesis of equal coefficients has been rejected with p-values smaller than .001.

[14] See for example Treiman and Yip (1989).

[15] See Shavit and Blossfeld (1993).

[16] See the appendix 8.1 for a more precise description of the classification of education levels adopted in this study.

without a college degree are classified as having low education, while those holding a college degree are in the high education group.

Table 14 presents the distribution across these educational categories in each generation and in each country. Italy is characterised in both generations by a lower fraction of college graduates, but experiences the largest percentage shift towards higher education from one generation to the other: while in the US the fraction of graduates increase by 69% in Italy the same fraction increases by 200%. Yet not all Italian dynasties shared in the same way this greater opportunity to reach a college degree.

Tables 15 and 16 present, for Italy and for the USA respectively, the intergenerational transition probabilities between the educational categories that we have just described. In Italy, the probability that the son of a graduate is a graduate is higher than in the USA (65.1% vs. 61.0%); viceversa the probability that the son of non-graduate reaches a college degree is substantially lower in Italy than in the USA (7.1% vs. 20.8%). The inspection of these transition probabilities clearly suggests that the opportunities of reaching a college degree are more unequally distributed in Italy than in the USA, even if Italy experiences a more substantial increase of the proportion of college graduates from one generation to the other.

The odds ratios for the two transition matrices, reported in Table 18, shows that the odds of reaching a college degree are in Italy almost 25 times higher if the father has a college degree, while in the USA having a graduate father increases the odds only by 6 times. Hence, both countries do not ensure a situation of equal opportunities in the transitions between education levels, but Italy appears to be more distant than the US from such a situation. This is confirmed also by the other scalar indicators contained in Table 18.[17]

One might argue that a college degree means more in Italy than in the USA in terms of human capital acquisition. Indeed at least one additional year of schooling is required in Italy to obtain a *laurea* and in some disciplines, like engineering or medicine, the *laurea* involves educational curricula that in the US are required for post graduate studies only. Therefore, as far as Italy is concerned, we provide evidence also for a different classification of educational categories according to which the high education group includes all the individuals that have reached a high school degree or more.[18]

Table 14 shows that with this alternative classification Italy is characterised by an even larger increase of the fraction of highly educated dynasties (262%); furthermore, among sons, the proportion of highly educated individuals in Italy (high school or more) becomes similar to the proportion of highly educated individuals in the US (college or more).

Yet even with such a favourable classification, the opportunities of reaching the higher educational category are more unequally distributed in Italy than in the US (see table 18). The odds of reaching a high school degree or more are now even larger if the father is in the same educational category (the odds ratio is 27.3) and the distance from a situation of equal opportunities increases with respect to the previous classification (see the indicator

[17] See the Appendix 8.3 for a description of the characteristics of these indicators.

[18] It should be noted that in the Italian education system high school degrees are widely differentiated and some of them provide explicit certification for entering the labour market in specific occupations.

MT in table 18). Only the Bartholomew index of movement MB indicates more mobility for Italy with this alternative educational classification, but this should not be surprising given that MB is an indicator of movement not an indicator of equality of opportunities (see the Appendix 8.3); its value is driven by the structural shift towards higher education that characterised Italy in the post-war period, but it hides the existence of unequal opportunities.

In table 19, following the same strategy proposed in table 13 for occupational mobility, we provide a statistical test for the existence of different intergenerational mobility patterns between education levels in Italy and in the US . Also in this case, and independently of the educational classification adopted for Italy, the effect of family background characteristics on the probability of reaching a higher education level appear in Italy significantly larger in a statistical sense. As suggested by the consideration of the pseudo R2 the income class and the education category of fathers are in Italy relatively more important predictors of the educational category of sons.

The pieces of the puzzle

The evidence that we presented so far shows undoubtedly that Italy features more equality between occupational incomes but also lower intergenerational mobility in terms of occupations and in terms of education levels. It seems fair to say that family background is a more important determinant of individual social fortunes in Italy than in the US.

In the Italian debate it has been argued quite convincingly[19] that barriers to entry/exit into/from certain occupations might explain the lack of mobility in Italy. The data currently available to us are not rich enough to show, in a comparable way across countries, whether the existence of non-competitive labour markets is the crucial factor driving the observed differences in mobility patterns. Yet one piece of evidence offered by our data certainly points in this direction: while in the US the probability of intergenerational persistence in self-employment is 20%, in Italy it is more than double, being equal to 42%. However, the existence of a prevalently public education system in Italy should have at least partially compensated for the lack of incentives to upward mobility induced by the labour market. On the contrary we observe that also educational mobility (in particular upward mobility) is substantially lower in Italy than in the US.

One could of course say that without a public education system both occupational and educational mobility would have been even lower in Italy. However, in the next section we suggest, with the help of a theoretical model, that this may not have been the case. Indeed, it is possible to argue that some intrinsic features of a public and centralised education system may cause lower intergenerational mobility independently of the labour market. Although the data are not rich enough to prove it, these perverse effects of a public education system might have contributed together with the existence of non competitive labour market to cause the existence of lower intergenerational mobility in Italy, particularly between education levels.

[19]See for example Cobalti and Schizzerotto (1992) and Schizzerotto and Bison (1996).

3 The Model

Human Capital and Wages

Population is a continuum, each person lives for two periods and is productive only in the second. His production depends on his human capital, which is described by a real number h_t. He earns a wage w_t which is equal to h_t. In each period t the distribution of human capital is denoted by G_t; the total human capital is therefore:

$$H_t = \int h dG_t(h) \tag{3.1}$$

Later we also introduce the talent of each person. To avoid misunderstanding, it is probably better to specify here that the productive efficiency and the wage of a person are *not* affected by the talent, which is only relevant in the process of acquiring education.

Preferences

The utility of each person depends on leisure of the first period, denoted by n_t, consumption of the second period c_{t+1}, and a term which describes the quality of the education which is left to the son. This last term also depends on the belief ν_{t+1} that the person has on the talent of the son: the higher this belief, the higher the utility he derives from the quality of the education system. We will see later that, *ceteris paribus*, a better talent allows each son to derive greater advantages from the education: so this monotonicity condition is reasonable. Formally we have:

$$U(n_t, c_{t+1}, \nu_{t+1}, e_{t+1}) = \log n_t + \log c_{t+1} + \nu_{t+1} \log e_{t+1} \tag{3.2}$$

The budget constraint of each person will depend on the institutional arrangement for the provision of education: so we shall state it later.

The Technology for Human Capital

Each person has a basic working ability, of quality normalised to 1, and a natural talent, which has no direct productive use, but is critical in acquiring additional human capital.

Talent is denoted by $a \in \{L, H\}$; it is transmitted from father to son with some persistency. This transmission follows a process which is determined according to a a first order Markov process:

	$a_{t+1} = L$	$a_{t+1} = H$
$a_t = L$	$1 - \alpha$	α
$a_t = H$	α	$1 - \alpha$

with $\alpha \in (0, 1/2)$. Since talent is sometimes unknown, agents will form a belief about it: we denote by ν_t the belief that the talent of the member born at t of the dynasty is H.

A higher quality ability can be created by the combination of a learning effort, the help of an educational system, and the direct or indirect contribution of the human capital of the father. This is however possible only if the talent of the person is of the high type. The technology has (as in Glomm and Ravikumar (1992)) a Cobb Douglas functional form. More precisely,

$$h_{t+1} = \begin{cases} 1 & \text{if } a_{t+1} = L; \\ \theta (1 - n_t)^{\beta} e_t^{\gamma} h_t^{\delta} & \text{if } a_{t+1} = H; \end{cases}$$

where n_t is the leisure enjoyed, e_t is the quality of education, and h_t is the human capital of the father.

Talent cannot be directly observed; it cannot be determined with precision unless it is put to the test of the education system. If the person decides to go to school, and fails, then he knows his talent was low; on the contrary if he succeeds he knows that it was high.

Two Institutions for Human Capital

As in Glomm and Rawikumar (1992) we consider two different possible institutional arrangements for the provision of the education, that is in the context of our model, for the determination of the quantity e_t.

The first is a purely private regime, where e_t is decided by the father, as a component of the total expenses out of his income. Since, as we have just seen, talent can only be determined conditional on the outcome of an attempt to get education, the choice of e_t is taken without precise knowledge of the talent of the son.

The second regime is a pure state schooling system. The quality of education provided to each child is the same, and is decided as follows. A tax rate τ_{t+1} is voted in each period, and chosen according to majority rule. The tax rate applied to the total income gives an amount spent on the collective education:

$$E_{t+1} = \tau_{t+1} H_{t+1} \tag{3.3}$$

We can now state the budget constraint formally. In the case of a private school system, the individual is facing the two constraints:

$$n_t \leq 1; c_{t+1} + e_{t+1} \leq h_{t+1};$$

while in the case of the public school system, when the tax rate is τ_{t+1}, we have:

$$n_t \leq 1; c_{t+1} \leq h_{t+1}(1 - \tau_{t+1}).$$

The Timing

The life of each person lasts for only two periods. A person born at date t knows the history of attempts to get an education, and of successes and failures, of former members of his dynasty. If we are in the private school system, he also knows the amount that the father has devoted to his education; while if we are in the state school system he knows the prevailing level of educational quality of the system.

On the basis of the history of his dynasty he now computes his belief on his own talent, denoted by ν_t; he then decides whether to go or not to go to school, a choice which is denoted as the choice between a Y or a N. If he decides Y, he also decides the amount of effort he devotes to the learning activity. He then goes to school, and this is the end of the first period.

At time $t+1$ the talent of the person is revealed and h_{t+1} is determined. In the state school system the tax rate τ_{t+1} is then voted. Then the remaining income is consumed and taxes are paid, or, in the private school system, the amount e_{t+1} of funds for the education of the son is provided. Then the son is born and the life of the older generation ends. Note that, to simplify notation, generations do not overlap in this model, but in each calendar period both generations are alive: the oldest in the first part and the youngest in the second part of the period.

To summarise, and to clarify the measurability restrictions for the agents: the decision about the education (that is, whether to go to school, and if so how much effort to spend in education) is taken without knowledge of the talent of the person; the vote on taxes, the consumption decision, and the amount for the education of the son, are decided after the additional information on the talent of the person has been obtained.

Learning about talent

For future reference we summarise briefly how the belief of each person about his own talent and the talent of the son evolves, and fix some useful notation.[20] If a person has initially a belief ν that he is talented, then he will have belief 1 on it after a success, and hence a belief $1-\alpha$ on the fact that the son is talented, and respectively 0 and α after a failure. If he decides N (not to go to school), then he will gather no information about his own talent, and will have a belief

$$\hat{\nu} \equiv \alpha + (1-2\alpha)\nu \tag{3.4}$$

on the talent of the son. We shall denote by $\hat{\nu}^i$ the ith iterate of the function defined in 3.4; note that this function is increasing in ν, and its iterates converge to the value 1/2 independently of the initial value. Finally, if $\nu = \alpha$, then one easily finds that:

$$\hat{\alpha}^i \equiv 1/2(1-(1-2\alpha)^{i+1}). \tag{3.5}$$

A final piece of notation: we define the function

$$L(x) \equiv x\log x - (1+x)\log(1+x). \tag{3.6}$$

[20] A similar learning process is in Piketty (1995) although in that model people learn about a parameter that is social and not dynastic.

To see why it is introduced, note that it is the value of the maximisation of $\log(1-y)+x\log y, y \in [0,1]$; a problem which appears frequently in the optimisation program of the agents.

The Optimal Policies

Let us begin with the case of the private school system. The optimal policy is decided by backward induction from the second period, after the decision Y or N, and the n_t has been taken. Conditional on this, we have three possible cases. First, the case of a (Y, n_t) decision and a success in the education process, (which occurs if the talent is high), it is easily found that the optimal expense decided by the father for the education of the son is

$$c_{t+1} = \frac{\nu_{t+1}}{1+\nu_{t+1}} h_{t+1} = \frac{1-\alpha}{1+(1-\alpha)} h_{t+1}. \tag{3.7}$$

while in the case of failure we have

$$e_{t+1} = \frac{\nu_{t+1}}{1+\nu_{t+1}} = \frac{\alpha}{1+\alpha}. \tag{3.8}$$

Finally, if the decision has been N, and the belief on his own talent was $\nu_t = \hat{\alpha}^{(i-1)}$, then:

$$e_{t+1} = \frac{\nu_{t+1}}{1+\nu_{t+1}} = \frac{\hat{\alpha}^i}{1+\hat{\alpha}^i}. \tag{3.9}$$

In the case of the state system, the important decision in the second period is the one about voting, since consumption is a pure residual from income after payment of taxes. In the three cases corresponding to the one described above for the private system case we have the following three optimal tax rates:

$$\tau_{t+1} = \frac{\nu_{t+1}}{1+\nu_{t+1}} = \frac{1-\alpha}{1+(1-\alpha)}; \tag{3.10}$$

$$\tau_{t+1} = \frac{\nu_{t+1}}{1+\nu_{t+1}} = \frac{\alpha}{1+\alpha}; \tag{3.11}$$

$$\tau_{t+1} = \frac{\nu_{t+1}}{1+\nu_{t+1}} = \frac{\hat{\alpha}^i}{1+\hat{\alpha}^i}. \tag{3.12}$$

We can now, in the case of either institutional arrangement, solve the problem of deciding in the first period the pair (Y, n_t) (go to school, with effort n_t), *versus* N.

Let us begin again with the private school system. With belief ν_t the first choice gives a success with probability ν_t and failure with probability $1-\nu_t$. So the agent born at t is comparing the maximum between two quantities. The first is the expected maximum utility from the choice (Y, n_t) today, assuming that in the following period the agent will make the optimal choice conditional on the new information. If we substitute these optimal solutions in the utility function 3.2 we find:

$$\max_{n_t} \log n_t + \tag{3.13}$$

$$\nu_t\{L(1-\alpha) + [1+(1-\alpha)]\beta \log(1-n_t) + [1+(1-\alpha)] \log \theta e_t^{\gamma} h_t^{\delta}\} + (1-\nu_t)L(\alpha)$$

In this sum, the term multiplied by ν_t is the utility in the second period after a success; the other term is the utility in the second period after a failure.

The second quantity we need to consider in the comparison at time t is the expected maximum utility from the choice N today: this has a very simple form, only dependent on the updated belief $\nu_{t+1} = \hat{\alpha}^i$ (that is, the belief that the person has on the son's talent, after no new information is gathered):

$$L(\nu_{t+1}) = L(\hat{\alpha}^i).. \tag{3.14}$$

Since the utility function has the special logarithmic form, it is easy to see that the optimal choices have a very simple form. In particular $n_t = 0$ if the choice is N, clearly, and:

$$n = \frac{1}{1 + \nu\beta[1 + (1-\alpha)]} \tag{3.15}$$

when the choice is Y. For future reference let us note that the optimal choice of expenditure for education is a function of the belief of the person on the son's talent, and of his realised human capital; while the optimal choice of Y versus N, and of the effort in school, is a function of the human capital and of the expenses in education of the (grand) father. We denote these two functions $D^P_{t+1}(\nu_t, e_t, h_t)$ and $e^P_{t+1}(\nu_{t+1}, h_{t+1})$.

The reasoning in the case of the state school system is similar. In the case of a decision Y, the optimal leisure is in this case:

$$n = \frac{1}{1 + \nu\beta}. \tag{3.16}$$

Again for future reference let us note that the optimal vote on taxes is a function of the person belief on the son's talent, while the optimal choice of Y versus N, and of the effort in school, is a function of the human capital and of the average level of education of the state system, e^S_t. The two functions are denoted by $D^S_{t+1}(\nu_t, e^S_t, h_t)$ and $\tau^S_{t+1}(\nu_{t+1})$.

A final comment. When a person decides how much effort to devote to the schooling activity, he has a coefficient $\nu\beta$ in front of the term $\log(1-n)$ in the state school system, and a factor $\nu\beta[1 + (1-\alpha)]$ in the private school system. This larger factor in the second case is reasonable, since this person is also considering the effect of his own income on the quality of education available to the son.

Dynasty

To get some intuition about the way the model works we can try to follow the typical path of a dynasty. After an initial failure, the belief of the son on his own talent falls to α, and the human capital to 1. Now for a sequence of periods the members of the dynasty will choose not to go to school. This for several reasons. Two of these reasons are common to either system: first, the belief on the talent is low; second, the human capital of the previous member is low, and accordingly is low the externality on his education process deriving from the human capital of the father. In the case of a private school system we have in addition the low level of the term e_t, i.e. the expense for education from the father.

After a few periods however the belief on the talent grows (by the fact that the iterates of the updating rule 3.5 are increasing) until it reaches a critical level, beyond which the member of the dynasty decides to go to school. For convenience we shall denote this critical level ν_P^* in the private school system, and ν_S^* in the state school system case. This critical level, or, equivalently, the length of this initial sequence of periods will depend of course on the institutional arrangement and on the equilibrium, and we discuss later how to characterise it.

Now until a new failure occurs (in which case the cycle we have just described starts all over again) the dynasty goes through a sequence of better and better periods. In each period each member goes to school, acquires human capital in an increasing quantity, and keeps the belief to a high level. In the private school system members of this dynasty devote an increasing amount to the education of their children; while in the state school system they vote for large tax rates in support of education. Eventually, however, failure occurs, and the cycle starts over.

4 Equilibria and Steady State Distributions

In this paper we shall concentrate our attention on the long run property of equilibria; and they can be easily studied by considering the invariant distribution on the relevant variables: human capital, beliefs over talent, investment in education and so on.

An observation will simplify the analysis. From our previous discussion of the typical history of a dynasty it should be clear that only certain typical beliefs over talent are possible in the long run, for a given critical belief. Let us see this in detail. Each dynasty experiences, in finite time with probability one, a failure. After this, the belief of the member of the dynasty in the next generation over his own talent at the moment of deciding about his schooling effort is α. Similarly for the following members the corresponding belief is $\hat{\alpha}^k, k = 1, 2, \ldots$ until the critical level is reached. After that the belief can only go to α, where the cycle begins again, or to $1 - \alpha$, and from this last belief the only transitions possible are either to $1 - \alpha$ again or to α.

If the critical level is above 1/2 there are countably many beliefs possible; if it is below, then there are only finitely many. In both cases, however, they are a subset of the countable set $\{\alpha, \hat{\alpha}, \hat{\alpha}^2, \ldots, 1 - \alpha\}$. Note that, in turn, this will produce a countable set of possible human capital level, and of possible expenditures in education and of tax rates voted.

We are now ready to examine more in detail the structure of the invariant distribution. The first step in this direction is clearly the definition of the appropriate state space. The natural candidates may seem at first very complicated. For instance, to each person may be associated several beliefs: one on his own talent at the moment of deciding the school effort, another on his own talent after the outcome of the education has been announced, and then the belief on the son's talent at the moment of deciding the expense for education (in the private school system) or the vote on the tax rate (in the state school system). Similarly there are two levels of human capital which are relevant for each individual: the one of the father, that will affect his education, and his own.

A much more economical representation is possible, however:

Definition 4.1 *The state space of the process is the product space $\mathcal{B} \times H = [0,1] \times R^+$ of beliefs over $\{H, L\}$ and of human capital values.*

This state space has to be understood as follows. For the pair (ν, h), ν is the belief on his own talent of a person, at the moment in which he decides the schooling effort n; and h is the human capital that the same person has at the end of the schooling period. In view of the comments we made earlier on the complexity of the natural candidates to the state space representation it may not be obvious that $\mathcal{B} \times H$ has all the relevant information. To make the discussion of this point more precise we say:

Definition 4.2 *A state space X is said to be a sufficient description of the process if the fact that the dynasty is in state $x \in X$ at time 0 provides sufficient information to describe the future conditions of the dynasty.*

The evolution is of course in the stochastic sense. In particular the information in x is sufficient to describe the optimal choices of effort, school expenditure, and voting for each member of the dynasty in future periods.

We now claim that

Lemma 4.3 *$\mathcal{B} \times H$ is a sufficient description.*

Proof. Consider for instance a dynasty in state $(1-\alpha, h_j)$. The representative of this dynasty has belief on his son's talent equal to $1-\alpha$ (because he had a success in education, as his human capital h_j proves); and he provides $e_j = \frac{1-\alpha}{1+(1-\alpha)} h_j$ of education. So the son has all the elements to decide his own schooling effort. The proof for the other types is similar.

We can now describe the transition probability over this state space. Let i be such that the belief $\hat{\alpha}^i$ is the critical belief, ν_P^* or ν_S^*.

Lemma 4.4 *The transition probabilities over $\mathcal{B} \times H$ are as follows (wp means: with probability):*

- *from $(\hat{\alpha}^{k-1}, 1)$ to $(\hat{\alpha}^k, 1)$ for $k = 0, \ldots, i-1$, wp 1;*

- *from* $(\hat{\alpha}^{i-1}, 1)$ *to* $(\hat{\alpha}^i, h_0)$ *wp* $\hat{\alpha}^i$, *and to* $(\hat{\alpha}^i, 1)$ *wp* $1 - \hat{\alpha}^i$;
- *from* $(\hat{\alpha}^i, 1)$ *and* $(1-\alpha, 1)$ *to* $(\alpha, 1)$ *wp* 1;
- *from* $(\hat{\alpha}^i, h_0)$ *to* $(1-\alpha, h_1)$ *wp* $1-\alpha$, *and to* $(1-\alpha, 1)$ *wp* α;
- *from* $(1-\alpha, h_j)$ *to* $(1-\alpha, h_{j+1})$ *wp* $1-\alpha$, *and to* $(1-\alpha, 1)$ *wp* α.

The proof is immediate.

The computation of the invariant distribution for this transition probability is reported in the appendix 8.4. Of course the probabilities in the transition matrix depend on the type of school system. We denote by Π, respectively Σ, the transition matrix in the private, respectively state, system; $\Pi(x, x')$ is the probability of the transition from x to x'. An equilibrium invariant distribution is a probability F^* that reproduces itself, when each person makes the optimal choice. More formally we say:

Definition 4.5 *A steady state equilibrium distribution for the private school system is a probability measure* F_P^* *over the product space* $\mathcal{B} \times H$ *such that*

i. $F_P^* = F_P^* \Pi$,

ii. each member of each dynasty is choosing effort and school expenditure optimally, according to the functions (D^P, e^P) *of section 3.*

Similarly we say:

Definition 4.6 *A steady state equilibrium distribution for the state school system is a triple* (τ^*, e^*, F_S^*) *of a tax rate, an average education quality and a probability measure* F_S^* *over the product space of beliefs and human capital such that* ($F_{S,H}$ *is the marginal of* F_S *over* H):

i. $F_S^* = F_S^* \Sigma$;

ii. $\tau^* \int h dF_{S,H}^*(h) = e^*$;

iii. τ^* *is the median voter tax rate for* F_S^*.

iv. each member of the each dynasty is choosing effort and vote on tax rate optimally, according to the functions (D^S, τ^S) *of section 3.*

5 Measures of Mobility

As we have seen, even on the reduced state space $\mathcal{B} \times H$ the transition matrix is infinite: so we have to find some simple index of the different degrees of mobility in the two educational systems. The simplest is the transition probability among two different classes of human capital.

We divide the total population in two classes: those who have a human capital equal to 1, the minimum value, and those who have a higher value. The first class will be denoted by C_1, the second by C_2. We can then compute the transition matrix between these two classes, say $p_{ij}, i = 1, 2; j = 1, 2$, where p_{ij} is the probability that the a dynasty is in the class transits from C_i to C_j; we have that:

Lemma 5.1 *The matrix of transition probability across classes is:*

$$\begin{pmatrix} (1 - \frac{\hat{\alpha}^i}{i+1}) & \frac{\hat{\alpha}^i}{i+1} \\ \alpha & (1 - \alpha) \end{pmatrix}$$

The term $\frac{\hat{\alpha}^i}{i+1}$ is a decreasing function of i.

Note that $\frac{\hat{\alpha}^i}{i+1} = \alpha$ when $i = 0$.

Proof. The notation will be cumbersome for the sake of clarity. Let F be an invariant distribution for the process described by the matrix Γ. From the ergodic theorem, the measure of the set of dynasty histories with two consecutive values of 1 of human capital is given by:

$$\sum_{\{(\nu,h):h=1\}} F(\nu, h) \left(\sum_{\{(\nu',h'):h'=1\}} \Gamma((\nu, h), (\nu', h')) \right).$$

From our computation of F in 8.4 we derive that the above quantity is equal to:

$$p(i + 1) - 2p\hat{\alpha}^i + q\alpha;$$

while the total fraction of population with human capital 1 is $p(i + 1)$. Taking ratios and using the value for p and q in the appendix 8.4 we get the result. The proof for the other row is obvious.

Recall now that $\hat{\alpha}^i = 1/2[1 - (1 - 2\alpha)^{i+1}]$; calculus applied to the function $\frac{1-(1-2\alpha)^x}{x}$ proves the second claim.

The value of $\frac{\hat{\alpha}^i}{i+1}$ can be considered an index of the mobility at the steady state equilibrium of the system we are analyzing: the higher this value the more mobile the society is. It is inversely related to the integer i, the number of periods a dynasty becomes "discouraged" after a failure.

We have now all the elements for a numerical computation of the steady state equilibrium values of the different proportions of population, different levels of human capital, effort in schooling and so on. The procedure to compute these values is discussed in the appendix.

6 Numerical Results

Tables 20, 21 and 22 contain the results of numerical simulation for three increasing values of the parameter α; this parameter is the transition probability of the Markov process that governs the transmission of talent. Low values of α imply high inheritability of talent while $\alpha = 0.5$ means that talent is randomly transmitted. Each of these three tables present the relevant economic indicators of our economies for different values of the parameters β and γ. These two parameters measure respectively the elasticity of a child's human capital with respect the effort $(1 - n_t)$ that he puts in the accumulation process and with respect to the quality of education e_t (inherited from the father in the private system and determined by tax revenues in the state economy).

In table 20 talent is assumed to be inherited at a very high degree ($\alpha = 0.1$). Panel A of this table shows that values of β and γ respectively equal to 0.3 and 0.1 make upward mobility lower in the state system than in the private system. Under these assumptions, the state system is also producing a higher proportion of unskilled workers, dynasties need to reach a higher level of "self confidence" in order to decide to go to school after a failure, and the number of generations that do not try to go to school because of lack of self confidence is higher.

The first row of Panel B, in the same table, shows that, for the same parameter values, the private system is characterized by higher income dispersion: since the income of individuals in the lower class is normalized to 1 in both systems, the larger median income of the upper class in the private system indicates greater inequality. The same Panel B shows also that, together with greater inequality, the private system features a greater average human capital and a better quality of education.

Moving to the other values of the parameters β and γ, Panel B of Table 20 shows that, as in Glomm and Ravikumar (1992), the private system produces unambigously more inequality, greater average human capital and a better quality of education. On the contrary, Panel A shows that the comparison concerning upward mobility is *not* unambiguous. In fact it depends in a clear way on the relative importance of individual effort and of the quality of education: i.e. it depends on the relative size of the parameters β and γ.

When individual effort is critical in determining the outcome, that is when the factor β is high compared to the factor γ, the private school system is *more* mobile than the state school system. Only when γ becomes relatively high (see the third row of Panel A in the table) then the mobility index reverses, and the state system is more mobile. Of course, at high values of γ also the degree of self confidence required for an investment in education and the number of generations that do not invest after a failure become smaller in the state system. Note, however, that even in this case the average human capital and the quality of education remain higher in the private school system.[21]

When α increases (see Tables 21 and 22) there is of course a loss of efficiency in the

[21]When the sum of β and γ increase the average human capital decreases (see panel B) because the externality created by the human capital of the father in the accumulation of the human capital of the child becomes less important ($\delta = 1 - \beta - \gamma$).

production of human capital under both systems,[22] but the essence of the comparison highlighted in Table 20 does not change. A lower degree of inheritability of talent makes the overall picture more favorable to the state system but, with the exception of the extreme case in which $\alpha = 0.5$, the state system remains less mobile unless γ is sufficiently high. Only at high values of α the state system tends to became almost as mobile as the private system even if γ is low. When $\alpha = 0.5$ the two systems appear indistinguishable from the point of view of mobility, but the private system continues to display higher inequality, higher average human capital and a better quality of education.

7 Conclusions

If one of the goals of a public education system is to favor equal opportunities of social mobility, the Italian schooling system failed to achieve this goal. The centralized and public structure of education financing in Italy has indeed ensured a substantial uniformity of the quantity and quality of education offered to both rich and poor families; but despite this offer of equal opportunities Italy, in comparison to the US, displays lower intergenerational mobility not only in terms of occupations but also in terms of education levels.

The fact that family background is a more important determinant of individual social fortunes in Italy than in the US is particularly puzzling given that in the US 98% of the expenditures for education is financed locally. From the viewpoint of this paper this is the distinctive feature that makes the US education system intrinsically *private*. Indeed, because of local financing (i) the quality of the education which is supplied in the US is significantly different according to the (perhaps implicit) price paid for it; and (ii) the quality of the education provided to the child is decided by the parent on the basis of this cost. In the US the quality of the pre-college education is significantly different in different neighborhoods and it has an implicit price in the property tax paid by residents and in the higher price of the houses in the best neighborhoods. The choice of the location of residence is clearly in large part a choice of the education provided to the child. *A fortiori* for college education for which in addition to local financing, 43% of funding is private in the US. The fact that in such a system family background is less important than in a system in which education is centralized and public is the puzzle that this paper has addressed.

The prevalence of non-competitive labor markets and barriers to entry/exit into/from occupations can certainly explain part of the observed evidence. But in this paper we propose a complementary explanation that highlights a worrisome distorsion of the incentives to human capital investment and to upward mobility that a centralized public education system generates.

When the same quality of education, financed through income taxes, is offered to everybody the individual incentive to accumulate human capital is reduced for two reasons. The first is the tax on income, which reduces the direct benefit to the person who decides how

[22]Note however that in simulations not reported here, when α is 0.3 we get, with θ appropriately lower, a picture which is quite similar to the one where α is low.

much effort to put in the schooling activity. The second is the impossibility to match higher talent and higher individual effort with a better education: while in the private system a father who expects his son to be talented can provide him with a better education out of his own income, in the state school system his contribution is to a common fund, and has no specific effect for the son.

Independently of the schooling system a society is more upwardly mobile the more likely a son of a poor family is to decide to acquire higher education. This decision hinges on the relative importance of individual effort and of the quality of education in the human capital accumulation process. If individual effort is relatively more important in the accumulation of human capital a private system should display more upward mobility because this system provides additional incentives to larger effort making people more willing to pursue the choice of education for a given level of confidence in their own ability. The importance of the quality of education goes, of course, the other way. This is the factor which is available to everybody in the state school system. So *ceteris paribus*, when the quality of education is relatively more important for the accumulation of human capital, a state system should display more mobility because the incentives to go to school rather than not are more similar across different income groups.

Our data are not rich enough to prove that this is the main reason for the low degree of social mobility in Italy in comparison to the US, but the evidence that we presented, in particular on educational mobility, suggests that the mechanism highlighted in our theoretical model is likely to be relevant. Non competitive labor markets can probably better explain the lack of downward occupational mobility in Italy; but what needs to be explained as well is the relatively low human capital investments among poor dynasties. And for this goal our approach seems appropriate.

More generally our model suggests that the evaluation of the performance of a centralized education system should take into account the relative importance of individual effort and of the quality of education in the accumulation of human capital. It seems possible to argue that in the case of elementary education individual effort is relatively less important, in which case a centralized public system that offers the same quality of education to everybody is the one that facilitates the probability that a poor dynasty invests in the education of a child. On the contrary in the case of higher education, in particular at the university level, individual effort is likely to be relatively more important making a decentralized system more preferable from the viewpoint of the creation of the right incentives to upward mobility; in this case, in fact, the education system must ensure the possibility of a proper matching between talents, individual effort and the quality of education

As a final note, one could argue that our paper has nothing to say on the sources, public or private, of education financing: the point is that in order for a state school system to generate more mobility than a private system it has to be relatively more capable to select talents and reward individual effort when such variables are crucial in the accumulation of human capital.

8 Appendices

8.1 The data

As far as Italy is concerned, our data come from a national survey conducted in 1985 by a group of Italian universities: the *Indagine Nazionale sulla Mobilitá Sociale*). A representative sample of 5016 individuals aged between 18 and 65 was interviewed on their working life, their social attitudes and their family background. From this file, we extracted information concerning the status of the respondent in 1985 and his/her family when he/she was 14. Therefore, while respondents are observed in the same year (1985), their parents are observed in different years, ranging in principle from 1934 to 1981.

From the original sample we excluded all individuals not belonging to the labour force or whose occupation was unknown. In addition, for comparability with the US sample (see below), we excluded all women and all individuals younger than 25; this latter restriction is justified by the fact that we want to allow for the possibility of completing university curricula. With these restrictions the original sample reduces to 1666 son-father couples; their age distribution is reported in table 1. The average age of each generation is similar and note that some parents were born during the 19th century.

US data comes, instead, from the Panel Study of Income Dynamics (PSID), that consists of a longitudinal sample of families interviewed for the first time in 1968 and then followed on a yearly basis. The subsample that we use is an extract of the original sample containing information on 1050 father-son couples, whose occupation was known and whose age was greater than 25 at the time of the interview.

An important difference between the two datasets is that US data are based on direct interviews to both sons and fathers, while Italian data on fathers are based on sons' recollections. Information on US sons were collected in 1990, while information on corresponding fathers refer to 1974. Because of the short interval between the two interviews, US sons are on average considerably younger than their fathers as shown in table 1.

In each country we consider the median income paid by each occupation as the indicator of individual long term economic status. As described in the text, we then group individuals in four classes constructed according to quartiles of the distribution of occupational incomes or, alternatively, according to income intervals. We then study mobility tables describing the probability of an intergenerational transition between the four classes.

It should be noted that we have not yet found a single classification of elementary occupations applicable to both countries, nor a conversion table from the national classifications into a common international one. For Italy our data set is based on the occupation classification developed by DeLillo-Schizzerotto (1985), who grouped 13.000 elementary occupations into 97 basic groups, characterized by a similar degree of social desirability (as measured by the ranking obtained in sample iterviews). For the US, we rely on the classification scheme developed by Duncan (1961), who estimated an index of social prestige (based on income and educational achievement) starting from a subgroup of occupations whose social desirability was estimated through direct interviews. In this case the classification scheme include 96 basic groups. Therefore we have a comparable number of occupational groups for the two countries, and these groups were created with similar metodologies, namely on the basis of a homogeneous degree of social desirability. But note that the ranking between occupations in the two countries does not need to be the same.

As far as occupational incomes are concerned, for the US sample we have information about the earnings of both generations. On the contrary, in the Italian sample, we do *not* have any direct information about incomes. We therefore merged occupational income data from another source according to the following procedure.

We started with incomes taken from the 1987 wave of the *Indagine sui Bilanci delle Famiglie Italiane* run by the Bank of Italy. Since this survey reports *net* incomes, we have estimated the corresponding gross incomes on the basis of the relevant fiscal legislation for 1987.[23] We then estimated an earning function using gross incomes. Regressors in the earning function were: age, 6 education dummies, 9 qualification dummies, 11 sector dummies and 5 geografic dummies. We used the estimated parameters to predict incomes for the individuals in our main sample. From these predicted individual incomes we constructed the occupational ranking. This procedure could of course be used only for the generation of sons. Therefore we were forced to use also for fathers the occupational ranking constructed for sons. In order to allow for a meaningful comparison, we imposed the same restriction on the US dataset as well.

As far as the educational levels are concerned, we have classified in the high education group all those individuals holding a *college degree* or a *PhD degree* in the US sample, or having obtained a *laurea* or a *dottorato di ricerca* in the Italian sample. This classification corresponds to the UNESCO classification *ISCED 6* and *ISCED 7*, and requires 18 and 16 years of school attendance, respectively in the two countries. People who attended some years of college without obtaining any degree where not considered as *college degree* holders. Because of some missing information on school attendance among fathers, the number of son-father pairs reduces to 1505 observation for Italy and to 1037 for US whenever the education of fathers is considered in the analysis . In the case of Italy we have also used an alternative classification scheme (see table 17): in this case we have included in the high education group all those individuals holding at least a *maturitá* degree i.e. a secondary school degree corresponding to ISCED 5 classification scheme; in such a case the minimum number of years of school attendance is 15.

8.2 Empirical measures of inequality

The indexes reported in table 2 are well known and widely used in the literature on inequality measurement. Therefore, in this appendix we just present the formulas that we have used to compute them. Denoting income with y, the first indicator in the table is the percentage

[23]The Italian system of personal income taxation is step-wise progressive and allows for tax deductions based on household composition. It is therefore possible to reconstruct for each individual his/her gross income starting from his/her net income. Note that preliminary versions of this paper have circulated with evidence based on net incomes.

difference between the 90th and the 10th percentile of the income distribution:

$$I_{90-10} = log(y_{90}) - log(y_{10})$$

This indicator measures the range of variation of incomes disregarding possible outliers in the top and bottom 10% of the distribution. Higher values imply higher inequality

The relative mean deviation of incomes is computed as

$$I_{relmeandev} = \frac{\sum_{i=1}^{n} |y_i - \bar{y}|}{2n\bar{y}}.$$

where $\bar{y}$ is the arithmetic sample mean; this index can be interpreted as the average percentage income transfer from those above the mean to those below the mean that would be necessary to achieve perfect equality. Higher values imply higher inequality.

The coefficient of variation is the ratio between the standard deviation and the arithmetic sample mean of incomes, i.e.:

$$I_{coefvar} = \left\{ \frac{\frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y})^2}{\bar{y}} \right\}^{1/2}.$$

The standard deviation of logarithms is instead defined as

$$I_{stdlog} = \frac{1}{n}\sum_{i=1}^{n}(logy_i - log\bar{y}_G)$$

where $\bar{y}_G$ is the geometric sample mean. In both cases higher values imply higher inequality.

The Gini's coefficient can be interpreted as the expected income gap (in percentage terms) between two individuals randomly selected from the population and is defined as:

$$I_{Gini} = \frac{2}{n^2\bar{y}}\sum_{i=1}^{n} i(y_i - \bar{y})$$

where incomes y_i are ordered in ascending order. The index varies between 0 (*maximum equality*) and 1 (*maximum inequality*).

The Atkinson index can be thought as an index constructed on the basis of a social welfare function such that ϵ represents the degree of (social) aversion to inequality:

$$I_{Atkinson} = 1 - \left(\frac{1}{n}\sum_{i=1}^{n} \left(\frac{y_i}{\bar{y}}\right)^{(1-\epsilon)} \right)^{1/(1-\epsilon)}$$

The index varies between 0 (*maximum equality*) and 1 (*maximum inequality*).

Finally, the Theil's measure of entropy is defined as

$$I_{Theil} = \frac{1}{n}\sum_{i=1}^{n} \frac{y_i}{\bar{y}} log\frac{y_i}{\bar{y}}$$

and again it reaches the maximum value of 1 in the case of greatest inequality.

8.3 Empirical measures of mobility

The measures of mobility presented in tables 5, 10 and 18 are probably less well known than the measures of inequality described above and require more discussion.

The indexes ML, MT, MD and MF can be better understood within a markovian interpretation of the interquartile transition matrices.[24] Given this interpretation, they measure the difference between the observed matrix and the limiting matrix of the Markov process. This limiting matrix has all rows equal to the invariant distribution; therefore it represents a situation of equal opportunities in which the probabilities of transition to the class of destination are the same independently of the class of origin. Hence, these measures of the difference between the observed matrix and the limiting matrix tell us how quickly the initial position of a dynasty becomes irrelevant for the determination of its social fortunes; or alternatively how distant the current situation is from a situation of equal opportunities.

It should be noted that while for interquartile matrices the invariant distribution is obviously the same in both countries and equal to 0.25 for each quartile, for interclass matrices the limiting distribution may in principle differ across countries. If this were the case for Italy and the US, these indicators would measure distances from different situations in the two countries, making the comparison less meaningful. This problem however is not particularly serious in our comparison, because the limiting distributions are fairly similar for Italy and for the US. This is shown in Tables 11 and 12 that present, respectively for Italy and for the US, the distributions of dynasties across income classes in the two generations and the invariant limiting distributions. The fact that the two invariant distributions are similar is confirmed by the Kolmogoroff index of dissimilarity (defined as one half times the sum of the absolute values of the differences between the frequecies of corresponding classes) that is equal to 0.07.

Looking more closely at the definitions of these indicators, ML is based on the modulus of the second largest eigenvalue of the transition matrix and is defined as:

$$ML = 1 - |\lambda_2|$$

It measures the distance from the invariant distribution in the following sense. Any transition matrix P can be decomposed as

$$P = \lambda_1 u'\pi + \sum_2^k \lambda_i A_i$$

where: u' is a row vector of one; π is the invariant limiting distribution; the $\lambda_i s$ are the eigenvalues ordered from the highest to the lowest and k is the order of the transition matrix; the matrices A_i are such that $A_i A_j = 0$ if $i \neq j$; $A_i A_j = A_i$ if $i = j$; $\sum_1^k A_i = I$.

Since the transition matrix P is stochastic, the first eigenvalue λ_1 is equal to 1; if the second largest eigenvalue is equal to zero the matrix P is equal to a matrix that has all

[24]Of course the applicability of this interpretation to intergenerational mobility tables is a matter of discussion; see, for example, Bartholomew (1982).

rows equal to the limiting invariant distribution: it is, therefore, a matrix that ensures equal opportunities because it displays the same transition probabilities independently of the class of origin. Inasmuch as the second largest eigenvalue differs from zero the matrix P does not ensure equal opportunities: hence, $ML = |1 - \lambda_2|$ is a measure of mobility that takes value 0 in a situation of perfect generational dependence and value 1 in a situation of equal opportunities.

MT is based on the trace of the transition matrix that is, of course, equal to the sum of the eigenvalues.

$$MT = \frac{k - tr(P)}{k - 1}$$

where k is the dimension of the matrix P. When the trace is equal to 1 all the eigenvalues except the first are equal to 0 and MT is equal to 1 implying the existence of equal opportunities. MT is instead obviously equal to 0 when the transition matrix P is equal to the identity matrix (perfect immobility).

MD is based instead on the determinant of the matrix P that is a function of the product of the eigenvalues.

$$MD = 1 - |det(P)|^{(1/(k-1))}$$

Because of the decomposition of the transition matrix described above, if all the eigenvalues are equal to 1 we are in a situation of perfect immobility and this indicator is indeed equal to 0. At the opposite end, however, it should be noted that for MD to be equal to 1 it is enough that two rows of the transition matrix are equal, in which case the determinant would be zero. *A fortiori* when the matrix P is equal to the limiting matrix of equal opportunities and all rows are equal, MD takes value 1.

For the interquartile matrix we report also the indicator MF that is based on a direct comparison between the transition probabilities of the observed matrix and .25 that is the transition probability of the limiting matrix in the case of interquartile transitions.

$$MF = 1 - \frac{1}{k^2} \sum_{ij} |\frac{p_{ij}}{.25} - 1|$$

where p_{ij} is the transition probability from class i to class j. This indicator is clearly equal to 1 in the case of equal opportunities, but can take negative values if the difference between the actual and the limiting matrix is sufficiently large

The indicators considered so far identify maximum mobility with a situation of perfect generational independence or equal opportunities. An alternative family of indicators defines instead a situation of perfect mobility as a situation in which some measure of the "social distance" covered by mobile dynasties is maximized. More precisely, these scalar indicators of mobility are constructed as weighted averages of the distances corresponding to each transition, where the weights are given by the transition probabilities. As highlighted in the literature, these two families of indicators do not necessarily ensure the same ranking of a given set of mobility matrices. Consider, for example, the case of a matrix characterized by probabilities equal to 1 in the secondary diagonal: such a matrix would imply perfect generational *dependence*, and therefore immobility, according to the first family of criteria, but high mobility according to the second. However the literature has identified some classes of matrices, that include the matrices analyzed in this paper, in which the two ordering are coherent.[25]

The most well known of these indicators is the Index of Bartholomew[26] of which we compute two variants. The first variant, MB, measures the average number of class boundaries crossed by dynasties from one generation to the other, while the second variant MA, can be interpreted as the average income change in percentage terms that a dynasty experiences from one generation to the other.

$$MB = \sum_i \sum_j f_{ij}|i-j|$$

$$MA = \sum_i \sum_j f_{ij}|W_i - W_j|$$

where f_{ij} is the joint frequency in cell (i, j); $|i-j|$ is the number of class borders crossed in the transition from i to j and $|W_i - W_j|$ is the percentage difference between median incomes of class i and j. It should be noted that the second variant of this index combines the effect of the probability of movement with the effect of the *income distance* covered by moving dynasties.

8.4 The Invariant Distribution

In this section we provide the values of the invariant distribution over the state space $\mathcal{B} \times H$, for a given value $\hat{\alpha}^i$ of the critical belief. The reader will recall that the integer i is the only factor determining this distribution.

In an invariant distribution, for each integer $k = 0, 1, \ldots, i-1$ there is a corresponding fraction p_k of the population in state $(\hat{\alpha}^k, 1)$, a fraction $p_i(1-\hat{\alpha}^i)$ and $p_i\hat{\alpha}^i$ respectively in state $(\hat{\alpha}^i, h_0)$ and $(\hat{\alpha}^i, 1)$ respectively.

It is immediate from the transition matrix that:

$$p_0 = p_1 \ldots = p_i \equiv p. \tag{8.17}$$

It will be useful now to use the following notational device: the state $(1-\alpha, 1_j)$ is the state of a person with belief $(1-\alpha)$ in the first period of his life, coming after j consecutive successes in his dinasty, and who fails at school. Now denote by q_j and r_j respectively the fraction of the population in state $(1-\alpha, h_j)$ and $(1-\alpha, 1_j)$ we have:

[25] See for example Shorrocks (1978), Bartholomew (1982) and Conlisk (1990).

[26] See Bartholomew (1982).

$$q_0 = p\hat{\alpha}^i, r_0 = p(1-\hat{\alpha}^i), q_{j+1} = (1-\alpha)q_j, r_{j+1} = \alpha q_j, j = 0, 1, 2, \ldots \tag{8.18}$$

But now, using 8.18 repeatedly and observing that:

$$p = \sum_0^\infty (r_j)$$

we can solve to get

$$p(1+i) + \frac{1}{\alpha} q_0 = 1,$$

and finally:

$$p = \frac{\alpha}{\alpha(i+1) + \hat{\alpha}^i}; q = \frac{\hat{\alpha}^i}{\alpha(i+1) + \hat{\alpha}^i}, \tag{8.19}$$

where $q = \sum_0^\infty (q_j)$ is the fraction of the population with human capital greater than 1 and, from 8.17, $(i+1)p$ is the fraction of the population with human capital equal to 1.

8.5 Numerical Computation

In this appendix we describe the procedure to compute the long run equilibrium. Of course given the complexity of the calculation this procedure is useful first of all for numerical purposes.

Let us begin again with the private school system. The procedure checks for each integer i if the corresponding belief $\hat{\alpha}^i$ is the critical belief of an equilibrium distribution. Recall that a critical belief is the least belief such that the member of a dinasty with that belief decides to go to school.

In the previous section we have determined the steady state equilibrium proportion of the population for the different beliefs. Note that there are several types of people having the belief $1-\alpha$; namely, those whose dinasty has had a sequence of one, two, and so on successes. These types will have different level of human capital. We now proceed to determine these levels and the corresponding proportions. Let us begin with the first. After the critical level $\hat{\alpha}^i$ is reached, the member of the dinasty goes to school. The father had a human capital equal to 1, a belief on his own talent equal to $\hat{\alpha}^{(i-1)}$, and has invested $e = \frac{\hat{\alpha}^i}{1+\hat{\alpha}^i}$ in the education of the son.

The son invests the optimal amount of effort given these characteristics, and succeeds with probability $\hat{\alpha}^i$. If he does, he has a human capital of

$$h_0 \equiv \theta \left(\frac{\hat{\alpha}^i \beta [1 + (1-\alpha)]}{1 + \hat{\alpha}^i \beta [1 + (1-\alpha)]} \right)^\beta \left(\frac{\hat{\alpha}^i}{1+\hat{\alpha}^i} \right)^\gamma.$$

Similar arguments give that the dinasties with j consecutive successes in the past have level of human capital that follows the difference equation

$$h_j = \theta \left(\frac{(1-\alpha)\beta[1+(1-\alpha)]}{1+(1-\alpha)\beta[1+(1-\alpha)]} \right)^{\beta} \left(\frac{(1-\alpha)}{1+(1-\alpha)} \right)^{\gamma} h_{j-1}^{(\gamma+\delta)}$$

for $j = 1, \ldots$.
We have conjectured so far that the integer i determines a critical belief $\hat{\alpha}^i$. The last step of the procedure is to verify this conjecture. If it is, we have found a stead state equilibrium; if it is not, we proceed to the next integer. To verify the conjecture we have to check that the belief $\hat{\alpha}^i$ is indeed the least one for which people go to school. But the difference in expected utility between the two choices Y and N for a person with belief ν on his own talent, expenditure e decided by the father and human capital 1 of the father is given by the function

$$\Psi(\nu, e) \equiv \nu\beta[1+(1-\alpha)]L(\frac{1}{\nu\beta[1+(1-\alpha)]})$$
$$+\nu[1+(1-\alpha)]\log(\theta e^{\gamma}) + \nu L(1-\alpha) + (1-\nu)L(\alpha) - \mathrm{L}(\hat{\nu}).$$

The final step is now obvious: find the least integer i such that

$$\Psi\left(\hat{\alpha}^i, \frac{\hat{\alpha}^i}{1+\hat{\alpha}^i}\right) \geq 0.$$

The procedure to determine the steady state equilibrium for the state school system is similar, and we provide here the main lines. In this case too we check if $\hat{\alpha}^i$ is the critical belief of the equilibrium, for every i. Recall now that the preferred level of taxes only depends on the belief of the father at the moment of voting, and is given in the equations 3.10, 3.11, and 3.12 above. A simple computation now determines the median voter in this population, and the winning tax rate $\tau(\hat{\alpha}^i)$. Also arguments like the one given above give the human capital for generations with j successes. The equations are now:

$$h_0 \equiv \theta \left(\frac{\hat{\alpha}^i\beta}{1+\hat{\alpha}^i\beta} \right)^{\beta} e^{\gamma};$$

and

$$h_j = \theta \left(\frac{(1-\alpha)\beta}{1+(1-\alpha)\beta} \right)^{\beta} e^{\gamma} h_{j-1}^{\delta},$$

for $j = 1, \ldots$. The e in the formulas for human capital above is for the moment a parameter to be determined. Keeping into account that the proportion of population with h_0 is $p\hat{\alpha}^i$, and the proportion of population with h_j is $q\alpha(1-\alpha)^j$ for every $j > 0$ we can now determine the aggregate human capital and therefore the aggregate income, *this last as a function of* e (besides i), $H(i, e)$ say. Now solving for e in

$$e = \tau(\hat{\alpha}^i)H(i, e)$$

determines a value of the education quality level in the state school system $e(i)$, say. The final step is, as before, the determination of the integer i for which indeed the belief $\hat{\alpha}^i$ is the critical level. The function giving the difference between the expected utility of the Y and the N decision, for person with father having a human capital equal to 1 is now given by:

$$\Phi(\nu, e) \equiv \nu\beta L(\frac{1}{\nu\beta}) + \nu \log(\theta e^{\gamma}); \tag{S.20}$$

and as before we conclude by determining the least integer i such that $\Phi(\hat{\alpha}^i, e(i)) \geq 0$.

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Table 1: Age distribution for both generations in Italy and in the US

Country	Father/son	Av.age	St.Dev.	Min. age	Max. age
Italy	Father	47	7	31	83
N = 1666	Son	44	11	25	65
United States	Father	47	7	27	74
N = 1050	Son	33	5	25	59

Note: Italian data refer to 1666 father-son pairs; sons were interviewed in 1985, and information regarding their fathers refers to the year in which sons were 14 years old. Source: *Indagine nazionale sulla mobilità sociale*. US data refer to 1050 father-son pairs; information on sons refer to 1990, while information on fathers refer to 1974. Source: *Panel Study of Income Dynamics*.

Table 2: Inequality measures for Italy and the US

Measure	Italy Father	US Father	Italy Son	US Son
90-10 percentile differential	140.6	164.3	131.5	150.3
relative mean deviation	12.2	14.6	13.2	14.3
coefficient of variation	33.8	37.5	34.8	36.0
standard deviation of logs	30.0	35.6	31.3	34.9
Gini coefficient	16.8	20.2	17.9	19.6
Atkinson ($\epsilon = 2$)	8.7	11.8	9.3	11.4
Theil entropy	5.0	6.6	5.5	6.1

Note: All measures are expressed in % terms. Higher values imply greater inequality. See the Appendix 8.2 for a description of these indicators.

Table 3: Italy: interquartile transition probabilities

	Son Q1	Son Q2	Son Q3	Son Q4	Abs. freq.
Father Q1	39.6	25.9	18.5	16.1	417
Father Q2	27.3	39.4	18.1	15.2	414
Father Q3	22.2	25.5	28.9	23.4	419
Father Q4	11.1	9.1	34.6	45.2	416
Abs. freq.	417	416	417	416	1666

Note: each cell contains the row-to-column transition probability. Q1-Q4 are the quartiles of the distribution of occupational incomes within each generation.

Table 4: USA: interquartile transition probabilities

	Son Q1	Son Q2	Son Q3	Son Q4	Abs.freq.
Father Q1	39.2	25.5	21.7	13.7	263
Father Q2	34.0	27.4	22.9	15.6	262
Father Q3	16.7	30.8	25.5	27.0	263
Father Q4	10.3	16.0	30.1	43.5	262
Abs.freq.	263	262	263	262	1050

Note: each cell contains the row-to-column transition probability. Q1-Q4 are the quartiles of the distribution of occupational incomes within each generation.

Table 5: Scalar indicators of mobility for interquartile transition matrices

	Italy	USA	Eq. opp.
$ML = 1 - \|\lambda_2\|$	0.65	0.67	1
$MT = \frac{k-tr(P)}{k-1}$	0.82	0.88	1
$MD = 1 - \|det(P)\|^{(1/(k-1))}$	0.87	0.94	1
$MF = 1 - \frac{1}{k^2} \sum_{ij} \|\frac{p_{ij}}{.25} - 1\|$	0.67	0.71	1
$MB = \sum_i \sum_j f_{ij} \|i-j\|$	0.92	0.96	-
$MA = \sum_i \sum_j f_{ij} \|W_i - W_j\|$	19.46	28.78	-

Note: $|\lambda_2|$ is the modulus of the second greater eigenvalue; $tr(P)$ is the trace of the interquartile transition matrix P; p_{ij} denotes the transition probability from quartile i to quartile j; f_{ij} is the joint frequency in cell (i, j); k is the number of quartiles; the distance $|i-j|$ is the number of quartile borders crossed in the transition from i to j. $|Wi-Wj|$ is the percentage difference between median incomes of quartile i and j.

Table 6: Italy: income distribution across quartiles or income classes

Quartiles			Income classes		
Quartile 1	Minimum	100	100	Minimum	Class 1
	Median	144	135	Median	
	Maximum	156	144	Maximum	
Quartile 2	Minimum	156	150	Minimum	Class 2
	Median	164	164	Median	
	Maximum	186	216	Maximum	
Quartile 3	Minimum	186	219	Minimum	Class 3
	Median	219	234	Median	
	Maximum	234	318	Maximum	
Quartile 4	Minimum	234	331	Minimum	Class 4
	Median	267	369	Median	
	Maximum	474	474	Maximum	

Note: statistics based on the distribution of sons' incomes; results are similar for the distribution of fathers. Minimum occupational income normalized to 100. Income classes are defined as intervals of equal size of the (log) difference between the highest and the lowest occupational incomes.

Table 7: USA: income distribution across quartiles or income classes

Quartiles			Income classes		
Quartile 1	Minimum	100	100	Minimum	Class 1
	Median	139	130	Median	
	Maximum	165	139	Maximum	
Quartile 2	Minimum	165	148	Minimum	Class 2
	Median	187	174	Median	
	Maximum	217	215	Maximum	
Quartile 3	Minimum	217	215	Minimum	Class 3
	Median	252	261	Median	
	Maximum	261	314	Maximum	
Quartile 4	Minimum	261	322	Minimum	Class 4
	Median	330	337	Median	
	Maximum	463	463	Maximum	

Note: statistics based on the distribution of sons' incomes; results are similar for the distribution of fathers. Minimum occupational income normalized to 100. Income classes are defined as intervals of equal size of the (log) difference between the highest and the lowest occupational incomes.

Table 8: Italy: interclass transition probabilities

	Son C1	Son C2	Son C3	Son C4	Abs.freq.
Father C1	21.8	50.4	22.3	5.4	367
Father C2	12.0	55.9	25.8	6.3	884
Father C3	5.9	27.0	51.6	15.5	341
Father C4	4.0	16.2	32.4	47.3	74
Abs.freq.	209	783	510	164	1666

Note: each cell contains the row-to-column transition probability. C1-C4 are income classes defined as intervals of equal size of the (log) difference between the highest and the lowest occupational incomes.

Table 9: USA: interclass transition probabilities

	Son C1	Son C2	Son C3	Son C4	Abs.freq.
Father C1	25.9	36.4	31.4	6.3	239
Father C2	22.5	37.7	29.7	10.1	337
Father C3	9.3	31.0	41.7	18.0	355
Father C4	4.2	15.1	42.0	38.7	119
Abs.freq.	176	342	373	159	1050

Note: each cell contains the row-to-column transition probability. C1-C4 are income classes defined as intervals of equal size of the (log) difference between the highest and the lowest occupational incomes.

Table 10: Scalar indicators of mobility for interclass transition matrices

	Italy	USA	Eq. opp.
$ML = 1 - \|\lambda_2\|$	0.55	0.65	1
$MT = \frac{k-tr(P)}{k-1}$	0.74	0.85	1
$MD = 1 - \|det(P)\|^{(1/(k-1))}$	0.79	0.90	1
$MB = \sum_i \sum_j f_{ij}\|i-j\|$	0.62	0.80	-
$MA = \sum_i \sum_j f_{ij}\|W_i - W_j\|$	22.44	27.55	-

Note: $|\lambda_2|$ is the modulus of the second greater eigenvalue; $tr(P)$ is the trace of the interclass transition matrix P; respectively; k is the number of classes; f_{ij} is the joint frequency in cell (i,j); the distance $|i-j|$ is the number of class borders crossed in the transition from i to j. $|W_i - W_j|$ is the percentage difference between median incomes of class i and j.

Table 11: Italy: actual marginal distributions and limiting distribution

	Class 1	Class 2	Class 3	Class 4
Father	0.22	0.53	0.20	0.04
Son	0.13	0.47	0.31	0.10
Limit	0.09	0.39	0.36	0.16

Note: marginal and limiting distributions are referred to the matrix of interclass transition probabilities. The limiting distribution is obtained under the assumption that the observed matrix describes a Markov process.

Table 12: USA: actual marginal distributions and limiting distribution

	Class 1	Class 2	Class 3	Class 4
Father	0.23	0.32	0.34	0.11
Son	0.17	0.33	0.36	0.15
Limit	0.15	0.31	0.36	0.17

Note: marginal and limiting distributions are referred to the matrix of interclass transition probabilities. The limiting distribution is obtained under the assumption that the observed matrix describes a Markov process.

Table 13: Determinants of the probability that a son is in income class 3 or 4

	ITALY model 1	ITALY model 2	ITALY model 3	USA model 1	USA model 2	USA model 3
Father in income class 3 or 4	0.37	0.35		0.22	0.19	
	(.03)	(.03)		(.03)	(.03)	
Father with college degree	0.18	0.02		0.19	0.05	
	(.09)	(.09)		(.04)	(.05)	
Son with college degree		0.31	0.39		0.47	0.50
		(.05)	(.05)		(.03)	(.03)
Father's age	-0.001	-0.001		0.009	0.004	
	(.002)	(.002)		(.002)	(.003)	
Son's age		-0.003	-0.03		0.005	0.007
		(.001)	(.001)		(.004)	(.003)
observed prob.	.427	.427	.427	.508	.508	.508
predicted prob.	.427	.428	.428	.511	.532	.530
Pseudo R2	.08	.10	.04	.07	.19	.16
log-likelihood	-939	-918	-984	-665	-578	-597
sample size	1505	1505	1505	1037	1037	1037

Note: Maximum likelihood estimates of a probit model in which the dependent variable takes value 1 when the son is in income class 3 or 4. The table reports the probability effects, evaluated at the sample averages, due to a discrete change of each dummy independent variable. For the age controls the reported effects are those of an infinitesimal age change.

Table 14: Actual marginal and limiting distributions for education in Italy and USA

	Italy E1 = no coll.	Italy E2 = coll.	Italy E1 = no HS	Italy E2 = HS+	USA E1 = no coll.	USA E2 = coll.
Father	0.97	0.03	0.92	0.08	0.84	0.16
Son	0.91	0.09	0.71	0.29	0.73	0.27
Limit	0.83	0.17	0.30	0.70	0.65	0.35

Note: marginal and limiting distributions are referred to the matrices of educational transition probabilities. Each limiting distribution is obtained under the assumption that the correspndent matrix describes a Markov process. For Italy: high education = college degree in column 1 and high school degree or more in column 2; for the USA: high education = college degree.

Table 15: Italy: transition probabilities from "no college" to "college"

	Son E1	Son E2	Abs.freq.
Father E1	92.9	7.1	1462
Father E2	34.9	65.1	43
Abs.freq.	1374	131	1505

Note: each cell contains the row-to-column transition probability. E1 = no college degree; E2 = completed college degree.

Table 16: USA: transition probabilities from "no college" to "college"

	Son E1	Son E2	Abs.freq.
Father E1	79.2	20.8	870
Father E2	38.9	61.1	167
Abs.freq.	754	283	1037

Note: each cell contains the row-to-column transition probability. E1 = no college degree; E2 = completed college degree.

Table 17: Italy: transition probabilities from "less than highschool" to "highschool or +"

	Son E1	Son E2	Abs.freq.
Father E1	75.9	24.1	1389
Father E2	10.3	89.7	116
Abs.freq.	1066	439	1505

Note: each cell contains the row-to-column transition probability. E1 = less than highschool; E2 = completed highschool or more.

Table 18: Scalar indicators of mobility for educational transition matrices

	Italy E2 = coll.	USA E2 = coll.	Italy E2 = HS or +	Eq. opp.
$OR = \frac{p_{12}/p_{11}}{p_{22}/p_{21}}$	24.6	6.0	27.3	1
$MT = \frac{k-tr(P)}{k-1}$	0.42	0.60	0.34	1
$MB = \sum_i \sum_j f_{ij}\|i-j\|$	0.12	0.27	0.14	-

Note:OR is the odds ratio; in a 2×2 matrix the indexes MT, MD and ML defined in table 10 are all equal; $tr(P)$ is the trace of the interclass transition matrix P; k is the number of classes; f_{ij} is the joint frequency in cell (i, j); the distance $|i - j|$ is the number of borders crossed in the transition from i to j.

Table 19: Determinants of the probability that a son reaches a high level of education

	ITALY 1 = College	ITALY 1 = HS or more	USA 1 = College
Father income class 3 or 4	0.12	0.20	0.12
	(.02)	(.03)	(.03)
Father with college degree	0.43		0.34
	(.06)		(.04)
Father with HS or more		0.60	
		(.06)	
Father's age	-0.000	-0.001	0.007
	(.000)	(.001)	(.001)
observed prob.	.09	.29	.27
predicted prob.	.07	.28	.25
Pseudo R2	.15	.13	.10
log-likelihood	-378	-784	-541
sample size	1505	1505	1037

Note: Maximum likelihood estimates of a probit model in which the dependent variable takes value 1 when the son has a high level of education. For Italy: high education = college degree in column 1 and high school degree or more in column 2; for the USA: high education = college degree. The table reports the probability effects, evaluated at the sample averages, due to a discrete change of each dummy independent variable. For the age controls the reported effects are those of an infinitesimal age change.

Table 20: High inheritability of talent: $\alpha = 0.1$

PANEL A						
School System	β	γ	Proportion of unskilled	Probability of upward mobility	Critical belief	First gen. to school after fail
State	0.3	0.1	0.60	0.07	0.34	4
Private			0.53	0.09	0.18	1
State	0.1	0.3	0.53	0.09	0.18	1
Private			0.50	0.10	0.10	0
State	0.1	0.6	0.53	0.09	0.18	1
Private			0.60	0.07	0.34	4
PANEL B						
School System	β	γ	Median income upp. class	Average human capital	Quality of education	Tax rate in state system
State	0.3	0.1	4.11	1.97	0.93	0.47
Private			8.18	3.19	1.33	
State	0.1	0.3	16.03	6.32	2.99	0.47
Private			459.63	35.53	16.65	
State	0.1	0.6	2.52	1.66	0.79	0.47
Private			48.85	5.22	2.30	

Note: In all the simulations described in this table θ has been set equal to 2.8. The income for individuals in the lower class is normalized to 1. The critical beliefs are the beliefs ν_P^* or ν_S^*, respectively for the private and the state system, that dynasties have to reach after a history of no schooling in order to decide to make an investemnt in education.

Table 21: Medium inheritability of talent: $\alpha = 0.3$

PANEL A						
School System	β	γ	Proportion of unskilled	Probability of upward mobility	Critical belief	First gen. to school after fail
State	0.3	0.1	0.59	0.21	0.42	1
Private			0.50	0.30	0.30	0
State	0.1	0.3	0.50	0.30	0.30	0
Private			0.50	0.30	0.30	0
State	0.1	0.6	0.59	0.21	0.42	1
Private			0.66	0.16	0.47	2
PANEL B						
School System	β	γ	Median income upp. class	Average human capital	Quality of education	Tax rate in state system
State	0.3	0.1	3.23	1.49	0.61	0.41
Private			6.06	1.90	0.79	
State	0.1	0.3	3.34	1.65	0.38	0.23
Private			219.88	3.68	1.53	
State	0.1	0.6	1.63	1.21	0.50	0.41
Private			15.35	1.37	0.52	

Note: In all the simulations described in this table θ has been set equal to 2.8. The income for individuals in the lower class is normalized to 1. The critical beliefs are the beliefs ν_P^* or ν_S^*, respectively for the private and the state system, that dynasties have to reach after a history of no schooling in order to decide to make an investemnt in education.

Table 22: Perfectly random transmission of talent: $\alpha = 0.5$

PANEL A						
School System	β	γ	Proportion of unskilled	Probability of upward mobility	Critical belief	First gen. to school after fail
State	0.3	0.1	0.50	0.50	0.50	0
Private			0.50	0.50	0.50	0
State	0.1	0.3	0.50	0.50	0.50	0
Private			0.50	0.50	0.50	0
State	0.1	0.6	0.50	0.50	0.50	0
Private			0.50	0.50	0.50	0
PANEL B						
School System	β	γ	Median income upp. class	Average human capital	Quality of education	Tax rate in state system
State	0.3	0.1	2.39	1.34	0.45	0.33
Private			3.94	1.47	0.82	
State	0.1	0.3	4.18	1.68	0.56	0.33
Private			76.53	1.76	0.92	
State	0.1	0.6	1.28	1.11	0.37	0.33
Private			2.83	1.11	0.70	

Note: In all the simulations described in this table θ has been set equal to 2.8. The income for individuals in the lower class is normalized to 1. The critical beliefs are the beliefs ν_P^* or ν_S^*, respectively for the private and the state system, that dynasties have to reach after a history of no schooling in order to decide to make an investemnt in education.

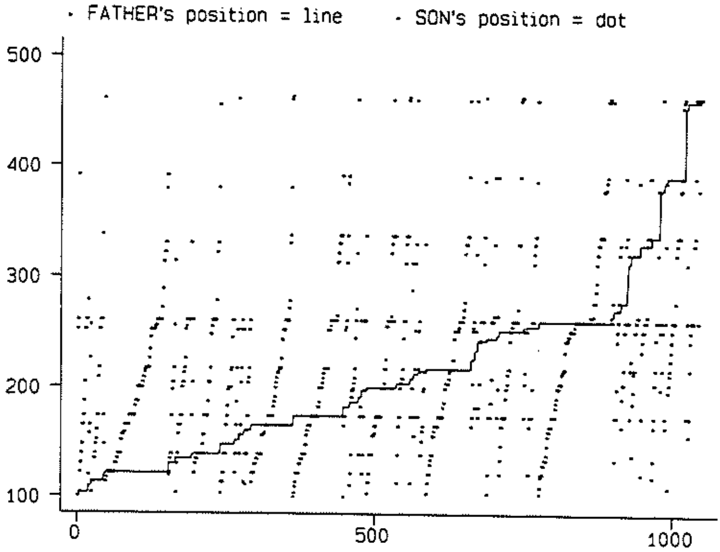

Figure 1: United States: occupational income of sons versus occupational income of fathers

Notes: In this figure the 1050 US dynasties have been ordered on the horizontal axis according to fathers' incomes measured by the continuous non decreasing line in the figure. On the vertical of each point on the income line of fathers, a point indicates the income of the corresponding son. To the extent that the points for sons do not lie on the income line of fathers there is evidence of occupational mobility in the US.

Sources: Our computations on data from the Panel Study on Income Dynamics.

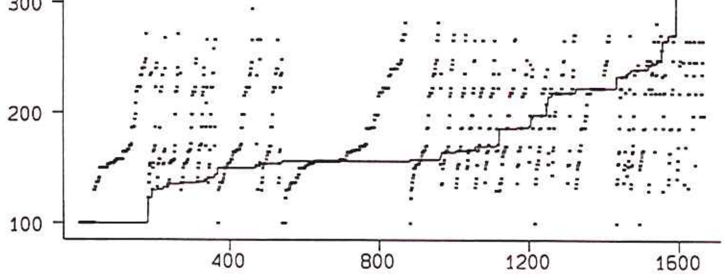

Figure 2: Italy: occupational income of sons versus occupational income of fathers

Notes: In this figure the 1666 Italian dynasties have been ordered on the horizontal axis according to fathers' incomes measured by the continuous non decreasing line in the figure. On the vertical of each point on the income line of fathers, a point indicates the income of the corresponding son. To the extent that the points for sons do not lie on the income line of fathers there is evidence of occupational mobility in Italy.

Sources: Our computations on data from *Indagine Nazionale sulla Mobilità sociale.*

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