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Bequest taxation, allocation of talents, education and efficiency

Stefano Staffolani and Enzo Valentini

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Abstract

In this paper we analyze intergenerational mobility on education. After a brief empirical analysis of the influence of family background on educational attainment, we present a dynamic model where the decisions concerning education may be financially constrained. Therefore, people who get higher educational levels are not necessarily the most talented. This "misallocation effect" causes a reduction in the efficiency of the economic system. We show that a proportional bequest taxation, whose yield is redistributed among all "youths", increases efficiency.

JEL Class.: D33, I22, I30, J24

Keywords: Education, bequest, talent allocation.

Indirizzo: Department of Economics, Marche Polytechnic University, P.zza Martelli, 8 - 60121 Ancona; E-Mail: s.staffolani@univpm.it valentini@deanovell.unian.it.

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1 Introduction

A large body of empirical findings has shown that a correlation between father/mother and children socio-economic status exists[1]. Among the most recent papers, Chevalier et al. (2005), using the Labor Force Survey database, confirm that, in the U.K., parents' and children's income and education are highly correlated, with stronger effects of maternal education than paternal and stronger effects on sons than on daughters. Comi (2004), using the LIS database, studied intergenerational mobility in income and education in European countries, finding that Italy is the most "immobile" country in Europe.

The aim of this paper is to check the relationship between intergenerational mobility and allocational efficiency, the latter requiring that higher educational levels be attained by more talented individuals.

Assuming that financial constraints are active in driving educational decisions (as section 3 seems to show) the theoretical model of section 4 predicts a lower ratio of educated individuals coming from non-educated families than from educated ones and affirms the existence of "misallocated individuals"[2].

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[1]See, among others, Charles and Hurst (2003), Ermisch and Francesconi (2001), Behrman and Rosenzweig (2002), Erikson and Goldthrope (2002).

[2]In the model people are assumed to be heterogeneous in their talents so that we refer

One of the main findings of the model is that intergenerational redistribution via bequest taxation is desirable because helping children endowed with high ability and coming from poor families to circumvent financial constraints, it increases the average talent of skilled people, generating a better ability allocation and an efficiency gain measured in terms of average utility[3].

The paper is organised as follows. Section 2 reports a brief survey concerning intergenerational persistence in status inequality and the influence of bequest taxation on it. In section 3 we examine the intergerational transition matrices of Italy, the US and the UK, trying to study the relationship between the allocation of individuals in unskilled/skilled position, their talent and their family background. In section 4 we present a theoretical model where an efficiency problem in talent allocation emerges and where both parents' "bequest" and state redistribution are crucial in determining financing for schooling and attainment of education. Section 5 concludes.

2 Brief overview of the literature on intergenerational mobility and bequest

Although there are no doubts about the persistence of status inequality, there is no general agreement on the causal mechanisms behind it. Focusing on differences in schooling decisions, two main theories have been developed and empirically checked by economists[4]:

- the most popular theory, started by Becker and Tomes (1979, 1986),

to "misallocated individuals" as those whose position is dependent on the family: unskilled children of unskilled parents who would have been skilled and skilled children of skilled parents who would have been unskilled if the allocation in the skilled position were not dependent on social class but on individual's talent alone.

[3]Noteworthy, this result emerges only in the case that the fiscal yield coming from bequest taxation is redistributed throughout all the population and it does not emerge if it is used to finance education.

[4]Checchi (2005) present a complete survey of education related topics and show some conclusions linked up with our issues.

emphasizes the role of “short-run” financial constraints, which make it difficult for low income families to enroll their children in higher education levels, even if children show high ability during compulsory school[5].

- the second hypothesis, recently emphasized by Carneiro and Heckman (2002), gives more importance to “long-run” factors, so that high-status children are, on average, the ones who posses the talent required to take advantage of higher education[6].

Actually, both “short-run” financial constraints and “long-run” family factors play a role in the persistence of educational attainment, the latter mainly via cultural influences and “ability” acquired in family environment. Moreover, the genetic transmission of talents from mother to children can play a role. Therefore, “nature” and “nurture” components of parental background are important in determining children’s educational outcomes. “Scholastic ability”, usually measured by grade attainments, comes from different sources, because it is both genetically transmitted (*nature*) and acquired into the family at early ages: richer and more educated families are better off in assisting children to develop cognitive ability (*nurture*)[7].

Bowles and Gintis (2002) decompose status persistence between generations in various channels, concluding: “wealth, race and schooling are important to the inheritance of economic status, but IQ is not a major contributor

[5]Checchi D. (2003), with a cross country analysis, suggests that financial constraints limit access to secondary school. Shea (2000) empirical results are potentially consistent with the hypothesis that credit market imperfections constrain low income households to make suboptimal investments in their children; Krueger (2004) reviews various contributions supporting the view that financial constraints have a significant impact on educational attainment. See also Kane(1994), Ellwood and Kane(2000).

[6]Carneiro and Heckman (2002): “most of the family income gap in enrollment is due to long-run factors that produce the abilities needed to benefit from participation in college”, however, they found that also “short-run” financial constraints play a (minor) role in socio-economic inheritance.

[7]See, among others, Mulligan (1999), Bowles and Gintis (2002), Plug and Vijverberg (2003).

and (...) the genetic transmission of IQ is even less important". Even if the correlation of IQ between parents and children ranges between 0.42 and 0.72 and if a positive relation between cognitive ability and earnings is well documented in economic literature (Bowles, Gintis and Osborne (2002), between others), Bowles and Gintis pointed out that IQ is not a relevant determinant of economic success by itself. Plug and Vijverberg (2003), considering differences in educational attainment between adopted children and children who are their parents' own offspring, found that it is only to a certain extent that ability is an important factor in explaining the educational attainment, but that about 50% of ability relevant for education is inherited [8].

There are many theoretical models that consider the influence of bequest taxation on inequality and/or on production and growth[9]. Few attempts have been made to investigate the relationship between bequest taxation, financial constraints and allocation of talent. Becker and Tomes (1986) consider financial constraints in education, but they do not contemplate bequest taxation and its consequences, simply emphasizing that income taxes reduce incentives to invest in education. More recently, Grossman and Poutvaara (2005), in a framework with a representative agent and intended bequest, suggested that a small bequest taxation may favor efficiency if parents evaluate their children's education and bequest leaving as substitute goods.

If financial constraints are relevant in leading to educational attainment and the bequest left to children contributes to determining schooling performance, the investigation of the motives for bequest becomes a crucial point. Four categories of motives are mentioned in economic literature[10]:

- the first is based on the idea of *altruistic bequests*: parents care about the utility of their children[11].

[8] One must be careful with these results, because the dataset used in the analysis reports IQ only for one parent.

[9] Atkinson and Stiglitz (1976), Kopczuk (2001), Blumkin and Sadka (2003), Cremer and Pestieau (2001), Michel and Pestieau (2004).

[10] See Cremer and Pestieau (2003) for a complete taxonomy.

[11] Barro(1974), Becker and Tomes(1986).

- the second refers to *exchange-related motives* that induce old men to remunerate their children for their care taking with an implicit "promise" of a bequest[12].

- the third considers that, in an uncertain world, *accidental bequests* should exist because people do not know the date of their death[13].

- lastly, parents may receive utility from the act of giving (*joy of giving*)[14]. Formally, this sort of bequests are included in the utility function as a consumption in the last period of life, and the crucial question is whether what matters to the parent is the net or gross of the amount.

The few empirical studies on this topic found some evidence that bequests are clearly intentional[15] and Page (2003) added that "there is a significant positive correlation between the amount of gift given and tax rates, especially for older households". This last evidence suggests that what matters to the donor is the "net" and not the "gross" amount left to children and reduces the relevance of the *accidental bequests* hypothesis. For our approach it is relevant to remember that Hurd and Smith (1999) found that more educated agents are more likely to leave pensions than less educated and that Fink et al. (2005) found that childrens' wealth does not affect parental bequests at all, suggesting that simple models of *joy of giving* could be the most suitable way to model bequest behaviour.

3 Empirical transitions, abilities and "misallocated individuals"

Individual data needed to produce empirical evidence about mobility and abilities are social background (e.g. parents education), educational attain-

[12] Cremer and Pestieau(1991).
[13] Davies(1981), Abel(1995).
[14] Cremer and Pestieau (2003), Glomm and Ravikunar(1992).
[15] See Bernheim et al. (2001), Joulfanian (2005), Fink et al. (2005).

ment and a proxi for talent. The last information is particularly difficult to be obtained. Economic literature considers IQ levels, results of literacy and mathematical proof made at early ages, or grades obtained at the end of school courses[16]. All these indicators, referring to students, aged usually above 12, are obviously influenced by the ability acquired in families, hence they measure the "scholastic" talent and not the "genetic" one.

Our analysis is based on three different databases: the Italian 2002 SHIW database[17], the British 1999 BCS database [18], the US NLSY 1997 database[19].

[16]See Woessman (2004), Bowles and Gintis (2002), Carneiro and Heckman (2002).

[17]The 2002 SHIW database is built by the Bank of Italy. Families are the object of the survey. Our individuals are householders and spouses/partners (whose father's and mother's education is available from the survey) as well as children living in the family who have stopped studying (4690 individuals). Talent can be proxied for those people who get the *maturità* title (higher secondary school certificate) or more alone, by means of the grade obtained at the end of the educational process (we use the standardised relative grade). Therefore, we consider as unskilled all those individuals whose highest educational level is *maturità*, and as skilled all those individuals who completed university. In order to increase the number of skilled parents, we consider "skilled" all fathers and mothers with the "maturità" or more.

[18] We analyze the cohort of individuals who answered to propensity scores in 1970, and who were re-interviewed in 1999 (5613 individuals). For these observation we know parents' education, the result of propensity score at the age of 10 and the highest educational level obtained at the age of around 40. Our categories of skilled/unskilled distinguish between people who obtained the *A-level* (at school until about the age of 16) or more from people who do not get it. As a measure of talent, we consider the *British Score Assessment* (BSA) in verbal method (the sum of *acceptable* answers to "word definition" and "similarities") and the BSA in quantitative methods (the sum of *acceptable* answers to "recall of digit" and "matrices items"). The data presented in the text refer to the standardized sum of answers of both indicators.

[19]The NLSY97 consists of a nationally representative sample of approximately 9000 individuals who were aged between 12 and 16 in 1996. Round 1 of the survey took place in 1997. In that round, both the individual and one of her parents were interviewed. Youths were consecutively interviewed every year collecting extensive information about labor market behavior and educational experiences over time. We analyse data from round 5, considering the children educational status in 2002 and defining skilled those who enrolled in college. We use the standardised PIAT score (whose results, corrected

Given that these three databases collect information in a very different way, that they refer to different cohort of individuals (all ages for Italy, people aged around 40 in 2000 for Great Britain and people aged between 17 and 23 in 2002 for the US) and that they present different classification for educational attainment, we will not use them for comparisons between countries[20].

Using these databases, we present:

- the two states intergenerational transition matrix (educational attainment of parents and children); section 3.1);
- the *ability matrix*, where we compute the average talent differentiating by educational attainment of parents and of the individuals (section 3.2);
- a rough proxy of "innate" talent to compute an *innate ability matrix* (3.3);
- the quota of *bad allocated* individuals, defined by the ratio of unskilled/skilled individuals with unskilled/skilled parents who, given their talent, should have/have not obtained the higher degree.

by the age of the answerers, are available from 1997 to 2002) as a measure of individual talent; for students who answered the test more than once, we use the earlier score (using the average score does not affect our results). The sample is composed of 4415 individuals.

[20]Countries can be compared using the TIMSS database that presents scores in Literacy and Math for students aged 14-18 in different countries and information on parents' education. Unfortunately, educational attainment of students has not been recorded. However, their *future intentions* with respect to their studies have been asked. Obviously, this is a different information from the one considering educational attainment. Therefore we will not use the TIMSS database here.

3.1 Transitions

As emphasised by the economic literature, intergenerational mobility is far from being perfect[21]. These results are strongly confirmed for Italy (table 1), the UK (table 2) and the US (table 3). In fact we always obtain that unskilled families show a lower percentage of skilled children than skilled families.

Table 1: Transition matrix, Italy, 2002 - Individuals with at least the secondary school

		Education		
Parents' education		Secondary Sch.	University	Total
Below Secondary Sch.	obs	2581	588	3169
	%row	81.45	18.55	100
Secondary Sch. or above	obs	925	596	1521
	%row	60.82	39.18	100
Total	obs	3506	1184	4690
	%row	74.75	25.25	100

Source: SHIW database

It emerges that the probability of getting education for children of unskilled parents is less than a half of the same probability for children of skilled, both for Italy and the US, whereas in the UK this measure is slightly higher than one half.

3.2 Talent and transitions

The availability of data on transitions and some proxies for talent (see notes 17, 18 and 19), allows us to calculate the average individual ability for the four groups outlined by the transition matrix. Our aim is to calculate the level of individual talent that allows, on average, access to a higher educational

[21]As said in introduction, see i.e. Chevalier et al. (2005), Ermisch and Francesconi (2001).

Table 2: Transition matrix, Great Britain, 1999 - cohort of individuals born in 1970

		Education		
Parents' Education		Below A Level	A level or above	Total
Below A level	obs	3232	1341	4573
	%row	70.68	29.32	100
A level or above	obs	498	542	1040
	%row	47.88	52.12	100
Total	obs	3730	1883	5613
	%row	66.45	33.55	100

Source: BCS database

level, considering separately children of skilled and unskilled parents.

Tables 4, 5 and 6 all confirm that, on average, the "talent", measured by the score obtained, is higher for children of skilled individuals[22].

Defining average talent as $\overline{a}^{JJ}$ for $J = S, U$, where the first index[23] identifies the parents' educational status (the highest between father and mother) and the second index identifies educational attainment of the individual, we have: $\overline{a}^{SS} > \overline{a}^{US} > \overline{a}^{SU} > \overline{a}^{UU}$.

At this stage, results suggest that an allocation problem should not arise because children of skilled parents get education more easily, but they are also the more talented, meaning that educated parents make the most educable children.

3.3 A rough proxy of "innate ability"

Different measures of talent imply different results in the empirical evidence. We know that section is a "Scholastic ability", affected by the talent acquired in family in the early years of life (and by the quality of school and many others factors) that is likely to be greater in an "educated family".

[22]Scores have been standardized for all countries.

[23]Obviously, S=Skilled, U=Unskilled.

Table 3: Transition matrix, USA, 2002 - cohort of individuals born between 1980-84

		Education		
Parents' Education		Below College	College or above	Total
Below College	obs	1655	625	2280
	%row	72.59	27.41	100
College or above	obs	844	1291	2135
	%row	39.53	60.47	100
Total	obs	2499	1916	4415
	%row	56.60	43.40	100

Source: NLSY97 database

Table 4: Average talent by group of individuals, Italy, 2002 - all population

		Education		
Parents' education		Below Secondary Sch.	Secondary Sch. or above	Total
Below Secondary Sch.	avg	-0.39	0.99	-0.14
Secondary Sch. or above	avg	-0.25	1.11	0.29
Total	avg	-0.36	1.05	-0.00

Source: SHIW database

In order to build a proxy of "innate" talent, or at least purified by every family factors, we estimate our measure of talent on parents educational attainments and we use the residuals to compute an *innate ability matrix*[24]. Hence, our measure of "innate" talent is the residual of the following regression:

$$a_i = \beta_0 + \beta_1 Parents_i + \epsilon \tag{1}$$

[24]We are obviously aware that the *innate ability matrix* does not reflect the true "genetic" ability, because of the genetic transmission of talent, documented by Bowles and Gintis (2002) and others. Our "innate ability" is, in fact, simply the "scholastic ability" constrained to the same average both for children of skilled and unskilled. It may represent "genetic" ability only assuming no genetic transmission of ability between generations.

Table 5: Average talent by group of individuals, Great Britain 1999- individuals born in 1970, talent at the age of 10

		Education		
Parents' Education		Below A Level	A level or above	Total
less than A level	avg	-0.30	0.39	-0.10
A level or more	avg	0.02	0.68	0.36
Total	avg	-0.25	0.47	-0.01

Source: BCS database

Table 6: Average talent by group of individuals, USA 2002 - individuals born in 1980-84, talent at the age of about 18

		Education		
Parents' Education		Below college	College or above	Total
Below college	avg	-0.50	0.14	-0.32
College or above	avg	-0.02	0.58	0.34
Total	avg	-0.34	0.44	0

Source: NLSY database

where *Parents* is a dummy indicating the highest degree obtained between father and mother of the individuals.

Tables 7, 8 and 9, present the results.

The ability ranking among the four groups of individuals is the same in all countries: $\overline{a}^{US} > \overline{a}^{SS} > \overline{a}^{UU} > \overline{a}^{SU}$. The more talented individuals are those coming from unskilled families who get education and the less talented are those coming from skilled parents and not getting education.

Therefore, if residuals of equation 1 are a "good" proxy for talent, allocation problems arise: some "talented" children of unskilled parents can not get education because of the position of their parents, whereas some children of skilled parents get education even if their talent is low.

Table 7: Average "innate ability" by group of individuals, Italy, 2002 - all population -

		Education		
Parents' education		Secondary	University	Total
Below secondary Sch.	avg	-0.26	1.12	-0
Secondary Sch. or more	avg	-0.53	0.83	-0
Total	avg	-0.33	0.98	-0

Source: SHIW database

Table 8: Average "innate ability" by group of individuals, Great Britain 1999- individual born in 1970, talent at the age of 10

		Education		
Parents' Education		Below A Level	A level or above	Total
Below A level	avg	-0.20	0.48	0.00
A level or above	avg	-0.34	0.31	0.00
Total	avg	-0.22	0.43	0.00

Source: LCS database

3.4 Misallocated individuals

Now, we will show that an allocation problem actually appears for both the two ability measures presented in the previous section.

We define the probability of being skilled as $q^{\cdot S}$, the probability of being skilled conditional on having unskilled parents as q^{US} and the probability of being skilled conditional on having skilled parents as q^{SS}.

Let $G(a)$ be the cumulated distribution of talent in the whole population; $G^U(a)$ and $G^S(a)$ are, respectively, the cumulated distribution of talent conditional on having unskilled parents or skilled parents.

Therefore, $\widetilde{a}^{\cdot S} \equiv [G(q^{\cdot S})]^{-1}$, $\widetilde{a}^{US} \equiv [G^U(q^{US})]^{-1}$ and $\widetilde{a}^{SS} \equiv [G^S(q^{SS})]^{-1}$ represent the "theoretical" minimum talent required to become skilled for the whole population, for children of unskilled parents and for children of

Table 9: Average "innate ability" by group of individuals, USA 2002- individual born between 1980-1984 , talent at the age of about 15

		Education		
Parents' Education		Below College	College or above	Total
Below College	avg	-0.18	0.46	0.00
College or above	avg	-0.36	0.24	0.00
Total	avg	-0.24	0.31	0.00

Source: YLSY97 database

skilled parents, respectively.

We define "misallocated individuals" those people whose ability is such that:

- $\widetilde{a}^{\cdot S} < a_i \leq \widetilde{a}^{US}$ if parents are unskilled and they are unskilled;
- $\widetilde{a}^{SS} < a_i < \widetilde{a}^{\cdot S}$ if parents are skilled and they are skilled.

In fact, our "misallocated individuals" are those whose position is dependent on the family:

- unskilled children of unskilled parents who would have been skilled if the allocation in the skilled position was not dependent on social class ($p^U_{badA} = Prob[\widetilde{a}^{\cdot S} < a_i \leq \widetilde{a}^{US}]$);
- skilled children of skilled parents who would have been unskilled if the allocation in the skilled position was not dependent on social class ($p^S_{badA} = Prob[\widetilde{a}^{SS} < a_i < \widetilde{a}^{\cdot S}]$).

Table 10 reports p^J_{badA} values, with $J = U, S$, for the three databases, where the talents are measured by means of the grade obtained at some level of the educational process or in some attitude tests and refers to "scholastic ability" (again see notes 17, 18 and 19).

For Italy, we obtain $\widetilde{a}^{\cdot U} = 0.86$ and $\widetilde{a}^{\cdot S} = 0.74$: for children of unskilled individuals a higher ability is required, on average, to get a university degree.

Table 10: Probability of misallocation (%)

	SHIW, Italy	BCS, UK	NLSY, USA
p^U_{badA}	3.47	2.25	5.18
p^S_{badA}	7.36	7.21	3.19

Table 11: Probability of misallocation (%), "innate ability"

	SHIW, Italy	BCS, UK	NLSY, USA
p^U_{badA}	6.69	5.07	12.68
p^S_{badA}	17.62	17.88	13.07

This result seems to confirm that financial constraints in the short run exist. Given the distribution of talent, these constraints concern about 3.5% of children of unskilled parents.

For Great Britain, $\widetilde{a}^{\cdot U} = 0.43$ and $\widetilde{a}^{\cdot S} = .36$. Considering the talent distribution for children of the unskilled, we can also state that 2.25% of them had an ability level such that, if they had been born in a skilled family, they would have got education.

For the US, $\widetilde{a}^{\cdot U} = 0.40$ and $\widetilde{a}^{\cdot S} = 0.19$ are the "scholastic ability" thresholds giving the frequencies of misallocated individuals showed in table 10. It looks like that the US educational system does not facilitate children of skilled parents in their educational path, but, on the other hand, it does not allow children of unskilled parents to circumvent financial constraints. It is arguable that the educational system is meritocratic, but lack of good public programs in this field forces a relevant number of highly talented individuals coming from unskilled families to abandon their studies.

Table 11 presents the results about "misallocated individuals" calculated using our measure of "innate ability". As expected, the frequency of "bad allocated" individuals is higher for all countries with reference to the frequency calculated in the "scholastic ability case" (table 10).

It is crucial to remember that, probably, the real "genetic ability" is something between the “scholastic ability” (influenced by early years in family) and our measure of “innate ability” (cleaned by all parents effects, even genetic transmission); therefore we can argue that the frequencies of bad allocated individuals should be collocated between the values displayed in tables 10 and 11. Although we can not exactly calculate the upgrade of “misallocated individuals”, these empirical results suggest that an efficiency problem actually arises.

4 The model

In this section we present a “non-overlapping” generation model which is able to justify the empirical results concerning talent allocation.

We assume that:

- individuals are heterogeneous in their talents;
- genetic talent transmission does not take place (talent is random);
- decisions concerning education are financially constrained, and therefore depend both on parents’ bequest and government’s redistribution;
- the cost of education is decreasing in talent;
- production is increasing in (or not affected by) talent;
- decisions concerning education, the amount of bequest to be left to children and the effort in the workplace are the endogenous variables.

We present our model through the following steps: first of all we analyze individual behavior in order to determine the optimal choice of effort, bequest and educational level (which can be financially constrained), secondly we analyze the intergenerational mobility at family level, that will depend on the “convenience” condition (the preference for getting education) and on the “possibility” condition (the capability of financing it); thirdly, considering the steady state (defined as flows equilibrium), we investigate on the welfare effects of a bequest taxation whose yields are redistributed among all "youths". Finally we analyze welfare consequences of bequest taxation in case yields are used to finance the education system.

4.1 Utility

The economy is composed of a set of agents of unitary mass living for one period and interested both in their consumption and on the bequest they leave to their (only) child[25] . Each individual must choose:

- her skill level (to obtain or not a given educational level);
- her effort in the workplace;
- the bequest to leave to her child.

Every individual in the economy is exogenously endowed with a given talent, which we label with $a_{i,t}$, for $0 \leq a_{i,t} \leq 1$, where i indicates the family and t the generation. As explained in the introduction, we assume that the talent of an individual is independent of the talent of her mother.

Effort (endogenous), talent (exogenous) and educational level (endogenous, but financially constrained as we will see later) determine the amount of earnings. We assume that, for a given effort and a given talent, the income of skilled individuals is $\mu > 1$ times the one of unskilled ondividuals, and we also assume that the cost of education is decreasing in individual talent.

In what follows we use notation $y_{i,t}^{SU}$ to indicate the variable y referring to an unskilled individual (second suffix U) born of a skilled mother, (first suffix, S, so that the first suffix always refers to the mother and the second to the individual). Index i indicates the family and index t the generation. The notation $y_{i,t}^{S\cdot}$ refers to the variable y of an individual born of a skilled mother in case the position of the individual, indicated by the point, is not relevant. Notation $y_{i,t}^{SJ}$, for $J = U, S$ refers to variable y of an individual born

[25]Following, for example, Michel and Pestieau (2004) and Glomm and Ravikumar (1992) we consider bequests as a consumption in the last period of life.

of a skilled mother in case the position of the individual (which can be both unskilled or skilled) is relevant.

Consider a skilled individual endowed with talent $a_{i,t}$. We assume that her consumption level is given by:

$$C_{i,t}^{JS} = \Sigma_{i,t}^{J.} - \xi(1 - a_{i,t}) + \mu(x_{i,t}^{JS} + \lambda a_{i,t}) - S_{i,t}^{JS} \quad for \quad J = U, S \tag{2}$$

where:

- $\Sigma_{i,t}^{J.} \equiv S_{i,t-1}^{J.}(1-T) + E(S_{t-1})T$ for $J = U, S$ is the endowment received by individual i from the previous generation, depending on the amount left to her by her mother ($S_{i,t-1}^{J.}$) taxed at rate T and on the amount obtained by redistribution ($E(S_{t-1})T$), depending on the average bequest[26];
- $\xi(1-a_{i,t})$ is the cost of education, decreasing in individual talent ($a_{i,t}$);
- $x_{i,t}^{JS}$ is the level of effort which, together with the exogenous talent multiplied by parameter $\lambda \geq 0$ (which measures the capability of creating income by means of ability), determines the income of the individual[27];
- μ is the skill premium;
- $S_{i,t}^{JS}$ is the amount she decides to leave to her child.

The consumption level of an unskilled individual is therefore given by:

$$C_{i,t}^{JU} = \Sigma_{i,t}^{J.} + (x_{i,t}^{JU} + \lambda a_{i,t}) - S_{i,t}^{JU} \quad for \quad J = U, S \tag{3}$$

because she does not spend on education and, for given talent and effort, perceives an income $\frac{1}{\mu}$ times lower than the one of skilled individual.

[26] In our model, the fiscal share T hits all the wealth given in life and left by parents to their children. Actually, only taxes on gifts and bequests exist, so our T can not be interpreted as the actual tax rate on bequests, but should be strongly lower than it.

[27] Therefore, $\mu(x_{i,t}^{JS} + \lambda a_{it}$ is the total revenue produced by the individual. Assuming separability between effort ($x_{i,t}^{JS}$) and talent ($a_{i,t}$) implies that effort creates revenue regardless of on talent and viceversa.

We assume that utility of a generic individual, other than on consumption and effort, may also depend on the amount of income not consumed during her life but left to her child (our "bequest"). Let us define the utility deriving from bequest as "psychological" utility.

In the case of *altruistic bequests*, the mother's "psychological" utility should depend both on the amount of her bequest net of taxes and on the amount her child receives by means of redistribution. In the *exchange related motives* and in the case of *joy of giving*, "psychological" utility will probably depend more on the gross amount of bequest than on the net amount. Finally, in the case of *accidental bequests*, the mother's "psychological" utility surely depends on the gross amount of bequest, because in that case mothers are not interested in welfare of their children.

Therefore, "psychological" utility ($UP_{i,t}^{J.}$) is influenced negatively by taxes. We assume that it can be written as follow:

$$UP_{i,t}^{J.} = \rho f(S_{i,t}^{J.}(1 - gT)) \quad for \quad J = U, S$$

where ρ is a parameter reflecting altruism toward children (or a parameter depending on risk aversion in the case of *accidental bequests*) , $S_{i,t}^{J.}$ is the gross amount of bequest left by a skilled ($J = S$) or unskilled ($J = U$) mother, and g a parameter which signals the relative importance of the different motives for bequest. For instance, if $g = 1$ every increase in the tax rate reduces utility (the case of altruistic bequest)[28] If $g = 0$, increase in taxation does not affect "psychological utility". This represents the pure case of *accidental bequest*, and it may probably approximate the *exchange related motives* and the *joy of giving motives.* In what follow our results will be analyzed for the different value of $0 \leq g \leq 1$. Nevertheless, we think that a value for g close

[28] In that case we should consider in "psychological utility", the amount received by children through redistribution also. Doing so, the model becomes immediately intractable. Therefore, not considering redistribution into "psychological utility", we reduce "psychological disutility" created by bequest taxation and redistribution. Our results will be biased downward, in the sense that the effect of bequest taxation on individual utility will be better than the one obtained throughout our model.

to zero is a good approximation of the real world.

For all individuals we assume a semi-linear utility function separable in consumption, effort and "psychological utility":

$$U_{i,t}^{JJ} = f(C_{i,t}^{JJ}) - \gamma x_{i,t}^{JJ} + \rho f(S_{i,t}^{JJ}(1-gT)) \quad for \quad J = U, S \tag{4}$$

where γ is a measure of the disutility of effort and $C_{i,t}^{JS}$ and $C_{i,t}^{JU}$ are defined in equations 2 and 3 respectively.

Differentiating equation 4 with respect to $S_{i,t}^{JJ}$ and using the definition of $C_{i,t}^{JJ}$ (equations 2 and 3), it emerges that $f'(C_{i,t}^{JJ}) = \rho f'[S_{i,t}^{JJ}(1-gt)]$.

Let us assume that the utility function of equation 4 is logarithmic in consumption and bequest[29]. In that case $C_{i,t}^{JJ} = \frac{1}{\rho} S_{i,t}^{JJ}$ must hold for $J = U, S$. Individuals allocate their overall income so that bequest is a share ρ of consumption in the whole life-cycle.

Therefore, if an individual chooses to acquire education her utility is:

$$U_{i,t}^{JS} = ln[\Sigma_{i,t}^{J.} - \xi(1-a_{i,t}) + \mu(x_{i,t}^{JS} + \lambda a_{i,t}) - S_{i,t}^{JS}] - \gamma x_{i,t}^{JS} + \rho ln(S_{i,t}^{JS}(1-gT)) \tag{5}$$

whereas if she remains unskilled, she gets:

$$U_{i,t}^{JU} = ln[\Sigma_{i,t}^{J.} + (x_{i,t}^{JU} + \lambda a_{i,t}) - S_{i,t}^{JU}] - \gamma x_{i,t}^{JU} + \rho ln(S_{i,t}^{JU}(1-gT)) \tag{6}$$

First order conditions of equations 5 and 6 give the optimal choice level for effort $x_{i,t}^{JJ}$ and bequest $S_{i,t}^{JJ}$, respectively in case the individual gets/does not get the skilled position:

$$S_{i,t}^{.S} = \frac{\rho\mu}{\gamma} \tag{7}$$

[29] Using a semi-linear utility function we are able to obtain analytical results for endogenous variables and check for the efficiency of bequest taxation. This specification of the utility function makes the amount of bequest not dependent on the ability, but simply on the status of the individual (skilled/unskilled). Without this simplification, even if it is possible to solve for the *convenience condition* and the *possibility condition* (see below), results are very hard to manipulate in terms of conditional probabilities. The main results of the model, and in particular the "allocation effect" which we will introduce later, do not depend on this specification.

$$x_{i,t}^{JS} = \frac{1+\rho}{\gamma} - \frac{\Sigma_{i,t}^{J.} + (\xi + \mu\lambda)a_{i,t} - \xi}{\mu} \quad for \quad J = U, S \tag{8}$$

$$S_{i,t}^{.U} = \frac{\rho}{\gamma} \tag{9}$$

$$x_{i,t}^{JU} = \frac{1+\rho}{\gamma} - \left[\Sigma_{i,t}^{J.} + \lambda a_{i,t}\right] \quad for \quad J = U, S \tag{10}$$

where bequest does not depend on talent and on taxation, and it is differentiated among individuals only because of their educational attainment. The amount left to children is not dependent on T because of the logarithmic form of the utility function: this result seems to be coherent with empirical data, where the relationship between tax rate and average bequest has not a clear sign[30].

Proposition 1 *Definition of endogenous variables*

Bequest and consumption depend on preference parameters only.

Effort is decreasing in talent and in the endowment received from the previous generation.

Individual whose mother left an amount lower than the average bequest should produce a lower effort if the tax rate increases (and viceversa).

If an individual gets a skilled position she produces more effort and she leaves more money to her child.

Proof*: see appendix.*

Substituting these optimal values in equations 5 and 6, we obtain that indirect utility functions are given by:

$$U_{i,t}^{JS} = \rho ln(\rho(1-gT)) - (1+\rho)ln\left(\frac{\gamma}{\mu}\right) - \gamma x_{i,t}^{JS} \quad for \quad J = U, S \tag{11}$$

$$U_{i,t}^{JU} = \rho ln(\rho(1-gT)) - (1+\rho)ln(\gamma) - \gamma x_{i,t}^{JU} \quad for \quad J = U, S \tag{12}$$

where $x_{i,t}^{JJ}$, for $J = U, S$, is defined in equations 8 and 10.

[30] Cremer and Pestieau (2003).

4.2 Getting education

In this economy, people will get skilled positions spending on education if the following two constraints are filled:

1. the *convenience* condition, so that the indirect utility of being in the skilled position is higher than the indirect utility of being in the unskilled one: $U^{JS}_{i,t} > U^{JU}_{i,t}$, for $J = U, S$;

2. the *possibility* condition, depending on the assumption of imperfect capital market: given their talent, only individuals who receive "enough" money from the previous generation can get the skilled position: $\Sigma^{J.}_{i,t} > \xi(1 - a_i)$.

Both conditions depend on the mother's qualification and on the individual's talent. To simplify notation, we define:

$$m \equiv \xi \frac{\gamma}{\mu\rho} \equiv \frac{\xi}{S^{S.}} > 1$$

as the ratio between education costs of the worst skilled individual (the one with talent 0) and the bequest left to children by skilled individuals[31].

Let us start with the *convenience* condition of point 1. The difference between equations 11 and 12 gives:

$$U^{JS}_{i,t} - U^{JU}_{i,t} = (1 + \rho)ln(\mu) - \gamma(x^{JS}_{i,t} - x^{JU}_{i,t}) \quad for \quad J = U, S \tag{13}$$

Note that, according to equations 8 and 10, the sign of $x^{JS}_{i,t} - x^{JU}_{i,t}$ depends on the mother's position and on the individual's ability.

Proposition 2 *The* convenience condition

An individual finds it convenient *to get education if her talent is higher than a given threshold, which depends on her mother's position: $a_{i,t} > \widehat{a}^{J.}_t$, for $J = U, S$.*

[31]We assume that m is higher than 1, so that at least the less talented children of skilled mothers are financially constrained.

The convenience *threshold is lower for children of unskilled mothers* $\widehat{a}_t^{U\cdot} < \widehat{a}_t^{S\cdot}$*, unless* $T = 1$.

Bequest taxation increases the convenience threshold for children of unskilled mothers and reduces it for children of skilled ones.

Proof*: see appendix.*

But not all individuals can get educated: again, the *possibility* constraint of previous point 2 may be fulfilled or not according to the mother's position and individual's ability.

Proposition 3 *The* possibility condition

An individual finds it possible *to get education if her talent is higher than a given threshold, which depends on her mother's position:* $a_{i,t} > \widetilde{a}_t^{J\cdot}$ *for* $J = U, S$.

The possibility *threshold is always higher for children of unskilled mothers* ($\widetilde{a}_t^{S\cdot} < \widetilde{a}_t^{U\cdot}$)*, unless* $T = 1$.

Bequest taxation reduces the possibility threshold for children of unskilled mothers and increases it for children of skilled ones.

Proof*: see appendix.*

Which of the two constraints is more stringent? Some of the children of unskilled/skilled mother would like to get education but they can not or they can get educated but they do not want to? To answer this question we must compare the constraints indicated previously.

Suppose $\widetilde{a}_t^{S\cdot} > \widehat{a}_t^{S\cdot}$, so that children of skilled mothers whose talent is such that: $\widehat{a}_t^{S\cdot} \leq a_{i,t}^{S\cdot} < \widetilde{a}_t^{S\cdot}$ *would like to get education but they can not.* If this inequality holds, we easily obtain (see propositions 2 and 3): $\widetilde{a}_t^{U\cdot} > \widetilde{a}_t^{S\cdot} > \widehat{a}_t^{S\cdot} > \widehat{a}_t^{U\cdot}$, so that all individuals are constrained solely by the *possibility constraint.*

Given the analytical definition for $\widehat{a}_t^{J\cdot}$ and $\widetilde{a}_t^{J\cdot}$ (for $J = S, U$, see equations, ii, iii, v, iv in the appendix) and calculating the above inequality for $T = 0$[32],

[32] Given that $\widetilde{a}_t^{S\cdot}$ is increasing in T whereas $\widehat{a}_t^{S\cdot}$ is decreasing, the above inequality is more stringent in case of $T = 0$.

after some algebraic steps, it is possible to show that:

$$\widetilde{a}_t^{S.} > \widehat{a}_t^{S.} \quad if \quad \frac{\rho}{1+\rho} < \frac{ln(\mu)}{\mu} \tag{14}$$

which may be fulfilled or not according to the values of the parameters. If $\rho > \frac{1}{1+e} = 0.582$ the above condition is never fulfilled. For lower values of ρ the previous condition can be respected according to the values of μ. For example[33], if $\rho = \frac{1}{2}$ it is respected if $1.85 < \mu < 4.5$, if $\rho = \frac{1}{4}$, it is respected for $1.29 < \mu < 12.71$. In the following part of the paper, we make the following hypothesis:

Assumption 1 *The parameters of the model are such that condition 14 is always respected, so that some of the individuals are* financially constrained *(they would like to get education but they can not) whereas none of them can get education but does not want to get it.*

4.3 The steady state

The next step is the definition of ϕ, the ratio of skilled workers in the whole population[34].

The evolution of the skilled ratio follows:

$$\phi_t = \phi_{t-1} - \phi_{t-1} p_t^{SU} + (1 - \phi_{t-1}) p_t^{US}$$

G being the cumulate distribution of talent, $p_t^{SU} = G(\widetilde{a}_t^{S\cdot})$ indicates the probability that a skilled mother's child becomes unskilled and $p_t^{US} = 1 - G(\widetilde{a}_t^{U\cdot})$ is the probability that a unskilled mother's child becomes skilled.

In steady state, flows between skilled and unskilled individuals are such that the ratio of skilled individuals in the population remains constant over

[33]Note that ρ represents the ratio between bequest and consumption in the whole life-cycle. Low values of ρ seem to be a "reasonable approximation" of the real world.

[34]We assume that the offer of skill creates its own demand. This happens both in the self-employment case or assuming a linear production function of the type $y = \mu\phi + (1-\phi)$ where y is output. See note 36 also.

time. Therefore, unless necessary, we will drop index t. The flow condition: $\phi p^{SU} = (1-\phi)p^{US}$ must hold, defining a constant skilled ratio:

$$\phi = \frac{p^{US}}{p^{US} + p^{SU}} \tag{15}$$

Let us now assume that the talent of individuals is uniformly distributed between 0 and 1. Given this hypothesis and the definition of $\widetilde{a}^{J\cdot}$, it is easy to calculate:

$$p^{UU} = \widetilde{a}^{U\cdot} \quad p^{US} = 1 - \widetilde{a}^{U\cdot} \quad p^{SU} = \widetilde{a}^{S\cdot} \quad p^{SS} = 1 - \widetilde{a}^{S\cdot} \tag{16}$$

(see figure 1). Solving the system of equations[35] 15 and 16 together with the definitions of $\widetilde{a}^{S\cdot}$ and $\widetilde{a}^{U\cdot}$, shown in the appendix (equations v and iv), we obtain the steady state skill ratio:

$$\phi^*(m, \mu) = \frac{1}{\mu(m-1)+1} \tag{17}$$

which is not dependent on the tax rate.[36]

Substituting $\phi^*(m, \mu)$ in equations v and iv in the appendix we can solve for the constant probability of change of state (from skilled to unskilled and viceversa) between sequential generations of the same family, and finally we can write the steady state transition probabilities of equation 16 in an explicit form:

[35]The same result is obviously obtained calculating the ergodic of the transition matrix defined by probabilities p^{ij}.

[36]The premium for skilled individuals, μ, should depend on the ratio of skilled workers in the population, so that $\mu = \mu(\phi)$. For instance, suppose that aggregate production function is $y = [\zeta\phi^r + (1-\phi)^r]^{\frac{\nu}{r}}$. In that case, given μ the ratio between the cost of skilled and the cost of unskilled workers (the latter normalized to the unity), it is easy to obtain the demand for skilled individuals: $\phi^D = \left[1 + \frac{\mu}{\zeta}^{\frac{1}{1-r}}\right]^{-1}$. Given the supply of skill defined by equation 17, the equilibrium is described by: $\phi^* = \left[[1+\zeta(m-1)]^{\frac{1}{r}}\right]^{-1}$ and $\mu = \zeta^{\frac{1}{r}}(m-1)^{\frac{1-r}{r}}$ so that both μ and ϕ depend on the parameters of the production function and on the value of m. Given that we are mostly interested in the effect of bequest taxation on aggregate utility and given that ϕ is not dependent on the tax rate, in this version of the paper we prefer to assume that $\nu = r = 1$ and $\zeta = \mu$ obtaining the result of the text.

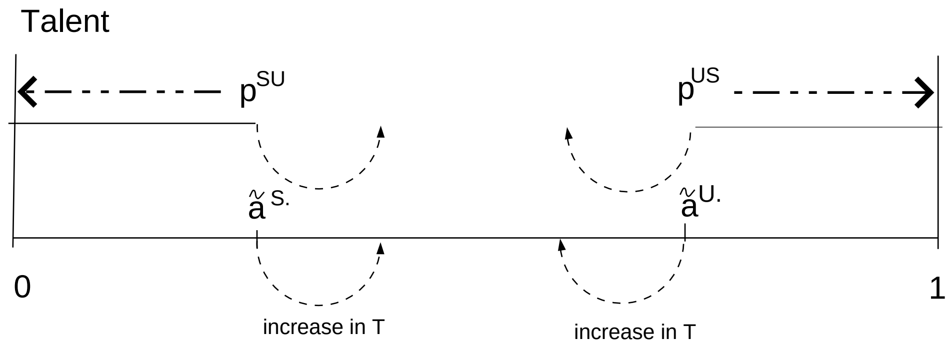

Figure 1: The effects of bequest taxation

$$p^{US} = \left[1 - \left(1 - \frac{1}{\mu}\right)\frac{1-T}{m}\right]\phi^*(m,\mu) \tag{18}$$

$$p^{SU} = \mu(m-1)\left[1 - \left(1 - \frac{1}{\mu}\right)\frac{1-T}{m}\right]\phi^*(m,\mu) \tag{19}$$

From equations 18 and 19 we obtain the following result:

Proposition 4 *The allocation effect*

The probability that a unskilled mother's child can achieve a skilled position and the probability that a skilled mother's child becomes unskilled increases in T (see figure 1). Intergenerational educational mobility is increasing in T.

Proof*: see appendix.*

4.4 Bequest taxation and individual utility

What are the effects of bequest taxation on individual utility? From equation 11 and 12 we obtain that utility is affected by bequest taxation throughout effort and fiscal charging, which reduces the amount received by children (J=U,S):

$$\frac{dU_i^{JS}}{dT} = -\rho\frac{g}{1-gT} - \gamma\frac{dx_i^{JS}}{dT}$$

$$\frac{dU_i^{JU}}{dT} = -\rho \frac{g}{1-gT} - \gamma \frac{dx_i^{JU}}{dT}$$

Therefore, bequest taxation affects individual utility through two different channels: the first, negative or nil (if $g = 0$) depends on the reduction of "psychological utility"; the second depends on variation of effort; it is positive for children of unskilled individuals and negative for children of skilled individuals(see the proof of the next lemma).

Proposition 5 *Individual utility*

Bequest taxation reduces utility of children of skilled mothers. It can raise utility of children of unskilled mothers (depending on the values of parameter g) and, for some of them, it relaxes the possibility constraint.

Proof*: see appendix.*

In fact, (see equations 11 and 12) when taxation increases:

- Children of skilled mothers will produce a higher effort and they obtain a lower "psychological utility" (unless $g = 0$), so that, for all of them, utility decreases. Furthermore, for some of them the *possibility constraint* strengthens and they can not get education,
- Children of unskilled mothers will produce a lower effort but they obtain a lower "psychological utility" (unless $g = 0$). For a not to high g, the utility of children of unskilled parents increases in T. Furthermore, for some of them the *possibility constraint* is relaxed and, by getting education, their utility increases.

4.5 Bequest taxation and average welfare

In this section, we investigate the relationship between bequest taxation and *average* economic variables, in particular average utility.

We proceed as follows: First of all, we consider that individuals, at each moment of time, can have skilled or unskilled mothers and also they can be skilled or unskilled. Therefore, we have four different "kinds" of individuals.

In a second step we will evaluate the average variables, as endowment, ability, effort for each group of individuals. Finally, we will aggregate variables through the four groups, obtaining results for the whole economy.

The four possible kinds of individuals are : 1) skilled individuals with unskilled mothers, 2) skilled individuals with skilled mothers, 3) unskilled individuals with skilled mothers, 4)unskilled individuals with unskilled mothers.

Computing:

- the probability to be in each of the four states;
- the average endowment ($\bar{\Sigma}$) of skilled and unskilled individuals;
- the average ability ($\bar{a}$) of skilled and unskilled individuals;
- the average effort ($\bar{x}$) of skilled and unskilled individuals;

it turns out that the average talent of skilled individuals increases in bequest taxation (T) whereas the average talent of unskilled individuals decreases in T. As expected, our *allocation effect* takes place: bequest taxation pushes more talented individuals toward the skilled positions.

We obtain the following result:

Proposition 6 *Welfare*

Redistributive policies based on bequest taxation can increase average utility.

In particular, the average utility function exhibits a maximizing T^*, with the following features:

If $g = 0$, $T^* = 1$ *because bequest taxation "allocates" the most talented individuals in the skilled position without affecting the "psychological utility" coming to parents from leaving bequests.*

If $g = 1$, T^* *can be both positive or negative because taxation heavily affects the "psychological utility" of individuals, and this effect may be stronger than the positive effect due to the better allocation of talents.*

If $0 < g < \overline{g} < 1, \quad 0 < T^* < 1.$

Proof: *see appendix.*

In our framework g is reasonably close to 0 (see paragraph 4.1). In that case, even considering the endogeneity of effort determination, we obtain that there exists a given level of bequest taxation which maximizes average utility.

This result is not surprising because it comes directly from what we called the *allocation effect*. Our economy is surely better off if the most talented individuals are those who get education because they spend less money in the educational process and because their contribution to the production process is higher.

4.6 Financing education

Different results emerge if we assume that bequest taxation, instead of being redistributed among all individuals as assumed above, is used to reduce education costs[37] (our ξ), so that redistribution goes from people who leave bequest to people who get education. In that case, the cost of education becomes $(\xi - \frac{E(S_{t-1})}{\phi_{t-1}}(1 - a_{i,t})$. Using the same utility function of equations 5 and 6, it is possible to show[38]:

Proposition 7 *Bequest taxation and education financing*

When bequest taxation is used to finance education, the steady state equilibrium will remain unchanged because the possibility constraint *is not affected by bequest taxation. Average utility may reduce with respect to T because of the "psychological effect".*

Proof*: see appendix.*

This surprising result may be intuitively explained as follows. At a first stage the cost of education is reduced, so that more people get education.The

[37]Public education is usually financed by income taxation. This would reduce the cost of education, our ξ, by taxing income produced by the same generation. We tried to analyze this case in our model, but we have not been able to obtain an analytical solution. From simulations we obtained the result that utility of individuals always decreases in income taxation.

[38]See appendix for proof.

per-capita public spending on education reduces and the"possibility constraint" is newly strengthened. Given our definition of steady state (flows equilibrium, constant number of skilled individuals) nothing changes because the possibility constraints of both skilled and unskilled are not affected by the tax rate. Therefore, redistributive policies (where fiscal income goes to all individuals) based on bequest taxation are more efficient in increasing the wellbeing of the economic system with respect to policies where bequest taxation is used in order to reduce the cost of education.

Checchi, Ichino and Rustichini (1999) try to solve the following puzzle: "why the Italian school system, which is strongly egalitarian in the quality and cost of education provided to rich and poor families, fails to generate at least the same degree of interegenerational mobility which prevails in the US, where the school system is instead highly decentralised and non egalitarian?". Their theoretical model suggests that a non standardized school system favors a better design of available education opportunities, favoring a better fit between the demand and supply of labor and, therefore, enhancing the returns of education, expecially for children coming from poor families. While they present a solution involving "incentives", our model refers to "constraints" and suggests that mobility and efficiency are favoured by intergenerational redistribution and not by an "equal" system in the sense that it assigns the same public expenditure to every individuals (as Checchi (2005) signals).

5 Conclusions

A strong link between parents' and children's socio-economic status has been pointed out in many empirical studies on intergenerational mobility.

In this paper we focus on the links between the educational attainments of parents and the ones of children with the aim of checking the relationship between intergenerational mobility and allocational efficiency, which requires higher educational level to be attained by more talented individuals.

In section 3 we give some empirical evidence concerning intergenerational mobility and talents. Managing data from SHIW (Italy), BCS (UK) and NYLS (US), and using different proxies for talent, it turns out that children of unskilled individuals gain skilled positions with lower probability than children of skilled individuals.

Using a different measure of talent ("scholastic" talent versus a "rough" proxy of "innate" talent) we show that the ratio of misallocated individuals[39] is between 2.3% and 12.7% in different countries for children of unskilled individuals and between 3.2% and 17.9% for children of skilled individuals.

These results seem to confirm Carneiro and Heckman's (2002) findings of 6% of individuals that, in the US, are credit rationed (short-run factors in their analysis).

The theoretical model presented in section 4 considers a world with heterogeneous agents endowed with different "inborn" talents. Each individual chooses her effort level, the amount of bequests and her educational attainment, which can be bound by financial constraints, so that for some individuals schooling decisions are rationed. Children of skilled parents require a lower talent to get the highest educational level than children of unskilled parents; the allocation of talent is far from being efficient.

A proportional taxation on bequests (T), whose yield is used for intergenerational redistribution, increases the probability that a child of unskilled parents can achieve a skilled position as well as the probability that a child of a skilled mother becomes unskilled. Therefore, intergenerational educational mobility is increasing in bequest taxation.

Furthermore, even considering the endogeneity of effort determination and the negative impact of bequest taxation[40] on "psychological utility", the model indicates that bequest taxation raises average utility because of the *allocational effect*. Given that an economy is surely better off if the most tal-

[39] Our misallocated individuals are: unskilled children of unskilled parents who would have been skilled, and skilled children of skilled parents who would have been unskilled, if the allocation in the skilled position was not dependent on parents condition.

[40] Note 28 argues that model results overestimate the negative impact of taxation.

ented individuals are those who get education, a program of intergenerational redistribution via bequest taxation has a positive efficiency effect because it partly separates education from wealth.

We also show that this positive *allocational effect* does not arise if the fiscal yield coming from bequest taxation, instead of being distributed among all youths, is devoted to finance education, so that it is distributed among students alone.

The model has shown that proportional bequest taxation increases both "equity" and "efficiency' of the economic system if its yields are used to redistribute among all individuals of the following generation, pushing the economic system toward a world of "equal opportunities".

Appendix 1: Proofs

Proof 1 *Definition of endogenous variables*

Because of the logarithmic form of the $f(.)$ function, $C_{i,t}^{JJ} = \rho S_{i,t}^{JJ}$ holds. Therefore, the first and second results are immediately obtainable from FOC'S.

The third result comes directly from the definition of $\Sigma_{i,t}^{J.}$ (see the first point after equation 2). In fact $\frac{\Sigma_{i,t}^{J.}}{dT} = E(S_{t-1}) - S_{t-1,i}^{JJ}$.

The last result comes from the comparison between equation 8 and 10. $x_{i,t}^{JS} > x_{i,t}^{JU}$ if $\xi(1 - a_{i,t}) > \Sigma_{i,t}^{J.}(1-\mu)$, where the term on the left is positive and the term on the right is negative.

Proof 2 *The convenience condition*

Using equations 8 and 10, the difference $x_{i,t}^{JS} - x_{i,t}^{JU}$ in equation 13 depends on $\Sigma_{i,t}^{J.}$. Defining ϕ_t as the endogenous ratio of skilled individual in the population at time t, the average bequest is $E(S_{t-1}) = \phi_{t-1} S_{t-1}^{.S} + (1-\phi_{t-1}) S_{t-1}^{.U}$ and the endowment received by a generic child is:

$$\Sigma_{i,t}^{J.} = S_{i,t-1}^{J.}(1-T) + [\phi_{t-1} S_{t-1}^{.S} + (1-\phi_{t-1}) S_{t-1}^{.U}]T \quad for \quad J = S, U \tag{i}$$

substituting equations 8 and 10 in eq. 13, using eq. i, and solving for $a_{i,t}$, we obtain $U_{i,t}^{JS} > U_{i,t}^{JU}$ if, respectively for children of unskilled and skilled mothers:

$$a_{i,t} > \widehat{a}_t^{U.} \equiv 1 - \frac{\frac{1+\rho}{\rho}\mu ln(\mu) - (\mu-1)[\phi_{t-1}(\mu-1)T + 1]}{m\mu} \tag{ii}$$

$$a_{i,t} > \widehat{a}_t^{S.} \equiv 1 - \frac{(\mu-1)[(1-\phi_{t-1})(\mu-1)T - \mu] - \frac{1+\rho}{\rho}\mu ln(\mu)}{m\mu} \tag{iii}$$

Comparing[41] the two thresholds, we immediately obtain $\widehat{a}_t^{U.} < \widehat{a}_t^{S.}$ if $(\mu - 1)^2(T-1) < 0$, which always holds because $\mu > 1$ and $T < 1$.

The last part of lemma 2 comes directly for the definition of $\widehat{a}_t^{S.}$ and $\widehat{a}_t^{U.}$

[41] In order to have $0 \le \widehat{a}_t^{U.} \le 1$, $0 \le \widehat{a}_t^{S.} \le 1$ some restrictions on parameter are needed. Nevertheless, as explained below, we will not use these thresholds so that we do not present these restrictions here.

Proof 3 *The possibility condition*

Children of unskilled mothers are not financially constrained in education if their talent is higher than a critical value which can be calculated solving $\Sigma_{i,t}^{U} \geq \xi(1 - a_{i,t})$ *in* $a_{i,t}$ *the condition:*

$$a_{i,t} > \widetilde{a}_t^{U\cdot} \equiv 1 - \frac{1 + (\mu - 1)\phi_{t-1}T}{m\mu} \tag{iv}$$

whereas for children of skilled mothers the threshold becomes:

$$a_{i,t} > \widetilde{a}_t^{S\cdot} \equiv 1 - \frac{\mu - (\mu - 1)(1 - \phi_{t-1})T}{m\mu} \tag{v}$$

Where $0 \leq \widetilde{a}_t^{S\cdot} \leq 1$, $0 \leq \widetilde{a}_t^{U\cdot} \leq 1$ *always holds. Furthermore, if* $(1 - T)(\mu - 1) \geq 0$, *then* $\widetilde{a}_t^{S\cdot} \leq \widetilde{a}_t^{U\cdot}$ *is always verified. Differentiating equations iv and v with respect to* T, *we obtain the result of the third part of lemma 3.*

Proof 4 *The allocation effect*

From equation 18 we have $\frac{dp^{US}}{dT} = \frac{\mu-1}{m\mu[\mu(m-1)+1]} \geq 0$;
From equation 19 we have $\frac{dp^{SU}}{dT} = -\frac{(\mu-1)(m-1)}{m[\mu(m-1)+1]} \leq 0$.

Proof 5 *Individual utility*

For an individual endowed with a given talent, the optimal effort depends on the amount received from the previous generation $\Sigma_{i,t}^{J\cdot}$*,defined in equation i, which in turn depends on the amount received both directly by the mother and by redistribution; considering* $S_{t-1}^{\cdot S} = \mu S_{t-1}^{\cdot U}$ *(see equations 7 and 9) we obtain:*

- *for* $J = S$, *so that for children of skilled mothers,*

$$\frac{d\Sigma_{i,t}^{S\cdot}}{dT} = -(\mu - 1)(1 - \phi)\frac{\rho}{\gamma} < 0 \tag{vi}$$

- *for* $J = U$, *so that for children of unskilled mothers,*

$$\frac{d\Sigma_{i,t}^{U\cdot}}{dT} = (\mu - 1)\phi\frac{\rho}{\gamma} > 0 \tag{vii}$$

First, we consider individuals with skilled mothers. Their utility depends on T in the following way:

$$\frac{dU_i^{S\cdot}}{dT} = -\rho \frac{g}{1-gT} - \gamma \frac{dx_i^{S\cdot}}{dT}$$

where $x_i^{S\cdot}$ is defined in equations 8 and 10. Using equation vi, $\frac{dU_i^{S\cdot}}{dT} < 0$ whichever the individual position be.

Now, let us consider individuals with unskilled mothers. Their utility depends on T in the following way:

$$\frac{dU_i^{U\cdot}}{dT} = -\rho \frac{g}{1-gT} - \gamma \frac{dx_i^{U\cdot}}{dT}$$

If $g = 0$, using equations 8 and 10, from equation vii) $\frac{dU_i^{U\cdot}}{dT} > 0$ always holds.

Following the same steps, but with $0 < g \leq 1$, $\frac{dU_i^{U\cdot}}{dT}$ has an indeterminate sign because of the two opposite effects outlined in the previous equation. The utility function exhibits a maximum in T^{UJ}, different between skilled and unskilled individuals because of the slightly dissimilar effect that T produces on effort in the two cases (see 8 and 10). After some algebraic steps it emerges that $U^{UU}(T)$ presents a maximum for

$$T^{UU} = \frac{1}{g} - \frac{1}{\mu - 1} \frac{1}{\phi^*(m, \mu)}$$

and $U^{US}(T)$ presents a maximum for

$$T^{US} = \frac{1}{g} - \frac{\mu}{\mu - 1} \frac{1}{\phi^*(m, \mu)}$$

In the case of unskilled individuals with unskilled mothers, $T^{UU} > 0$ if $g < (\mu-1)\phi(m, \mu)$; in the case of skilled individuals with unskilled mothers, $T^{US} > 0$ if $g < \frac{(\mu-1)\phi(m,\mu)}{\mu}$.

Proof 6 *Welfare*

From equations 11 and 12, average utility in the whole population is:

$$\overline{U} = \phi(1+\rho)ln\left[\frac{\mu}{\gamma}\right] + \rho ln(\rho) + \rho ln(1-gT) - \gamma[(1-\phi)\overline{x}^U + \phi\overline{x}^S)] \quad \text{(viii)}$$

where $\overline{x}^J$ for $J = U, S$, is the average effort of unskilled and skilled individuals.

In steady state equilibrium, from equation 10 and 8, the average effort of skilled and unskilled workers is given by:

$$\overline{x}^S = \frac{1+\rho}{\gamma} - \frac{\overline{\Sigma}^S + (\xi + \mu\lambda)\overline{a}^S - \xi}{\mu} \tag{ix}$$

$$\overline{x}^U = \frac{1+\rho}{\gamma} - (\overline{\Sigma}^U + \lambda\overline{a}^U) \tag{x}$$

where $\overline{\Sigma}^J$ and $\overline{a}^J$, for $J = U, S$, are respectively the average values of endowment received from the previous generation and the average talent of individuals.

In order to calculate $\frac{d\overline{U}}{dT}$ we need to calculate $\frac{d\overline{x}^J}{dT}$, for $J = U, S$. From equations ix and x, these derivatives depend on derivatives of $\overline{\Sigma}^J$ and $\overline{a}^J$ with respect to T. The following part is devoted to calculate these derivatives.

For skilled individuals, the probability of having an unskilled mother is:

$$q^{US} = \frac{(1-\phi^*(m,\mu))p^{US}}{\phi^*(m,\mu)p^{SS} + (1-\phi^*(m,\mu))p^{US}} = p^{SU}$$

where the last term is obtained substituting the definition of ϕ of equation 15[42]*. Furthermore, in steady state the number of stayers must be constant, so that $q^{SS} = p^{SS}$ and $q^{UU} = p^{UU}$.*

A skilled individual will receive the endowment of equation i, for $J = S$, with probability q^{SS} and the same endowment but for $J = U$ with probability q^{US}.

To keep the notation simple, let us define

$$\Theta(T) = \left(\frac{(\mu-1)(1-T)}{m\mu}\right)^2$$

[42]In fact, q^{US} is the probability of having U mother conditional to be an S individual. p^{SU} is the probability of being an individual of type U, conditional to having a mother of type S, hence the two probabilities refer to the same stock of individuals. In steady state the number of movers between the two states must be the same, so that q^{US}=p^{SU}, q^{SU}=p^{US}, and q^{SU}= p^{US}.

where $\frac{d\Theta}{dT} < 0$.

With some algebraic steps we obtain the average endowment of skilled individuals:

$$\overline{\Sigma}^S = [1 + \mu(m-1)\Theta(T)]\, \phi^*(m,\mu)\xi \tag{xi}$$

with

$$\frac{d\overline{\Sigma}^S}{dT} = \phi^*(m,\mu)\xi\mu(m-1)\frac{d\Theta}{dT} \leq 0 \tag{xii}$$

An unskilled individual will receive the endowment of equation i, for $J = U$ *with probability* q^{UU} *and the same endowment but for* $J = S$ *with probability* q^{SU}*, so that the average endowment of an unskilled individual is:*

$$\overline{\Sigma}^U = [1 - \Theta(T)]\, \phi^*(m,\mu)\xi \tag{xiii}$$

with

$$\frac{d\overline{\Sigma}^U}{dT} = -\phi\xi\frac{d\Theta}{dT} \geq 0 \tag{xiv}$$

Given $\widetilde{a}^{S\cdot}$ *and* $\widetilde{a}^{U\cdot}$ *(equations v and iv), and given the hypothesis of uniform distribution of talent with support on* $[0,1]$*, we can easily compute the average talent of children of unskilled mothers who remain unskilled (*$\frac{\widetilde{a}^{U\cdot}}{2}$*) and the average talent of the ones who become skilled (*$\frac{1+\widetilde{a}^{U\cdot}}{2}$*); the same for children of skilled mothers (respectively,* $\frac{\widetilde{a}^{S\cdot}}{2}$ *if they become unskilled, and* $\frac{1+\widetilde{a}^{U\cdot}}{2}$ *if they get the skilled position.). The* q^{JJ} *probabilities, for* $J = U, S$*, allow us to compute average talent of the skilled (*$\overline{a}^S$*) and of the unskilled (*$\overline{a}^U$*):*

$$\overline{a}^S = \frac{\phi^*(m,\mu)}{2}\left[\mu(m-1)\left(2 - \Theta(T)\right) + 1\right] \tag{xv}$$

$$\overline{a}^U = \frac{\phi^*(m,\mu)}{2}\left[\mu(m-1) + \Theta(T)\right] \tag{xvi}$$

The average talent of skilled individuals is increasing in bequest taxation (T*) whereas the average talent of unskilled individuals is decreasing in* T*.*

In fact,

$$\frac{d\bar{a}^S}{dT} = \frac{\phi^*(m,\mu)}{2}\mu(m-1)\left(-\frac{d\Theta}{dT}\right) \tag{xvii}$$

and

$$\frac{d\bar{a}^U}{dT} = \frac{\phi^*(m,\mu)}{2}\left(\frac{d\Theta}{dT}\right) \tag{xviii}$$

From equations x, ix, xii, xiv, xvii and xviii:

$$\frac{d\bar{x}^S}{dT} = -\phi^*(m,\mu)(m-1)\frac{d\Theta}{dT}\frac{\xi-\mu\lambda}{2}$$

$$\frac{d\bar{x}^U}{dT} = \left[\xi - \frac{\lambda}{2}\right]\frac{d\Theta}{dT}\phi^*(m,\mu)$$

Plugging these last derivatives into equation viii we finally obtain:

$$\frac{d\overline{U}}{dT} = \rho\left[\phi^*(m,\mu)^2\frac{(\mu-1)^2(2\mu-1)}{\mu}\frac{m-1}{m}(1-T) - \frac{g}{1-gT}\right]$$

Defining:

$$M(m,\mu) = \phi^*(m,\mu)^2\frac{(\mu-1)^2(2\mu-1)}{\mu}\frac{m-1}{m}$$

we obtain

$$\frac{d\overline{U}}{dT} = \rho\Bigg(m,\mu)[M(1-T) - \frac{g}{1-gT}\Bigg]$$

For $g = 0$ it turns out that the average utility exhibits a maximum $T = 1$. If $g > 0$ the utility is maximized for[43]*:*

$$T^* = \frac{1}{2}\left[\frac{1+g}{g} - \sqrt{\left(\frac{1-g}{g}\right)^2 + \frac{4}{M(m,\mu)}}\right]$$

In order to have $T^* < 1$ we need that $g < M$. This condition assures that an optimal bequest taxation exists.

Proof 7 *Bequest taxation and education financing*

Assume that fiscal yield given by $\frac{E(S_{t-1})}{\phi_{t-1}}T$ is used to finance education, so that consumption of skilled individual is given by :

[43]Given $\frac{1+g}{g} \geq 2$ for $0 \leq g \leq 1$, we can consider the root with minus sign alone.

$$C_{i,t}^{JS} = S_{i,t-1}^{\cdot J} - \left(\xi - \frac{E(S_{t-1})}{\phi_{t-1}}T\right)(1-a_{i,t}) + \mu(x_{i,t}^{JS} + \lambda a_{i,t}) - S_{i,t}^{JS} \quad for \quad J = U, S \tag{xix}$$

whereas consumption for the unskilled is:

$$C_{i,t}^{JU} = S_{i,t-1}^{\cdot J} + (x_{i,t}^{JU} + \lambda a_{i,t}) - S_{i,t}^{JU} \quad for \quad J = U, S \tag{xx}$$

and that the utility function is the one presented in equation 4. From FOCs we can define the optimal level for choice variables and indirect utility for both skilled and unskilled individuals. We obtain that S_{it}^{J}*, for* $J = S, U$*, is equal to the one defined in equation 7 and 9 whereas the different type of redistribution modifies the optimal effort.*

In the hypothesis that the possibility constraint *holds, we can write it for both skilled and unskilled individuals:*

$$S_{t-1}^{\cdot J}(1-T) - \left(\xi - \frac{E(S_{t-1})}{\phi_{t-1}}T\right)(1 - a_{i,t}) > 0 \quad for \quad J = S, U$$

where $E(S_{t-1}) = \phi_{t-1}\frac{\mu\rho}{\gamma} + (1-\phi_{t-1})\frac{\rho}{\gamma}$*. The minimum level of ability which allows individuals to obtain education becomes:*

$$\widetilde{a}^{S\cdot} = 1 - \frac{\mu(1-T)}{m\mu - \left(\frac{1}{\phi_{t-1}} + \mu - 1\right)T} \tag{xxi}$$

$$\widetilde{a}^{U\cdot} = 1 - \frac{1-T}{m\mu - \left(\frac{1}{\phi_{t-1}} + \mu - 1\right)T} \tag{xxii}$$

Given these two thresholds, the transition probabilities are the ones defined in equation 16 and the definition of ϕ *is the same as the one in equation 15. Therefore, we can solve for the steady state quota of skilled* $\phi^*(m,\mu)$*, obtaining that the steady state quota of skilled individuals is the same as the one in equation 17, and substitute it into equations xxi and xxii, obtaining:*

$$\widetilde{a}^{S\cdot} = 1 - \frac{1}{m}$$

and

$$\widetilde{a}^{U\cdot} = 1 - \frac{1}{m\mu}$$

which are not dependent on the tax rate T*.*

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