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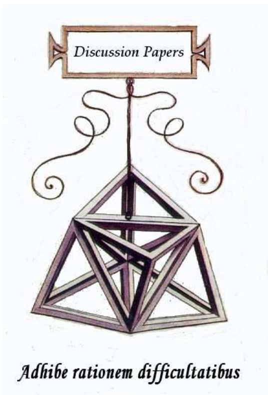

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Intergenerational Mobility in Italy

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Abstract

This paper analyzes the intergenerational mobility in a large sample of Italian households in the period 1998-2008. We measure mobility by Markov matrices and related mobility indexes suggested by Bartholomew (1973) and Shorrocks (1978). Mobility both in the educational attainment and occupational status decreased over time. Notably the probability of a child with a father with a upper secondary school of obtaining an university degree strongly declined, while the probability of a child of becoming a blue-collar increased independent of the occupation of father. Increased persistence in member of professions class signals an increase in the barriers to entry for professions. Finally, the occupational classes related to entrepreneurial jobs show a decrease in their size.

Keywords: Mobility Index; Educational Mobility, Occupational Mobility, Markov Chain
JEL Classification Numbers: C01; C12; D63; J60; J62

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1 Introduction

Intergenerational social mobility is one of a key feature of a society. Generally, low mobility is associated to higher inefficiency (most talented individuals are not allocated in the best positions) and higher injustice (initial positions and not individual efforts decides your welfare, see Comi (2004)). These considerations justify the notable interest of economists and sociologists in the analysis of social mobility, even though from different point of view. Sociologists are mainly interested in the measurement of social mobility, while economists mainly in the effect of mobility on welfare (Bernasconi and Dardanoni (2005)).

Becker and Tomes (1979) provide a pioneering theoretical contribution on the causes of social mobility. In their analysis "[...] the fortunes of children are linked to their parents not only through [their] investment but also through endowments acquired from parents. The equilibrium income of children is determined by their market and endowed luck, the own income and endowment of parents, and [...] the degree of inheritability and the propensity to invest in children". Therefore, the crucial features of analysis are the economic position of parents, their characteristics (e.g. genetic characteristics, education, occupation, etc.), the environment where individuals take their decision (e.g. developed capital markets, secure property rights, degree of competition of markets, etc.) and luck.

From an empirical point of view intergenerational social mobility is measured following two main methodologies (see Checchi (1997)). The first estimates the *income elasticity* of offspring with respect to parents'income (in some version permanent income is considered), even though the estimate can present difficulties in its interpretation. The second approach is based on the estimate of *Markov matrices*; mobility is measured in terms of the probability of offspring to better/worse their economic conditions (measured by, e.g., income, educational attainment, occupational status) with respect to the parents'one. Implicit in this approach is the presence of a stochastic component due to luck of individuals (Bartholomew (1973)). Related to the second approach, some authors proposed a set of mobility indexes satisfying some welfare properties (see Shorrocks (1978), Cowell (1985), Fields and Ok (1996)).

In this paper we follow the second approach for the analysis of the social mobility across Italian generations. In particular, we focus on the mobility in educational attainment and occupational status in the period 1998-2008 of a representative sample of Italian households drawn from Survey of Household of Income and Wealth made by Bank of Italy.

Preliminary to empirical analysis we present the welfare properties of some mobility indexes generally used in literature proposed by Shorrocks (1978) and Bartholomew (1973) and discuss their statistical properties (Anderson and Goodman (1957) and Trede (1999)) (a topic generally neglected in literature).

In the empirical analysis we define three cohorts of children in relation to their year of birth (1947-1956, 1957-1966 and 1967-1976); for each child we have the education attainment and occupational status of her/his father at the same age of child.

As regards educational attainment we consider three classes: compulsory school, upper secondary school and education degree. The persistence in each class increased from the first to the last cohort. The probability of a child with a father with compulsory school of obtaining a higher educational attainment increased, but, notably, the probability of a child with a father with upper secondary school decreases. Overall, we find that social mobility as measured by mobility indexes decreased from the first to the last cohort. The analysis suggests that in the long run there will be a substantial decrease in the mass of individuals with a compulsory education in favour of an university degree.

As regards occupational status we consider seven classes: unemployed, blue-collar, small employer and member of family business, own account worker, office-worker/teacher, member of professions, and manager/school head/magistrate. The persistence in blue-collar, office-worker/teacher and member of professions classes increased from the first to the last cohort, signalling a lower mobility of poor people, an increasing demand of a “safe” job, and an increase in barriers to entry in many professions. On the contrary the persistence in small employer and member of family business and manager/school head/magistrate classes decreased, pointing out a decline in entrepreneurial jobs. The probabilities of entry into blue-collar class from all the other classes increases from the first to the last cohort, while exactly the opposite holds for manager/school head/magistrate class. Mobility therefore display a downward trend, in the sense that classes of occupations with low income tends to increase their mass. Overall mobility indexes point out a reduction in mobility for the most recent cohorts. Finally, the classes corresponding to more entrepreneurial occupation display an ongoing reduction.

The paper is organised as follows. Section 2 introduces Markov matrices as measure of social mobility, the indices of social mobility based on Markov matrix, and discuss their welfare and statistical properties. Empirical analysis on Italian data is in Section 3. Finally, Section 4 contains some concluding remarks. Appendix gathers some descriptive statistics of data used in the analysis and some robustness checks.

2 Social Mobility Measured by Mobility Indexes

We assume that social mobility can be entirely represented by Markov matrices, which elements are transition probabilities (see Bartholomew (1973)); in particular, transition probabilities measure the probability of changes in social/income/occupational classes occurring from one period to the next one. Given this assumption, we can calculate synthetic indexes of mobility called *mobility indexes*, which should provide a measure of social mobility.

In the next section we will provide a very short introduction to Markov Chains, which are at the basic of Markov matrices; then in Section 2.2 we present a set of mobility indexes and their statistical properties.

2.1 Basic on Markov Matrices

Here we adopt the terminology of Bartholomew (1996). Let be k all the possible social/income/occupational classes which an individual can belong to, and n_{ij} $i, j = 1, ..., k$ be the number of individuals in the sample being in class i in the first period and in class j in the next period. The total sample size is equal to $n = \sum_{i=1}^{k} n_i$. Define p_{ij} the probability that an individual in class i in current period to move into class j in the next period, i.e.:

$$p_{ij} \equiv p(x_{t+1} = j) \mid (x_t = i), \tag{1}$$

where x is a random variable assuming values in the $(k \times k)$ state space (in our particular case x can represent different social/income/occupational levels). Assuming that state space is closed, i.e. k are all the possible realisations of x, we have that:

$$\sum_{j=1}^{k} p_{ij} = 1. \tag{2}$$

Following Bailey (1964) we denote by $\mathbf{P}$ the *transpose* of the matrix of transition probabilities called *Markov matrix*. Assume that $n_i > 0$ with $i = 1, ..., k$; then if $\mathbf{P}$ is regular, that is all classes have non zero probability to "receive" the system, there exists a unique vector $\pi = (\pi_1, ..., \pi_k)'$ solving the equation

$$\pi = \mathbf{P}'\pi. \tag{3}$$

(see Bartholomew (1996)); π is called the *equilibrium vector* (or *ergodic distribution*) as for any probability vector p_0 the limit $p_0' \lim_{t\to\infty} \mathbf{P^t} = \pi'$. Prais (1955) shows that π' is independent of the unit of time in which the elements of $\mathbf{P}$ are measured. This is particular important for the application to social mobility because this means that if $\mathbf{P}$ is the Markov matrix measuring the mobility between children and father, then $\mathbf{P}^2$ is the Markov matrix measuring the mobility between grandson and grandfather.

2.2 Mobility Indexes

Shorrocks (1978) lists some properties which an index of social mobility should satisfy. The first is the *Property* of *Monotonicity*, which intuition can be grasped considering two Markov matrices being equal but one off-diagonal element at the expense of the diagonal component; then index of social mobility should be higher for that matrix with the higher off-diagonal element, which means higher probability to move between different classes and less probability to stay in the same class. More formally, taken two Markov matrices $\mathbf{P}^a$ and $\mathbf{P}^b$ such that:

$$\mathbf{P}^b \succ \mathbf{P}^a, \tag{4}$$

i.e. $p_{ij}^b \geq p_{ij}^a$ for all $i \neq j$ and $p_{ij}^b > p_{ij}^a$ for some $i \neq j$, the *Property* of *Monotonicity* can be expressed as:

$$\text{if } \mathbf{P^b} \succ \mathbf{P^a} \Rightarrow I(\mathbf{P^b}) > I(\mathbf{P^a}). \tag{5}$$

Property 5 provides a quasi-ordering over the set of all Markov matrices. Indeed consider the following Markov matrices:

$$\mathbf{P^a} = \begin{bmatrix} 0.2 & 0.4 & 0.4 \\ 0.3 & 0.5 & 0.2 \\ 0.5 & 0 & 0.5 \end{bmatrix} \qquad \mathbf{P^b} = \begin{bmatrix} 0 & 0.5 & 0.5 \\ 0.3 & 0.4 & 0.3 \\ 0.5 & 0.5 & 0 \end{bmatrix}$$

$\mathbf{P^b}$ presents a higher mobility than $\mathbf{P^a}$, in fact the off-diagonal elements of $\mathbf{P^b}$ are bigger, or the same (for some $i \neq j$), than those of $\mathbf{P^a}$. In this case mobility indices should display a higher value for matrix $\mathbf{P^b}$ according to Property 5.

However this property does not provide a complete ordering of Markov matrices; consider the following two Markov matrices:

$$\mathbf{P^c} = \begin{bmatrix} 0.3 & 0.7 & 0 \\ 0.4 & 0.2 & 0.4 \\ 0.5 & 0 & 0.5 \end{bmatrix} \qquad \mathbf{P^d} = \begin{bmatrix} 0.3 & 0.6 & 0.1 \\ 0.5 & 0.2 & 0.3 \\ 0 & 0.5 & 0.5 \end{bmatrix}$$

we observe that some off-diagonal elements of $\mathbf{P^d}$ are smaller than of those of $\mathbf{P^c}$ and viceversa; therefore we cannot rank $\mathbf{P^c}$ and $\mathbf{P^d}$ according Property 5.

The Property of Monotonicity implies that Markov matrices equal to the identity matrix will be ranked lower than any other Markov matrix. Since the identity matrix arises when no transition between classes take place, Shorrocks (1978) suggests to assign to Markov matrix equal to identity matrix the minimum value of the index of mobility, i.e. 0. This defines the *Property* of *Immobility*, i.e.

$$I(\mathbf{IM}) = 0, \tag{6}$$

where **IM** is the identity matrix.

A Markov matrix with identical rows and the same transition probabilities in each row, $\mathbf{P}_M$, is usually denoted as the case of *Perfect Mobile Society* (see Prais (1955)); even though the case of *Perfect Mobile Society* does not imply the maximum amount of movement between classes, we can argue that the index of mobility should reach its maximum value with $\mathbf{P_M}$, i.e. 1; accordingly Property of *Perfect Mobile Society* requires that:

$$I(\mathbf{P_M}) = 1 \text{ if } \mathbf{P_M} = ux', \tag{7}$$

where $u = (1, 1, 1, ..., 1)'$ and $x'u = 1$.

A very disappointing result proved by Shorrocks (1978) is that mobility indices generally satisfy the Property of Immobility, while Property of Monotonicity and Property of *Perfect Mobile Society* can never be jointly satisfied.

2.2.1 Mobility Indices Proposed in Literature

In the following we present the most important indexes of mobility in literature.

Shorrocks (1978) proposed a simple index based on the determinant of $\mathbf{P}$, i.e.:

$$I_D(\mathbf{P}) = 1 - |det(\mathbf{P})| = 1 - |\prod_{i=1}^{k} \lambda_i|, \tag{8}$$

where λ_i represents the eigenvalues of $\mathbf{P}$. I_D has the serious drawback of taking value 1 (maximum mobility) when any two rows (or columns) of the matrix are identical.

Another mobility index proposed by Shorrocks (1978) is:

$$I_S(\mathbf{P}) = \frac{k - trace(\mathbf{P})}{k-1}. \tag{9}$$

The range of I_S is $[0, k/(k-1)]$ and a high value means high mobility. I_S measures the average probability across all classes that an individual will leave her/his initial class in the succeeding period (see Formby et al. (2004)); alternatively I_S can be viewed as normalized distance of $\mathbf{P}$ away from the identity matrix $\mathbf{I}$ (see Bartholomew (1996)).

However, I_S is calculated by considering only the main diagonal of $\mathbf{P}$, thus completely ignoring the length of transitions. In this regard Bartholomew (1973) proposed:

$$I_B(\mathbf{P}) = \frac{1}{k-1} \sum_{i=1}^{k} \sum_{j=1}^{k} \pi_i p_{ij} |i - j|, \tag{10}$$

where π_i is an element of the associated ergodic distribution of $\mathbf{P}$. I_B is in $[0, 1]$, with $I_B = 1$ meaning that the society presents maximum mobility, whereas with $I_B = 0$ that there is no mobility. The basic intuition of $I_B = 1$ is that transition probabilities p_{ij} contributes to mobility in relation to the length of jump (the length of transition), i.e. $|i-j|$, and how many individuals in equilibrium are on a given class, i.e. π_i. We remark that since I_B weights each transition probability p_{ij} with the absolute distance across states relative to the same transition, i.e. $|i-j|$, the states should be defined taking increasing or decreasing values of variable measuring mobility.

In this regard, since the metrics of states is not exactly defined in many circumstances, i.e. the jump of two classes could imply much more mobility than twice the jump of one class, Bartholomew (1973) proposed:

$$I_{BM}(\mathbf{P}) = \frac{1}{(k-1)^2} \sum_{i=1}^{k} \sum_{j=1}^{k} \pi_i p_{ij} (i-j)^2, \tag{11}$$

where weights of transition probabilities are equal to the square of the length of transitions. I_{BM} is again in $[0, 1]$.

Finally, also the mobility along the transition path can be interesting when the convergence to equilibrium is very slow; the following index is inspired by Fiaschi and Lavezzi (2004) and aim to measure such mobility:

$$I_{FL}(\mathbf{P}) = \frac{1}{k-1} \sum_{i=1}^{k} \sum_{j=1}^{k} \frac{n_i}{n} p_{ij} |i-j|, \tag{12}$$

I_{FL} corresponds to I_B but instead of the elements of ergodic distribution we use $\frac{n_i}{n}$ which represents the distribution of observations in each actual states.

Table 1 reports the value of mobility indexes calculated for the six different Markov matrices $\mathbf{P_M}$, $\mathbf{P^a}$, $\mathbf{P^b}$, $\mathbf{P^c}$, $\mathbf{P^d}$, $\mathbf{IM}$ discussed is Section 2.2.

Index	$\mathbf{P_M}$	$\mathbf{P^a}$	$\mathbf{P^b}$	$\mathbf{P^c}$	$\mathbf{P^d}$	$\mathbf{IM}$
I_S	1	0.92	1.27	0.99	1.03	0
I_B	0	0.23	0.27	0.21	0.18	0
I_{BM}	0	0.18	0.21	0.12	0.09	0
I_{FL}	0	0.22	0.30	0.18	0.19	0

Table 1: Mobility indexes for six different Markov matrices

All indexes satisfy the Property of Monotonicity (see Eq. (5)), being the mobility index of $\mathbf{P^a}$ always lower than index of $\mathbf{P^b}$ for all indexes. Even though the Property of Monotonicity cannot provide an ordering, mobility indexes suggest that mobility is higher for $\mathbf{P^c}$ with respect to $\mathbf{P^d}$ with the exception of I_S. The Property of Immobility (see Eq. (6)) is satisfied by all indexes as they assume the minimum value equal to zero for the identity matrix **IM**. Finally, the Property of Perfect Mobile Society (see Eq. (7)) is satisfied only by I_S, but for all other mobility indexes is violated, being indexes equal to zero.

2.3 Statistical Properties of the Estimates

The maximum likelihood (ML) estimator of $\mathbf{P}$, $\hat{\mathbf{P}}$, is given by:

$$\hat{\mathbf{P}} = [\hat{p}_{ij}] = \left[\frac{n_{ij}}{n_i}\right], \tag{13}$$

where $n_i = \Sigma_{j=1}^{n} n_{ij}$ (see, e. g., Norris (1997, pp. 55-56)). $\hat{\mathbf{P}}$ being the ML estimator, these estimates are consistent.

In general, take $\mathbf{P}$ and a function I such that $I : \mathbf{P} \rightarrow \Re$. Since $\mathbf{P}$ is unknown, then $I(\mathbf{P})$ is unknown as well. A natural estimator is $\hat{I} = I\left(\hat{\mathbf{P}}\right)$, which, in turn, is consistent (see Trede (1999)). I can represent any function (linear and non-linear), e.g. a mobility index calculated on $\mathbf{P}$.

(Stuart and Ord, 2004, p. 260,) show that the distribution of $\vec{n}_i$ converges to a n-variate normal distribution, with means $n_i p_{ij}$, variances $n_i p_{ij}(1 - p_{ij})$ and covariances $cov(n_{ij}, n_{iq}) = -n_i p_{ij} p_{iq}$. Thus $\sqrt{n_i}(\hat{p}_{ij} - p_{ij})$ tends towards the normal distribution $N(0; p_{ij}(1 - p_{ij}))$.

Since the rows of $\mathbf{P}$ are independent and each row tends towards a n-variate normal distribution, we have

$$\sqrt{n}\left(\text{vec}\left(\hat{\mathbf{P}}' - \mathbf{P}'\right)\right) \xrightarrow{d} N(0, \mathbf{V}),$$

where

$$\mathbf{V} = \begin{bmatrix} \mathbf{V}_1 & & \\ & \ldots & \\ & & \mathbf{V}_k \end{bmatrix} \tag{14}$$

is a block diagonal with

$$\mathbf{V}_m = [v_{m,ij}] = \begin{cases} \frac{p_{mi}(1-p_{mi})}{p_m} & \text{for } i = j \\ -\frac{p_{mi}p_{mj}}{p_m} & \text{for } i \neq j \end{cases}$$

for $m = 1, ..., k$ and 0 elsewhere.

Therefore the asymptotic distribution of I is given by:

$$\sqrt{n}\left(I\left(\hat{\mathbf{P}}\right) - I(\mathbf{P})\right) \xrightarrow{d} N\left(0, \sigma_I^2\right). \tag{15}$$

An estimate of σ_I^2, $\hat{\sigma}_I^2$, can be obtained by a bootstrap procedure on transition matrix. Since $I(\mathbf{P})$ is normally distributed, then $(1-\alpha)$-confidence interval for $I(\mathbf{P})$ is

$$I\left(\hat{\mathbf{P}}\right) \pm c\frac{\hat{\sigma}_I}{\sqrt{n}}, \tag{16}$$

where c is the $\left(1-\frac{\alpha}{2}\right)$-quantile of the $N(0,1)$. Alternatively,

$$s = \frac{I\left(\hat{\mathbf{P}}\right) - I(\mathbf{P})}{\frac{\hat{\sigma}_I}{\sqrt{n}}} \tag{17}$$

converges towards a Gaussian distribution under the null hypothesis $I\left(\hat{\mathbf{P}}\right) = I(\mathbf{P})$.

Finally, given two transition matrices $\hat{\mathbf{P}}^1$and $\hat{\mathbf{P}}^2$, we have that:

$$s = \frac{I\left(\hat{\mathbf{P}}^1\right) - I\left(\hat{\mathbf{P}}^2\right)}{\sqrt{\frac{\hat{\sigma}_{I^1}^2}{n} + \frac{\hat{\sigma}_{I^2}^2}{n}}}, \tag{18}$$

converges towards a Gaussian distribution under the null hypothesis $I\left(\hat{\mathbf{P}}^1\right) = I\left(\hat{\mathbf{P}}^2\right)$.

2.3.1 Test of Hypotheses

Test of hypotheses directly follow from the statistical properties of indexes. Assume that every $p_{ij} > 0$. The test of equality of p_{ij} to a given p_{ij}^0 is based on the fact that $\sqrt{n_i}(\hat{p}_{ij} - p_{ij}^0)$ has a limiting normal distribution with means zero, and variance and covariance depending on p_{ij}^0. Therefore the hypothesis H_0 of equality of the i-th row of a Markov matrix to p_{ij}^0, i.e.:

$$H_0 : p_{ij} = p_{ij}^0 \text{ for } j = 1, ..., k \text{ for a given } i. \tag{19}$$

can be tested observing that:

$$\sum_{j=1}^{k} n_i \frac{(\hat{p}_{ij} - p_{ij}^0)^2}{p_{ij}^0} \tag{20}$$

has an asymptotic χ^2-distribution with $k-1$ degrees of freedom (see Anderson and Goodman (1957)).

In the same manner, take the i-th row, the test if $p_{ij}(t)$ is independent of t, i.e. $\hat{p}_{ij}(t)$ are not statistically different for T independent samples, can be tested observing that:

$$\sum_{j=1}^{k} \sum_{t=1}^{T} n_i(t-1)[\hat{p}_{ij}(t) - \hat{p}_{ij}]^2 / \hat{p}_{ij}, \tag{21}$$

where $\hat{p}_{ij}$ are estimated pooling all Tsamples, has a χ_i^2-limiting distribution with$(k-1)(T-1)$ degrees of freedom.

Finally, given the normal distribution of the estimate of each mobility index, test of equality between two mobility indices $I(\hat{P_1})$ and $I(\hat{P_2})$, i.e.:

$$\frac{I(\hat{\mathbf{P_1}}) - I(\hat{\mathbf{P_2}})}{\sqrt{\frac{\hat{\sigma_1}^2}{n} + \frac{\hat{\sigma_2}^2}{n}}} \tag{22}$$

where $\hat{\sigma_1}^2$ and $\hat{\sigma_2}^2$ are the estimated variances of indexes $I(\mathbf{P_1})$ and $I(\mathbf{P_2})$, converges towards a Gaussian distribution under the null hypothesis $I(\hat{\mathbf{P_1}}) = I(\hat{\mathbf{P_2}})$.

3 Empirical Analysis

In the following we will study the intergenerational mobility across Italian households in terms of their educational attainment and occupational status. In the next section we describe the dataset used in the analysis.

3.1 The Dataset

The dataset used in the analysis is build from a survey conducted by Bank of Italy, the *"Survey on household income and wealth"*($SHIW$), a nationally representative household survey based on a random sample of approximately 8,000 households, that is available from 1977 to 1986 annually and at odd years after 1987. The survey include data on income, occupation, housing, retirements and education.

We consider the last six waves covering the period 1998-2008, and, in particular, we consider all heads of household aged from 30 up to 59 (i.e born between 1947 and 1976). We restrict our attention to these waves because all heads of household are asked to recall some characteristics of their parents, among which year of birth, educational attainment and occupational status, indicatively referred to the same current age of the respondent. Given the available information in the $SHIW$ we will measure social mobility by changes in educational attainment and occupational status between children and fathers.[1] Overall we have a sample of 11311 observations for the educational attainment and of 9443 for occupational status. We removed those heads of household not giving information on their fathers (i.e. 2360 observations for educational attainment and 1912 for occupational status) and the repeated observations due to longitudinal component (panel) present in the waves (about 30% of households persist from a wave and the next one).

[1]Other studies that use these two variables are Piraino (2007) and Checci et al. (1999). We select only fathers to follow the standard procedure adopted in most of similar studies of social mobility (e.g. Checchi (1997), Piraino (2007) and Chevalier et al. (2003)

3.2 Intergenerational Educational Mobility

Education attainment is measured by the maximum educational attainment. In particular, we consider five classes of educational attainment: None Education (NE), Primary School (PS) (five years), Lower Secondary School (LSS) (eight years), Upper Secondary School (USS) (thirteen years) and University Degree (UD) (eighteen and more than eighteen years of education).[2]

To our scopes the presence of a compulsory regime of education introduce a crucial bias in the estimate of intergenerational educational mobility. In the considered period there was a progressive increase in the years of compulsory school: at the beginning of period (1947) the compulsory age of education was 10 years; in 1962 a reform raised years to 14 (lower secondary school in our classification).

In order to take into account the presence and the changes in the compulsory regimes of education we use only three classes of educational attainment in the analysis, where the first includes NE, PS and LSS (denote it CS), the second USS and the third UD.[3]

Tables 2, 3 and 4 report the estimate of transition probabilities between the three educational classes for three cohorts defined by the year of birth of heads of household: the first cohorts includes the heads of household born in the period 1947-1956 (Cohort I), the second one those born between 1957 and 1966 (Cohort II) and the third one those born between 1967 and 1976 (Cohort III).[4]

As expected during the considered period there was a general increase in the level of educational attainment of children with respect to fathers for all three cohorts. Indeed, elements above the main diagonal in transition matrices are generally higher than elements below the main diagonal (see 2, 3 and 4) and the changes in the distributions of fathers and children across the three classes tends to favour classes USS and UD in all three cohorts (see Tables 7, 8 and 9). The general impression is, however, that the advance in educational attainment was very strong for Cohort I, and much less strong for Cohort II and, overall, for Cohort III. These

[2]The classification into five classes, both for children and their fathers, is based on the data retrieved in the questionnaire of Bank of Italy (respectively card A16 and card A24). As regard sons, the first class corresponds to the answer 1 (None Education) of the card A16, the second one corresponds to the answer 2 (Primary School) , the third corresponds to the answer 3 (Lower Secondary School), the fourth category corresponds to the answers 4 and 5 (Vocational and Upper Secondary School) and the last one corresponds to the answers 6, 7 and 8 (Three and Five year University Degree and Postgraduate Qualification). For fathers, the first three classes are similar to those of children, while the fourth class corresponds to the answer 4 (Upper Secondary School) of the card A24 and the last class corresponds to the answers 5 and 6 (University Degree and Postgraduate Qualification).

[3]In appendix A we present the estimates of transition matrices and mobility indexes with five educational classes.

[4]Dataset and codes written in R are available on authors' website.

findings are consistent with the results in Checchi (2010), who uses the same dataset but apply a different methodology of analysis.

The persistence increased from Cohort I to Cohort III for classes USS and UD (0.48 vs 0.588 and 0614 for USS and 0.539 vs 0.619 and 0.682 for UD) and decreased for CS (0.586 vs 0.496 and 0.481).[5] The estimates of index I_S reported in Table 5 suggests that the overall educational mobility decreased from Cohort I to Cohort III. Tests of equality between I_S of Cohort I and Cohort III is rejected at 1% significance level; however, the equality between I_S of Cohort II and Cohort III cannot be rejected at 10% significance level (see Table 6).

[5] P-values of test of equality are 0, we can reject the null hypothesis at a confidence level of 5%.

Table 2: The estimated transition matrix of educational attainment for Cohort I (1947-1956). Class CS includes the following educational attainment: None Education, Primary School and Lower Secondary School; class USS: Upper Secondary School; and class UD University Degree.

Fathers\ Children	CS	USS	UD	N.Obs.
CS	0.586	0.338	0.075	4064
USS	0.093	0.480	0.425	315
UD	0.087	0.373	0.539	154
N.Obs.	2369	1628	536	4533

Table 3: The estimated transition matrix of educational attainment for Cohort II (1957-1966). Class CS includes the following educational attainment: None Education, Primary School and Lower Secondary School; class USS: Upper Secondary School; and class UD: University Degree.

Fathers\Children	CS	USS	UD	N.Obs.
CS	0.496	0.434	0.069	3744
USS	0.054	0.588	0.357	433
UD	0.054	0.325	0.619	190
N.Obs.	1884	1945	538	4367

Table 4: The estimated transition matrix of educational attainment for Cohort III (1967-1976). Class CS includes the following educational attainment: None Education, Primary School and Lower Secondary School; class USS: Upper Secondary School; and class UD: University Degree.

Fathers\Children	CS.	USS	UD	N.Obs.
CS	0.481	0.437	0.080	1947
USS	0.085	0.614	0.299	349
UD	0.021	0.295	0.682	115
N.Obs.	963	1118	330	2411

The probability that children, with a father in class CS, of obtaining a higher educational attainment than that of his father is increasing from Cohort I to Cohort III, even tough only slightly from Cohort II to Cohort III (0.414 vs 0.504 and 0.519).[6] On the contrary, the fact that children with a father in class USS of taking an UD is decreasing from Cohort I to Cohort III (0.425 vs 0.356 and 0.299).[7] Checchi (2010) and Checci et al. (1999) present a similar evidence. This finding is particularly puzzling because from one hand (demand side of labour market) the changes in technology in favour of more skilled workers, and from the other hand (supply side of labour market) the reduction in the imperfections of capital market and the higher level of per capita income would suggest that UD should be always and always increasing over time; this means that the probability of going into class UD should be increasing from Cohort I to Cohort III independent of initial class of educational attainment.

Indexes I_B, I_{BM} and I_{FL} confirm that the overall educational mobility decreased from Cohort I to Cohort III (see Table 5). Test of equality of indexes I_B, I_{BM} and I_{FL} of Cohort I and III are all rejected at 5% confidence level, while only for indexes I_B, I_{BM} tests on Cohort II vs III can be rejected at 10% confidence level.

Table 5: Mobility indices of educational attainment for the three different cohorts. Standard errors are reported in parenthesis; they are computed via a bootstrap procedure with 300 bootstraps (see Efron and Tibshirani (1993))

Index\Cohort	I (1947 – 1956)	II (1957 – 1966)	III (1967 – 1976)	(1947 – 1976)
I_S	0.697 (0.023)	0.648 (0.023)	0.612 (0.025)	0.667 (0.014)
I_B	0.131 (0.006)	0.109 (0.006)	0.096 (0.006)	0.118 (0.003)
I_{BM}	0.072 (0.003)	0.058 (0.003)	0.052 (0.004)	0.065 (0.002)
I_{FL}	0.234 (0.004)	0.263 (0.004)	0.263 (0.006)	0.257 (0.003)

[6] P-values of test of equality are 0 and we can reject the null hypothesis at a confidence level of 5%.
[7] P-values of test of equality are 0 and we can reject the null hypothesis at a confidence level of 5%.

Table 6: P-value of the test of equality between mobility indexes of Cohorts I and II and between Cohorts II and Cohorts III.

Index\Cohort	I vs III	II vs III
I_S	0.008	0.132
I_B	0	0.068
I_{BM}	0	0.099
I_{FL}	0.047	0.481

The ergodic distributions reported in Tables 7, 8 and 9 highlight how the distribution dynamics is far to be exhausted: the mass of class UD of the youngest children should increase from 0.14 (the mass of actual children in Cohort III) to 0.45 in the long run; at the same time class CS should decrease from 0.40 to 0.09.

A general remark is that the ergodic distributions of the last two cohorts appear very similar confirming that not appreciable changes in the distributional dynamics of educational attainment happened in the two periods related to the cohorts.

As Checchi (Checchi) explains, Italy shows a low educational attainment that is probably the joint result of lower transition rates and higher drop-out rates. Trivellato and Bernardi (Trivellato and Bernardi) in their analysis show that still exists a fraction of population that not completing compulsory school. An additional fraction of students does not enter and/or drops out of completing upper secondary school and a further fraction does not enter tertiary education Checchi (Checchi).

Table 7: The estimated distribution of fathers and children and the ergodic distribution of educational attainment for Cohort I (1947-1956). Class CS includes the following educational attainment: None Education, Primary School and Lower Secondary School; class USS: Upper Secondary School; and class UD: University Degree.

	CS	USS	UD
Dist. Fathers	0.89	0.07	0.03
Dist. Children	0.52	0.36	0.12
Ergodic Distr.	0.19	0.41	0.41

Table 8: The estimated distribution of fathers and children and the ergodic distribution of educational attainment for Cohort II (1957-1966). Class CS includes the following educational attainment: None Education, Primary School and Lower Secondary School; class USS: Upper Secondary School; and class UD: University Degree.

	CS	USS	UD
Dist. Fathers	0.85	0.09	0.04
Dist. Children	0.43	0.44	0.12
Ergodic Distr.	0.10	0.46	0.44

Table 9: The estimated distribution of fathers and children and the ergodic distribution of educational attainment for Cohort III (1967-1976). Class CS includes the following educational attainment: None Education, Primary School and Lower Secondary School; class USS: Upper Secondary School; and class UD: University Degree.

	CS	USS	UD
Distr. Fathers	0.81	0.14	0.05
Distr. Children	0.40	0.46	0.14
Ergodic Distr.	0.09	0.46	0.45

3.3 Intergenerational Occupational Mobility

A first step in the analysis of intergenerational occupational mobility is the definition of the ranking of possible occupations. Following a standard methodology used in literature (see Checci et al. (1999)) we rank occupations according to the median income of children.[8] On the basis of figures reported in Table 25, 26, 27 reported in Appendix B we define seven occupational classes: Unemployed (UN), Blue-Collar (BC), Small Employer and Member of Family Business (SE&FB), Own Account Worker (OAW), Office-Worker/Teacher (OW&T), Member of Professions (MP), and Manager/School Head/Magistrate (M&M).[9]

The persistence in occupation between generations is strongly changed in the three cohorts. Tables 10, 11 and 12 contain the estimate of transition probabilities between the seven classes for the three cohorts. The persistence in BC and OW&T is strongly increased from Cohort I to Cohort III (0.43 vs 0.572 and 0.442 vs 0.528); persistence in class MP also increased, but with less magnitude (0.215 vs 0.256).[10] We argue that the higher persistence in BC signals a lower mobility of poor people; the higher persistence in OW&T is instead likely due to the increasing demand of a "safe" job, being in large part this class composed by public jobs. Finally, the increase of persistence of class MP is probably due to the increase of barrier to entry in many professions (e.g. order of lawyers, of public notary, etc. see Bortolotti and Fiorentini (Bortolotti and Fiorentini)). The persistence in classes SE&FB and M&M is strongly decreased (0.224 vs 0.146 and 0.335 vs 0.163).[11] Being both classes related to entrepreneurial jobs, this cannot be considered a positive feature.

[8]Cowell and Schluter (1998) suggest that the use of categorical data should increase the robustness of mobility measures expecially when we use data on income profile. They demonstrate that to obtain robust estimates of transition probabilities it is necessary make a robust choice of income classes.

[9]In the questionnaire of Bank of Italy for children we refer to card B01: the first class corresponds to the answer 12 (Unemployed), the second one corresponds to answers 1 (Blue-Collar),the third one corresponds to answers 7 and 9 (Small Employer and Member of Family Business), the fourth class corresponds to the answer 8 (Own Account Worker), the fifth one corresponds to answers 2 and 3 (Office Worker and Teacher), the sixth class corresponds to answer 6 (Member of Professions), and the last one corresponds to the answers 4 and 5 (Junior/Middle Manager and Senior Manager/Official/School Head and Magistrate). As regards father we refer to card A25: the first class corresponds to the answer 9 (Unemployed), the fourth one contains only small employers, the other classes correspond to the same answers of those of children.

[10]P-values of test of equality is 0 for class BC and OW&T, thus they are statistically different at a confidence level of 5%. For class MP the null hypothesis can not refused at the confidence level.

[11]P-values of test of equality is both 0. They are statistically different at a confidence level of 5%.

Table 10: The estimated transition matrix of occupational status for Cohort I (1947-1956). Class UN includes: Unemployed; BC: Blue-Collar; SE&FB: Small Employer and Member of Family Business; OAW: Own Account Worker ; OW&T: Office-Worker/Teacher; MP: Member of Professions; and M&M: Manager/School Head/Magistrate.

Fathers\Children	UN	BC	SE/FB	OAW	OW&T	MP	M&M	N.Obs.
UN	0.064	0.330	0.023	0.141	0.171	0.052	0.216	57
BC	0.055	0.430	0.045	0.092	0.289	0.023	0.062	1855
S.E./M.F.B.	0.027	0.090	0.224	0.073	0.369	0.038	0.176	68
OAW.	0.053	0.213	0.101	0.187	0.304	0.061	0.078	784
OW&T	0.024	0.151	0.028	0.051	0.442	0.091	0.209	521
MP	0.034	0.036	0.044	0.117	0.172	0.215	0.379	73
M&M	0.036	0.043	0.030	0.047	0.369	0.136	0.335	184
N.Obs.	191	1047	186	358	1168	185	407	3542

Table 11: The estimated transition matrix of occupational status for Cohort II (1957-1966). Class UN includes: Unemployed; BC: Blue-Collar; SE&FB: Small Employer and Member of Family Business; OAW: Own Account Worker ; OW&T: Office-Worker/Teacher; MP: Member of Professions; and M&M: Manager/School Head/Magistrate.

Fathers\Children	UN	BC	SE&FB	OAW.	OW&T	MP	M&M	N.Obs.
UN	0.080	0.229	0.019	0.125	0.416	0.016	0.112	63
BC	0.060	0.494	0.038	0.085	0.240	0.029	0.051	1953
SE&FB	0.016	0.176	0.136	0.137	0.312	0.153	0.067	77
OAW.	0.039	0.275	0.085	0.176	0.310	0.048	0.063	724
OW&T	0.022	0.170	0.012	0.066	0.496	0.116	0.114	675
MP	0.015	0.103	0.062	0.107	0.197	0.343	0.169	113
M&M	0.018	0.026	0.020	0.055	0.441	0.124	0.312	222
N.Obs.	181	1250	160	372	1284	263	317	3827

Table 12: The estimated transition matrix of occupational status for Cohort III (1967-1976). Class UN includes: Unemployed; BC: Blue-Collar; SE&FB: Small Employer and Member of Family Business; OAW: Own Account Worker ; OW&T: Office-Worker/Teacher; MP: Member of Professions; and M&M: Manager/School Head/Magistrate.

Fathers\Children	UN	BC	SE&FB	OAW.	OW&T	MP	M&M	N.Obs.
UN	0.087	0.429	0.011	0.040	0.252	0.090	0.088	47
BC	0.043	0.572	0.019	0.055	0.254	0.031	0.023	1042
SE&FB	0.009	0.201	0.146	0.097	0.356	0.067	0.122	43
OAW.	0.039	0.331	0.097	0.193	0.239	0.034	0.0632	377
OW&T	0.015	0.217	0.025	0.039	0.528	0.063	0.109	398
MP	0.052	0.128	0.017	0.032	0.421	0.256	0.092	57
M&M	0.019	0.113	0.019	0.107	0.459	0.117	0.163	110
N.Obs	97	856	78	173	653	101	116	2074

Index I_S reported in Table 13 decreases from Cohort I to Cohort III but, not surprisingly, the test of equality cannot be rejected at conventional statistical level of significance (see Table 14).

Table 13: Mobility indices of occupational status for the three different cohorts. Standard errors are reported in parenthesis; they are computed via a bootstrap procedure with 300 bootstraps (see Efron and Tibshirani (1993))

Index\Cohort	I (1947 – 1956)	II (1957 – 1966)	III (1967 – 1976)	(1947 – 1976)
I_S	0.851 (0.017)	0.827 (0.014)	0.842 (0.017)	0.836 (0.009)
I_B	0.121 (0.004)	0.111 (0.003)	0.109 (0.003)	0.114 (0.002)
I_{BM}	0.057 (0.003)	0.052 (0.002)	0.053 (0.002)	0.055 (0.001)
I_{FL}	0.183 (0.004)	0.154 (0.003)	0.135 (0.004)	0.158 (0.002)

Table 14: P-value of the test of equality between mobility indexes of Cohorts I and II and between Cohorts II and Cohorts III.

Index\Cohort	I vs III	II vs III
I_S	0.37	0.24
I_B	0.01	0.43
I_{BM}	0.13	0.35
I_{FL}	0	0

Comparing the off-diagonal elements it emerges how the probabilities of entry into class BC from all the other classes (except UN) are strongly higher in Cohorts III with respect to Cohort I, while exactly the opposite holds for class M&M. Mobility therefore display a downward trend, in the sense that classes of occupations with low income tend to increase their mass. The distribution of children across occupation and ergodic distributions reported in Tables 15, 16, and 17 confirm this finding: the mass of BC of children is equal to 0.29 in Cohort I and 0.41 in Cohort III, while the mass of M&M is 0.11 in Cohort I and 0.05 in Cohort III; looking at ergodic distributions this dynamics is still more evident (0.17 vs 0.33 and 0.22 vs 0.08).[12] Furthermore the mass of SE&FB decreases from Cohort I to Cohort III both for children and for ergodic distribution (0.05 vs 0.04 and 0.05 vs 0.03).[13] Class OW&T appears how the class receiving the main inflows, but its mass is almost constant over time (also its mass in the ergodic distributions)

[12] P-values of test of equality is both 0. They are statistically different at a confidence level of 5%.

[13] P-values of test of equality is both 0. They are statistically different at a confidence level of 5%.

Table 15: The estimated distribution of fathers and children and the ergodic distribution of occupational status for Cohort I (1947-1956). Class UN includes: Unemployed; BC: Blue-Collar; SE&FB: Small Employer and Member of Family Business; OAW: Own Account Worker ; OW&T: Office-Worker/Teacher; MP: Member of Professions; and M&M: Manager/School Head/Magistrate.

	UN	BC	SE&FB	OAW.	OW&T	MP	M&M
Distr. Fathers	0.01	0.52	0.02	0.22	0.15	0.02	0.05
Distr. Children	0.05	0.29	0.05	0.10	0.33	0.05	0.11
Ergodic Distr.	0.04	0.17	0.05	0.08	0.35	0.09	0.22

Table 16: The estimated distribution of fathers and children and the ergodic distribution of occupational status for Cohort II (1957-1966). Class UN includes: Unemployed; BC: Blue-Collar; SE&FB: Small Employer and Member of Family Business; OAW: Own Account Worker ; OW&T: Office-Worker/Teacher; MP: Member of Professions; and M&M: Manager/School Head/Magistrate.

	UN	BC	SE&FB	OAW.	OW&T	MP	M&M
Distr. Fathers	0.02	0.51	0.02	0.19	0.17	0.03	0.06
Distr. Children	0.05	0.32	0.04	0.10	0.33	0.07	0.08
Ergodic Distr.	0.03	0.23	0.04	0.09	0.37	0.12	0.12

Table 17: The estimated distribution of fathers and children and the ergodic distribution of occupational status for Cohort III (1967-1976). Class UN includes: Unemployed; BC: Blue-Collar; SE&FB: Small Employer and Member of Family Business; OAW: Own Account Worker ; OW&T: Office-Worker/Teacher; MP: Member of Professions; and M&M: Manager/School Head/Magistrate.

	UN	BC	SE&FB	OAW.	OW&T	MP	M&M
Distr. Fathers	0.02	0.50	0.02	0.18	0.19	0.03	0.05
Distr. Children	0.04	0.41	0.04	0.08	0.31	0.05	0.05
Ergodic Distr.	0.03	0.33	0.03	0.06	0.39	0.07	0.08

Mobility indexes I_B, I_{BM} and I_{FL} reported in Table 13 point out a reduction in mobility from Cohort I to Cohort III, but this decrease is statistically significant at usual confidence level only from Cohort I to Cohort II (see Table 14, except I_{BM}). Overall we therefore find that mobility decreased over time and that mobility is mainly towards classes of occupation with low incomes.

Finally, we observe that the mass of classes SE&FB and M&M, which include more entrepreneurial jobs, display an ongoing reduction from Cohort I to Cohort III declining from an overall mass of 0.16 in Cohort I to 0.09 in Cohort III for children and from 0.27 to 0.11 in the ergodic distribution (see Tables 15, 16, and 17).

4 Concluding Remarks

We find evidence of an increase in the persistence across generations of educational attainment, and that the probability of a child with a father with compulsory school of obtaining a higher educational attainment increased, while the probability of a child with a father with upper secondary school decreases. Overall, we find that social mobility as measured by mobility indexes decreased from the first to the last cohort. Also occupational mobility appears decreasing over time, with a lower mobility of poor people, an increasing demand of "safe" jobs, an increase in barriers to entry in many professions, and a declining size of entrepreneurial occupations.

A future line of research should jointly consider these two dimensions, allowing to depict a clear picture of social mobility. Moreover, we consider children not making any distinction of gender. Such distinction could provide very interesting information on the evolution of gender gap in term of opportunity of educational attainment and occupational status.

Appendix

A Educational Mobility

In this section we present the estimates for the educational mobility with five classes.

Table 18: The estimated transition matrix of educational attainment for Cohort I (1947-1956). Class NE includes None Education; class PS: Primary School; class LSS: Lower Secondary School; class USS: Upper Secondary School; and class UD University Degree.

Fathers\Children	NE	PS	LSS	USS	UD	N.Obs.
NE	0.048	0.361	0.375	0.197	0.017	924
PS	0.003	0.184	0.396	0.343	0.074	2111
LSS	0.000	0.049	0.159	0.600	0.192	527
USS	0.000	0.015	0.085	0.507	0.392	274
UD	0.002	0.025	0.063	0.341	0.569	137
N.Obs.	50	757	1253	1447	466	3973

Table 19: The estimated transition matrix of educational attainment for Cohort II (1957-1966). Class NN includes None Education; class PS: Primary School; class LSS: Lower Secondary School; class USS: Upper Secondary School; and class UD University Degree.

Fathers\Children	NE	PS	LSS	USS	UD	N.Obs.
NE	0.015	0.161	0.547	0.264	0.011	559
PS	0.001	0.051	0.468	0.422	0.056	1892
LSS	0.000	0.013	0.246	0.614	0.125	731
USS	0.000	0.004	0.053	0.576	0.365	387
UD	0.004	0.017	0.037	0.340	0.601	172
N.Obs	19	215	1370	1678	459	3741

Table 20: The estimated transition matrix of educational attainment for Cohort III (1967-1976). Class NE includes None Education; class PS: Primary School; class LSS: Lower Secondary School; class USS: Upper Secondary School; and class UD University Degree.

Fathers\Children	NE	PS	LSS	USS	UD	N.Obs.
NE	0.022	0.139	0.571	0.247	0.020	194
PS	0.011	0.031	0.504	0.415	0.048	823
LSS	0.000	0.006	0.303	0.581	0.110	508
USS	0.000	0.000	0.081	0.649	0.270	292
UD	0.000	0.008	0.016	0.274	0.702	96
N.Obs	7	58	704	894	250	1913

Table 21: The estimated transition matrix of educational attainment for Cohort I (1947-1956). Class NE includes None Education; class PS: Primary School; class LSS: Lower Secondary School; class USS: Upper Secondary School; and class UD University Degree.

NE	PS	LSS	USS	UD
0.0	0.03	0.09	0.44	0.44

Table 22: The estimated transition matrix of educational attainment for Cohort II (1957-1966). Class NE includes None Education; class PS: Primary School; class LSS: Lower Secondary School; class USS: Upper Secondary School; and class UD University Degree.

NE	PS	LSS	USS	UD
0.0	0.01	0.06	0.47	0.45

Table 23: The estimated transition matrix of educational attainment for Cohort III (1967-1976). Class NE includes None Education; class PS: Primary School; class LSS: Lower Secondary School; class USS: Upper Secondary School; and class UD University Degree.

NE	PS	LSS	USS	UD
0.0	0.0	0.07	0.47	0.45

Table 24: Mobility indices of educational attainment for the three different cohorts. Standard errors are reported in parenthesis; they are computed via a bootstrap procedure with 300 bootstraps (see Efron and Tibshirani (1993))

Index\Cohort	I (1947 − 1956)	II (1957 − 1966)	III (1967 − 1976)	(1947 − 1976)
I_S	0.883 (0.013)	0.877 (0.012)	0.823 (0.02)	0.855 (0.008)
I_B	0.075 (0.005)	0.062 (0.004)	0.047 (0.004)	0.061 (0.003)
I_{BM}	0.023 (0.002)	0.018 (0.001)	0.013 (0.001)	0.018 (0.001)
I_{FL}	0.316 (0.003)	0.318 (0.003)	0.276 (0.003)	0.311 (0.002)

B Average and Median Income and Standard Deviation of Log Income for Occupations

Table 25: Average and median income and standard deviation of log income for occupations of children in Cohort I

	Mean	Median	SD log income
BC	15632	15574	0.146
SE&FB	28604	15572	0.399
OAW	19652	17200	0.596
OW&T	20044	18686	0.057
MP	35306	26374	0.259
M&M	33911	28532	0.146

Table 26: Average and median income and standard deviation of log income for occupations of children in Cohort II

	Mean	Median	SD log income
BC	15101	15572	0.098
SE&FB	22192	16195	0.388
OAW	20195	17127	0.266
OW&T	19372	18135	0.078
MP	29181	21158	0.317
M&M	35726	30225	0.319

Table 27: Average and median income and standard deviation of log income for occupations of children in Cohort III

	Mean	Median	SD log income
BC	14736	14810	0.103
OAW	21305	16120	0.271
OW&T	18036	17127	0.089
SE&FB	37439	17922	0.456
MP	23805	20150	0.308
M&M	25687	23273	0.092

C Comparison between Census of ISTAT and the Sample SHIW for occupations

In this section we show that the size distribution of occupations derived by various censuses of ISTAT broadly matches the size distribution of our sample derived by SHIW.

Table 28: Census of ISTAT vs our sample derived by SHIW (percentage of workers in each occupation)

Year of census\Occupation	MP&SE	OAW.	MM&BC&OW&T
1971	0.020	0.207	0.771
1981	0.034	0.171	0.793
1991	0.071	0.179	0.747
2001	0.076	0.166	0.756
SHIW 1998	0.117	0.108	0.774

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