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Occupational Mobility across Generations: a Theoretical Model with an Application to Italy

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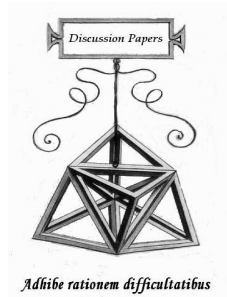Email: davide.fiaschi@unipi.it

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Occupational Mobility across Generations: a Theoretical Model with an Application to Italy

Abstract

This paper proposes a simple theoretical model to identify the main determinants of intergenerational occupational mobility with an application to Italian data. We assume that occupational mobility is described by a Markov matrix and that three factor affect the occupational choice of an individual: the income incentives of each occupation, the family background and the occupational structure.

The empirical application of the proposed model to a sample of Italian families describes Italy as a less mobile country, and in particular we show that occupational mobility decreases for children born between 1966 and 1976. This result is due to the worsening of opportunities. The estimate of three synthetic indexes confirms the decease of mobility.

Contents

I.   Introduction

Intergenerational economic mobility, one the stylized fact both in economics and sociology, refers to the correlation between parents and children's socio-economic status. High correlation means low mobility, and, in general, 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 decide your welfare). There is a large body of research on intergenerational economic mobility in most developed countries as well as some developing countries.

Starting from Becker and Tomes 1979, Solon 1992 and Zimmerman 1992, the seminal works in this literature, numerous economists and sociologists analyze intergenerational mobility from different point of view.

The majority of these studies measures economic mobility using an index, the intergenerational elasticity (IGE), or the closely associated correlation coefficient (Becker and Tomes 1986, Piraino 2007, Bjorklund and Jantti 2009 and Corak and Piraino   2010). These indexes are synthetic measures of the correlation between socio-economic status of two subsequent generations, therefore, they do not provide any information on the processes lying behind such correlations (Franzini et al 2013). An alternative method to measure economic mobility is represented by the estimate of *Markov matrix*. The value added of *Markov matrix*, and then of the transition matrix, is that it offers a more detailed depiction of intergenerational mobility. It provides a picture of the movement of individuals among the specified classes. Moreover, transition matrix lets one develop easily interpretable mobility measures (see Bartholomew 1973, Shorrocks 1978 and Formby et al 2004).

The measurement of mobility is widely debated in the literature, but less attention is dedicated to the identification of the main determinants of intergenerational mobility. From a socio-political point of view, the research of determinants of mobility is essential to design effective social policy measures. Though focused on alleviating social and economic inequalities, the social policy of a country tend o reproduce stratification in terms of power, class and other forms of inequality (Eberharter 2013. In this paper we propose a simple theoretical model to identify the determinants of intergenerational occupational mobility with an application to Italy.

Why occupational mobility? Socio-economic status can by measured by different variables, the most common are social class, occupational status and income (see, e.g., Erikson and Goldthorpe 1992, Cobalti and Schizzerotto 1994, Checchi et al 1999, Solon 2002, Piraino 2007, Bjorklund and Jantti 2009, Franzini et al 2013 and Corak 2013). We use the occupational status, defined as the highest occupation got by parents and children[1], because it allows to take into account

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[1]Bjorklund and Jantti 2000 summarize some of the relative merits of occupation for the measurement of intergenerational mobility, and discuss scenarios in which it provides very

both several key aspects of background, i.e. individual position in the social scale, his or her prestige, relation capital and the capacity to influence important economic decisions, and the changes in the occupational structure (Prais 1955, Erikson and Goldthorpe 1992, Breen 2004, Granovetter 2005 and Long and Ferrie 2013).

Many studies on mobility concerns United States, Scandinavian countries, Germany or Canada. There is less evidence for Italy, as for other southern European countries, and probably this is due to the lack of long panels (Cervini-Pla 2014).

The work of Checchi et al 1999 is one of the first analysis about mobility in Italy. They compare Italy and United states concluding that Italy has lower levels of mobility than the US despite having lower levels of inequality. Also Mocetti 2007 finds evidence of a stronger persistence among sons' income distribution, in paricular among the upper quantile, and this highlights the inadequacy of the institutional setting in guaranteeing opportunities of upwards mobility for individuals from low-income families. Finally, Piraino 2007 provides an analysis of the degree of intergenerational mobility in Italy. He estimates the intergenerational income elasticity and shows that mobility is limited.

This paper integrates this strand of literature. We, first, present the theoretical model to identify the determinants of occupational mobility, and then, we show the results for Italy.
According to our model the occupational status of each individual is the result of the interaction between three different channels: the *income incentives*, the *opportunities* and the *occupational structure*. The income incentives are the set of characteristics of each occupational class which determines the individual will to move to a particular class. Dardanoni et al 2006 discuss that all individual's actions that affect his or her occupational status represent the *effort*, and the equality of opportunity holds only if the occupational status of children depends on their own efforts. Regarding the opportunities, they are factors reflecting both individual skills and family background, i.e. his or her native abilities, education, but also parents' education and social connection. Dardanoni et al 2006 denote them as *circumstances*.
The last channel that affects children's occupational status is the occupational structure, that is exogenous changes, related to circumstances, in the labour market that necessarily generate mobility (Prais 1955 and Bjorklund and Jantti 2000).

Considering an economy with only two occupational classes (*Working and Lower Middle* and *Upper Middle Capitalist* class), we discuss how each determinant affects occupational mobility. We assume that occupational mobility can be described by a *Markov* matrix and we deduce three synthetic indexes to measure the overall occupational mobility, proposed by Shorrocks 1978, the opportunities,

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different results from those where intergenerational mobility is measured by income.

and the incentives for children to not change their occupational class respectively.

From an empirical point of view, the model is estimated on data available from the Survey on Household Income and Wealth (SHIW) carried on by the Bank of Italy. We partition the sample into three Cohorts on the base of year of birth of the head of household ($1947-56$, $1957-66$ and $1967-76$). We show that occupational mobility decreases over time, in particular occupational mobility is low for the youngest cohort, and the changes in the occupational structure seems to lead to an increase in the downward mobility. Finally the estimate of the model's parameters suggests that the decrease of occupational mobility is due to the decrease of opportunities for the Working and Lower Middle class to move upward.

The paper is organized as follows. Section II. presents the theoretical model for occupational mobility analysing the three determinants and discusses the synthetic mobility indexes. Section III. is devoted to the empirical analysis on Italy, and to a brief analysis of the relationship between income inequality and mobility. Section IV. concludes.

II. A Model of Occupational Mobility

In the following we propose a simple model of occupational choice to identify the crucial determinants of the occupational mobility of a society: i) the social prestige and/or **income incentives** to choose one occupation instead of another (see, e.g., Corak 2013); ii) the different **opportunities** generally related to family background and socio-economic environment of individuals (see, e.g., Becker and Tomes 1979 and Cap. 3 in Corak 2004); and, finally, iii) the **occupational structure**, i.e. the possibility of occupation given by the production side of economy (see, e.g., Prais 1955).

Consider an economy with two classes of occupations denoted by the *Working and Lower Middle* (**WLM**) class, and the *Upper Middle and Capitalist* (**UMC**) class[2].

The life-time (indirect) utility of individual i, U_i, only depends on her occupation, i.e.:

$$U_i = \begin{cases} W_i, & \text{if individual belongs to WLM class;} \\ \Pi_i, & \text{if individual belongs to UMC class.} \end{cases} \tag{1}$$

Assume that life-time utility in each class has a stochastic component; in particular:

$$\log W_i \sim \mathcal{N}\left(\mu_{WLM}; \sigma^2_{WLM}\right); \tag{2}$$

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[2]We limit the theoretical model only to two classes for simplicity reasons. The extension to more than two classes is straightforward from the theoretical point of view, but it does not add any additional insights of the phenomenon, and the increase in the model's parameters make the results of the empirical application less clear.

$$\log \Pi_i \sim \mathcal{N}\left(2\theta_i\mu_{UMC}; \sigma^2_{UMC}\right), \tag{3}$$

where $\mathcal{N}(\cdot)$ is the Gaussian distribution, with $0 \leq \mu_{WLM} \leq \mu_{UMC}$, $\sigma^2_{WLM} \leq \sigma^2_{UMC}$, and $\theta_i \in [0, 1]$. θ_i is an idiosyncratic factor that reflects both individual skills and family background, i.e. her native abilities, education, but also parents' education and social connections (the "circumstances" in Dardanoni et al 2006)[3].

An individual decides to belong to UMC class *if and only if*:

$$\mathbf{E}\left[\Pi_i\right] \geq \mathbf{E}\left[W_i\right] + \sigma^{RP}, \tag{4}$$

where σ^{RP} is the risk premium depending on the attitude towards risk of individual i. Assuming that individual i is risk-adverse or risk-neutral, $\sigma^{RP} \geq 0$, and not decreasing in $\sigma^2_{UMC}/\sigma^2_{WLM}$, Condition (4) becomes:

$$2\theta_i\mu_{UMC} \geq \mu_{WLM} + \sigma^{RP}\left(\frac{\sigma^2_{UMC}}{\sigma^2_{WLM}}\right) \Rightarrow \theta_i \geq \frac{\mu_{WLM} + \sigma^{RP}\left(\dfrac{\sigma^2_{UMC}}{\sigma^2_{WLM}}\right)}{2\mu_{UMC}} \equiv \lambda; \tag{5}$$

given θ_i, λ measures the probabilty mass of indiviuals that decide to move towards UMC class on the base of the **income incentives** of each occupation. A high level of λ means a *lower* probability to move upward.

As regards the **opportunities** determined by family background and social environment of individual i, we assume that if her parents belong to WLM class, the probability distribution of θ_i is giving by:

$$f(\theta_i|WLM) \sim \mathcal{U}\left(0, \theta^{\max}\right), \tag{6}$$

where $\mathcal{U}\left(0, \theta^{\max}\right)$ means a uniformly distributed random variable in the range $[0, \theta^{\max}]$, with $\theta^{\max} \leq 1$; otherwise if her parents belong to UMC class, the probability distribution of θ_i is giving by:

$$f(\theta_i|UMC) \sim \mathcal{U}\left(\theta^{\min}, 1\right), \tag{7}$$

with $\theta^{\min} \geq 0$.

Figure 1: **A Comparison between opportunities of individuals whose parents belong to different occupational classes.**

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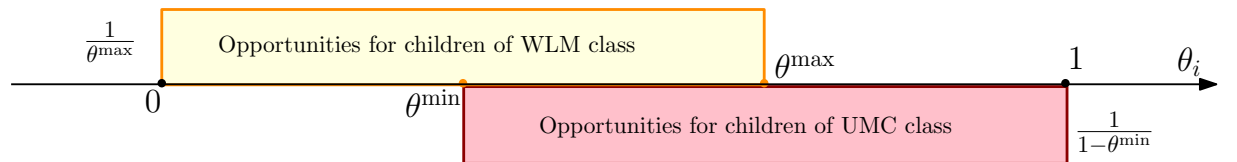
[3] θ_i is assumed to be known by individual i. This assumption makes irrelevant to know the probability distribution of it.

Figure 1 shows the different opportunities for individuals whose parents belong to different occupational classes. A higher $\theta^{\max}$ tends to favour a change in occupational class for individuals whose parents are in WLM class. The same applies with a lower $\theta^{\min}$ for individuals whose parents are in UMC class.

When $\theta^{\max} < \lambda$ and $\theta^{\min} > \lambda$ no changes in occupational classes should be observed. When $\theta^{\max} < \lambda$ and $\theta^{\min} < \lambda$, only individuals whose parents belong to UMC class change their class; hence in the long run all individuals will be doomed to belong to WLM class. The opposite happens when $\theta^{\max} > \lambda$ and $\theta^{\min} > \lambda$, with all individuals in the UMC class in the long run.

The condition to observe a change for both classes are therefore given by:

$$\theta^{\max} > \lambda; \tag{8}$$

and

$$\theta^{\min} < \lambda, \tag{9}$$

Under Assumptions (8) and (9) the occupational mobility of a society is completely described by the following *Markov matrix* $\mathbf{Q}$[4]:

Fathers\Children	WLM	UMC
WLM	$\dfrac{\lambda}{\theta^{\max}}$	$\dfrac{\theta^{\max} - \lambda}{\theta^{\max}}$
UMC	$\dfrac{\lambda - \theta^{\min}}{1 - \theta^{\min}}$	$\dfrac{1 - \lambda}{1 - \theta^{\min}}$

The first element in the main diagonal of $\mathbf{Q}$, $\lambda/\theta^{\max}$, represents the probability of a child with a father in WLM class to belong to WLM class given the probability distribution (6) and her incentives to belong to WLM class reported in Condition (5), i.e.:

$$\mathbf{Pr}\left[\theta_i \leq \lambda | WLM\right] = \frac{\lambda}{\theta^{\max}}. \tag{10}$$

Similarly the second element of the main diagonal of $\mathbf{Q}$, $(1 - \lambda)/\left(1 - \theta^{\min}\right)$, represents the probability of a child with a father in UMC class to belong to UMC class given the probability distribution (7) and her incentives to belong to UMC class reported in Condition (5).

The first out-of-diagonal element, $(\theta^{\max} - \lambda)/\theta^{\max}$, is given by:

$$\mathbf{Pr}\left[\theta_i > \lambda | WLM\right] = 1 - \mathbf{Pr}\left[\theta_i \leq \lambda | WLM\right] = 1 - \frac{\lambda}{\theta^{\max}} = \frac{\theta^{\max} - \lambda}{\theta^{\max}}. \tag{11}$$

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[4]$\dfrac{\lambda}{\theta^{\max}} > \dfrac{1 - \lambda}{1 - \theta^{\min}}$ guarantees that $\mathbf{Q}$ is a monotone Markov transition matrix (see Dardanoni 1995)

Social mobility, measured by $\mathbf{Q}$, determines also the shares of individuals in the two classes in the long run. In particular, the equilibrium distribution implied by $\mathbf{Q}$ is given by[5]:

$$\pi_{\mathbf{Q}} = \left[\frac{1}{1 + \gamma(\theta^{\min}, \theta^{\max}, \lambda)}, \frac{\gamma(\theta^{\min}, \theta^{\max}, \lambda)}{1 + \gamma(\theta^{\min}, \theta^{\max}, \lambda)} \right]. \tag{12}$$

where

$$\gamma = \frac{(\theta^{\max} - \lambda)(1 - \theta^{\min})}{\theta^{\max}(\lambda - \theta^{\min})}; \tag{13}$$

the first (second) element of $\pi_{\mathbf{Q}}$ represents the equilibrium probability masses of WLM (UMC) class. Higher $\theta^{\min}$ and/or $\theta^{\max}$ results in a lower equilibrium mass of WLM class ($\partial\gamma/\partial\theta^{\min} > 0$ and $\partial\gamma/\partial\theta^{\max} > 0$), while a higher λ leads to the opposite outcome, a higher equilibrium mass of WLM class ($\partial\gamma/\partial\lambda < 0$)[6].

II.A. Measures of Occupational Mobility

Heuristically the complement to 2 of the trace of $\mathbf{Q}$ defines a measure of occupational mobility (a lower trace corresponding to a higher mobility)[7]. Under Assumptions (8) and (9) we have:

$$I_S = 2 - \text{tr}(\mathbf{Q}) = 2 - \frac{\lambda(1 - \theta^{\min} - \theta^{\max}) + \theta^{\max}}{\theta^{\max}(1 - \theta^{\min})}; \tag{16}$$

where $I_S \in [0, 2]$ (0 minimum social mobility, and 2 maximum). As expected $\partial I_S/\partial\theta^{\max} > 0$ and $\partial I_S/\partial\theta^{\min} < 0$, i.e. occupational mobility increases with $\theta^{\max}$ and decreases with $\theta^{\min}$.

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[5]See Bartholomew 1973 for more details.

[6]To identify $\lambda, \theta^{\max}$ and $\theta^{\min}$ we have to solve the following system of three equations (notice that we have three parameters and three independent equation because the sum of the elements in each row is equal to one):

$$\begin{cases} \dfrac{\lambda}{\theta^{\max}} = q_{11} \\[2ex] \dfrac{1 - \lambda}{1 - \theta^{\min}} = q_{22} \\[2ex] \dfrac{(\theta^{\max} - \lambda)(1 - \theta^{\min})}{\theta^{\max}(\lambda - \theta^{\min})} = \pi_1 \end{cases} \tag{14}$$

from which we get:

$$\theta^{min} = \frac{(1 - q_{11})\pi_1 - (1 - q_{22})\pi_2}{q_{22}\pi_2 - \pi_1 q_{11}}, \quad \theta^{\max} = (q_{11}\theta^{\min} + 1 + q_{11})\frac{\pi_1}{(1 - \pi_1)q_{11}} \quad and \quad \lambda = q_{11}\theta^{\max}. \tag{15}$$

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[7]A simple intuition of I_S is to see it as the sum of the out of diagonal element of $\mathbf{Q}$.

Instead occupational mobility has an ambiguous relationship with λ. Higher λ means less (upward) mobility for WLM children and higher (downward) mobility for UMC children. Under the condition $\theta^{\min} + \theta^{\max} < 1$ the first effect prevails on the second and I_S decreases with λ. This should be the most plausible case because this would mean that the less upward mobility of lower social occupational class WLM more than compensate the higher downward mobility of higher social occupational class UMC (this is the case for Italy, see Section III.). Under the Assumptions (8) and (9) the occupational mobility can be decomposed into two components, the first related to incentives, and the second to opportunities.

Figure 2: **Disentangle the occupational mobility due to incentives and opportunities.**
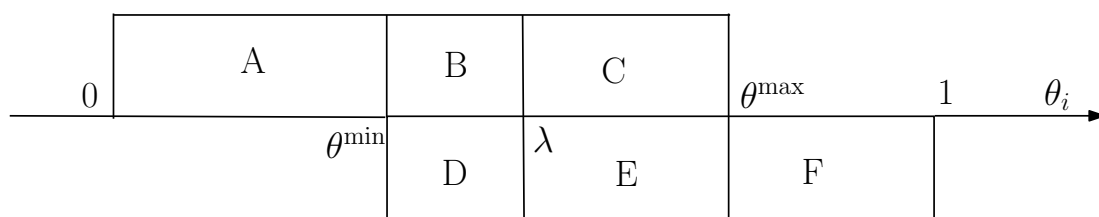
In Figure 2 I_S is measured by area (C+D)[8]. Area (B+C) measures the probability to move upward for children with parents in WLM class independent of incentives (i.e. the level of λ). Likewise Area (D+E) measures the probability to move downward. Area (B+C+D+E) can therefore proxy for the socio-economic opportunities of individuals, that is:

$$I_{OPP} = 2 - \frac{\theta^{\min}(1 - \theta^{\min}) + \theta^{\max}(1 - \theta^{\max})}{\theta^{\max}(1 - \theta^{\min})}. \tag{17}$$

I_{OPP} reaches the highest value equal to 2 for $\theta^{\min} = 0$ and $\theta^{\max} = 1$.

The difference $I_{INC} \equiv I_{OPP} - I_S$, i.e. area (B+E) in Figure 2, measures the incentives for children to **not** change their occupational class with respect their parents; in particular

$$I_{INC} = \frac{\lambda - \theta^{\min}}{\theta^{\max}} + \frac{\theta^{\max} - \lambda}{1 - \theta^{\min}}; \tag{18}$$

I_{INC} is in the range $[0, 1)$. Eqs.(16)-(18) therefore allows to disentangle the part of occupational mobility due to incentives and to opportunities.

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[8]Area C is equal to $\left(1 - \frac{\lambda}{\theta^{\max}}\right)$, while area D is equal to $\left(1 - \frac{1 - \lambda}{1 - \theta^{\min}}\right)$.

II.B.   Three Types of Societies

In this section we discuss three extreme types of Markov matrix, $\mathbf{Q}$, corresponding to three extreme cases of society.

1 *Perfect Mobile Society* (see Prais 1955): the probability of entering a particular class is independent of the class of one's parents. In our model this means $\theta^{\min} = 0$ and $\theta^{\max} = 1$, from which:

$$\mathbf{Q_{PMS}} = \begin{bmatrix} \lambda & 1 - \lambda \\ \lambda & 1 - \lambda \end{bmatrix}, \tag{19}$$

and

$$\pi_{\mathbf{Q_{PMS}}} = \begin{bmatrix} \lambda, 1 - \lambda \end{bmatrix}. \tag{20}$$

It is worth noting that *Perfect Mobile Society* does not imply the symmetric mobility between classes; with $\lambda = 1/2$

$$\mathbf{Q_{PMS}} = \begin{bmatrix} 1/2 & 1/2 \\ 1/2 & 1/2 \end{bmatrix}, \tag{21}$$

while with $\lambda = 0$

$$\mathbf{Q_{PMS}} = \begin{bmatrix} 0 & 1 \\ 0 & 1 \end{bmatrix}; \tag{22}$$

however Q_{PMS} reported in (21) shows both downward and upward mobility, while Q_{PMS} reported in (22) just upward mobility (notice that $I_S = 1$ for both Q_{PMS}). Accordingly in a *Perfect Mobile Society* $I_{OPP} = 2$ and $I_{INC} = 1$. A comparison between Q_{PMS} in (21) and (22) highlights how between socio-economic mobility and social welfare there is not a perfect correspondence: Q_{PMS} in (21) appears to be Pareto-dominated by Q_{PMS} in (22) since the second one has the same mobility, but all individuals are in UMC class in the equilibrium distribution.

2 *Perfect Immobile Society*: no movements between classes take place. In our model this means $\theta^{\min} > \lambda$ and $\theta^{\max} < \lambda$:

$$\mathbf{Q_{PIS}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}. \tag{23}$$

In this case $I_S = 0$ and $I_{OPP} = I_{INC} = 0$ by definition.

3 *Ex-Post-Minimum Inequality Society*: class WLM is the absorbing class in the equilibrium distribution. In our model this means $\theta^{\min} < \lambda$ and $\theta^{\max} < \lambda$, from which:

$$\mathbf{Q_{EPMIS}} = \begin{bmatrix} 1 & 0 \\ \dfrac{\lambda - \theta^{\min}}{1 - \theta^{\min}} & \dfrac{1 - \lambda}{1 - \theta^{\min}} \end{bmatrix}, \tag{24}$$

with

$$\pi_{\mathbf{Q_{EPMIS}}} = \begin{bmatrix} 1, 0 \end{bmatrix}. \tag{25}$$

Since $I_S = 1 - \dfrac{1-\lambda}{1-\theta^{\min}}$ we observe that a decrease in λ leads to an increase in mobility but ex-post inequality is the same. We refer to this case as *Ex-Post-Minimum Inequality Society* because all observations in the long-run will be concentrated in the WLM class characterized by minimum variance. If $\theta^{\min} > \lambda$ and $\theta^{\max} > \lambda$, from which:

$$\mathbf{Q} = \begin{bmatrix} \dfrac{\lambda}{\theta^{\max}} & \dfrac{\theta^{\max} - \lambda}{\theta^{\max}} \\ 0 & 1 \end{bmatrix}, \tag{26}$$

with

$$\pi_{\mathbf{Q}} = \begin{bmatrix} 0, 1 \end{bmatrix}. \tag{27}$$

with $I_S = 1 - \dfrac{\lambda}{\theta^{\max}}$. We can not refer to this case as *Ex-Post-Minimum Inequality Society* since UMC class, where all observations will be concentrated in the long-run, shows higher variance and then a higher level of inequality.

II.C. A Decomposition of the Observed Occupational Mobility

Prais 1955 discusses how the observed occupational mobility can be traces to two types of forces related to i) **occupational mobility** due to the choices of individuals (Prais denotes it as "true" occupational mobility); and ii) the occupational mobility due to **occupational shifts**, changes in the occupational structure caused both by changes in the supply side and in differences in the reproduction rates within each occupational class. Prais 1955 assumes that *observed* transition matrix $\mathbf{P}$ is the result of the product of two Markov transition matrices $\mathbf{Q}^\top$ representing the true occupational mobility, and $\mathbf{R}^\top$ representing the occupational shifts.

Given the choices of individuals and the shares of observations at period t, $s_{t+1}^{UN} = \mathbf{Q}^\top s_t$ would be the vectors of allocations of individuals to each occupational class if there were not any constraints from the supply side of economy or different reproduction rates in each classes. The observed vector at period $t+1$ is generally different from s_{t+1}^{UN}. $\mathbf{R}$ reflects these possible differences due to occupational shifts, i.e.:

$$s_{t+1} = \mathbf{R}^\top s_{t+1}^{UN} = \mathbf{R}^\top \mathbf{Q}^\top s_t = \mathbf{P}^\top s_t \tag{28}$$

In particular in our framework with just two classes:

$$\mathbf{R}^\top = \begin{bmatrix} r_{11} & r_{21} \\ r_{12} & r_{22} \end{bmatrix}; \tag{29}$$

where r_{11} can be meant as the probability for individual i, who would aim to belong to WLM class, to be in WLM class; r_{21} is the probability for individual i, who would aim to belong to UMC class, to belong to WLM class because of the occupational structure; r_{12} is the probability for individual i, who would aim to belong to WLM class, to belong to UMC class, and r_{22} is the probability for individual i, who would aim to belong to UMC class, to be in that class.
We observe two extreme situations:

1 *No occupational shifts* happened, i.e. $s_{t+1,WLM} = s_{t,WLM}$ and $s_{t+1,UMC} = s_{t,UMC}$; then:

$$\mathbf{R_{NOS}} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}; \tag{30}$$

where no constraints are present in the individual choices.

2 *Maximum occupational shifts* happened, then:

$$\mathbf{R_{MOS}} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}; \tag{31}$$

where maximum constraints are present in the individual choices.

In general we observe $\mathbf{P}$, then to estimate $\mathbf{Q}$ from $\mathbf{P}$ we need $\mathbf{R}$, and the estimate of $\mathbf{R}$ is possible only imposing some identifying assumptions. Prais 1955 follows a criterion of *minimum* occupational mobility to identify $\mathbf{R}$: he proposes an algorithm starting from the first class of fathers, and *sequentially* arriving to the top one, which allocates children in each class minimizing the changes between occupational classes with respect to their fathers class[9]. We instead estimate $\mathbf{R}$ under the criterion of the *jointly minimum* occupational mobility, measured by the opposite of the trace of $\mathbf{R}$, subject to the observed occupational shifts, i.e.:

$$\max_{\mathbf{R}} \quad \mathrm{tr}(\mathbf{R}) \qquad \text{subject to} \begin{cases} s_{t+1} = \mathbf{R}^{\top} s_t, \\ \sum_{j=1}^{k} r_{ij} = 1 & \forall i = 1...k, \\ r_{ij} \geq 0 & \forall ij \end{cases} \tag{32}$$

Therefore we assume that individuals are able to realise their optimal choice conditioned to the occupational structure. In addition to the situation where no occupational shifts happened we have two other solutions to Problem 32:

3 *Occupational shifts* happened in favour of WLM class, i.e. $s_{t+1,WLM} > s_{t,WLM}$ and $s_{t+1,UMC} < s_{t,UMC}$; then:

$$\mathbf{R^*_{WLM}} = \begin{bmatrix} 1 & 0 \\ \dfrac{s_{t,UMC} - s_{t+1,UMC}}{s_{t,UMC}} & \dfrac{s_{t+1,UMC}}{s_{t,UMC}} \end{bmatrix}; \tag{33}$$

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[9]See Appendix A for a numerical example.

where some individuals choosing UMC class are constrained to belong to WLM class.

4 *Occupational shifts* happened in favour of UMC class, i.e. $s_{t+1,WLM} < s_{t,WLM}$ and $s_{t+1,UMC} > s_{t,UMC}$; then:

$$\mathbf{R}^*_{\mathbf{UMC}} = \begin{bmatrix} \dfrac{s_{t+1,WLM}}{s_{t,WLM}} & \dfrac{s_{t,WLM} - s_{t+1,WLM}}{s_{t,WLM}} \\ 0 & 1 \end{bmatrix} ; \qquad (34)$$

where some individuals choosing WLM class are constrained to belong to UMC class.

III.   An Estimate of Occupational Mobility in Italy

Now we estimate the theoretical model presented in Section II. and the indexes of mobility for a sample of heads of household born in the period $1947 - 1976$. In particular we partition the sample into three cohorts on the base of the year of birth: the first cohort includes those 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).

Section III.A. describes the dataset in more details, and Section III.B. contains the estimates.

III.A.   The Dataset

The dataset is build from a a nationally representative household survey carried on by the Bank of Italy, the *"Survey on Household Income and Wealth"* ($SHIW$).

In particular we consider the last eight waves conducted in the period 1998-2012, selecting all heads of household aged from 22 up to 65 (i.e born between 1947 and 1976). We focus on these waves because all heads of household are asked to recall some characteristics of their parents, among which year of birth and occupational status, indicatively referred to the same current age of the respondent[10]. Following the standard approach in literature we measure occupational mobility comparing occupational status of children and their fathers (see, Checchi 1997 and Piraino 2007). We removed those heads of household not giving informations on their fathers and the repeated observations due to longitudinal component (panel) present in the waves (about 30% of households persists from a wave and the next one). We get a sample of $11,807$ observations divided into $4,015$ in Cohort I, $4,848$ in Cohort II and $2,944$ in Cohort III.

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[10] Asking to the respondent the occupational status of his or her parents at the same current age we control for the life cycle component.

III.B.   The Estimate of Italian Occupational Mobility

In accordance to the theoretical model we define two occupational classes: the *Working* and *Lower Middle* (**WLM**) class and the *Upper Middle* and *Capitalist* (**UMC**) class. Following a large sociological literature we rank occupational classes according to their social prestige, such as the Hope-Goldthorpe scale (see, e.g., Goldthorpe and Hope 1974, and more recently Cap.12 in Giddens and Sutton 2013). Hope-Goldthorpe scale mainly reflects the average income paid by each occupation, but a number of other social criteria enter into its construction (see Giddens and Sutton 2013 for more details).

The eight socio-economic classes of Hope-Goldthorpe scale are pooled into WLM class which includes blue-collars, clericals and teachers; and UMC class which consists of managers, member of profession, entrepreneurs and self-employment workers (see Cap.12 in Giddens and Sutton 2013)[11]. According to the nine ISCO classes, for both children and fathers, our two occupational classes correspond respectively to: the first class (WLM) includes ISCO categories from 3 to 7 excepted the 6 category; the second class (UMC) concerns ISCO categories from 1 to 2 and the 6th [12].

Table 1 contains the estimate of **P** (the *observed* total mobility), **R** and **Q** matrices for each cohort. The overall persistence in occupational status between generations, estimated by **P**, increased for WLM class and decreased for UMC class (from Cohort I to Cohort III the probability to remain in WLM class increased from 0.74 to 0.86, while the probability to remain in UMC class decreased from 0.48 to 0.37)[13]. Accordingly the probability to move upward decreased from Cohort I to Cohort III (the probability to move upward fom WLM class decreases from 0.26 to 0.14), while the probability to move downward increased from 0.52 to 0.63[14]. The high persistence in the first class is also found by Pisati 2000 and Di Pietro and Urwin 2003 even if our estimates give a even worse picture of this phenomenon (0.85 vs 0.51 in Pisati 2000). This higher persistence is mainly due to our inclusion in WLM class of blue-collar and office workers.

Looking at **Q** we observe that, also in this case, Cohort I and II are similar, but Cohort III shows an increase of the persistence for WLM class. The comparison between **P** and **Q** highlights that occupational shifts played a role only for Cohort

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[11]In the questionnaire of Bank of Italy for children we refer to card B01: the first occupational class corresponds to the answers 1 2, 3 and 12 (Blue-collar, Office worker, Teacher and Unemployed), the second class corresponds to the answers 4, 5, 6, 7 and 8 (Junior and senior Middle Manager/Official/School Head and Magistrate, Member of Professions, Small Employer and Own Account Worker). As regards fathers we refer to card A25 with the same classification.

[12]Franzini et al 2013 develop an analysis of occupational mobility using three categories using the ISCO classes: managers, classes from 1 to 2, white-collars, classes from 3 to 5, and blue-collars, classes from 6 to 9

[13]We can reject the null hypothesis of equality between all these transition probabilities at the usual confidence level of 5%.

[14]We can reject the null hypothesis of equality between all these transition probabilities at the usual confidence level of 5%.

III. In particular the *true* persistence in UMC class is higher (0.37 vs 0.45), and at the same time, the probability to move downward is lower (0.55 vs 0.63). This result is due to the shifts in the occupational structure stressed by **R** ($r_{22} << 1$). In particular, for Cohort I **R** shows a small upward bias for children whose fathers are in WLM class suggesting that some of them are constrained to move towards to the upper class (0.02%); for Cohort II holds the opposite, children whose fathers are in UMC class are constrained to move downward. For Cohort III the constraint to mobility employed by occupational structure is more evident: 0.24% of children with a father in UMC class are obliged to move downward. Therefore the occupational shifts lead to an increase in the downward mobility for the youngest cohort.

Table 2 reports the estimate of the parameters of the theoretical model presented in Section II.. From Cohort I to Cohort III $\hat{\lambda}$ increases (0.52 vs 0.56) suggesting less income incentives for an individual in WLM class to move to UMC class, and higher income incentives for an individual in UMC class to access to WLM class. From Cohort I to Cohort III both $\theta^{\min}$ and $\theta^{\max}$ decreases showing that increases the opportunities for UMC individuals to move downward and decreases the opportunities to move upward for WLM individuals.

As expected $\theta^{\min} + \theta^{\max} < 1$ for all cohorts implying that I_S is decreasing in λ (remind that higher λ means less incentives to upward mobility for children with WLM parents). Moreover from Cohort I to Cohort III I_{OPP} decreases confirming the reduction of opportunities to change occupational class, and, finally, I_{INC} increases highlighting an increase of the incentives for children to remain in the same class of their fathers[15].

Table 1: **Estimate of Markov matrices of socio-economic mobility for Cohort I, II and III** ($1947 - 56$, $1957 - 66$ **and** $1967 - 76$).

	P				**R**				**Q**		
Cohort I	WLM	UMC	N.Obs	**Cohort I**	WLM	UMC	N.Obs	**Cohort I**	WLM	UMC	N.Obs
WLM	0.74	0.26	2742	**WLM**	0.98	0.02	2742	**WLM**	0.74	0.26	2742
UMC	0.52	0.48	1273	**UMC**	0	1	1273	**UMC**	0.52	0.48	1273
N.Obs	2713	1302	4015	**N.Obs**	2713	1302	4015	**N.Obs**	2713	1302	4015
Cohort II	WLM	UMC	N.Obs	**Cohort II**	WLM	UMC	N.Obs	**Cohort II**	WLM	UMC	N.Obs
WLM	0.77	0.23	3406	**WLM**	1	0	3406	**WLM**	0.77	0.23	3406
UMC	0.55	0.45	1442	**UMC**	0.02	0.98	1442	**UMC**	0.55	0.45	1442
N.Obs	3435	1413	4848	**N.Obs**	3435	1413	4848	**N.Obs**	3435	1413	4848
Cohort III	WLM	UMC	N.Obs	**Cohort III**	WLM	UMC	N.Obs	**Cohort III**	WLM	UMC	N.Obs
WLM	0.86	0.14	2112	**WLM**	1	0	2112	**WLM**	0.85	0.15	2112
UMC	0.63	0.37	832	**UMC**	0.24	0.76	832	**UMC**	0.55	0.45	832
N.Obs	2308	636	2944	**N.Obs**	2308	636	2944	**N.Obs**	2308	636	2944

Notes: Columns 2-4 report the estimate of **P**; columns 6-8 report the estimate of **R**; and columns 10-12 report the estimate of **Q** respectively.
Source: Our calculations based on SHIW (Bank of Italy).

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[15]We can reject the null hypothesis of equality between the two values of each parameter at the usual confidence level of 5%.

Table 2: **Estimate of λ, $\theta^{\min}$, $\theta^{\max}$, I_S, I_{OPP} and I_{INC}.**

Cohort	$\hat{\lambda}$	$\hat{\theta}^{\min}$	$\hat{\theta}^{\max}$	I_S	I_{OPP}	I_{NIC}
I	**0.52**	**0.010**	**0.70**	**0.78**	*1.68*	**0.90**
	(0.013)	(0.001)	(0.02)	(0.01)	(0.02)	(0.04)
II	0.55	0.008	0.71	0.78	1.71	0.93
	(0.013)	(0.002)	(0.019)	(0.003)	(0.005)	(0.002)
III	**0.56**	**0.001**	**0.67**	**0.72**	**1.67**	**0.95**
	(0.03)	(0.003)	(0.003)	(0.01)	(0.006)	(0.004)

Notes: Standard errors are reported in parenthesis; they are computed via a bootstrap procedure with 1000 bootstraps (see Efron and Tibshirani 1993).

III.C.   Occupational Mobility and Income Inequality

An emerging body of evidence suggests that more income inequality is present and more likely is that family background plays a strong role in determining the children's outcome, and then lower intergenerational mobility (e.g., see Durlauf 1996 and Andrews and Leigh 2009). The OECD 2011 states that rising inequality "can stifle upward social mobility, making it harder for talented and hard-working people to get to rewards they deserve. Intergenerational earnings mobility is low in countries with high inequality such as the United Kingdom, Italy, and the United States, and much higher in the Nordic countries, where income is distributed more evenly."

Andrews and Leigh 2009 and Corak 2013 show that countries with greater inequality tend to be countries with low intergenerational mobility. Krueger 2012 represents this negative relationship with what he has referred to as "The Great Gatsby Curve"[16]. The empirical evidence discussed by Krueger 2012 and Corak 2013 shows Italy as a country with high inequality and low mobility.

In our model to investigated this relationship we compare the variance of the life-time utility and the Gini index (used as measures of income inequality) and the Shorrocks index (the measure of mobility) for each cohort[17].
The variance of the life-time utility is derived from the model as follow:

$$\sigma^2_{logU_i} = \pi_{WLM}\sigma^2_{WLM} + \pi_{UMC}\sigma^2_{UMC} + \pi_{WLM}\pi_{UMC}\left[\left(\frac{1+\lambda}{2}\right)\mu_{UMC} - \mu_{WLM}\right]^2, \tag{35}$$

where π_{WLM} and π_{UMC} are the long-run distribution of observations in WLM class and UMC class respectively[18].

Contrary to the expectations, the model suggests a positive relationship between income inequality and mobility, and this result is confirmed by the empir-

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[16]Krueger used this label for the first time during the speech "The Rise and Consequences od Inequality" to the Centre for American Progress on January 12, 2012.

[17]We compute also the Gini index since it is robust to the outlier value and to the metrics.

[18]For the Shorrocks index see Section II.A.

ical evidence. In fact, Table 3 shows that from Cohort II to Cohort III mobility decreases (0.78 vs 0.72) as income inequality (0.74 vs 0.67)[19].

Table 3: **The Shorrocks and Gini index, and the Variance of life-time utility in each Cohort.**

Cohort	I	II	III
I_S	0.78	0.78	0.72
$\sigma^2_{logU_i}$	0.74	0.74	0.67
I_{Gini}	0.33	0.31	0.29

The fact that mobility has not increased during a period in which inequality of incomes has decreased may seem debatable, but it can not be. "Imagine that all incomes are close to being equal, then mobility would be close to zero because there would be so little to gain from getting a better job or working harder. And by the same token social mobility might be very great in a society yet income inequality also be very great" [20]

IV.   Concluding Remarks

In this paper we propose a simple theoretical model to identify the main determinants of occupational mobility. We also provide an application to Italy using data from the Survey on Household Income and Wealth (SHIW) for the period $1979 - 2008$.

The theoretical model identifies three main determinants: the **income incentives**, a set of characteristics of each occupational class which induces the individual will to move to a particular class, the **opportunities** related to his or her native abilities, education, family background and to the socio-economic environment, and the **changes** in the **occupational structure**, exogenous factors related to the supply side of the labour market. The latter represents a constraint to the individual choice to change own occupational class.

The application to our sample describes Italy as a less mobile society in particular occupational mobility decreases for individuals born between $1967 - 1976$. The estimate of the model's parameters suggests that the decrease of mobility is mainly due to the decrease of opportunities for children with a father in the Working and Lower Middle class.

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[19]Gini index and variance are computed using the total income of each head of household. In particular for each wave (1998-2012) we compute the two measures of inequality, and then we calculate the geometric mean.

[20]http://www.becker-posner-blog.com/2014/02/social-mobility-and-income-inequalityposne html

Future research should be take into account the possibility to assume that θ_i, the parameter measuring the opportunities, is not known by individual i. Individual has only beliefs on θ_i depending on the socio-economic status of the past generations and also on the genetic transmission of abilities.

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A The Numerical Example for the Decomposition of Observed Occupational Mobility.

To identify $\mathbf{R}$ (and therefore $\mathbf{Q}$) we can make different assumption on the allocation of children on each occupational class. We follow the criterion of *minimum occupational mobility* as in Prais 1955, but we measured it in terms of the trace of the $\mathbf{R}$ matrix. Consider for example the following Markov and transition matrices:

$$
\mathbf{M} = \left[\begin{array}{ccc|c}
15 & 33 & 35 & 83 \\
33 & 55 & 17 & 105 \\
58 & 0 & 54 & 112 \\
\hline
106 & 88 & 106 & 300
\end{array}\right]
\qquad
\mathbf{P} = \left[\begin{array}{ccc|c}
0.18 & 0.40 & 0.42 & 83 \\
0.32 & 0.52 & 0.16 & 105 \\
0.52 & 0 & 0.48 & 112 \\
\hline
106 & 88 & 106 & 300
\end{array}\right]
$$

The actual distribution of fathers (s_t) is written in the extreme right-hand column and the distribution of children (s_{t+1}) is written down in the bottom row. Tables below show the two approaches (Prais and ours respectively) to obtain the matrix representing the changes of the occupational structure:

$$
\mathbf{C^{PRAIS}} = \left[\begin{array}{ccc|c}
83 & 0 & 0 & 83 \\
23 & 82 & 0 & 105 \\
0 & 6 & 106 & 112 \\
\hline
106 & 88 & 106 & 300
\end{array}\right]
\qquad
\mathbf{C^{OURS}} = \left[\begin{array}{ccc|c}
83 & 0 & 0 & 83 \\
11 & 88 & 6 & 105 \\
12 & 0 & 100 & 112 \\
\hline
106 & 88 & 106 & 300
\end{array}\right]
$$

The matrix $\mathbf{R}$ is than derived by dividing each row by the sum of the element in it, i.e.:

$$
\mathbf{R^{PRAIS}} = \left[\begin{array}{ccc}
1 & 0 & 0 \\
0.22 & 0.78 & 0 \\
0 & 0.05 & 0.95
\end{array}\right]
\qquad
\mathbf{R^{OURS}} = \left[\begin{array}{ccc}
1 & 0 & 0 \\
0.10 & 0.84 & 0.06 \\
0.11 & 0 & 0.89
\end{array}\right]
$$

We interpret $\mathbf{R}$ as the matrix of the constraints to individual occupational choice deriving from the occupational structure. Prais 1955 assumes that, if a child can not remain in the same class of her father, she moves downward in a lower occupational class with respect to that of her father. Unlike Prais, we assume that, if the occupational structure limits individual choices, then individual can move both downward and upward but minimizing the overall mobility.