METHODOLOGICAL NOTE for the *equalchances.org* database

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Inequality of opportunity and social mobility: a comparative study

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1. Introduction

The notion of "equality of opportunities" has been of long-standing relevance in public debates and is increasingly proposed as a principle of social justice by politicians of different orientations. Typically, the meaning of equality of opportunity remains vague in the public discourse, and this may partly explain its popularity.

An economic literature addressing (in)equality of opportunity has grown from early work by Roemer (1993, 1998) and Fleurbaey (1994, 2008). The conceptual basis is provided by the distinction between individual efforts and pre-determined circumstances. Several approaches to operationalize this distinction have been proposed and applied to different data (see Roemer and Trannoy 2016, for a review).

A related but distinct literature in economics focuses on the intergenerational transmission of economic status (see Black and Devereux 2011, for a review). Empirical analyses on the relationship between the economic status of parents and children have typically used single-number expressions for levels of intergenerational persistence. This is in the form of the statistical association between the economic outcome (e.g. income or earnings) of an individual with that of his/her family of origin. One of the patterns emerging from this literature is that countries with greater cross-sectional income inequality also tend to be less economically mobile (Corak, 2013).

In sociology, there is a tradition of research on social mobility, both in terms of intergenerational transmission of occupational status (Blau and Duncan 1967) and social class (Erikson and Goldthorpe 1992). While there has been much discussion and several developments on the empirical measurement of social mobility (Breen and Jonsson 2005), there has not been an in-depth reflection on how to conceptualize and measure inequality of opportunity. Indeed, most sociological studies treat mobility and opportunity as largely overlapping concepts, with the degree of mobility being understood as a measure of overall 'fairness' or 'openness' of societies (Swift, 2004).

Our work is informed by (and contributes to) these three distinct literatures. We have obtained access and harmonized datasets from a variety of sources (see Appendix B). On the basis of these data, we estimate indexes of inequality of opportunity and intergenerational socio-economic persistence in a large number of countries and for different years. The empirical evidence is organized in the publicly accessible database: "*equalchances.org*". This online portal is designed to make the material readable by a large audience (such as scholars, students, policy makers, and journalists). The informative section also includes a range of data visualization tools and highlights patterns of association amongst variables of interest. The beta version of *equalchances.org* includes six key indicators (see Section 2 for definitions and estimation methodology):

- $\boldsymbol{IOP_A}$: Absolute inequality of opportunity

- $\boldsymbol{IOP_R}$: Relative inequality of opportunity

- **IGE**: Intergenerational earnings elasticity

- **ITS**: Intergenerational transmission of socioeconomic status

- $\mathbf{EDU}_{\boldsymbol{A}}$: Absolute mobility in education

- $\mathbf{EDU}_{\boldsymbol{R}}$: Relative mobility in education

The coverage of the database by index and year is shown in Appendix A (Tables A1-A4). Due to different data requirements, the coverage is not uniform across indexes.[1]

[1] Version 1.0 of the database, which will include additional countries and covariates, will be released in December 2018.

2. Methodology

This section explains our estimation methods and how they relate to prior studies in the relevant literatures. We begin by describing the first index (IOp) provided in the database, which builds on the literature addressing the measurement of inequality of opportunity. We then describe the methods used to quantify the rate of transmission across generations in income and socio-economic status.

2.1 Inequality of opportunity

The conceptual basis for the definition of IOp is provided by the distinction between individual *efforts* and pre-determined *circumstances*. Roemer (1993) introduced a theoretical model that has become the standard reference for the measurement of inequality of opportunity (Ferreira and Peragine, 2016; Ramos and Van De Gaer, 2016; Roemer and Trannoy, 2016). An individual outcome *(y)* is the result of the interaction of two sets of variables, circumstances beyond individual control *(c)* and choice efforts *(e)*:

$$y_i = f(c_i, e_i) \qquad (1)$$

where $y_i \in Y$ is a single-dimension outcome attained by the individual i (e.g. income, consumption, health), c_i is a set of variables beyond individual control that affect y_i (e.g. socioeconomic background, race, gender) and e_i is a (scalar) variable, called 'effort', summarising all individual choice variables. According to Roemer, there is equality of opportunity if individuals exerting the same degree of effort achieve the same outcome.[2]

Typically, measures of inequality of opportunity derived from Roemer's framework are estimated following a two-step procedure. First, the original outcome distribution, Y, is transformed into a counterfactual distribution, $\tilde{Y}$, which reproduces all inequalities due to circumstances and does not reflect any inequality due to effort. Then, a suitable inequality index, I, is applied to $\tilde{Y}$. This procedure involves taking a stance on three key methodological choices: (i) how to account for effort when obtaining $\tilde{Y}$; (ii) the econometric method to use to estimate $\tilde{Y}$; and (iii) the choice of the inequality index to measure dispersion in $\tilde{Y}$.

[2] Circumstances beyond individual control may affect the *level* of effort exerted. The *degree* of effort is a measure of the effort exerted adjusted for the effect of circumstances on effort. Roemer defines equality of opportunity with reference to the degree of effort exerted.

On the first decision, there are two prevailing views. In the *ex post* approach, $\tilde{Y}$ should reflect inequality between individuals who have exerted the same degree of effort. This can be done by identifying effort *tranches*, groups of individuals who have exerted the same effort independently from their circumstances. Then, any outcome variability observed between individuals exerting the same effort is considered inequality of opportunity (see Checchi and Peragine, 2010).

The *ex ante* approach focuses instead on *types*, which are sets of individuals characterized by the same combination of circumstances. The type-specific outcome distribution is interpreted as the opportunity set of individuals belonging to each type. Then, inequality of opportunity is the inequality between such opportunity sets. Since scholars typically use the type's mean outcome to summarise the opportunity set, inequality of opportunity amount to between-type inequality.

Both approaches are consistent with Roemer's theory, but they are not equivalent (Fleurbaey and Peragine, 2013). In practice, however, the *ex ante* approach has become the standard method, largely because it is simpler to implement empirically (Brunori et al., 2013; Barros et al., 2009; Wendelspiess and Soloaga, 2014). Since comparability is one of the objectives of the EqualChances project, the database contains only *ex ante* estimates of inequality of opportunity.

The second choice concerns the econometric strategy used to estimate $\tilde{Y}$. To implement an ex ante measure of inequality of opportunity, one aims to quantify the degree of association between an outcome and a set of observable circumstances. This can be done non-parametrically (Checchi and Peragine, 2010) or parametrically (Bourguignon et al., 2007; Ferreira and Gignoux, 2011). The non-parametric approach partitions the population into groups with identical observable circumstances. Then $\tilde{Y}$ is obtained by replacing the individual outcome with the average outcome of the type to which the individual belongs. The main drawback of this approach is that it is very demanding in terms of degrees of freedom. Even with a low number of categorical circumstances, interactions grow exponentially with the number of categories, which can lead to biased inequality of opportunity estimates (Brunori et al., 2016).

To minimize such risk, we opt for the parametric approach, which estimates a reduced-form linear regression:

$$y_i = a + \beta_1 c_{1,i} + \beta_2 c_{2,i} + \ldots + u_i \quad (2)$$

where u_i represents the residual after controlling for the direct and indirect (through effort) effects of circumstances on the outcome. Ex ante inequality of opportunity is then quantified as the inequality in the predicted values from Eq. (2), that is $\tilde{Y} = \hat{Y}$.

The third choice concerns the inequality index that maps $\tilde{Y}$ into a scalar number. The literature has generally favoured the use of the mean logarithmic deviation (MLD), which is a member of the entropy family of inequality measures, well known for its decomposability properties: $MLD(Y) = \frac{1}{n}\sum_{i=1}^{n}\left(log\left(\frac{\mu}{y_i}\right)\right)$; where n is the size of the population and μ the mean of Y. A relative index of inequality of opportunity is then obtained in the form of the ratio: $IOpRel_{MLD} = \frac{MLD(\tilde{Y})}{MLD(Y)}$, where the numerator measures inequality in a counterfactual population where there is no within-type variation, while the denominator denotes overall inequality in the outcome of interest.

However, the MLD is rather insensitive to low levels of inequality, which translates into conservative estimates of relative inequality of opportunity. This is why we opt for a different inequality measure, the Gini coefficient. While the Gini coefficient is less conservative, it has the main drawback of imperfect additive decomposability:

$$Gini(Y) = Gini(\mu_1, \ldots, \mu_m) + \sum_{j=1}^{m} w_j\, Gini(y_i)_{i\in j} + K \quad (3)$$

where the first term in the right-hand side is $Gini(\tilde{Y})$, the second is within-type inequality, and K is the overlapping term. K cannot be ascribed to between-type inequality, but it also cannot be considered part of the within-type inequality. It may be considered a mix of the two (Lambert and Aronson, 1993). The relative index of inequality of opportunity thus becomes

$$IOpRel = \frac{Gini(\mu_1,\ldots,\mu_m)}{Gini(\mu_1,\ldots,\mu_m)+\sum_{j=1}^{m} w_j Gini(y_i)_{i\in j}+K} \quad (4)$$

where the residual appears in the denominator but not in the numerator.

$IOpRel$ is the ratio between IOp and total inequality. When there is no common support for type-specific distributions, K equals zero and $IOpRel$ has the same interpretation as $IOpRel_{MLD}$. When there is some overlap between the type-specific distributions, $IOpRel$ is

lower than the share of total inequality due to between-type inequality. Nevertheless, *IOpRel* is on average more than twice $IOpRel_{MLD}$.

2.1.1 Empirical implementation

We measure inequality of opportunity with a unidimensional measure of well-being, following Roemer (1998). We focus on inequality of opportunity in household equivalent income—i.e. household income divided by the square root of household size. When income is unobserved or unreliably measured, per-capita consumption is preferred.

Choice of circumstances

Which circumstances should be included among the regressors in Eq. (2)? The empirical literature has generally attempted to use all observable factors beyond individual control that can have an impact on the individual outcome. Therefore, variables describing socioeconomic background, gender, and place of birth are often included in the vector *c*. With sub-optimal data, the choice of circumstances is crucial. First, estimates of *IOp* and *IOpRel* are sensitive to the number of regressors used. Second, the role of circumstances in determining individual outcome may differ across countries.

In this project, we consider comparable estimates of inequality of opportunity based on three key circumstances: *parental education*, *parental occupation* and *origin*.[3] With *origin*, we refer to race, ethnic origin, parental culture, parental religion, or area of birth. We do not estimate inequality of opportunity on surveys where one or more of these dimensions are not observable. Our estimates can therefore be seen as comparable in the sense that they measure the inequality of opportunity associated with three precise dimensions of unfair inequality. [4]

Econometric specification

Model (2) does not consider possible interactions between circumstances. Moreover, different surveys may contain more than one variable in each of the three circumstance domains, and each variable can be considered with varying levels of detail. To avoid *ad hoc* solutions, we adopt a statistical criterion to select the most appropriate model specification in each country.

Our algorithm selects the 'best model' following six steps:

[3] Gender is excluded because the outcome is defined at the household level.
[4] We do not use additional observable dimensions in richer surveys. Therefore, we are under-using higher-quality data in certain countries for the sake of comparability with less detailed datasets

i. for each of the three domains, all potential regressors are considered;[5]

ii. all possible linear models that include three regressors, one for each circumstance, are specified;

iii. the out-of-sample mean square error (*MSE*) of each model is estimated by *10*-fold cross-validation;[6]

iv. the model that results in the lowest *MSE** is selected;

v. all interactions of the three regressors in the model selected in (*iv)* are specified and the *MSE* for each possible interacted model is estimated;

vi. the "best model" is the model with the lowest *MSE* among the models estimated in *(v)* if its *MSE* is lower than *MSE*;* otherwise the "best model" is the model selected in *(iv)*.

The estimations above are carried out on nationally representative surveys only. Individual sampling weights are used in all regressions and to estimate *IOp* and *IOpRel*. The sample of interest is working age individuals with observable circumstances.[7] Standard errors and confidence intervals are obtained by calculating normalised standard errors based on 500 replications of each index. This procedure accounts for the fact that the inequality index is estimated on a distribution of predicted values. Outcomes are winsorized at 99%.

2.2 Intergenerational earnings mobility

A large literature in labour economics investigates the relationship between parent and child income/earnings (see surveys by Solon 1999, Bjorklund and Jantti 2009, Black and Devereux 2011). The basic approach used in the literature to obtain estimates of intergenerational earnings mobility is to estimate the following regression:

$$y_i^c = \alpha + \beta y_i^p + \epsilon_i \qquad (5)$$

[5] For example, consider a survey containing information about father's years of schooling. Possible regressors to describe this circumstance could be: (i) father's years of schooling (ii) logarithm of father's years of schooling; (iii) father's educational attainment (four discrete categories): no schooling, primary, secondary, tertiary; (iv) dummy for father's education: at least secondary; (v) dummy for father's education: at least tertiary; and so on.

[6] See Brunori et al. (2016) for a discussion of the use of cross-validation to select the most appropriate model specification when estimating inequality of opportunity.

[7] The definition of 'working age' may vary slightly across countries. Household weights are used if they are the sole weights available. Missing weights are imputed with average weight.

where y_i^c where is the logarithm of permanent individual earnings of children and y_i^p is the logarithm of permanent individual earnings of the parents. The coefficient estimate for β, named the 'intergenerational earnings elasticity' (IGE), can be interpreted as the percentage variation in children's earnings associated to a 1 percent variation in the earnings of their parents. The lower the estimated IGE, the higher the degree of intergenerational mobility in a given country.

If one were to limit the estimation of Eq. (5) to countries where lifetime measures of earnings are available, the empirical literature on intergenerational mobility would include estimates for a handful of nations (e.g. Canada, Norway, Sweden and a few others). The IGE can be estimated in a larger number of countries when single-year observations of earnings are used for both parents and children. This, however, introduces a well-documented bias due to the temporary fluctuations in yearly earnings. Moreover, the direction and size of the bias will depend on the age at which individual earnings are recorded in the data (for both parent and child).[8] In order to reduce (but not eliminate) this type of bias, a number of studies use multi-year averages of earnings to proxy for lifetime income (Solon, 1992). However, this approach requires a reasonably long intergenerational panel, which is still only applicable to a relatively small number of countries. In fact, even when long-panel income data is available for a generation of individuals, it is often not possible to create a *direct* intergenerational link with the income of the preceding generation.[9]

For these reasons, an increasing number of studies in both advanced and emerging economies have obtained estimates of intergenerational mobility by exploiting a different type of intergenerational link. These studies use survey data with retrospective information on parental socio-economic status to estimate the IGE through a Two-Sample Two-Stage Least Squares (TSTSLS) methodology. The TSTSLS approach was introduced in the empirical literature on intergenerational mobility by Björklund and Jäntti (1997) for a comparative study of mobility in the U.S.A. and Sweden. Since then, the approach has been replicated in a variety of contexts to estimate the IGE when direct information on parental earnings is not available. This development in the literature has allowed the estimation of the IGEs for a number of additional countries, with a particularly significant impact on the coverage of the developing world (e.g. Ferreira and Veloso, 2006; Nunez and Miranda. 2010; Piraino, 2015).

[8] See Nybom and Sthuler (2016), and Chen et al. (2017) for an illustration of the different type of biases introduced by short-term proxies of permanent earnings.

[9] While it is in principle possible to use samples of co-residing parents and children, this practice is largely absent from the literature due to potential selection effects.

Two-Sample Two-Stage Estimation

Since our interest is in obtaining estimates of intergenerational earnings mobility for the largest possible number of countries, this paper adopts the TSTSLS approach. This estimator requires two independent samples representative of the same population to overcome missing information about parental income. Specifically, the 'main sample' contains information on offspring earnings, as well as recall socio-economic information on parents, which are assumed to be time-invariant (e.g. highest educational attainment, main occupation). The second, or auxiliary, sample is instead used to derive a prediction of earnings for the so-called "pseudo-parents". These individuals are typically observed in an earlier survey of the same population, which includes reports of both income and the same set of time-invariant socio-economic characteristics recalled by children in the main sample.

On the basis of this information, the IGE can be obtained in two stages: first, we use the auxiliary sample to estimate

$$y_i^{ps} = \gamma z_i^{ps} + \vartheta_i + \eta_i \qquad (6)$$

where y_i^{ps} are the yearly earnings of pseudo-parents, z_i^{ps} is the vector of time-invariant socio-economic characteristics used to predict income, ϑ_i is the permanent component of pseudo-parents' earnings that is not captured by the observed predictors, and η_i are the transitory components and shocks affecting yearly earnings. In the second stage, we estimate the following equation on the sample of children:

$$y_i^c = a + \beta \hat{y}_i^p + \omega_i \qquad (7)$$

where y_i^c are the yearly earnings of children and $\hat{y}_i^p = \hat{\gamma} z_i^p$ are the imputed permanent earnings of parents.[10]

While the TSTSLS estimator allows to significantly expand the number of countries included in the analysis, it has the main limitation that the predictors of parental earnings can affect child earnings independently of the first-stage model. In particular, parental education and occupation are likely to have a positive impact on the child's earnings beyond the indirect effect through parental income. The implication is that the TSTSLS estimate of the IGE may

[10] The imputation multiplies the estimated coefficients from the first-stage sample to the values of parental characteristics reported by children in the main sample.

suffer from an upward bias, which led scholars in the literature to treat these estimates as upper bounds of the 'true' intergenerational elasticity.

In order to the gauge the extent to which our TSTSLS estimates may suffer from upward bias, we use the longitudinal information in the Panel Study of Income Dynamics (PSID) for the United States. We estimate the IGE for the U.S.A. using both a simple OLS (obtained by averaging real fathers' earnings over five years) and the two-sample procedure. We find that the intergenerational elasticity estimate is 0.491 when using OLS as compared to 0.535 for the TSTSLS. While this is consistent with an upward bias in the TSTSLS procedure, it is also possible that the OLS estimate may suffer from a downward bias due to measurement error in observed earnings (Solon, 1992). These two measures may thus be seen as lower and upper bounds, respectively, of the underlying intergenerational elasticity.[11] On the basis of this simple exercise, we suggest that the methodology used to estimate the IGEs in our database can provide a reasonably accurate reflection of the true levels of intergenerational persistence across countries.

Empirical implementation

International comparisons of intergenerational mobility are often made om the basis of IGEs estimated using different methodologies, different income definitions and selection rules. Largely, this reflects different types of data available for the empirical analyses. Our database tries to maximize the degree of comparability by exploiting the same retrospective parental socio-economic information and the same outcome variable for both generations in all countries considered. In particular, we predict parental earnings using three categories of parental education (lower than secondary; secondary, tertiary) and nine occupational categories on the basis of the ISCO-08 classification (managers, professionals, technicians and associate professionals, clerical support workers, service and sales workers, skilled, agricultural, forestry and fishery workers, craft and related workers, plant and machine operators and assemblers, elementary occupations). The outcome variable is personal employee income, computed as the sum of all wages and salaries.[12]

Following a number of previous studies in the earnings mobility literature, the empirical analysis is currently restricted to males only. While this is a non-trivial sample selection,

[11] Our results are consistent with the results in Bjorklund and Jantti (1997) who perform the same type of comparison and reach a similar conclusion.
[12] Note that we will use the term income or earnings interchangeably when referring to our outcome variable.

gender differences in labour force participation across countries would affect the interpretation of our international comparisons, especially in the developing world. In addition, in order to minimize the potential for life-cycle bias, we consider males aged around 40 years old on average (see Haider and Solon 2006, Böhlmark and Lindquist, 2006; and Nybom and Stuhler, 2016). In particular, we include in the main sample all native male individuals aged 30 to 54, with a positive personal employee income. The auxiliary samples of pseudo-fathers include all male heads of household aged 30 to 54, with positive employee incomes. These samples are taken from various surveys representative of the same national populations which took place between 14 and 19 years before the survey used for the main samples.[13]

2.3 Intergenerational mobility in education

This section of the database includes measures of educational mobility as estimated in the World Bank (2018) "Fair Progress" report. We use two different measures of educational mobility from the report. The first is an "absolute" index, which captures the share of people in a given cohort that have attained more education than their parents. The second is a relative index, which is given by a regression coefficient from an estimation analogous to that used in Eq. (4) for earnings.

2.4. Intergenerational transmission of Socio-Economic Status

In sociology, Socio-Economic Status (SES) refers to the position of individuals, families, households, or other aggregates in the social structure of societies (Blau and Duncan 1967). The term is commonly used to identify groups of people who share a similar position with relation to access to a set of economic, social and cultural resources that provide heterogeneous life chances and affects their living conditions (Bradley and Corwin 2002; Sirin 2005; Winkleby et al. 1992). Higher access to socio-economic and cultural resources is usually associated to higher living conditions and better opportunities in different arenas of the social life.

[13] This implies that the 'real' fathers of respondents in our main sample are generally older than the pseudo-fathers we use in the auxiliary sample.

In our database, the intergenerational transmission of status (ITS) refers to the association between the social status of parents and children (Breen and Jonsson 2005). This can be seen as complementary to intergenerational social mobility, which instead refers to the chances of moving away from the social position of origin (i.e. upward or downward mobility). The higher the ITS, the lower the degree of 'openness' and 'fluidity' of society (Breen 2004).

Our objective is to compute the degree of ITS for the largest possible number of countries. This implies three main methodological steps: (i) choose observed variables that can measure the position of individuals in the social stratification system and recode them into appropriate levels; (ii) summarize the information conveyed in such variables in one single index; and (iii) quantify the intergenerational transmission of status. We next describe each step in detail.

Choice of variables representing SES

In the sociological literature, there are two main approaches to measuring SES. The first uses information on the occupation held by individuals at some point in their working life. Within this approach, one can identify the position of individuals in the occupational structure with a qualitative categorical classification of individuals, such as social classes (Goldthorpe and Erikson 1992; Breen 2004; Weeden and Grusky 2005) or by means of quantitative indicators of occupational status or prestige (Ganzeboom et al. 1992; Treiman 2013).

The second perspective conceives SES as a multidimensional construct, which cannot be measured directly, but can be operationalized through a set of observed variables, such as education, occupation, income and/or wealth (Galobardes et al. 2007; Hoff et al. 2002; McLaughlin et al. 2011; Dmitrieva 2013). Typically, SES has been measured by including in the analysis one or more of these variables separately. However, this does not consider the correlations among these indicators, which may indicate that they are expression of the same latent construct (Moreno-Maldonado et al. 2017).

Our approach is to consider SES as a multidimensional (unobservable) construct, and to use jointly observed educational attainment and occupation as visible expressions of this construct. This approach has three main advantages. First, education and occupation are widely recognized as indicators of SES and as key factors in determining life chances (e.g. Ganzeboom et al. 1992; Green 1970; Nam and Powers 1965; Winkler and Stolzenberg 1999, Hollingshead 1975). Second, from a practical point of view, they can be operationalized as

ordinal variables, which facilitates the creation of a quantitative index of SES. Third, information on these aspects is available for a large number of countries and datasets, as well as for both children and their parents.

We did not use individual income or family wealth as additional variables, as they are much less frequently available for both parents and children in many datasets. In addition, occupation is less volatile than one-shot measures of income (Goldthorpe 2013) and it can be recalled relatively well by survey respondents through retrospective questions.

Creating an SES index

Following recent literature (Shavers 2007; Moreno-Maldonado et al. 2017), we build an SES index by combining information on individuals' educational attainment and occupational level. This approach takes into consideration various proxies of status and can be applied cross-nationally, also in developing countries, since it does not require a strict ex-ante harmonization of the education and occupational indicators (although desirable, when possible to achieve). Moreover, using more than one variable may be helpful to compensate for potential measurement error in each variable.

The SES index is obtained using Principal Component Analysis (PCA). PCA is a common tool for aggregating multiple indicators into a single index. It finds the direction(s) of the greatest variance of the linear combinations of a set of variables (Jolliffe, 1986). Suppose, that we believe that a set of variables (education and occupation in our case) are elements or indicators of a higher-order latent concept (SES in our case). We aim to obtain an overall measure of the latent concept by combining the common variances of the two indicators. When the variables in the model have much in common (i.e. they share a high common variance) the principal component extracted by PCA has the greatest power in explaining most of the covariance among these variables (Rencher 2002). In other words, PCA works on the covariance or correlation matrix to extract the direction in the multivariate space that is the "most informative" (see Kolenikov and Angeles 2004, for a formal derivation). In this sense, the first component can be interpreted as a measure of size, or a degree of expression of a SES.

PCA works best on variables that are continuous and (at least) approximately normal. A practically important violation of the normality assumption underlying PCA occurs when the variables are discrete, as it is often the case with education or occupation (Rencher, 2002).

Kolenikov and Angeles (2004; 2009) provide an overview of PCA and examine the performance of different procedures for using PCA with discrete data. They argue that an SES index on discrete data can be obtained by computing the polychoric correlations between two (or pairs of) ordinal variables.

We apply polychoric PCA on observed variables measuring the occupational and educational levels on samples of individuals aged 30-54. The underlying assumption is that at this stage of life most of the individuals have already established their long-term occupation. In order to for the SES index to be more comparable across countries, educational and occupational variables from different datasets have been re-coded in the same categories. Table 1 reports the categorization for education of the child and father, while Table 2 reports the operationalization of occupation. Values have been assigned to the two ordinal variables from the lowest to the highest category.[14]

Table 1. Highest level of education achieved by the individuals and their fathers

Education	Value
Lower than primary education	1
Primary education	2
Secondary education	3
Tertiary education	4

Table 2. Occupational classes for individuals and their fathers.

Occupation	Value
High level non-manual (e.g. managers and professionals)	5
Medium level non-manual (e.g. technician and associate professionals)	4
Low level non-manual (e.g. service and sales workers)	3
Skilled manual workers (e.g. skilled agricultural, craft, trade workers)	2
Unskilled manual workers (e.g., plant and machine operators, elementary occupations)	1
Unemployed	0

Interpreting results from polychoric PCA

A typical measure of fit by the principal components is the *proportion of explained variance*. If we expect that the variables are indicators of a common latent concept, we would want to see high proportions of variance being explained by the first principal component. It means that the variables used as an input have a lot in common. The eigenvalue of each component

[14] In some cases, the criteria had to be slightly adjusted. For example, in the National Income Dynamic Survey of South Africa, and in the Australian HILDA, only three educational categories can be derived (i.e. primary or less than primary, secondary and tertiary) from the original educational variable. We perform robustness checks, and find that working with 3 or 4 categories for education does not affect our final estimation of the intergenerational transmission of SES.

is proportional to the proportion of the variance that is correlated with its eigenvector. Therefore, the higher the proportion of explained variance, the higher the corresponding eigenvalue. By using the Kaiser criterion, we retain a component if the corresponding eigenvalue is higher than 1 (Yeomans and Golder, 1982). If we expect a unique latent component from the PCA, we should see only the first component showing an eigenvalue higher than 1.

We perform the polychoric PCA for each country and for each year of available data by including in the model education and occupation of the individuals and their fathers. Observations are weighted using post-stratification weights. For explanatory purpose, some results from European Social Survey have been reported in Table 3. The estimates shown in Table 3 suggest to retain only the first component (eigenvalue= 1.611) which explains about 81% of the total variance. Therefore, we retain the first component, which can be interpreted as a SES index. We do this in each year for all countries in the database.

Table 3. Results of the polychoric PCA on the individual's occupation and education, (Country: Austria. Survey: ESS 2006)

Component	Eigenvalues	Proportion of explained variance
1	1.611	0.806
2	0.388	0.194
Goodness of fit tests:		
Pearson = 1549.953, Prob. (>chi2(8)) = 0		
LR = 1788.128, Prob. (>chi2(8)) = 0		

Measuring of intergenerational transmission of SES

The last step consists of finding a suitable measure to quantify the degree of ITS. Social stratification researchers pay particular attention to the distinction between absolute and relative mobility rates. Absolute rates refer to the proportions of individuals of given class origins who move to different class destinations, while relative rates compare the chances of individuals of differing class origins arriving at different destinations (Erikson and Goldthorpe 1992). Absolute mobility measures overall movements between classes that could be affected by changes in the occupational structure, while relative mobility is used to measure the extent of social fluidity, net of structural transformations (Breen 2004).

We adopt a relative measure of association between the SES of origin and the SES attained: the Spearman correlation coefficient. This is a nonparametric measure of rank correlation that quantifies the degree of statistical dependence between the ranks of two variables. The

Spearman coefficient is equal to the Pearson correlation between the rank values of two variables. The coefficient can be estimated on both continuous and discrete ordinal variables.

We interpret the Spearman correlation between father's SES and child's SES as a measure of relative ITS, net of changes between origins-destinations that are due to modifications in the social structure across generations. The higher the correlation between child's SES and father's SES, the lower social mobility in that country-year. To evaluate the uncertainty around the Spearman rank correlation and provide confidence interval at 95%, we used bootstrapping with 500 replications (Efron and Tibshirani, 1986).

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Appendix A. Database coverage

Table A1: Inequality of opportunity coverage by year and country

country	1988	1993	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Australia													x	x	x	x	x	x	x	x	x	x	x
Austria												x						x					
Belgium												x						x					
Brazil	x			x																		x	
Bulgaria																		x					
Chile														x			x						
Croatia																		x					
Cyprus												x						x					
Czech Republic												x						x					
Denmark												x						x					
Ecuador																						x	
Estonia												x						x					
Finland												x						x					
France												x						x					
Germany												x						x					
Ghana																				x			
Greece												x						x					
Guatemala								x															
Guinea										x													
Hungary												x						x					
Iceland												x						x					
Ireland												x						x					
Italy		x	x			x		x		x		x		x		x		x		x			
Korea					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
Latvia												x						x					
Lithuania												x						x					
Luxembourg												x						x					
Malta																		x					
Mexico										x			x				x						
Netherlands												x						x					
Norway												x						x					
Panama					x						x					x							
Poland												x						x					
Portugal												x						x					
Romania																		x					
Rwanda							x																
Slovak Republic												x						x					
Slovenia												x						x					
South Africa																x			x	x		x	
Spain												x						x					
Sweden												x						x					
Switzerland																		x					
United Kingdom												x					x	x					
United States																		x					

Table A2: Intergenerational elasticity of earnings coverage by country and year

country	2006	2008	2009	2010	2012	2013	2014
Austria				X			
Belgium				X			
Brazil							X
Chile			X				
Czech Republic				X			
Denmark				X			
Ecuador	X						
Finland				X			
France				X			
Germany				X			
Ghana						X	
Greece				X			
Ireland				X			
Italy				X			
Luxembourg				X			
Mexico			X				
Netherlands				X			
Panama		X					
Portugal				X			
Slovak Republic				X			
Slovenia				X			
South Africa					X		
Spain				X			
Switzerland				X			
United Kingdom				X			
United States				X			

Table A3: Socio-economic status transmission coverage by year and country

country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Australia															X	X	X	X	X	X	X	X	X		
Austria												X		X	X	X					X			X	
Belgium												X		X	X	X		X		X	X	X		X	
Bulgaria																X		X		X	X	X			
Croatia																		X		X	X				
Cyprus															X	X		X		X	X	X			
Czech Republic												X		X	X			X			X	X		X	
Denmark												X		X	X	X		X		X	X	X		X	
Estonia														X	X	X		X		X	X	X		X	
Finland												X		X	X	X		X		X	X	X		X	
France															X	X		X		X	X	X		X	
Germany												X		X	X	X		X		X	X	X		X	
Greece												X		X	X			X		X	X				
Hungary												X			X	X		X		X	X	X			
Iceland														X	X						X	X			
Ireland												X		X	X	X		X		X	X	X		X	
Israel												X						X		X		X		X	
Italy			X		X			X		X		X		X	X	X		X		X	X	X			
Latvia															X						X				
Lithuania															X					X	X	X			
Luxembourg												X		X	X						X				
Malta																					X				
Netherlands												X		X	X	X		X		X	X	X		X	
Norway												X		X	X	X		X		X	X	X		X	
Poland												X		X	X	X		X		X	X	X		X	
Portugal												X		X	X	X		X		X	X	X		X	
Romania																					X				
Russia																		X		X		X			
Slovak Republic														X	X	X		X		X	X	X			
Slovenia												X		X	X	X		X		X	X	X		X	
South Africa																		X		X		X		X	
Spain												X		X	X	X		X		X	X	X		X	
Sweden															X	X		X		X	X	X		X	
Switzerland												X		X		X		X		X	X	X		X	
Turkey																		X							
Ukraine														X		X		X		X		X			
United Kingdom	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table A4: Educational mobility coverage by country and year

country	1991	1995	1999	2000	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Afghanistan													X					
Albania																		X
Angola										X								
Argentina																	X	
Armenia																		X
Australia																	X	
Austria																X		
Azerbaijan																		X
Bangladesh												X						
Belarus																		X
Belgium																X		
Benin													X					
Bhutan						X												
Bolivia										X								
Bosnia and Herzegovina																		X
Botswana											X							
Brazil																X		
Bulgaria														X				
Burkina Faso											X							
Cabo Verde									X									
Cambodia														X				
Cameroon									X									
Canada																X		
Central African Republic										X								
Chad													X					
Chile															X			
China														X				
Colombia															X			
Comoros																X		
Congo, Dem. Rep.														X				
Congo, Rep.													X					
Costa Rica																	X	
Croatia																		X
Cyprus														X				
Czech Republic																X		
CV¥te d'Ivoire										X								
Denmark																X		
Djibouti														X				
Dominican Republic																	X	
Ecuador															X			
Egypt, Arab Rep.														X				
El Salvador																	X	
Estonia																X		
Ethiopia															X			
Fiji										X								
Finland																X		
France																X		
Gabon							X											
Georgia																		X
Germany																X		
Ghana														X				
Greece																		X
Guatemala																X		
Guinea					X													
Guinea-Bissau												X						
Honduras																	X	
Hungary																X		
Iceland														X				
India													X					
Indonesia																X		
Iran, Islamic Rep.																X		
Iraq														X				
Ireland																X		
Israel																X		
Italy																		X
Japan														X				
Jordan												X						
Kazakhstan																		X
Kenya															X			
Kiribati								X										
Korea																X		
Kosovo																		X
Kyrgyz Republic																		X

Table A4 (continued): Educational mobility coverage by country and year

country	1991	1995	1999	2000	2002	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Lao PDR														X				
Latvia																		X
Lebanon													X					
Lesotho												X						
Liberia																X		
Lithuania																X		
Macedonia, FYR																		X
Madagascar														X				
Malawi															X			
Malaysia																	X	
Maldives											X							
Mali																X		
Mauritania		X																
Mauritius														X				
Mexico													X					
Moldova																		X
Mongolia																		X
Montenegro																		X
Morocco								X										
Mozambique										X								
Namibia											X							
Nepal													X					
Netherlands																X		
New Zealand			X															
Nicaragua																	X	
Niger																X		
Nigeria														X				
Norway																X		
Pakistan	X																	
Panama										X								
Papua New Guinea											X							
Paraguay																	X	
Peru																X		
Philippines			X															
Poland																X		
Portugal																X		
Romania																		X
Russia														X				
Rwanda				X														
Senegal								X										
Serbia																		X
Sierra Leone													X					
Slovak Republic														X				
Slovenia																X		
South Africa																X		
South Sudan											X							
Spain																X		
Sri Lanka														X				
Sudan											X							
Swaziland											X							
Sweden																X		
Switzerland																X		
SV£o TomV© and Principe												X						
Taiwan, China																	X	
Tajikistan																		X
Tanzania														X				
Thailand														X				
Timor-Leste									X									
Togo																	X	
Tonga											X							
Tunisia																X		
Turkey																		X
Tuvalu												X						
Uganda																X		
Ukraine														X				
United Kingdom																X		
United States																	X	
Uruguay																	X	
Uzbekistan																		X
Vanuatu												X						
Venezuela, RB																	X	
Vietnam														X				
West Bank and Gaza													X					
Yemen, Rep.																X		
Zambia												X						

Appendix B. List of surveys

• BHPS 1991-2008, British Household Panel Survey, detailed information: Institute for Social and Economic Research- University of Essex (url: https://www.iser.essex.ac.uk/bhps)

• CASEN 2006, Encuesta de Caracterizacin Socioeconmica Nacional, detailed information: Ministerio de Desarrollo Social (url: http://observatorio.ministeriodesarrollosocial.gob.cl/casen/casen_cuestionario.php)

• CASEN 2009, Encuesta de Caracterizacin Socioeconmica Nacional, detailed information: Ministerio de Desarrollo Social (url: http://observatorio.ministeriodesarrollosocial.gob.cl/casen/casen_cuestionario.php)

• CASEN, 2013, Encuesta de Caracterización Socioeconómica Nacional, detailed information: Ministerio de Desarrollo Social - Gobierno de Chile (URL: http://catalog.ihsn.org/index.php/catalog/6035)

• CFPS, 2012, China Family Panel Studies, detailed information: 2013 Institute of Social Science Survey – ISSS (URL: http://www.isss.pku.edu.cn/cfps/EN/)

• CGSS, 2014, Canada's General Social Survey, detailed information: Minister responsible for Statistics Canada. © Minister of Industry, 2013 (URL: https://www.statcan.gc.ca/pub/89f0115x/89f0115x2013001-eng.htm)

• CMSHBS, 2010, Continuous Multipurpose Household Survey (CMS) / module 2010/2011 Household Budget Survey (HBS), detailed information: Bureau of Statistics - Government of Lesotho (URL: http://catalog.ihsn.org/index.php/catalog/4917)

• CSES, 2012, Cambodia Socio-Economic Survey, detailed information: National Institute of Statistics - Ministry of Planning (URL: https://nada-nis.gov.kh/index.php/catalog/17)

• CWIS, 2009, Core Welfare Indicators Survey 2009-2010, Poverty Survey, detailed information: Central Statistics Office (CSO) - Ministry of Finance and Development Planning (URL: http://catalog.ihsn.org/index.php/catalog/2044)

• E123, 2012, ENQUETE 1 – 2 – 3, detailed information: Institut National de la Statistique – Ministère du plan et suivi de la mise en œuvre de la révolution de la modernité (URL: http://www.dial.ird.fr/enquetes-statistiques/enquetes-1-2-3)

• ECAM-III, 2007, Enquête Camerounaise Auprès des Ménages, detailed information: institut National de la Statistique (INS) - Ministère de l'Economie, de la Planification et de l'Aménagement du Territoire (URL: http://catalog.ihsn.org/index.php/catalog/2256)

• ECASEB, 2008, Enquête Centrafricaine pour le Suivi-Evaluation du Bien-être, detailed information: Institut Centrafricain des Statistiques et des Etudes Economiques et Sociales - République centrafricaine - Ministère du plan, de l'économie et de la coopération internationale (URL: http://catalog.ihsn.org/index.php/catalog/6033)

• ECHP 1995, European Community Household Panel, detailed information: Eurostat (url: http://ec.europa.eu/eurostat/web/microdata/european-community-household-panel)

• ECOM, 2011, Enquête Congolaise Auprès des Ménages pour le Suivi et l'Evaluation de la Pauvreté, detailed information: Centre National de la Statistique et des Études Économiques (CNSEE) - Ministère de l'Économie, du Plan, de l'Aménagement du Territoire et de l'Intégration (URL: http://catalog.ihsn.org/index.php/catalog/4889)

• ECOSIT-III, 2011, Enquête sur la Consommation des Ménages et le Secteur Informel au Tchad, detailed information: Institut National de la Statistique, des Etudes Economiques et Démographiques (INSEED) (URL: http://catalog.ihsn.org/index.php/catalog/4923)

• ECV, 2013, Encuesta Condiciones de Vida, detailed information: Instituto de Estadística y Censos - 2015 INEC (URL: http://www.ecuadorencifras.gob.ec//documentos/web-inec/ECV/ECV_2015/)

• ECV 2014, Encuesta de Condiciones de Vida, detailed information: INEC (url: http://www.ecuadorencifras.gob.ec//documentos/web-inec/ECV/ECV_2015/)

• ECVM, 2009, Enquête sur les Conditions de Vie des Ménages 2009-2010, detailed information: Institut National de la Statistique et de la Démographie (URL: http://catalog.ihsn.org/index.php/catalog/2117)

• EDAM, 2012, Enquêtes Djiboutiennes Auprès des Ménages, detailed information: Direction en charge des Statistiques, aujourd'hui la DISED (autrefois la DINAS) - Le Ministère de l'Économie, des Finances (URL: http://www.ministere-finances.dj/EDAM.html)

• EESIC, 2014, Enquête sur l'emploi, le secteur informel et la consommation des ménages aux Comores, detailed information: Direction Générale de la Statistique et de la prospective - Commissariat Général au Plan (URL: http://catalog.ihsn.org/index.php/catalog/6496)

• EGEP, 2005, Enquête Gabonaise pour l'Evaluation et le Suivi de la Pauvreté, detailed information: Direction Générale de la Statistique et des Etudes Economiques (DGSEE) - Ministère de la Planification, de la Programmation du Développement et de l'Aménagement du Territoire (URL: http://catalog.ihsn.org/index.php/catalog/41)

• EH 2008, Encuesta de Hogares, INE-Ministerio de Planificación para el Desarrollo (url: http://anda.ine.gob.bo/ANDA4_2/index.php/catalog/231)

• EIBEP 2003, Enquêté Integrée de Base pour l'Evaluation de la Pauvreté, detailed information: Direction Nationale de la Statistique - Ministere du Plan et de la Cooperation (url: http://catalog.ihsn.org/index.php/catalog/1432/related_materials)

• EICV 2000, Enquête Intégrale sur les Conditions de Vie des Ménages, detailed information: National Institute of Statistics of Rwanda - Government of Rwanda (url: http://microdata.statistics.gov.rw/index.php/catalog/27)

• EICV-III, 2010, Enquête Intégrale sur les Conditions de Vie des Ménages, detailed information: National Institute of Statistics of Rwanda - Government of Rwanda (URL: http://catalog.ihsn.org/index.php/catalog/3142)

• ELEP, 2012, Enquête Légère pour l'Evaluation de la Pauvreté, detailed information: Institut National de la Statistique - Gouvernement guinéen (URL: http://catalog.ihsn.org/index.php/catalog/5122)

• ELMPS, 2012, Egypt - Labor Market Panel Survey, detailed information: Economic Research Forum (URL: http://www.erfdataportal.com/index.php/catalog/45)

• EMICOV, 2011, Enquête Modulaire Intégrée sur les Conditions de Vie des ménages, detailed information: Institut National de la Statistique et de l'Analyse Économique (INSAE) (URL: http://catalog.ihsn.org/index.php/catalog/5123)

• EMOVI, 2011, Encuesta Movilidad Social en México, detailed information: El Centro de Estudios Espinosa Yglesias (URL: http://www.ceey.org.mx/encuesta/emovi-2011)

• ENAHO, 2014, Encuesta Nacional de Hogares sobre Condiciones de Vida y Pobreza, detailed information: Instituto Nacional de Estadística e Informática (INEI) - Presidencia del Consejo de Ministros (PCM) Dirección Nacional de Censos y Encuestas (DNCE) - INEI (URL: http://webinei.inei.gob.pe/anda_inei/index.php/catalog/249)

• ENCOVI 2000, Encuesta nacional de Condiciones de Vida, detailed information: INE (url: https://www.ine.gob.gt/index.php/encuestas-de-hogares-y-personas/condiciones-de-vida)

• ENCOVI, 2014, Encuesta Nacional de Condiciones de Vida, detailed information: El Instituto Nacional de Estadística – INE (URL: https://www.ine.gob.gt/index.php/encuestas-de-hogares-y-personas/condiciones-de-vida)

• ENCV, 2013, Encuesta Nacional de Calidad de Vida, detailed information: Dirección de Metodología y Producción Estadística – DIMPE (URL: http://catalog.ihsn.org/index.php/catalog/5301)

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