Intergenerational Transmission of Education. A Meta-Analysis of Sibling Correlations Published Between 1972–2018*

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Abstract

Intergenerational social mobility has long been studied by examining sibling similarities in educational attainment. We identified 61 studies with 157 published and unpublished estimates of sibling correlations in education of ca. 5,500,000 siblings from 16 countries and conducted a meta-analysis of these estimates. Across all studies, the average sibling correlation in education is 0.49 (95% CI: 0.46–0.51). More interestingly, we show that the sibling correlation in the US is among the highest studied; only in India and Spain sibling correlations are higher. Further, we show that sibling correlations are higher in economically less equal countries, lending support to the 'Great Gatsby Curve.' We also find that brother correlations, sister correlations, and correlations that do not distinguish by sex are on average of similar size.

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Introduction

One's own effort and merit rather than circumstances at birth should determine success in life—this idea of equality of opportunity is a powerful force in Western societies and a core research area of social science. Examining the correlation between parental social status and children's social status (e.g. Chetty *et al.*, 2017; Hout, 2018; Sorokin, 1927) to gauge the intergenerational transmission of advantage is one way of assessing equality of opportunity in a society. However, this method has been criticized for potentially underestimating the effects of family background on children's success. An alternative approach that captures the total family background effect on children's outcomes are sibling correlations in education. Education is a key outcome in studies of social mobility, as it is the most important linchpin in the transmission of resources from one generation to the next (Blau and Duncan, 1967) and a key predictor of children's life chances.

Sibling correlations are a measure of the variation in education that is explained by features that siblings have in common, such as genetic endowments, parental resources, as well as neighborhood and school factors and have long been used as an omnibus measure of family background effects. Their great advantage of parent–child correlations is that they capture both observed and unobserved forms of family background effects and can be interpreted as the lower bound of the family background effect (Björklund and Jäntti, 2012), as sibling-specific family factors are not captured by the sibling correlation.

Leveling the playing field to provide equality of opportunity for everyone is an important goal for policymakers, and comparing how institutional structures such as welfare states and educational systems facilitate or hinder the intergenerational transmission of advantage has been an important research area for social scientists. While some report a curious similarity of levels of social mobility across countries (Clark, 2014; Erikson and Goldthorpe, 1992; Featherman *et al.*, 1975; Lipset and Bendix, 1959), others suggest that countries with greater socio-economic inequalities have lower social mobility, most prominently Corak (2013) with his metaphor of a 'Great Gatsby curve.'

Comparative social mobility research usually relies on parent–child associations in income, occupational status, or education (e.g. Barone and Ruggera, 2018; Breen *et al.*, 2009; Bukodi *et al.*, 2018; Hertz *et al.*, 2007; Maas and van Leeuwen, 2016). Parent–child associations are however subject to omitted variable bias (Hout, 2015), a problem less important for sibling correlations. Conversely, mobility research using sibling correlations in education are usually single-country studies (e.g. Bredtmann and Smith, 2018; Grätz, 2018; Marks and Mooi-Reci, 2016). Only few studies have attempted to compare sibling correlations in education across countries (e.g. Dahan and Gaviria, 2001; Sieben, 2001).

In our study, we compare sibling correlations in education across countries to examine the institutional foundations of the intergenerational transmission of advantage. We conduct a meta-analysis of all sibling correlations in education published from 1972–2018, which we identified in a systematic literature search. We found more than 150 correlations from 16 countries. Meta-analysis is a set of methods that allows to synthesize data from a population of existing studies. Modeling the sibling correlations in a meta-analysis does not simply allow us to estimate a pooled sibling correlation, but also to contribute to existing research with new insights into comparative mobility research. Our meta-analysis will provide the most powerful country comparison of sibling correlations to date.

Data and methods

We conducted our analyses in three steps. First, we identified all existing sibling corelations in education in published and unpublished research. Second, we developed a coding scheme and classified studies to produce a database of their findings. Third, we performed a meta-analysis to draw conclusions from their combined findings.

Literature search and inclusion criteria

We aimed to include all sibling correlations in education, published or unpublished, in our data collection. In a first step, we conducted a bibliographic search. The initial retrieval of studies involved searching for articles in the Web of Science and Sociological Abstracts databases. We subdivided the search procedure by the following command lines with the following key words:

- educational attainment AND brother correlation OR fraternal correlation OR sororal correlation OR sister correlation OR sibling correlation,
- educational attainment AND brother similarity OR fraternal similarity OR sororal similarity OR sister similarity OR sibling similarity,
- educational attainment AND brother dissimilarity OR fraternal dissimilarity OR sororal dissimilarity OR sister dissimilarity OR sibling dissimilarity,
- educational attainment AND brother resemblance OR fraternal resemblance OR sororal resemblance OR sister resemblance OR sibling resemblance.

Along with 'educational attainment' other socio-economic outcomes have been searched as well, namely 'educational achievement,' 'income,' 'occupation,' 'social class,' and 'socio-economic status.' We did not specify any limitations on date, geography, age, or other population characteristics. We did not restrict the search to English-language articles, yet used English-language search terms and were only able to include articles in languages spoken by the research team (English, Dutch, Russian, German, Uzbek, French, Latvian).

In a second step, we compared search results to those obtained from Google Scholar as well as Education Resources Information Center (ERIC) and EconLit, adding any studies not previously identified in our search.

In a third step, we conducted a backward search, following up the references in the eligible studies as well as in existing narrative reviews (Björklund and Salvanes, 2011; Black and Devereux, 2011; Griliches, 1979) to identify studies that were not found in earlier steps as well as a forward search, where we used Google Scholar to screen studies citing the eligible studies, potentially allowing us to find recent and unpublished studies.

In a fourth step, we contacted authors in the field to obtain any unpublished studies.

Inclusion and exclusion criteria

Studies were included in the meta-analysis if they met the following criteria. Firstly, we excluded twin studies, as twins cannot be seen as a representative sample of a population (Smits and Monden, 2011) and are systematically different in terms of birth spacing (a meta-analysis of twins studies on educational attainment is provided by Branigan *et al.*, 2013). Secondly, we excluded studies in which respondents where still living in the parental home (e.g. Dahan and Gaviria, 2001) or when they had not yet finished education (e.g. Grätz, 2018). Thirdly, we excluded studies that only reported sibling correlations in educational achievement (e.g. test scores) or IQ and not actual attainment. Fourthly, we had to exclude a number of studies from the meta-analysis that only reported sibling correlations for pooled samples of several countries (Sieben and de Graaf, 2001, 2003) and studies that reported only complex path models but no zero-order sibling correlations (e.g. Kuo and Hauser, 1995). In some cases, we contacted study authors to establish the correct estimate from a study, which was not always possible. The latter two types of studies we counted in our analyses of the publication of sibling correlations, but not in the meta-analysis.

A complete list of studies included in our meta-analysis is included in the Appendix.

Coding of effect sizes and study characteristics

In a first step, we extracted sibling correlations in education from all eligible studies. We extracted sibling correlations reported for brothers, sisters, and correlations for brothers and sisters jointly, as well as the accompanying sample sizes. A few studies included other types of sibling correlations, e.g. for twin samples or for mixed-sex sibling pairs—we disregarded these estimates, as those studies always also reported brother, sister, or joint estimates of the sibling correlation. When studies reported estimates from different samples or stratified by birth cohorts, these were recorded as separate estimates.

Sibling correlations in the studies were reported as a Pearson correlation r, as the intra-class correlation in a random-effects model, or as a path coefficient in a structural equation model. In all of these cases, the substantive interpretation of the sibling correlation is identical and estimates can be treated like a Pearson correlation. In some cases, the sibling correlation was not reported directly, but instead the variance components for between family variation σ_a^2 and the within family variation σ_b^2 in education where reported. For those cases, we calculated r as

$$r = \frac{\sigma_a^2}{\sigma_a^2+\sigma_b^2}$$

While a correlation r can be considered an effect size, meta-analyses usually draw on the Fisher's z-transformed correlation, which is given by

$$z = \frac{1}{2} \times ln(\frac{1+r}{1-r})$$

The standard error of z is

$$SE_z = \sqrt{\frac{1}{n-3}}$$

where n equals the sample size. The reason for this transformation is that the sampling distribution of r is not symmetrical except when the population r equals 0.

In terms of study characteristics, we recorded the *country* a sample was stemming from, we recorded whether the sample was nationally *representative* or not, we recorded the *birth cohort*, whether an estimate includes *singletons* (which is possible when the correlation stems from a random-effects model), and the *academic discipline* of the study, sociology or economics.

Meta-analysis

Meta-analysis is a technique for synthesizing existing studies, allowing researchers to estimate a single overall effect size over a range of studies, or, which is more interesting in our context, to model the variability of effect sizes (net of differences due to sampling variation) using a random-effects meta-regression (Borenstein *et al.*, 2009). In other words, we can test whether sibling correlations in education vary by the country or period of data collection.

In a first step, we conduct a random-effects meta-analysis which allows the true sibling correlation in education estimated by each study θ_i to vary between studies, assuming that they have a normal distribution around an average effect θ:

$$z_i = \theta + u_i + e_i,\ u_i \sim N(0, \tau^2) \text{ and } e_i \sim N(0, \sigma_i^2)$$

σ_i^2 is the variance of the sibling correlation z_i based on the calculations outlined above and τ^2 is the between-study variance that is estimate from the data.

In a second step, we estimate a random-effects meta-regression that allows us to model the sibling correlation as a function of a vector of study characteristics x plus between study variance not explained by the study characteristics:

$$z_i = \beta_0 + \beta_1 x_i + u_i + e_i,\ u_i \sim N(0, \tau^2) \text{ and } e_i \sim N(0, \sigma^2)$$

β_0 is an intercept, x_i is a vector of study characteristics and β_1 a vector of regression coefficients.

We further rely on the Q test statistic to assess the presence of heterogeneity between sibling correlations. Under the null hypothesis, Q follows a chi-squared distribution with $k - 1$ degrees of freedom, and τ^2 informs us about the amount of variance between the sibling correlations, and the I^2 statistic denotes the proportion of true variation of sibling correlations as opposed to variation stemming from random sampling error.

Preliminary results

Sample characteristics

Figure 1 presents some basic descriptives of the sibling correlation studies we identified in our literature search. Since the first studies of sibling correlations in education in the 1970's there has been a steady increase in published studies over time (Panel A of Figure 1). Both economists and sociologists have engaged in sibling correlation research to similar extent (Panel B of Figure 1). The vast majority of sibling correlations in education have been published for the US (51%), but in total, sibling correlations in education have been published for 14 countries. Sibling correlations that comprise all sibships, not just sibships of brothers or sisters are higher than pure sister correlations, whereas brother correlations have a bimodal distribution, indicating that data have more spread than sister correlations (Panel D of Figure 1).

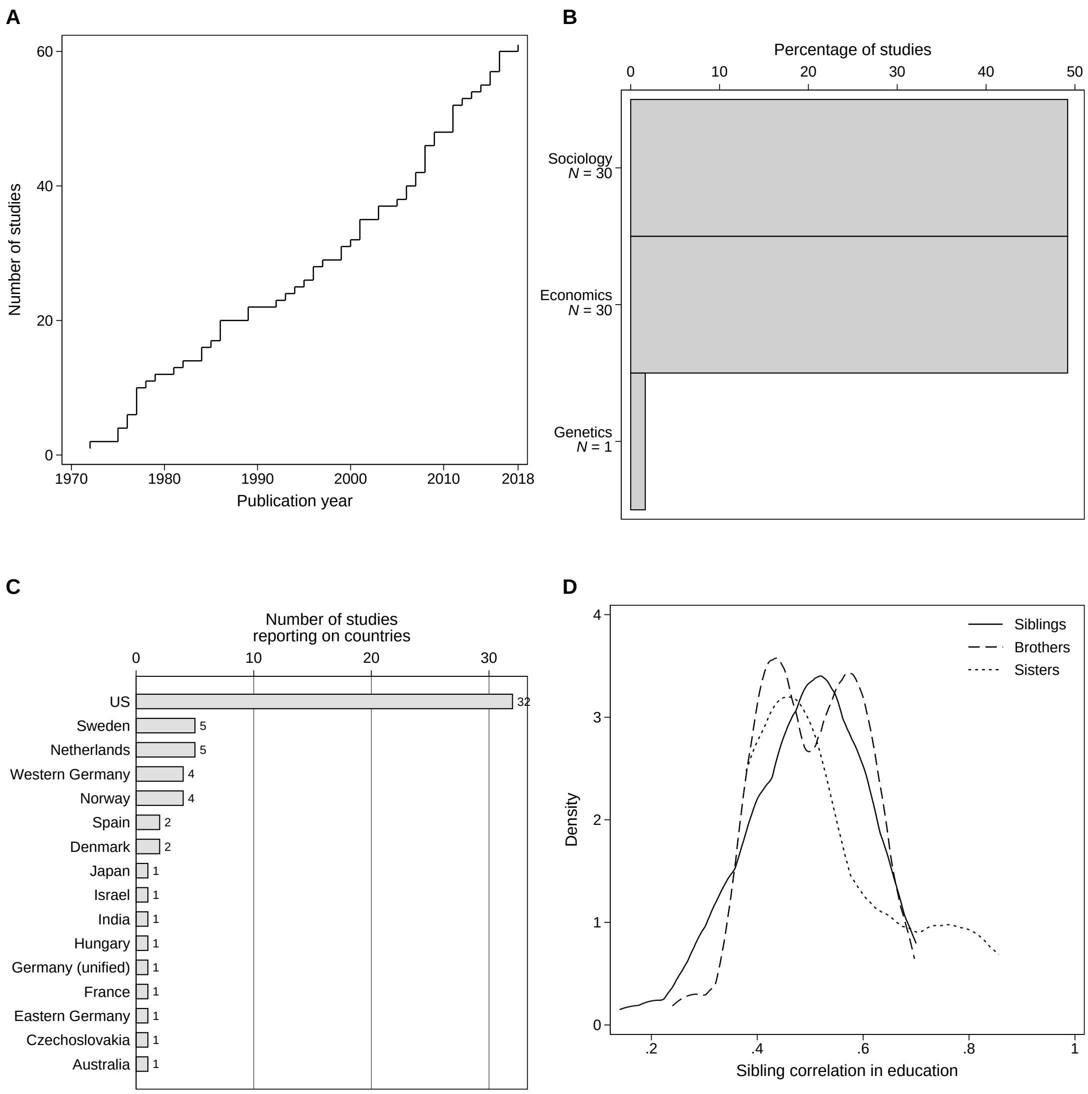

Figure 1: Panel A: Publication of sibling correlation studies over time. Panel B: Academic disciplines that conduct sibling correlation studies. Panel C: Number of sibling correlation estimates by country. Panel D: Density of sibling, brother, and sister correlations in education

Overall sibling correlation

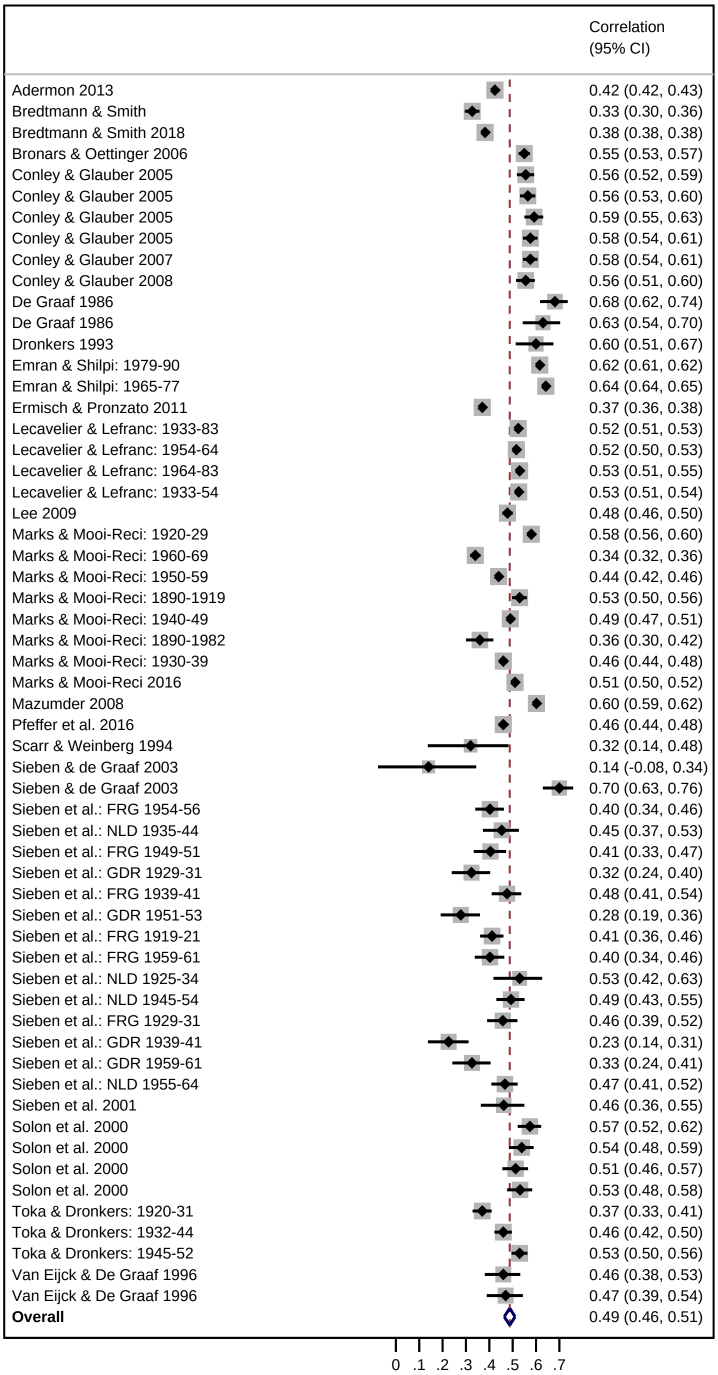

Figure 2: Forest plot summarizing sibling correlations in education (Pearson's r) and their 95% confidence intervals ($k = 58$). Squares represent random effect weights and the diamond represents the weighted mean effect size estimated in a random-effects model.

The overall sibling correlation across all studies is 0.49 (95% confidence interval: 0.46–0.51, Figure 2). Q equals 25,347 ($df = 132$, $p = .00$), indicating that there is substantial heterogeneity between the estimates of the studies. I^2 equals 99.5%, indicating that sibling correlations are usually estimated quite precisely and that the bulk of heterogeneity is not due to sampling error.

Figure A1 and Figure A2 show brother and sister correlations, for which the pooled effects are 0.49 (95% CI: 0.48–0.50) and .52 (95% CI: 0.48–0.56), respectively. Given the overlap in confidence intervals, we can conclude that brother and sister correlations in education are not significantly different from one another.

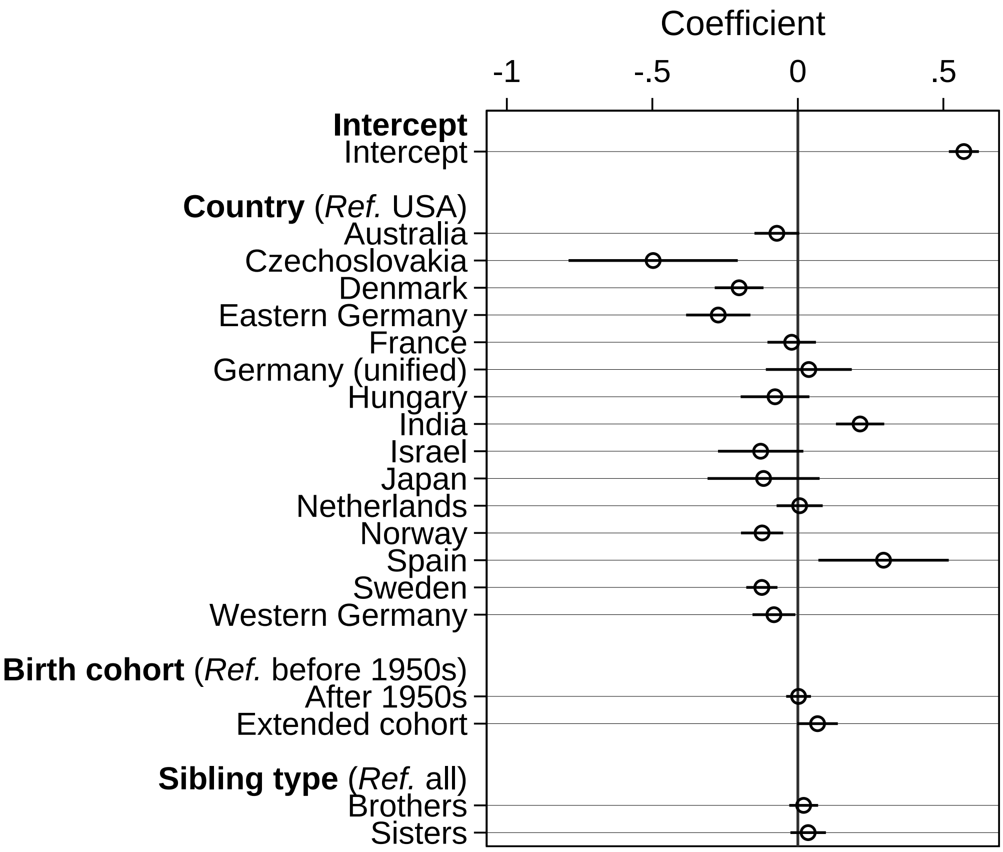

Figure 3: Coefficients from a random effects meta-regression, $N = 157$.

Note: Error bars denote 95% confidence intervals.

Meta-regression

We modeled the heterogeneity around the pooled sibling correlation in a random effects meta-regression, shown in Figure 2. The model reveals the following three key findings. First, countries differ in the size of their sibling correlations. The US serve as the reference category in this analysis. Czechoslovakia, Denmark, Eastern Germany, Norway, Sweden, and Western Germany have lower sibling correlations than the US. Conversely, India and Spain show stronger sibling correlations than the US.

With respect to birth cohort effects, sibling correlations in education of birth cohorts from before the 1950's are no different from those born after the 1950's.

Lastly, there are no differences between sibling correlations calculated for brothers, sisters, or brothers and sisters taken together.

In a further step, we replaced the country dummies in the regression equation with income inequality as measured by the Gini coefficient to assess whether family background effects are greater in less equal countries. Figure 4 shows the predicted sibling correlation by the Gini coefficient, revealing that the more economically unequal a country is, the greater the family background effect is.

Publication bias

We further analyzed our data to find indications of publication bias—if sibling correlations are not being published or more difficult to find if they are higher or lower than they usually are, this would affect the external validity of our study. Figure 4 shows a funnel plot that is usually used to assess the presence of publication bias. In the absence of publication bias, one would expect that the estimates of sibling correlations would fall into the funnel shape. Our set of estimates differs markedly from this shape. However, we believe that this is due to the difference between register-based and survey-based studies, which lead to systematically different estimates.

In a further step, we also inluded a variable in our meta-regression indicating whether an estimate was published (in an article or a book) or 'unpublished' (i.e. in a working or conference paper) and found that estimates did not differ in size by publication status.

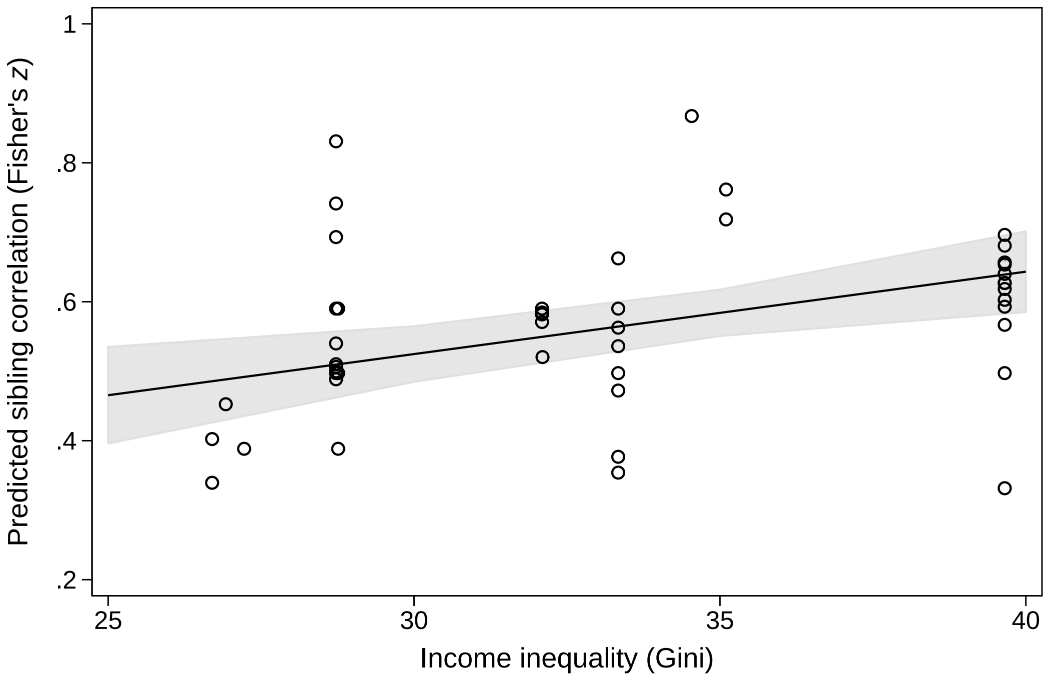

Figure 4: The more economically unequal a country is, the greater the family background effect: Predicted sibling correlation in education (in Fisher's z metric) by income inequality (as expressed by the Gini coefficient). Dots indicate estimates from the meta-analysis, size of dots denote random-effects weights of the estimates.

Note: Income inequality data obtained from the World Bank (2018, 'si.pov.gini') for the years 1960–2017 and averaged per country. Model controls for birth cohort dummies.

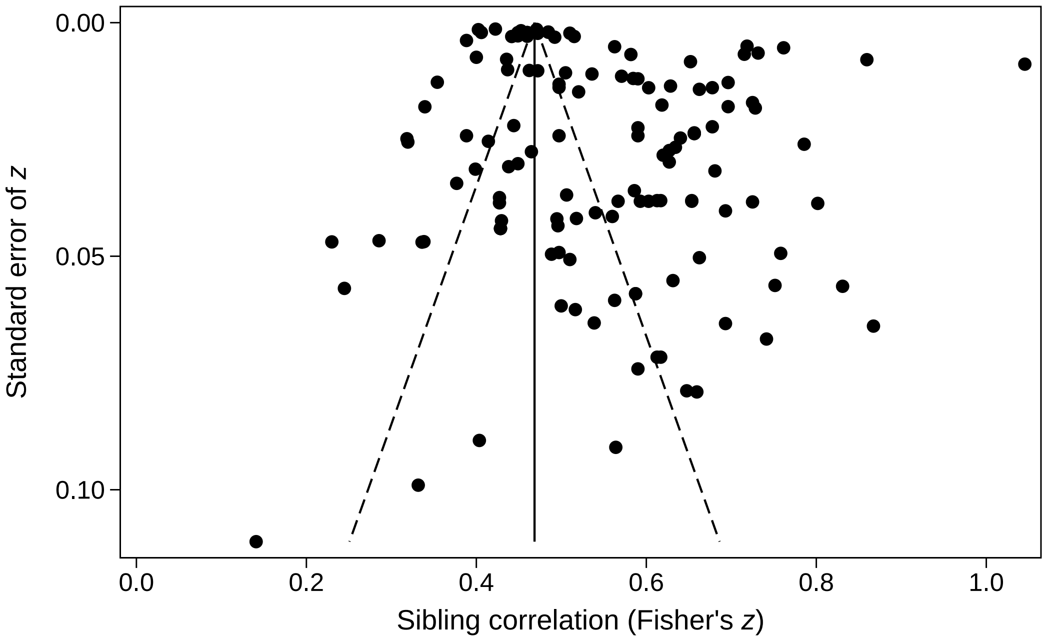

Figure 5: Funnel plot of standard error by sibling correlation. Solid line indicates the average sibling correlation as obtained from a fixed-effects meta-analysis. Dashed lines indicate the 95% confidence intervals around the average sibling correlation.

Note: Error bars denote 95% confidence intervals.

Conclusion

We conducted a meta-analysis of published sibling correlations in education to examine the variation in family background effects across countries and over time. We were able to identify more than 60 studies from 16 countries over the 20th century, allowing us to compare the intergenerational transmission of advantage in a country comparison of unprecedented size.

We have several key results. First, there are marked country differences in the intergenerational transmission of advantage. This result stands in marked contrast to findings relying on parent–offspring correlations, which have long suggested that there is little difference in social mobility (e.g. Clark, 2014; Erikson and Goldthorpe, 1992). A potential explanation for this is that parent–offspring correlations are known to underestimate the intergenerational transmission of advantage, whereas sibling correlations can be considered omnibus measures of family background effects that capture more aspects of family background.

Second, there is a substantial spread in the sibling correlations between countries, ranging from .14 in Czechoslovakia to .66 in India and .70 in Spain, with the US with .53 ranging in between these extremes.

Third, we found evidence for the 'Great Gatsby curve,' the hypothesis that there is less social mobility in countries with greater economic inequality. Our predictions showed that sibling correlations in countries with low inequality (Gini coefficient of .25) have sibling correlations of .43, whereas sibling correlations in high-inequality countries (Gini = .40) are substantially higher, with a value of .57.

Finally, we found no evidence of gender differences in sibling correlations. Research has long been interested in differences between the sexes in intergenerational mobility and found mixed results (e.g. Benin and Johnson, 1984), but our analysis of all findings to date shows that there are no significant gender differences in sibling correlations in education.

We found it difficult to say something about the development of intergenerational transmission of advantage over time, as studies differ in their delineation of birth cohorts. A broad distinction between cohorts born before and after 1950 showed no statistically significant difference, indicating that there was no difference over time. In further analyses, we plan to conduct more focused comparisons of sibling correlations in single countries like the US over time.

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Appendix

Forest plots of brother and sister correlations

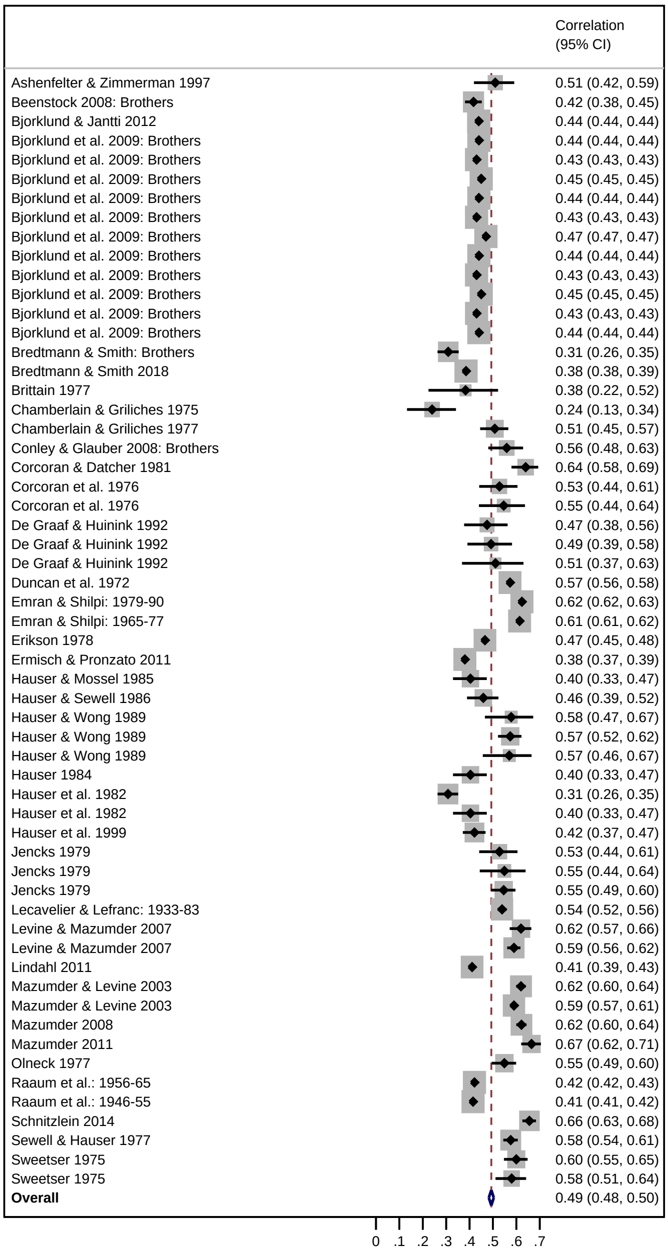

Figure A1: Forest plot summarizing brother correlations in education (Pearson's r) and their 95% confidence intervals ($k = 58$). Squares represent random effect weights and the diamond represents the weighted mean effect size estimated in a random-effects model.

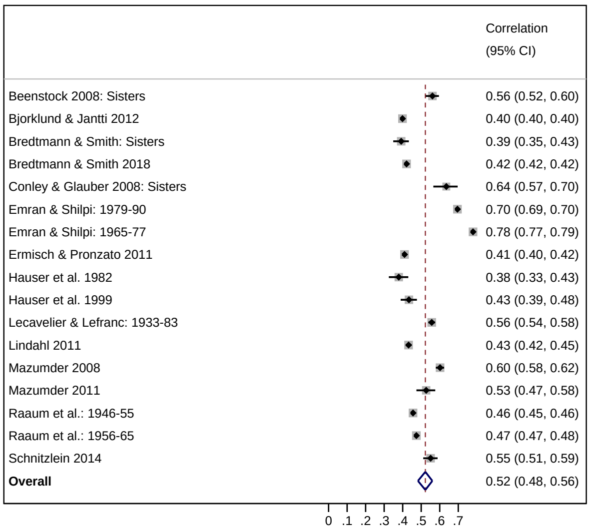

Figure A2: Forest plot summarizing sister correlations in education (Pearson's r) and their 95% confidence intervals ($k = 58$). Squares represent random effect weights and the diamond represents the weighted mean effect size estimated in a random-effects model.

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