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Introduction

Formal educational qualifications are considered a key channel of social mobility in advanced industrial societies. Since the pioneering work of Blau and Duncan (1967), a very large number of studies, across many countries and periods, has documented that education mediates a substantial portion of the association between social origins and destinations (Bernardi and Ballarino, 2016; Breen & Goldthorpe, 2001; Breen & Luijkx, 2004; Hout, 1988; Ishida et al., 1995; Jerrim & Macmillan, 2015; Jonsson, 1996; Torche, 2011; Treiman & Yip, 1989; Warren et al., 2002). In their comprehensive reviews, Breen and Jonsson (2005) and Hout and DiPrete (2006) both conclude that education indeed is the most significant mediator of the association.

The guiding sociological framework for understanding the mediating role of education is commonly referred to as the origins-education-destinations (OED) triangle. In this framework, social origins (O) are hypothesized to affect social destinations (D) both indirectly through educational attainment (E) and directly, i.e., through paths other than educational attainment. Figure 1 presents the OED triangle. Each of the three arrows in the triangle has a specific theoretical interpretation used to make predictions about the role of education in social mobility (Erikson & Goldthorpe, 1992; Grusky, 1983; Halsey et al., 1980; Treiman, 1970). The OD path not running via E is interpreted as the impact of ascriptive or non-meritocratic family factors, the OE path as the extent of class inequalities in educational attainment, and the ED path as the occupational returns to education.

[Figure 1 about here]

In this paper, we argue that the OED framework would benefit from explicitly considering how skills formed early in life affect education's mediating impact on the intergenerational occupational association. Research shows that cognitive and noncognitive skills are very unevenly distributed by family background from early on in life, and that these

inequalities appear to persist well into adolescence (e.g., Farkas, 1996, 2003; Feinstein, 2003; Heckman, 2006, 2008). As skills also have been found to strongly affect success in the educational system and on the job market even among individuals with similar educational attainment (e.g., Jencks et al., 1979; Farkas, 1996; Murnane et al., 2000; Bowles, Gintis, & Osborne, 2001; Kerckhoff, Raudenbush, & Glennie, 2001; Heckman, Stixrud, & Urzua, 2006), the conventional OED framework may attribute too large a role to education as an independent mediator of the intergenerational occupational association.

We present a formal decomposition analysis that explicitly considers how bringing early skills into the OED framework provides insights into the underlying processes through which education becomes a channel of social reproduction. We distinguish between two processes, sorting and acquisition, by which education becomes a mediator. Whereas sorting refers to the portion of education's mediating effect that is explained by the sorting or selection into schooling on early skills, acquisition refers to the (residual) portion of education's mediating effect that cannot be explained by skill-based sorting.

Our study is not the first to consider the role of skills, or more broadly merit, in processes of social reproduction. One line of research examines how skills in addition to education mediate the OD association (Breen and Goldthorpe, 1999, 2001; Gugushvili, Bukodi, & Goldthorpe, 2017). Another line examines the relative mediating impacts on the OD association of skills and education when the two are considered jointly as mediators (Kerckhoff, Raudenbush, & Glennie, 2001). Common to these studies is that they treat education and skills as simultaneously impacting occupational destinations. In contrast, our approach assumes a temporal ordering in which early skills precede educational attainment. Thus, our approach is conceptually similar to the recursive modeling framework of the status attainment tradition (Duncan, 1968; Sewell et al., 1969; Duncan, Featherman, & Duncan, 1972; Jencks et al., 1972, 1979), but—while this framework considers a broad range of mediators of

the OD association (Kerckhoff, 1989; Farkas, 2003)—our approach specifically considers how the mediating impact of education is affected by factoring in measures of early skills.[1]

The OED Framework

We begin by presenting the standard OED framework, relying on simple path diagrams and the rules of path analysis for linear models (Duncan, 1966). We realize that the assumption of linearity is potentially limiting, but for the analytical purposes pursued here, we see this assumption as inconsequential.[2] Figure 2 presents the path diagram comprising class origins (O), attained education (E), and class destinations (D). The diagram posits that a part of the OD association is mediated via E. In the figure, the indirect effect of O on D via E is given by $\theta^*\gamma^*$, the direct effect of O on D other than through E by β^*, and the total OD effect is given by the sum of the indirect and direct effects, $\beta^* + \theta^*\gamma^*$. The fraction of the total effect that results from the indirect effect is given by $\theta^*\gamma^* / \left(\beta^* + \theta^*\gamma^*\right)$; that is, the fraction of OD-association that is mediated by E. We may obtain the path coefficients in Figure 2 from two linear regression models,

$$E(D) = \beta^* O + \gamma^* E \qquad (1a)$$

$$E(E) = \theta^* O \qquad (1b)$$

Substituting (1b) into (1a) yields the decomposition of the total effect into its direct and indirect parts.

[Figure 2 about here]

Stratification scholars use the OED framework in Figure 2 to make predictions about the role of education in social reproduction (Erikson & Goldthorpe, 1992; Grusky, 1983; Halsey et al., 1980; Treiman, 1970).[3] The direct path (i.e., OD path not running via E) is often interpreted as originating in ascriptive processes. For example, among individuals with similar levels of attained education, individuals born into advantaged families may exploit their social networks or reputation to help their children succeed in the labor market, whereas the same opportunities do not exist for individuals born into disadvantaged families. Thus, the direct path is a measure of the extent to which advantage is passed on from parents to children independently of formal educational qualifications, and is commonly referred to as the direct effect of social origins. By way of contrast, the indirect path measures the extent to which education channels advantage from parents to children: Whereas the OE path measures the degree of family background inequalities in educational attainment (Breen et al., 2009; Shavit & Blossfeld, 1993), the ED path measures the occupational returns to education (Shavit & Müller, 1998).

Because the indirect effect consists of two paths (OE and ED), education can be mediator of social reproduction for different reasons. For example, if we find that the mediating impact of education is more important in one country than another, it may be that in the first country, the OE path dominates the ED path, whereas in the other, the ED path dominates the OE path. For the first country, we would conclude that education is an important mediator because of its strong dependence on family background, that is, on family background influences that lie beyond the immediate control of the individual. For the second country, we would conclude that education is an important mediator because of the high returns to education, i.e., because of educational achievements that are unrelated to family background.

Early Skills and the OED Framework

The literature on skill formation shows that human abilities develop in a series of sensitive periods in early childhood, influenced by an interaction between genetics and circumstances of upbringing (Shonkoff & Phillips, 2000). The literature typically distinguish between two types of skills: cognitive and noncognitive (Heckman, 2008). Cognitive skills refer to "the ability to manipulate words and numbers, assimilate information, make logical inferences, and so forth" (Jencks et al., 1972:53). Noncognitive skills refer broadly to personality traits, defined as "patterns of thought, feelings, and behavior" (Borghans et al., 2008:974). According to Heckman (2008), cognitive skills are the first to establish—a finding that is supported by studies showing that measures of IQ tend to stabilize around age 10. Although noncognitive skills develop in parallel, they are generally more susceptible to parental inputs in later stages of childhood (Cunha & Heckman, 2007, 2008). Moreover, cognitive and noncognitive skill formation is not separate processes. Skills can be self-reinforcing in the sense that early learning reinforce motivation to learn more and makes learning at later stages more efficient, and cross-fertilizing when for example higher levels of emotional security or self-regulation leads to more vigorous learning of cognitive skills (Heckman, 2008).

Research finds both cognitive and noncognitive skills to be important determinants of labor market success (for a review, see Farkas, 2003). The impact of skills on labor market outcomes can be indirect via their effects on educational attainment or direct, i.e., net of their effects on education (Duncan, Featherman, & Duncan, 1972; Jencks et al., 1972). Direct effects will be present if there are productivity gains associated with cognitive or noncognitive skills or if employers seek to hire workers who have certain personal traits that predispose them to respond to incentives, making it easier for employers to motivate worker effort (Bowles, Gintis, & Osborne, 2001; Goldthorpe, 2014). Empirical research finds that skills tend to be rewarded in the labor market even net of educational attainment (e.g., Jencks et al., 1972, 1979; Farkas,

1996; Murnane et al., 2000; Bowles, Gintis, & Osborne, 2001; Kerckhoff, Raudenbush, & Glennie, 2001; Heckman, Stixrud, & Urzua, 2006). As we return to in the next section, these net labor market returns to skills affect how we interpret the mediating role of education in the OED framework.

An Extended OED Framework

We propose to extend the OED framework by differentiating between two processes that lead education to become a mediator in the conventional OED framework.[4] The first process, which we term *sorting*, is the nonrandom sorting of students into schooling on traits such as cognitive and noncognitive skills (independently of social origins). Insofar as these skills affect social destinations independently of education and social origins, education's mediating role will reflect processes of skill formation that occur before children start in school. Put differently, in our framework, sorting refers to the confounding influence of early skills on the ED association (conditional on origins).

The second process, which we term *acquisition*, is the impact of formal educational qualifications on labor market outcomes such as social destinations *net of early skills*. Independently of skills, formal education may provide individuals with human, social, and cultural capital, all of which is rewarded in the labor market (Torche, 2011). Similarly, as formal qualifications are directly visible to potential employers, these employers may screen and eventually hire employees based on their qualifications (Hout, 1988; Breen & Jonsson, 2007; Goldthorpe, 2014). Thus, independently of any sorting into schooling on skills, education may affect social destinations. In sum, we distinguish between sorting and acquisition as two separate processes through which education becomes a mediator of the origins-destinations association. In what follows, we provide an updated OED framework that formally defines these two components of education's mediating role.

Implications of the Extended OED Framework

Figure 3 presents our updated OED framework. The path diagram assumes that early skills (A) are affected by class origins (O), that early skills (A) affect education (E) net of class origins, that early skills (A) affect class destinations (D) net of class origins and education, and that education (E) affects class destinations (D) net of early skills and class origins. We consequently assume that early skill formation processes precede educational and occupational attainment. In this updated framework, A operates both as a mediator (of the OE association) and as a confounder (of the ED association). To examine the substantive implications of the extended framework, we rely on the rules of path analysis to express the paths in Figure 3 in terms of linear equations:

$$E(D) = \beta O + \gamma E + \lambda A \tag{2a}$$

$$E(E) = \theta O + \delta A \tag{2b}$$

$$E(A) = \pi O \tag{2c}$$

Substituting (2c) into (2b) and subsequently substituting (2b) into (2a), we obtain the decomposition of the total effect of O on D:

$$\begin{aligned} &\beta O + \gamma(\theta O + \delta A) + \lambda A = \\ &\beta O + \gamma(\theta O + \delta \pi O) + \lambda \pi O = \\ &(\beta + \gamma\theta + \lambda\pi + \gamma\delta\pi) O \end{aligned}$$

Thus, the total effect of origins on destinations decomposes into four components:

β: Direct effect not via A and E

$\gamma\theta$: Indirect effect via E, not via A

$\lambda\pi$: Indirect effect via A, not via E

$\gamma\delta\pi$: Indirect effect via A and E

Using this decomposition, we can regroup the effects to define direct and indirect effects that differ from those in the conventional OED framework.[5] First, we can define a *direct effect of O on D other than through E* as $\beta + \lambda\pi$. This direct effect is the sum of the direct effect not via A and E *and* the indirect effect via A, but not via E, in Figure 3. The former term, β, is the direct effect of origins on destinations other than through both early skills and education. The latter term, $\lambda\pi$, is relegated to the direct effect, as it does not involve any paths running through E. This term captures the part of the OD association that is transmitted via class inequalities in early skills *independently of* formal schooling.

[Figure 3 about here]

Second, we may define an *indirect effect through E net of A* as the sum of the two remaining components, $\gamma\theta + \gamma\delta\pi$, which refer to the paths involving E as an intermediate variable between O and D in Figure 3. We can rewrite this indirect effect as $\gamma\theta + \gamma\delta\pi = (\theta + \pi\delta)\gamma = \theta^{*}\gamma$, which suggests that the mediating impact of education *net of early skills* is the product between the total OE association and the net returns to schooling (i.e., net of early skills and social origins). This indirect effect has a specific interpretation that differs from the interpretation of the indirect effect in the conventional OED framework. It may be interpreted as the indirect effect of education on social mobility net of the confounding influence of sorting into education on early skills. In other words, it captures processes of acquisition.

While the conventional OED framework provides a measure of the *gross* mediating impact of education on social reproduction, our updated framework gauges the *net* mediating impact of education, net of early skills. The difference between the two is a measure of the extent to which the confounding influence of sorting on early skills explains education's mediating impact. To better grasp this difference, we derive it mathematically. Using that $\gamma^* = \gamma + \delta\lambda m$, where m is a correction or rescaling factor defined in the Appendix, the difference is given by

$$\begin{aligned} IDE_{dif} &= \theta^*\gamma^* - \theta^*\gamma \\ &= \theta^*\left(\gamma^* - \gamma\right) \\ &= \theta^*\left(\gamma + \delta\lambda m - \gamma\right) \\ &= \theta^*\delta\lambda m \end{aligned} \tag{3}$$

We highlight two features of the difference in (3). First, the difference depends on the term, $\delta\lambda m$, and on the total effect of O on E, θ^*. We may think of the term $\delta\lambda m$ as capturing the confounding impact of *sorting* on early skills into education. It captures the degree to which early skills (net of class origins) confounds the ED association. More broadly, we may consider the difference in (3) as a scaled degree of confounding, with both *m* and the total OE effect, θ^*, being scale factors. Second, because all parameters involved in (3) can be safely assumed positive, we find that the conventional OED framework will tend to produce *larger estimates of the indirect effect* than our updated framework. Thus, if interpreted literally, the conventional OED framework will tend to overstate the independent role of education in processes of social reproduction.

Implications for Comparative Mobility Research

What are the implications of our updated framework for comparative research on the role of education in social reproduction? As described earlier, in the conventional framework,

education can be a mediator for different reasons, depending on the magnitude of the OE path relative to the ED path. We would consider a country in which the ED path dominates more meritocratic or achievement-based than a country in which the OD path dominates. However, our updated framework suggests that even in countries in which the ED path dominates, its underlying sources may differ widely, depending on the extent of the confounding influence of sorting on early skills into formal education. Even if two countries have similar magnitudes of their respective OE, ED, and OD associations—indicating that the mediating impact of education is the same in the two countries—the underlying sources may be very different depending on the relative importance of sorting and acquisition. In our decomposition, the term $\delta\lambda m$ captures the relative importance of the two processes.

To give a better idea about the consequences of our updated framework for the conventional interpretation of education's mediating role, consider a country in which sorting dominates acquisition ($\delta\lambda m$ is high in relative terms). In this country, early skill formation processes account for most of education's mediating role. This would appear to imply that education's role in education in the country is not as meritocratic as one would have concluded based on the conventional OED framework or, at least, is not driven by education's equalizing impact on family background differentials in labor market attainment. In contrast, it is driven by skills acquired early in life, not by those acquired via formal schooling. Indeed, as children have relatively little, if any, control over their early skill formation process, scholars using the conventional OED framework and focusing on the ED association may, somewhat erroneously, conclude that formal education strongly facilitates social mobility as a result of the labor market returns to education. Now consider another country in which acquisition dominates sorting ($\delta\lambda m$ is low in relative terms). In contrast to the first country, in this country, education is a mediator of the OD association because of its effects on labor market outcomes independently

of family background and skills formed early in life. For this country, the conventional OED framework provides an adequate interpretation: As a result of its labor market returns, formal schooling facilitates social mobility.

The two countries present the extremes of a continuum for which either sorting (on early skills) or acquisition dominates the mediating role of education. In comparative mobility research, disentangling the two appears highly relevant, as the interpretation of the independent role of formal schooling in social mobility processes critically depends on whether sorting or acquisition dominates. Moreover, as we return to in the Discussion, disentangling the two processes are also crucial for developing effective policies that foster social mobility.

Empirical example

This section presents empirical estimates of the extent to which education's mediating role results from the confounding caused by sorting into education on early skills, that is, it quantifies the relative magnitude of the term $\delta\lambda m$ defined above. We analyze data from the National Child Development Study 1958 (NCDS) and the British Cohort Study (1970). The NCDS is longitudinal sample of approximately 17,000 individuals born in a single week in 1958 in England, Scotland, and Wales. Respondents have been re-interviewed at ages 7, 11, 16, 23, 33, and 42, allowing us to follow their life course in terms of family background, early skill formation, educational attainment, and occupational attainment up to occupational maturity. The BCS has a setup very similar to the NCDS, following roughly 17,000 individuals born in a single week in 1970 in England, Wales, and Scotland throughout their life course. Respondents have been re-interviewed at ages 5, 10, 16, 26, 30, 38, and 42, allowing us to follow the individuals in a way very similar to the NCDS. Comparing findings based on the NCDS and the BCS allows us to examine not only the confounding role of early skills for these two birth cohorts, but also the extent to which the confounding role has changed over time. To

retain as many observations as possible, in both analyses, we use multiple imputation (with 25 imputations). The final NCDS and BCS samples comprise 16,888 and 15,291 respondents, respectively.

Measures

For both samples, we measure the *occupational attainment* of parents (O) and respondents (D) using dummy variables indicating whether the father or the respondent was part of the service class.[6] For NCDS, we measure father's class position at child age 11, and for BCS at child age 10. For NCDS, we measure the respondent's class position at ages 41-42, and for BCS at age 42. Because we also have information on father's and respondent's class position in other waves, we include these measures in our multiple imputation models. We measure the respondent's *educational attainment* (E) with a dummy indicating whether the respondent completed a higher education by age 33 in the NCDS and by age 34 in the BCS.[7] We also include educational attainment variables from other waves in our multiple imputation models.

For measuring *early skills*, we utilize a broad set of cognitive test scores measured at ages 7 and 11 in the NCDS, and at ages 5 and 10 in the BCS.[8] All of these skills arguably help determine educational attainment, and are also skills that are valued in the labor market. To facilitate comparison, we use tests that are as comparable as possible across the two surveys. For a detailed description of the tests, including their reliabilities, we refer to Shepherd (2012) for the NCDS, and to Parsons (2014) for the BCS. At age 7 in the NCDS, respondents complete tests in reading (tapping word recognition and comprehension), in drawing a human figure (tapping mental and perceptual ability), in copying designs (tapping perceptuo-motor ability), and in mathematics (tapping arithmetic ability). At age 11 in the NCDS, respondents complete tests in reading (tapping comprehension), mathematics (tapping arithmetic ability), and general ability (tapping general mental ability).

At age 5 in the BCS, respondents complete tests in verbal vocabulary (tapping language comprehension and expressive ability), in drawing a human figure (tapping mental and perceptual ability), in copying designs (tapping perceptuo-motor ability), in complete a human profile (tapping the same ability as for the draw-a-human-figure test), and in reading age (measuring the number of words read correctly).[9] At age 10 in the BCS, respondents complete tests in reading (tapping word recognition), mathematics (measuring arithmetic, number skills, fractions, algebra, geometry, and statistics), and four subscales of the British Ability Scales (BAS): word definitions, word similarities, recall of digits, and matrices (tapping verbal and non-verbal ability).

Analytical Strategy

We use the comprehensive sets of early skill measures in our decomposition analyses by successively controlling for them in five steps. In the first model, we report the baseline results not employing our correction for early skills, i.e., the conventional OED estimates of the total, direct, and indirect effects. In the second model, we control for a single measure of reading ability at age 7 or age 5 (depending on the survey) using our updated OED framework. In the third model, we control for the three tests at age 7 or age 5 which appear in both surveys (reading, draw-a-human-figure, and copying designs). In the fourth model, we control for all tests available at age 7 or age 5 in the two respective surveys. In the fifth model, we include the skills measured at age 11 or age 10 depending on the survey. Although skills measured at ages 10 or 11 are affected by early schooling experiences much more than skills measured at ages 5 or 7, we include them because they are skills still measured relatively early in life and thus provide an important control for the selection into higher education on early skills.[10]

Results

Table 1 shows descriptive statistics for the origins, destinations, and education variables in the two surveys. As we would have expected, there is an upgrading of the class structure both across generations within surveys and across the surveys, which are separated by 12 years. Moreover, we see substantial educational expansion in that 25 percent in the NCDS complete a higher education (by age 33), and 38 percent do so (by age 34) in the BCS.

[Table 1 about here]

Table 2 presents estimates of the path coefficients involved in the conventional OED decomposition for the two surveys. As the final column shows, the total effect of origins declines over the 12 years separating the two surveys, from 27 percentage points in the NCDS to 22 percentage points in the BCS. Estimates of odds ratios (not reported here) provide a virtually identical picture: The odds ratio declines from 3.0 in the NCDS to 2.4 in the BCS, corroborating the conclusion that social mobility has increased between the two cohorts.

[Table 2 about here]

Table 2 also provides evidence on the sources of this decline in the total effect, using the conventional OED framework. We find that the decline is driven entirely by a decline in the direct effect (column 4), not in the direct effect (column 1). Whereas the direct effect is 14 percentage points in both surveys, the indirect declines by a factor of 1.60 from about 13 to 8 percentage points. Because the indirect effect consists of two path coefficients (γ^* and θ^*), we are able to pinpoint which of the two is the major driver of this change. We find that the occupational returns to schooling, i.e., the ED path (γ^*), declines by a factor of 1.44, and the class origins inequality in higher education attainment declines by a factor of roughly 1.11. Thus the major source of change is found in the *declining* occupational returns to schooling, not in the decreasing family background inequality in schooling.[11]

Given our updated OED framework, we are able to examine the extent to which the decline in the indirect effect of schooling on the intergenerational occupational association between the 1958 and 1970 birth cohort results from changes in the confounding role of early skills. Table 3 provides for each survey estimates of the path decomposition, the percent mediated (i.e., the percentage of the total OD association that is mediated by E), and a test-statistic for the null hypothesis that the confounding term is zero.[12]

[Table 3 about here]

In Model 1a, the conventional OED approach yields an estimate of 48.1 percent mediated, suggesting that roughly half of the intergenerational occupational association can be explained by education. In Model 2a, we control for a reading test score at age 7 using our updated OED framework. We find that indirect effect now reduces to 11.8 percentage points and the percent mediated reduces to 44.2 percent. Thus, in relative terms and controlling only for a single measure of early skills, we find that not controlling for early skill formation results in the conventional percent mediated being overstated by about 9 percent. As the final column in Table 3 shows, the change in the indirect effect induced by controlling for the skills measure effect is statistically significant at conventional levels.

Further controlling for two early skills measures (draw-a-human figure and copying designs) in Model 3a, we find that the percent mediated drops to 43.5 percent, meaning that the sorting component now accounts for by about 11 percent of the mediating role of education. Adding a measure of arithmetic skills in Model 4a leads to a further reduction to 42.5 percent mediated. Thus, controlling for all available cognitive skill measures at age 7, the sorting component accounts for by about 13 percent and is statistically significant at conventional significance levels. Further controlling for three skill measures at age 11 in Model 5a corroborates the result that the sorting component is substantial: The percent mediated drops to 38.1 percent, meaning that the sorting component now accounts for 26 percent. In sum,

controlling for early skill formation in our updated OED framework significantly reduces the mediating role of education in intergenerational social reproduction for the NCDS.

Turning to the BCS (panel b in table 3), we find that the conventional OED framework yields a percent mediated of 36.6 percent. Thus, as we would have expected in light of the indirect effects reported in Table 2, education is not as great a mediator of social reproduction in 1970 birth cohort as in the 1958 birth cohort. As we also reported in Table 2, the major source of this difference was in the declining occupational returns to education (i.e., a weakened ED association). Thus the question is whether the change between the two cohorts in the sorting component can account for this difference. However, the results for the BCS in Table 2 shows that this appears not to be the case. For example, comparing models 3b and 3a––which include roughly similar measures of early skills—we find that the sorting component accounts for 11 percent of the gross mediating influence of education in both models. Thus, by this token and in relative terms, the sorting component is as important in the 1970 cohort as in the 1958 cohort for accounting for the mediating role of education in social reproduction in England, Wales, and Scotland.[13]

The reported pattern of stability between the two cohorts is further corroborated in models 5b and 5a, which also include measures of skills at age 10 (for the BCS) and age 11 (for the NCDS). For the BCS, the percent mediated drops to 28.7, which means that not accounting for early skills lead to an overstatement of about 28 percent in the conventional OED framework. For the NCDS, the corresponding percentage was 26, a very similar figure. In conclusion, the sorting on early skills does not appear to be able to account for why education has become a less powerful mediator of the origins-destinations association over time in England, Wales, and Scotland.

Discussion

This paper updates the widely used OED framework to include early skill formation. We present a formal decomposition analysis that breaks down education's mediating impact into a component related to the sorting into schooling on early skills and a residual component related to the independent role of education in processes of social reproduction. We suggest that researchers using the OED framework should consider how the conventional interpretation of education's mediating impact depends on the extent to which the confounding influence of early skills accounts for the mediating impact. Indeed, a key analytical result of our updated OED framework is that the conventional framework will tend to overstate the independent role of formal schooling in mediating the origins-destinations association. Put differently, education is a mediator partly because of early skill formation processes that are unrelated to formal schooling. Empirical estimates from the UK suggest that the overstatement of education's mediating role in the conventional OED framework may be as large as 25 percent, a substantial overstatement.

Our study has immediate implications for comparative research on social mobility. In this literature, scholars are often interested in comparing the mediating role of education in social mobility between countries or over time within the same country (Bernardi & Ballarino, 2016; Breen & Karlson, 2014; Ishida et al., 1995; Kuha & Goldthorpe, 2010). A key hypothesis in this literature, derived from the liberal theory of industrialism, states that as countries industrialize and educational systems expand, educational achievements should become the primary basis for labor market allocation, thus replacing ascriptive family background characteristics in hiring processes (Erikson & Jonsson, 1996). However, using the conventional OED framework for testing this hypothesis is problematic in the light of the results we report in this paper.

Two countries may differ in the overall mediating role played by education in social mobility simply because of differences in how important is the confounding influence of sorting on early skills. Put in substantive terms, if education *filters* the impact of early skills on labor market outcomes differently in two countries (Allmendinger, 1989), then such differential filtering could explain any country difference in the indirect effect of education reported using the conventional OED framework. A similar point can be raised in comparisons between cohorts or periods within the same country. If, for example, the dependence of educational choice on early skills declines over time, then the conventional OED framework would lead one to conclude, potentially erroneously, that formal education has become a more important mediator over time.

Resolving such issues is ultimately an empirical matter and a potential agenda for future research. The empirical study analyzing two birth cohorts in the UK that we conduct in this paper shows that the sorting-on-skills component plays as large a role in the 1970 cohort as in the 1958 cohort. Thus, the decline in the mediating role of education between these two cohorts (which is driven primarily in the occupational returns to schooling) cannot be explained by changes in the sorting component, at least to the extent we are able to measure it here. Future studies using other countries or analyzing cohorts separated by more than 12 years might help us resolve whether the pattern we find for the UK can be found elsewhere.

A limitation of the framework we present in this paper is that it is not clear-cut when to measure early skills. Although one would want to measure skills so early that they are not yet affected by formal schooling experiences, the drawbacks of measurements in the pre-school years are that they may be less reliable and that skills are not yet fully matured at this stage of the life cycle. Indeed, measures of IQ are found to stabilize around age 10 (Heckman, 2008). Thus, to the extent the model properly captures all relevant factors in the OED process, using skills measured at age 5-7 likely leads to an upper-bound estimate of the skill-adjusted

mediating role of education, while skills measured at age 10-11 leads to a lower-bound estimate.

A second limitation of the framework is that many factors other than early skills may account for the mediating role of education. While early skills arguably are an important factor, unobserved variables such as beliefs and skills not measured by conventional cognitive and noncognitive tests also likely play an important role. Insofar as individuals sort into schooling on these characteristics, we may expect that the independent mediating role is overstated to an even larger degree than what we report. While the methodology we present in this paper easily can accommodate several control variables that potentially could proxy these characteristics and traits (see the appendix), they are rarely measured, and, as a consequence, we cannot control for all of these factors. This places a natural constraint on the extent to which our updated framework is able to disentangle the sorting on all unobserved variables from the role played by acquisition.

The analytical and empirical findings in this paper show that conventional estimates of the role of education in social reproduction pick up the impact of early skill formation processes unrelated to the impact of formal education. As a consequence, the role of education may be overstated. This finding has important policy implications. Education is widely regarded as the key to promoting mobility in advanced industrial societies. Investments in education are often politically motivated by providing better opportunities for disadvantaged children. However, our analysis suggests that educational investments may not fully fulfill the promises of an education-based meritocracy. In contrast, early childhood influences—as they manifest themselves in the cultivation of skills—play a crucial part in social mobility over and above the impacts of formal schooling. By this token, policies that help foster skills among disadvantaged children early in life would be a welcomed addition to investments in education.

Notes

[1] We realize that prominent status attainment studies (Sewell et al., 1969; Duncan, Featherman, & Duncan, 1972; Jencks et al., 1972, 1979) explicitly examined the independent effects of education on occupational and economic attainment once they factored in measures of skills and even relatively early measures of skills (Duncan, 1968). However, none of these studies explicitly examined how accounting for early skills would impact the *mediating* impact of education on social reproduction, which is the key concern of this article. Still, in formulating an extended OED framework, we build extensively on the status attainment tradition and the path models that this tradition relied on.

[2] In other words, we use the system of linear equations as a tool for outlining the analytical implications of omitting ability in the OED framework. However, as Hout (1988) discovered, origins and education interact in such a way that the OD association is weaker for higher levels of education. Thus, the linearity assumption implies that we use an average of the effects by educational level to proxy the general social processes that this paper examines (i.e., so-called conditional variance weighting).

[3] Stratification theories also make predictions about how the role of education in mobility should change over time in tandem with industrialization and post-industrialization processes (Erikson & Goldthorpe, 1992; Grusky, 1983; Halsey et al., 1980; Treiman, 1970). Two major theories, the liberal theory of industrialism and status maintenance theory, agree that the indirect path via education should increase in importance over time. While both theories argue that educational qualifications increasingly sort people into occupations, meaning that the ED link should strengthen over time, the former argues that ascriptive family factors, captured in the OD link, should decline in significance over time, whereas the latter argues that privileged

families increasingly monopolize educational credentials to secure privileges for their offspring, captured in a strengthening of the OE link.

[4] In making this distinction, we draw on the literature on the returns to schooling in economics (see, e.g., Blundell, Dearden, & Sianesi, 2005; Card, 1999; Griliches, 1977). Economists have devoted considerable attention to the bias that arises in the estimated returns from selection into schooling on abilities. More advanced levels of schooling require more able students, and more able students tend to pursue more advanced levels of schooling. Therefore, the estimated returns to schooling will reflect the positive selection on ability rather than the genuine or causal effect of schooling on labor market outcomes. However, in contrast to the economics literature, in this paper, we do not make any causal claims regarding the impact of schooling, but rather present a simple decomposition that breaks down education's mediating impact into a component explained by and a component unexplained by early skills. Duncan, Featherman, and Duncan (1972:91) is an early example discussing these issues in the status attainment tradition.

[5] This regrouping of effects is inspired by the statistical literature on how to control for what is known as post-treatment confounders in causal mediation analysis (see, e.g., VanderWeele, 2009; Wodtke, 2018). In our setup, early skills are a post-treatment confounder of the indirect effect of education on the origins-destinations association.

[6] We use the derived social class measures available in the surveys. Our dummy coding separates those placed in classes I and II from those in III, IV, and V, but notice that these numerals do not refer to EGP classes.

[7] We code higher education attainment in terms of NVQ levels 4 and 5.

[8] The NCDS and BCS also include some measures of non-cognitive skills (or proxies thereof). However, as these measures do not exist in both surveys, we do not use them here. Supplementary analyses (available from the authors upon request) show that adding these

variables to the models do not change any of the major results we report here, suggesting that the noncognitive skill measures in the surveys do not account for the mediating impact of education once cognitive skills are taken into account.

[9] Notice that the distribution of the test measuring the number of correct words has an extremely heavy tale (35 percent of the respondents score 1 word, and 18 percent score 2, meaning that more than 50 percent of the respondents are placed at the very low end of the distribution). We therefore use the vocabulary test at age 5 as our measure of reading/language skills to be compared with the reading test age 7 in the NCDS. Moreover, in the models including all age 5 test scores, we include the natural log of the number of correct words.

[10] Because our framework relies on linear path models, we also conducted a series of analyses in which we modelled destinations with a logit model using the decomposition principles set forward in Breen, Karlson, and Holm (2013). The pattern of results are virtually identical to those reported in the main text with the only difference being that the level of percent mediated is a few percentage points lower in all models. Results are available from the authors upon request.

[11] This finding of declining occupational returns is consistent with results based on other surveys (see van de Werfhorst, 2007).

[12] Using structural equation modeling, we test whether $\delta\lambda = 0$, thus omitting the scale factor *m* in the testing.

[13] We notice that the percent mediated in Model 4b is slightly larger than the percent mediated in Model 3b. This likely results from suppression effects once we enter the two additional skill variables in Model 4b.

References

Allmendinger, J. (1989). Educational Systems and Labor Market Outcomes. *European Sociological Review*, *5*(3), 231–250.

Angrist, J. D., & Krueger, A. B. (1991). Does Compulsory School Attendance Affect Schooling and Earnings? *Quarterly Journal of Economics*, *106*, 979–1014.

Bernardi, F., & Ballarino, G. (2016). *Education, Occupation and Social Origin: A Comparative Analysis of the Transmission of Socio-Economic Inequalities.* Cheltenham, Gloucestershire: Edward Elgar Publishing.

Blau, P. M., & Duncan, O. D. (1967). *The American Occupational Structure*. New York: Wiley.

Blundell, R., Dearden, L., & Sianesi, B. (2005). Evaluating the Effect of Education on Earnings: Models, Methods and Results from the National Child Development Survey. *Journal of the Royal Statistical Society: Series A (Statistics in Society), 168*(3), 473–512.

Borghans, L., Duckworth, A. L., Heckman, J. J., & ter Weel, B. (2008). The Economics and Psychology of Personality Traits. *Journal of Human Resources*, *43*(4), 972–1059.

Bowles, S., Gintis, H., & Osborne, M. (2001). The Determinants of Earnings: A Behavioral Approach. *Journal of Economic Literature*, *39*(4), 1137–1176.

Breen, R., & Goldthorpe, J. H. (2001). Class, Mobility and Merit: The Experience of Two British Birth Cohorts. *European Sociological Review*, *17*(2), 81–101.

Breen, R., & Jonsson, J. O. (2005). Inequality of Opportunity in Comparative Perspective: Recent Research on Educational Attainment and Social Mobility. *Annual Review of Sociology*, *31*, 223–243.

Breen, R., & Karlson, K. B. (2013). Education and Social Mobility: New Analytical Approaches. *European Sociological Review*, *30*(1), 107–118.

Breen, R., & Luijkx, R. (2004). Social Mobility in Europe between 1970 and 2000. In R. Breen (Ed.), *Social Mobility in Europe* (pp. 37–76). Oxford: Oxford University Press.

Breen, R., Luijkx, R., Müller, W., & Pollak, R. (2009). Nonpersistent Inequality in Educational Attainment: Evidence from Eight European Countries. *American Journal of Sociology*, *114*(5), 1475–1521.

Card, D. (1999). The Causal Effect of Education on Earnings. In O. Ashenfelter, & D. Card (Eds.), *Handbook of Labor Economics, Volume 3* (pp. 1801–1863). New York: North-Holland.

---. (2001). Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems. *Econometrica*, *69*(5), 1127–1160.

Cunha, F., & Heckman, J. (2007). The Technology of Skill Formation. *American Economic Review*, *97*(2), 31–47.

---. (2008). Formulating, Identifying and Estimating the Technology of Cognitive and Noncognitive Skill Formation. *Journal of Human Resources*, *43*(4), 738–782.

Duncan, O. D. (1966). Path analysis: Sociological examples. *American Journal of Sociology*, *72*(1), 1–16.

---. (1968). Ability and Achievement. *Eugenics Quarterly*, *15*(1), 1–11.

Duncan, O. D., Featherman, D. L., & Duncan, B. (1972). Socioeconomic Background and Achievement. New York: Seminar Press.

Elwert, F., & Winship, C. (2014). Endogenous Selection Bias: The Problem of Conditioning on a Collider Variable. *Annual Review of Sociology*, *40*, 31–53.

Erikson, R., & Goldthorpe, J. H. (1992). *The Constant Flux: A Study of Class Mobility in Industrial Societies*. Oxford: Clarendon Press.

Erikson, R., & Jonsson, J. O. (1996). *Can Education be Equalized? The Swedish Case in Comparative Perspective*. Boulder, CO: Westview Press.

Farkas, G. (1996). *Human Capital or Cultural Capital? Ethnicity and Poverty Groups in an Urban School District.* New York: A. de Gruyter.

---. (2003). Cognitive Skills and Noncognitive Traits and Behaviors in Stratification Processes. *Annual Review of Sociology*, *29*(1), 541–562.

Feinstein, L. (2003). Inequality in the Early Cognitive Development of British Children in the 1970 Cohort. *Economica*, *70*, 73–97.

Goldthorpe, J. H. (2014). The Role of Education in Intergenerational Social Mobility: Problems from Empirical Research in Sociology and Some Theoretical Pointers from Economics. *Rationality and Society*, *26*(3), 265–289.

Griliches, Z. (1977). Estimating the Returns to Schooling: Some Econometric Problems. *Econometrica*, *45*, 1–22.

Grusky, D. B. (1983). Industrialization and the Status Attainment Process: The Thesis of Industrialism Reconsidered. *American Sociological Review*, *48*, 494–506.

Gugushvili, A., Bukodi, E., & Goldthorpe, J. H. (2017). The Direct Effect of Social Origins on Social Mobility Chances: 'Glass Floors' and 'Glass Ceilings' in Britain. *European Sociological Review*, *33*(2), 305–316.

Halsey, A. H., Heath, A. F., & Ridge, J. M. (1980). *Origins and Destinations: Family, Class, and Education in Modern Britain*. Oxford: Clarendon Press.

Heckman, J. J. (2006). Skill Formation and the Economics of Investing in Disadvantaged Children. *Science*, *312*, 1900–1902.

----. (2008). "Schools, Skills, and Synapses." *Economic Inquiry*, *46*(3), 289–324.

Heckman, J. J., Stixrud, J., & Urzua, S. (2006). The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior. *Journal of Labor Economics*, *24*(3), 411–482.

Hout, M. (1988). More Universalism, Less Structural Mobility: The American Occupational Structure in the 1980s. *American Journal of Sociology*, *93*(6), 1358–1400.

Hout, M., & DiPrete, T. A. (2006). What We Have Learned: RC28's Contributions to Knowledge about Social Stratification. *Research in Social Stratification and Mobility*, *24*(1), 1–20.

Ishida, H., Muller, W., & Ridge, J. M. (1995). Class Origin, Class Destination, and Education: A Cross-National Study of Ten Industrial Nations. *American Journal of Sociology*, *101*(1), 145–193.

Jackson, M. (2013). *Determined to Succeed? Performance versus Choice in Educational Attainment*. Stanford: Stanford University Press.

Jencks, C., Smith M., Acland H., Bane, M. J., Cohen, D., Gintis, H., Heyns, B., & Michelson, S. (1972). *Inequality. A Reassessment of the Effect of Family and Schooling in America*. New York: Basic Books.

Jencks, C., Bartlett, S., Corcoran, M., Crouse, J., Eaglesfield, D., Jackson, G., McClelland, K., Mueser, P., Olneck, M., Schwartz, J., Ward, S., & William, J. (1979). *Who Gets Ahead? The Determinants of Economic Success in America*. New York: Basic Books.

Jerrim, J., & Macmillan, L. (2015). Income Inequality, Intergenerational Mobility, and the Great Gatsby Curve: Is Education the Key? *Social Forces*, *94*(2), 505–533.

Jonsson, J. O. (1996). Stratification in Post-Industrial Society: Are Educational Qualifications of Growing Importance?" In R. Erikson, & J. O. Jonsson (Eds.), *Can Education be Equalized? The Swedish Case in Comparative Perspective* (pp. 113–144). Boulder, CO: Westview Press.

Kerckhoff, A. C. (1989). On the Social Psychology of Social Mobility Processes. *Social Forces*, *68*(1), 17–25.

Kerckhoff, A. C., Raudenbush, S. W., & Glennie, E. (2001). Education, Cognitive Skill, and Labor Force Outcomes. *Sociology of Education*, *74*, 1–24.

Kuha, J., & Goldthorpe, J. H. (2010). Path Analysis for Discrete Variables: The Role of Education in Social Mobility. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, *173*(2), 351–369.

Murnane, R. J., Willett, J. B., & Levy, F. (1995). The Growing Importance of Cognitive Skills in Wage Determination. *NBER Working Papers 5076*, National Bureau of Economic Research, Inc.

Murnane, R. J., Willett, J. B., Duhaldeborde, Y., & Tyler, J. H. (2000). How Important are the Cognitive Skills of Teenagers in Predicting Subsequent Earnings? *Journal of Policy Analysis and Management*, *19*(4), 547–568.

Parsons, S. (2014). *Childhood Cognition in the 1970 British Cohort Study*. Centre for Longitudinal Studies, University of London.

Sewell, W. H., Haller, A. O., & Portes, A. (1969). The Educational and Early Occupational Attainment Process. *American Sociological Review*, *34*, 82–92.

Shavit, Y., & Blossfeld, H. P. (1993). *Persistent Inequality: Changing Educational Attainment in Thirteen Countries.* Boulder, CO: Westview Press.

Shavit, Y., & Muller, W. (1998). *From School to Work. A Comparative Study of Educational Qualifications and Occupational Destinations*. Oxford: Oxford University Press.

Shepherd, P. (2014). *1958 National Child Development Study User Guide: Measures of Ability at Ages 7 to 16.* Centre for Longitudinal Studies, University of London.

Shonkoff, J. P., & Phillips, D. (2000). *From Neurons to Neighborhoods: The Science of Early Child Development*. Washington DC: National Academy Press.

Torche, F. (2011). Is a College Degree Still the Great Equalizer? Intergenerational Mobility across Levels of Schooling in the United States. *American Journal of Sociology*, *117*(3), 763–807.

Treiman, D. J. (1970). Industrialization and Social Stratification. *Sociological Inquiry*, *40*(2), 207–234.

Treiman, D. J., & Yip, K. B. (1989). Educational and Occupational Attainment in 21 Countries. In M. L. Kohn (Ed.), *Cross-National Research in Sociology* (pp. 373–394). Newbury Park, California: Sage Publications.

van de Werfhorst, H. G. (2007). Scarcity and Abundance: Reconciling Trends in the Effects of Education on Social Class and Earnings in Great Britain 1972–2003. *European Sociological Review*, *23*(2), 239–261.

VanderWeele, T. J. (2009). Marginal Structural Models for the Estimation of Direct and Indirect Effects. *Epidemiology*, *20*(1), 18–26.

Warren, J. R., Sheridan, J. T., & Hauser, R. M. (2002). Occupational Stratification across the Life Course: Evidence from the Wisconsin Longitudinal Study. *American Sociological Review*, *67*(3), 432-455.

Winship, C., & Korenman, S. (1997). Does Staying in School Make You Smarter? The Effect of Education on IQ in *The Bell Curve*. In B. Devlin et al. (Eds.), *Intelligence, Genes, and Success: Scientists Respond to The Bell Curve* (pp. 215-234). New York: Springer.

Wodtke, G. T. (2018). Regression-based Adjustment for Time-varying Confounders. *Sociological Methods & Research*, online first (accessed 23-Nov-2018): https://doi.org/10.1177/0049124118769087.

Appendix

Deriving the sorting term

To derive the term capturing the impact of sorting on early skills into education, we exploit a property of regression coefficients. We can write the coefficient relating A to E in Figure 3 as

$$\delta = \frac{COV(E, A \mid O)}{V(A \mid O)}$$

and we can write the "reverse" coefficient relating E to A, defined in Figure A1, as

$$\rho = \frac{COV(E, A \mid O)}{V(E \mid O)}$$

Because the numerators are equal, we have that

$$\rho = \delta m \qquad \text{where } m = \frac{V(A \mid O)}{V(E \mid O)}.$$

According to the standard formula for omitted variable bias, we have that

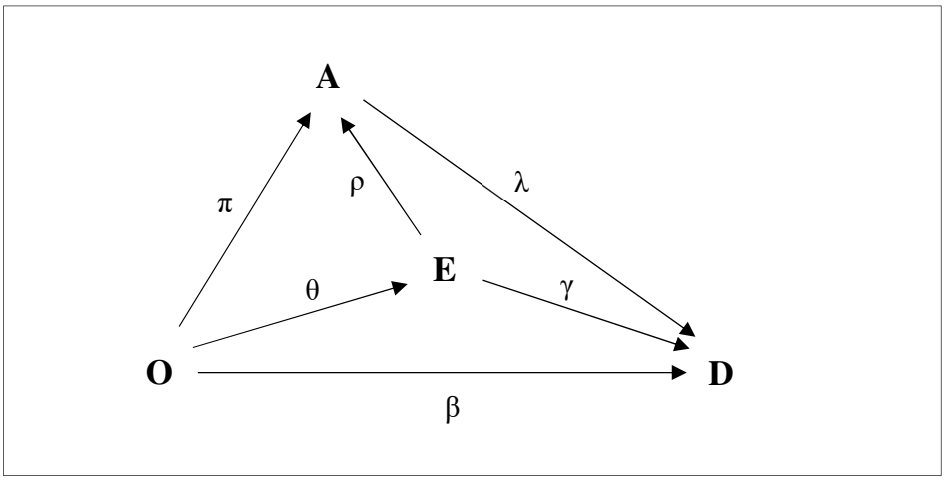
$$\gamma^* = \gamma + \lambda\rho,$$

which we accordingly may write as

$$\gamma^* = \gamma + \lambda\delta m \qquad \text{where } m = \frac{V(A \mid O)}{V(E \mid O)}.$$

Notice that we can calculate *m* using the residuals from two respective regressions of A and E on O. Also notice that, whenever A and E are standardized to unit variance, m measures the ratio between the explanatory power of origins in ability and education, respectively. If the explanatory power is the same, the correction factor equals unity and will therefore not affect the sorting term.

Figure A1. The Origins-Education-Destinations Framework in which Ability is a Mediator of the ED association.



Multiple Control Variables

Including more than one proxy for unobserved variables in our extended OED framework is straightforward. In this situation, we replace A in the system of equations in (2) in the main text with *K* variables, Z_k,

$$E(D) = \beta O + \gamma E + \sum_{k=1}^{K} \lambda_k Z_k$$

$$E(E) = \theta O + \sum_{k=1}^{K} \delta_k Z_k$$

$$E(Z_k) = \pi_k O$$

and use substitution to obtain the decomposition of the total effect of O on D:

$$\left(\beta + \gamma\theta + \sum_{k=1}^{K} \lambda_k \pi_k + \gamma \sum_{k=1}^{K} \delta_k \pi_k \right) O ,$$

where

β : Direct effect not via Z_k and E

$\gamma\theta$: Indirect effect via E, not via Z_k

$\sum_{k=1}^{K} \lambda_k \pi_k$: Indirect effect via Z_k, not via E

$\gamma \sum_{k=1}^{K} \delta_k \pi_k$: Indirect effect via Z_k and E.

Thus, adding multiple control variables that proxy unobserved variables poses no additional difficulties in our extended OED framework.

Table 1. Descriptive Statistics, NCDS and BCS. Percent

	NCDS	BCS
Fraction of service class origins	23.3	28.5
Fraction of service class destinations	39.3	46.7
Fraction of higher educated	25.2	38.0

Note: NCDS and BCS sample sizes are 16,888 and 15,291, respectively. Multiply imputed data with 25 datasets.

Table 2. Path Coefficients of Origins on Destinations via Education, NCDS and BCS.

	β^* DO|E	γ^* DE|O	θ^* EO	$\gamma^*\theta^*$ Indirect	$\beta^* + \gamma^*\theta^*$ Total
NCDS (Born 1958)	0.139	0.472	0.272	0.128	0.267
BCS (Born 1970)	0.139	0.328	0.244	0.080	0.219

Note: NCDS and BCS sample sizes are 16,888 and 15,291, respectively. Multiply imputed data with 25 datasets. All coefficients are statistically significant at a 5-percent significance level.

Table 3. Total, Direct and Indirect Effects of Origins on Destinations Other Than Through Education, NCDS and BCS. Regression Coefficients and Standard Errors in Parentheses.

a. National Child Development Study (NCDS)

	Total Effect	Direct Effect	Indirect Effect	Percent Mediated	t-value (H_0: $\delta\lambda = 0$)
1a. Conventional OED	0.267 (0.011)	0.139 (0.010)	0.128 (0.005)	48.1 (2.2)	-
2a. Corrected for test score at age 7 in reading	0.267 (0.011)	0.149 (0.010)	0.118 (0.005)	44.2 (2.0)	12.59
3a. Corrected for three test scores at age 7 in reading, draw-a-human-figure, and copying designs.	0.267 (0.011)	0.151 (0.010)	0.116 (0.005)	43.5 (2.0)	14.81
4.a Corrected for four test scores at age 7 in reading, draw-a-man, copying designs, and problem arithmetic	0.267 (0.011)	0.153 (0.010)	0.114 (0.005)	42.5 (2.0)	14.81
5a. Further corrected for three test scores at age 11 in reading, mathematics, and general ability	0.267 (0.011)	0.165 (0.010)	0.102 (0.004)	38.1 (1.9)	9.14

b. British Cohort Study (BCS)

	Total Effect	Direct Effect	Indirect Effect	Percent Mediated	t-value (H_0: $\delta\lambda = 0$)
1b. Conventional OED	0.219 (0.011)	0.139 (0.011)	0.080 (0.004)	36.6 (2.4)	-
2b. Corrected for test score at age 5 in verbal vocabulary	0.219 (0.011)	0.144 (0.011)	0.075 (0.004)	34.4 (2.3)	8.13
3b. Corrected for three test scores at age 5 in vocabulary, human figure drawing, and copying designs.	0.219 (0.011)	0.147 (0.011)	0.072 (0.004)	32.9 (2.2)	10.94
4b. Corrected for five test scores at age 5 in vocabulary, human figure drawing, copying designs, complete a human profile, and number of words read correctly.	0.219 (0.011)	0.147 (0.011)	0.072 (0.004)	33.0 (2.3)	9.82
5b. Further corrected for six test scores at age 10 in reading, mathematics, BAS matrices, BAS word definitions, BAS word similarities, and BAS recall of digits	0.219 (0.011)	0.156 (0.011)	0.063 (0.003)	28.7 (2.0)	9.52

Note: NCDS and BCS sample sizes are 16,888 and 15,291, respectively. Multiply imputed data with 25 datasets. BAS refers to the British Ability Scales. All estimates are significant at a 5-percent significance level.

Figure 1. The Origins-Education-Origins Triangle

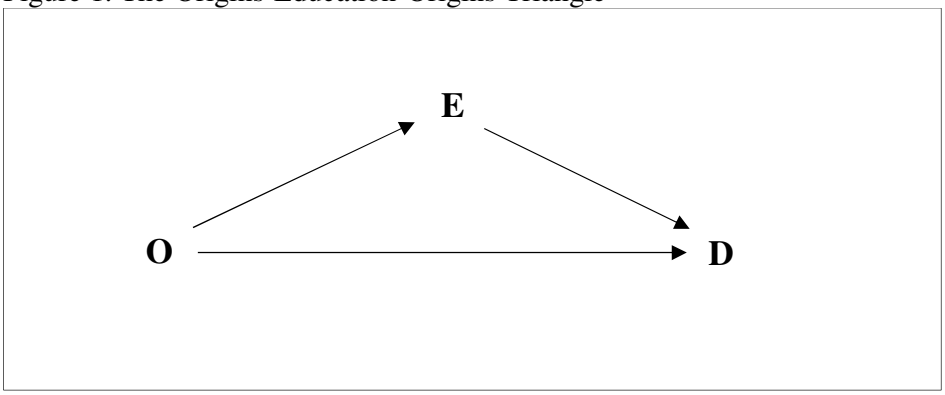


Figure 2. Path Diagram of the Origins-Education-Origins Triangle

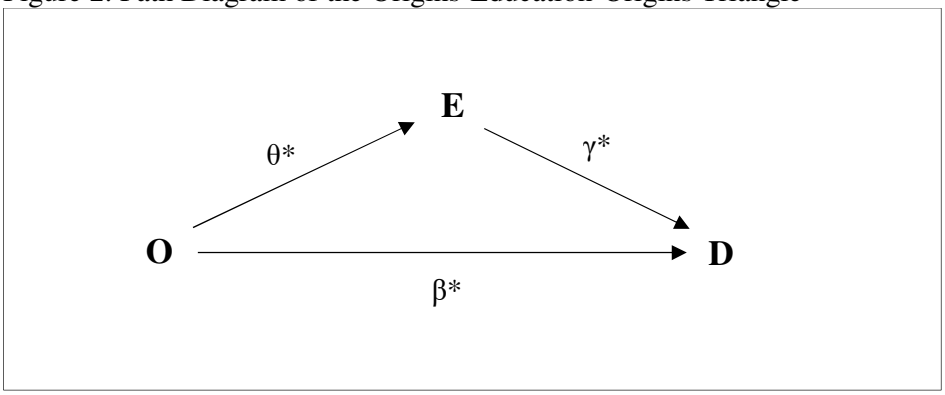


Figure 3. The Origins-Education-Origins Triangle Including Early Skills (A) as a Control Variable for the Education-Destinations Path and as being Dependent on Origins.