



Does industrial development predict equalization in educational opportunity? A multiverse analysis[☆]

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ABSTRACT

There is mixed empirical evidence for the modernization theoretical prediction that inequality of educational opportunity is reduced through societal developments generated by industrialization. This paper conducts a multiverse analysis with 768 distinct multilevel regression models in order to comprehensively test this prediction and to investigate how sensitive inference about the cross-level interaction effect is to variation in analytic choice. The alternative analysis scenarios or “universes” differ in the criteria used for the exclusion of observations, the operationalization and adjustment of micro- and macro-level variables, and the choice of regression model formula. The models are fit to data from 26 European countries that cover from four to six ten-year birth cohorts spanning a period from the 1930s to the 1980s. In aggregate, the multiverse of results is consistent with an industrialization-related decrease in the effects of social origins on the expected duration of schooling and on the completion of upper secondary education. However, the evidence for declining social origin differentials in the odds of completing tertiary education is considerably weaker, suggesting that the equalization is concentrated at the lower levels of education. It was also found that for all three educational outcomes there are reasonable analytic choice combinations that lead to an inability to observe the predicted equalization.

1. Introduction

This study provides a multiverse analysis of the modernization theoretical prediction that inequality of educational opportunity (“IEO”) is reduced through societal developments produced by industrialization. The prediction is substantially different from the expectation of mere educational expansion since it entails that, between offspring of differing social origins, the expected levels of educational attainment become increasingly similar. Because empirical research has not yet agreed on a uniform conclusion in regard to this claim (e.g. Bar Haim & Shavit, 2013; Momo, Rud, Cabus, De Witte, & Groot, 2019; Sieben & de Graaf, 2003; Treiman & Yip, 1989; van Doorn, Pop, & Wolbers, 2011), the application of the multiverse analytical approach is advantageous. This approach involves the consideration of a large number of reasonable analytic scenarios (universes) for the purpose of investigating whether different analytic choice combinations lead to different conclusions (Steegen, Tuerlinckx, Gelman, & Vanpaemel, 2016). In the present context, an advantage is that the aggregate of the results obtained from the different universes affords more information about the empirical adequacy of the modernization thesis than would a traditional

course of analysis. Moreover, analyzing the multiverse of results enables the identification of the points of analytic choice that play the greatest role in influencing the (in)ability to detect the predicted equalization. Before elaboration of the present study, the context is introduced.

Modernization theory, sometimes called the functionalist or liberal theory of industrialization, is often invoked in IEO literature to explain why the ascribed factors of social background shape educational attainment to different degrees in different countries and birth cohorts (Goldthorpe, 2014, 266–267; Meraviglia & Buis, 2015, 39). In its broader sociological context, modernization theory describes a universal trajectory of societal development from agrarian to post-industrial society. The theory asserts that progress on this trajectory is primarily driven by advancement in technological and economic aspects (or the “critical variables” of industrialization) so that similarly advanced societies converge to resemble one another in aspects beyond those of the technological and economic (Bell, 1999; He, 2012; Knobl, 2003; Levy, 1966; Rostow, 1960; Schmidt, 2010; Tipps, 1973). In effect, modernizing societies converge by substituting for their traditional structures, institutions and norms the alternatives that are more conducive to the functioning of the technologically and economically advanced state of

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affairs (Marks, 2014, 25–26).

In relation to convergence in the educational aspects, modernization theory makes on one hand the less controversial prediction that the development and maturation of the industrial society necessitates educational expansion in order to meet the human capital demand imposed by labor markets whose needs are mutated by technological innovations and growth in higher-skill economic sectors (Becker & Mayer, 2019, 149; Walters, 2004, 99). On the other hand, there is the more controversial prediction that the absolute increases in schooling are not sufficient as regards the efficient functioning of a relatively modernized society such that gradual reduction in IEO is required (Marks, 2014; Treiman, 1970).

The prediction of equalization in educational opportunity follows from the fundamental proposition of modernization theory that the technological-economic development entails an increasingly rational, open and universalistic society to whose occupational role structure individuals are allocated, for the sake of economic efficiency, on the basis of merit (Knobl, 2003; Levy, 1966; Marks, 2014). The logic is that, since education is in a relatively modernized society profoundly involved in the allocation of individuals to occupations, and more generally to social hierarchies, the meritocratic state of affairs cannot obtain if education selects for and signals ascribed characteristics like parental status instead of individual talent and effort. Hence, the constancy of the theory requires that, as industrial development and its demand for human capital introduce educational expansion and selection by education, the increases in schooling disproportionately benefit the lower strata – those whose potentials have been the most neglected – with the consequence that the origin-based differentials in educational attainment decline (Becker & Mayer, 2019, 149–150; Brown, 1995, 25; Meraviglia & Buis, 2015, 39; Sieben & de Graaf, 2001, 442; Treiman, 1970).

With the functionalist-meritocratic rationale for the equalization set, modernization theory posits secondary mechanisms that indirectly link the maturation of industrial society to a further reduction in IEO. These include increases in individualism and decline in the role of institutions such as family and social class in self-identification; illegitimation of the particularistic policies and practices of nepotistic discrimination and stratification; converging socialization of children and youth via mass culture and communication; urbanization via its effects on socialization and availability of schooling; and improvement in working class living conditions due to economic growth (Marks, 2014, 22–23, 168–169). Even after the completion of these processes, modernization theory does not claim that social origin differentials in educational attainment disappear completely. It is plausible that in the hypothetical meritocracy the heritability of cognitive ability ensures that the children of privileged origins remain somewhat better positioned to accumulate education (Marks, 2019).

Despite the impression that the modernization thesis is clear in its proposals and so its adequacy should be readily testable, the empirical literature has not reached any firm conclusion. At the outset, there are studies that investigate the degree to which IEO has tended to decline or persist over time in industrial societies by regressing in consecutive birth cohorts a durational or nominal measure of educational attainment on an indicator of social origins derived from parental occupational or educational status (Breen & Jonsson, 2005, 224; Erikson, 2020). An oft-cited collection of such single-country studies, Shavit and Blossfeld (1993), concluded on the basis of thirteen countries that the 20th century was marked by considerable educational expansion but constant IEO. The authors inferred from this that absolute increases in schooling reduce conflict over the relative distribution such that social origin differentials may remain stable over time (Blossfeld & Shavit, 1993, 22). Nevertheless, for many of the thirteen countries as well as other countries, later studies have observed concurrent expansion and equalization over 20th-century birth cohorts (Breen & Jonsson, 2005, 226; Marks, 2014, 185) and, eventually, it was proposed that the former analyses were statistically underpowered (Breen, Luijkx, Müller, & Pollak, 2009,

1507). Even so, there remain studies that support the thesis of persistent inequality (e.g. Bukodi & Goldthorpe, 2013; Pfeffer, 2008) as well as studies that find declining inequality (e.g. Barone & Ruggera, 2018; Breen et al., 2009; Breen, Luijkx, Müller, & Pollak, 2010).

A more targeted approach to investigating the modernization thesis, the approach considered in the present study, involves including in the IEO regression a proxy indicator of industrialization in order to explicitly model the association between IEO and the contextual factor that determines modernization (e.g. Bar Haim & Shavit, 2013; Momo et al., 2019; Treiman & Yip, 1989; van Doorn et al., 2011). This requires that individual-level observations of education and social origins are pooled from multiple societies and then nested in macro-level units whose relative levels of industrialization are indicated with the chosen proxy variable. This approach is advantageous in two ways. First, the observation of variation in the level of industrial development makes unnecessary the assumption that modernization is linear with time. Secondly, since the proxy variable is not constant between countries, its use enables the consideration of cross-national variation in conjunction with the temporal variation for the purpose of testing the prediction.

The results obtained with the more targeted approach are also mixed. In their seminal study, Treiman and Yip (1989) joined data from 21 countries' early to mid 20th-century birth cohorts and enriched the analysis with information on the countries' energy consumption and proportion of labor in agriculture. Evidence was found for declining parental status inequality, but the indicators of industrialization were not associated with a reduction in the relative educational disadvantage, measured in years of education, of those whose father's occupational prestige or education was low. Later studies vary from this seminal study in key areas, such as the operationalization of social origins and industrialization, and some report results more amenable to modernization theory. These include the study by van Doorn, Pop, and Wolbers (2011), in which the analysts incorporated GDP as the indicator of industrialization and social origins were only considered with reference to parental education. Using data from 28 European countries, they concluded that "the industrialization thesis is the most important explanation" for the variation in the inequality across countries and cohorts (van Doorn et al., 2011, 113). Momo, Rud, Cabus, De Witte, and Groot (2019) replicated the finding in a data set of 48 non-European countries, whereas Sieben and de Graaf (2001) and Sieben and de Graaf (2003) observed among a smaller number of Western countries a negative association between energy consumption and the influence of parental occupational status. While these studies vary in the operationalization of social origins and industrialization, they share the characteristic of modeling IEO as the linear slope of social origins on a durational measure of education. In contrast, Bar Haim and Shavit (2013) operationalized educational attainment as degree completion and, with data from 24 European countries, modeled IEO as the slope of social origins on the log odds of completion. Their findings suggest that neither economic productivity nor educational expansion is associated with a reduced influence of the father's education on the odds of completing upper secondary or tertiary education.

That a firm and generally accepted conclusion cannot be drawn on the basis of the extant studies is unsatisfactory. Thoroughgoing analyses of macrosociological regularities in IEO and social stratification are hampered by the uncertainty about the typical effects of industrial development on differential educational attainment. Perhaps more important, because the question of whether modernization theory has potency in the fields of education and stratification relates to questions of broader sociological import, the lack of a generally accepted conclusion limits sociological inference about the nature of modernity. This is evidenced by the discrepancy between modernization theory and the theory of multiple modernity. The latter rejects that there exist the kinds of predictable commonalities in societal development that the former proposes, and instead maintains that there are a plurality of trajectories toward a diverse set of modernities (Eisenstadt, 2000; Schmidt, 2010). Even when such commonalities are accepted,

Table 1
Summary of the multiverse specification.

1. Exclusion of observations
(a) Ages 25–75, 1930s–1980s birth cohorts (Lenient)
(b) Ages 30–65, 1940s–1970s birth cohorts (Strict)
2. Operationalization of educational attainment
(a) Theoretical years of education (linear modeling)
(b) Self-reported years of education (linear modeling)
(c) Completion of upper secondary education (logistic modeling)
(d) Completion of tertiary education (logistic modeling)
3. Data for social origins
(a) Father
(b) Both parents
4. Operationalization of social origins
(a) International Socio-Economic Index of Occupational Status (ISEI)
(b) Standard International Occupational Prestige Scale (SIOPS)
(c) Theoretical years of education (Yrs. ed.)
(d) Erikson-Goldthorpe-Portocarero Class Schema (EGP)
(e) International Standard Classification of Education 1997 (ISCED)
5. Centering of continuous social origins predictors
(a) Centering within cluster (CWC)
(b) Centering at grand mean (CGM)
6. Data for industrialization
(a) Birth decade (Birth)
(b) Decade after birth (After)
7. Operationalization of industrialization
(a) Per capita energy consumption (Energy)
(b) Per capita gross domestic product (GDP)
(c) Mean of z-scored energy consumption and GDP (Both)

sociologists disagree about their contents. This is apparent in the observation that by proposing that ascriptive inequalities are constituted by “carry-overs from a less advanced period” and thus are smoothed out over time, modernization theory comes in direct contradiction with the conflict theoretical sociological tradition (Collins, 1971, 1008). Strands of this tradition contend that the reproduction of ascriptive inequalities is inherent to the power struggle of modern societies, that the reproduction cannot be amended by the means of extant institutions (e.g. education), and therefore that changes to the stratificatory status quo are to be expected only under relatively extraordinary circumstances (Bourdieu & Passeron, 1990; Bowles & Gintis, 2011; Marks, 2014, 27). Accordingly, synthesizing a common understanding of modernity is impeded by, among other factors, the uncertainty about the adequacy of modernization theory in the context of IEO research.

One plausible reason for the previous empirical studies not suggesting a uniform conclusion is the variation in analytic choice. According to Steegen et al. (2016), in the traditional course of analysis the analytic choices that precede fitting a model to data limit the analysis to a subset with the result that many reasonable variations of the modeling process are left unexplored. Most obvious in the present context is that there are many reasonable ways to operationalize each of the theoretical variables (i.e. educational attainment, industrialization and social origins), and none of the realistically available options is error-free. Given the error, it is likely that in any data set one reasonable option or choice combination will return model coefficients that are consistent with modernization theory, whereas another reasonable option or choice combination would not. This is further amplified by other researcher choices that concern, for example, the exclusion of observations and the matching of individual-level data with the chosen macro-level indicator. The result is that each individual study is to some degree biased by its analytic choice combination. A corollary of this is that, had each of the previous analyses of the modernization thesis considered a plurality of reasonable analytic choice combinations, they would have been more likely to converge on a common conclusion.

On the basis of the above-mentioned reasons, the present study follows the proposal of Steegen et al. (2016) that researchers substitute a multiverse analysis for the traditional course of analysis. This involves considering multiple reasonable options at important points of analytic choice and summarizing the relevant coefficient estimates and their

respective tests of statistical significance across all choice combinations (universes). Therefore, the present study contributes to the empirical literature, first, by investigating the empirical adequacy of the modernization thesis and, secondly, by assessing how variation in analytic choice influences the conclusions.

2. Method

This section describes the data used, the points of analytic choice considered in the multiverse analysis, and the regression models that are fit to the data. For each point of analytic choice, multiple options are considered on the basis of prior literature. Table 1 summarizes the specification of the multiverse analysis.

2.1. Individual-level data and measures

The individual-level data on educational attainment and social origins come from the 2002–2010 rounds of the European Social Survey (ESS) (ESS Round 1, 2002; ESS Round 2, 2004; ESS Round 3, 2006; ESS Round 4, 2008; ESS Round 5, 2010). The ESS is a biennial cross-national survey that uses random sampling and post-stratified weighting to approximate a representation of European populations. Unlike the newer rounds, these rounds of the ESS can be augmented with the ISCO-88 occupations of the parents of the respondent (Ganzeboom, 2013). Because most measures of social origins require the father’s or both parents’ ISCO occupations, the inclusion of this information is crucial. For each round, countries with discrepancies in the coding of educational attainment were removed. After this operation, observations from 26 countries remained. These countries were: Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine and the United Kingdom.

2.1.1. Exclusion of observations

Analyses of IEO routinely remove observations on the basis of respondent age. On one hand, respondents of a younger age are more likely to be in the middle of completing a degree with the consequence that information on their final educational attainment is incomplete. On the other hand, older respondents present the problem of differential mortality, which entails that the available data may be biased relative to the actual birth cohort (Ganzeboom & Treiman, 1993, 471). However, the removal of observations creates a reduction in statistical power. Based on these concerns, two reasonable sets of exclusion criteria were considered. Lenient exclusion criteria subset the data to respondents who were 25 to 75 years old at the time of the survey ($n = 112,635$). With strict exclusion criteria, the corresponding age range was 30–65 ($n = 83,513$). The former has the advantage of increased statistical power due to the inclusion of more birth cohorts (1930s–1980s) in the analyses, whereas the latter includes fewer birth cohorts (1940s–1970s) but is forceful in adjusting for the age-related problems indicated above. Additionally, in both lenient and strict universes respondents born outside the surveyed country were pruned, since no information was available on where these individuals were educated.

2.1.2. Operationalization of educational attainment

Typical measures of educational attainment are those that relate to the duration of education and those that relate to the completion of levels of education such as upper secondary or tertiary education (Breen & Jonsson, 2005, 225). The former have the advantage that they enable education to be treated as a unitary process that can be parsimoniously modeled as the linear outcome of social origins and other predictors (Connelly, Gayle, & Lambert, 2016, 5). The latter explicitly relate to the successful achievement of some level on the educational trajectory and the estimates of IEO are in this sense more “structural” (Mare, 1993, 353). The ESS data contain the respondents’ highest level of completed

education (less than lower secondary education, lower secondary education, upper secondary education, post-secondary non-tertiary education, lower tertiary education or higher tertiary education) as well as their impression of how many years of formal education they have received. This information was used to construct four alternative measures of educational attainment. First, there were two durational measures: *theoretical years of education* and *self-reported years of education*. Theoretical (or “virtual”) years of education is the most typical measure in the relevant literature (e.g. Ganzeboom & Treiman, 1993; Momo et al., 2019; Treiman & Yip, 1989; van Doorn et al., 2011). This measure reports the cumulative duration it ideally takes to obtain the highest level of education reported by the respondent. Information from the UNESCO ISCED conversion tables (UNESCO, 2004) and the International Stratification and Mobility File by Ganzeboom and Treiman (2012) were used to find the appropriate number of years for each country and level of education. Self-reported years of education, on the other hand, is the respondents’ estimation of the duration of their education. It is seldom considered in the literature since it may conflate multiple degrees at a lower level of education as well as grade retention with a higher degree. However, considering self-reported years of education as a reasonable option offered the opportunity to investigate the sensitivity of the results to alternative operationalization. Secondly, two binary outcomes, the completion of upper secondary education and the completion of tertiary education, were considered (as in Bar Haim & Shavit, 2013). A respondent was coded as having completed upper secondary education if they reported a degree in any track of upper secondary education or at a higher level, and was coded as having completed tertiary education if they reported a degree in lower tertiary education (equivalent to BA level, academic or professional) or higher. These outcomes represent important transition points in all societies included in the data, and enable the consideration of logistic modeling along with the linear modeling.

2.1.3. Operationalization of social origins

According to Erikson (2020, 2), in IEO research the typical measures of social origins relate to parental (or only the father’s) education, social status, social class, or earnings. In the ESS data, there is information on parental occupation (ISCO-88 when the respondent was 14 years old) and parental education (ISCED-97, highest degree at time of survey: less than lower-secondary-educated, lower-secondary-educated, upper-secondary-educated, post-secondary-non-tertiary-educated, tertiary-educated). The occupational data were exploited to derive alternative measures of social status and class, whereas the ISCED was used as it stands, but was also converted to theoretical years of education in the manner described above. Following prior research, the measures constructed with parental occupation were the *Standard International Occupational Prestige Scale* (SIOPS) (as used in e.g. Treiman & Yip, 1989), the *International Socio-Economic Index of Occupational Status* (ISEI) (e.g. Sieben & de Graaf, 2001) and the *Erikson-Goldthorpe-Portocarero Class Schema* (EGP) (e.g. Barone & Ruggera, 2018). Treiman’s (1977) SIOPS measures social status on the basis of popular evaluations of occupational prestige, whereas ISEI is based on international averages of socio-economic characteristics such as income and education (Ganzeboom & Treiman, 2003). With regard to EGP, six nominal class categories could be identified (as in e.g. Barone & Ruggera, 2018). These are *unskilled blue collar workers* (VII), *skilled blue collar workers* (V+VI), *farmers and the self-employed in agriculture* (IVc), *the self-employed in non-agricultural sectors* (IVa+b), *white collar workers* (III) and *service class professionals* (I+II). For each measure, two variants were considered to be reasonable options. One variant is based on the father’s information, and the other variant is based on both parents’ information. Using both parents’ information entailed taking the means of the continuous scales, or in the cases where the predictor was categorical, using the dominance criterion to select for each respondent the parent with the higher level of education or class position. When the dominance criterion was applied to EGP, only the non-self-employed classes could be included because

ordinal ranking of classes was required.

2.2. Macro-level data and measures

Country- and cohort-specific macro-level data were used to investigate how the IEO relation between educational attainment and social origins varies with modernization. Since in modernization theoretical literature modernization denotes the process of general societal development that follows technological-economic advancements of industrialization (Levy, 1966), the present purpose requires that there are macro-level indicators that measure the level of industrial development (as in e.g. Momo et al., 2019; Sieben & de Graaf, 2003; Treiman & Yip, 1989; van Doorn et al., 2011).

2.2.1. Operationalization of industrialization

Measuring industrialization is not unproblematic because for cross-national and longer-term temporal analysis there are only a few indicators for which comparable data exists (Horrendorf, Rogerson, & Valentinyi, 2014). In fact, the use of one of two indicators appears standard in studies that investigate the modernization thesis. These are *per capita energy consumption* (e.g. Sieben & de Graaf, 2003; Treiman & Yip, 1989) and *per capita gross domestic product* (GDP) (e.g. Bar Haim & Shavit, 2013; van Doorn et al., 2011). Using the former, it is assumed that the more technologically advanced societies consume more energy, whereas the rationale for using GDP is that the economic modernization is manifest in increased production. Both energy consumption and GDP were in this study considered reasonable options. Following an earlier example, the mean of the two z-scored variables was considered a third alternative (Treiman & Yip, 1989). The data for energy consumption were provided by the Database of World Energy Consumption 1820–2018 assembled by Paolo Malanima (Kander, Malanima, & Warde, 2013; Malanima, 2020). The GDP information was obtained from the 2020 data set of the Maddison project (Bolt & van Zanden, 2014,2020).

2.2.2. Matching together the macro- and individual-level data

To pair the macro-level indicators with individual-level observations, the latter were first grouped by country and decade of birth. Such grouping was done, in this and previous studies (e.g. Bar Haim & Shavit, 2013; Sieben & de Graaf, 2003; van Doorn et al., 2011), because the macro-level indicators vary between countries as well as temporally, so only the country-cohort combination properly identifies the societal environment of each individual-level observation. Moreover, nesting observations on only the basis of country, or only on the basis of birth cohort, would lead to far too few macro-level units with the consequence that statistical power would be lacking. In the universes with lenient exclusion of observations, this resulted in 156 country-cohort combinations (26 countries × 6 ten-year birth cohorts). With strict criteria, the number of country-cohorts was 104 (26 countries × 4 ten-year birth cohorts). Two alternative approaches were then used to match the country-cohorts with the indicators. In the first approach, the macro-level data concern the decade of birth, and for each indicator the mean of the unique birth years is calculated to represent the country-cohort’s level of industrialization. In the second approach, it is not the decade of birth, but the decade after, from which data is used. It is not obvious whether one should prefer to use data from the decade of birth (as in e.g. Bar Haim & Shavit, 2013) or the decade after (e.g. van Doorn et al., 2011). The former option may more accurately reflect the environment of early socialization and schooling, whereas the latter may be more relevant for the educational transitions the individual makes.

2.3. Analytic approaches

To test the modernization thesis, two general types of regression formulae, multilevel linear and multilevel logistic, were fit to the data.

These correspond to the main approaches to the estimation of IEO in a single-level context, namely to least squares regressions of offspring years of education on social origins and to logistic regressions of the log odds of completing some level of education contingent on social origins. The extension of these models to the multilevel framework permits the simultaneous modeling of micro- and macro-level characteristics as determinants of educational attainment. Accordingly, the nesting of individual-level observations to country-cohorts of differing levels of industrialization enables the estimation of the cross-level interaction between the individual-level predictor and the macro-level predictor (Aguinis et al., 2013; McNeish & Kelley, 2019).

2.3.1. Linear modeling

In the universes with a durational measure of educational attainment, linear multilevel models of the following type were fit to the data:

$$\begin{aligned}
 \text{Duration}_{ij} &= \beta_{0j} + \beta_{1j}\text{Origins}_{ij} + \beta_2\text{Gender}_{ij} + \beta_3\text{Round}2_{ij} \\
 &\quad + \beta_4\text{Round}3_{ij} + \beta_5\text{Round}4_{ij} + \beta_6\text{Round}5_{ij} + \epsilon_{ij} \\
 \beta_{0j} &= \gamma_{00} + \gamma_{01}\text{Industrialization}_j + u_{0j} \\
 \beta_{1j} &= \gamma_{10} + \gamma_{11}\text{Industrialization}_j + u_{1j}
 \end{aligned}
 \tag{1}$$

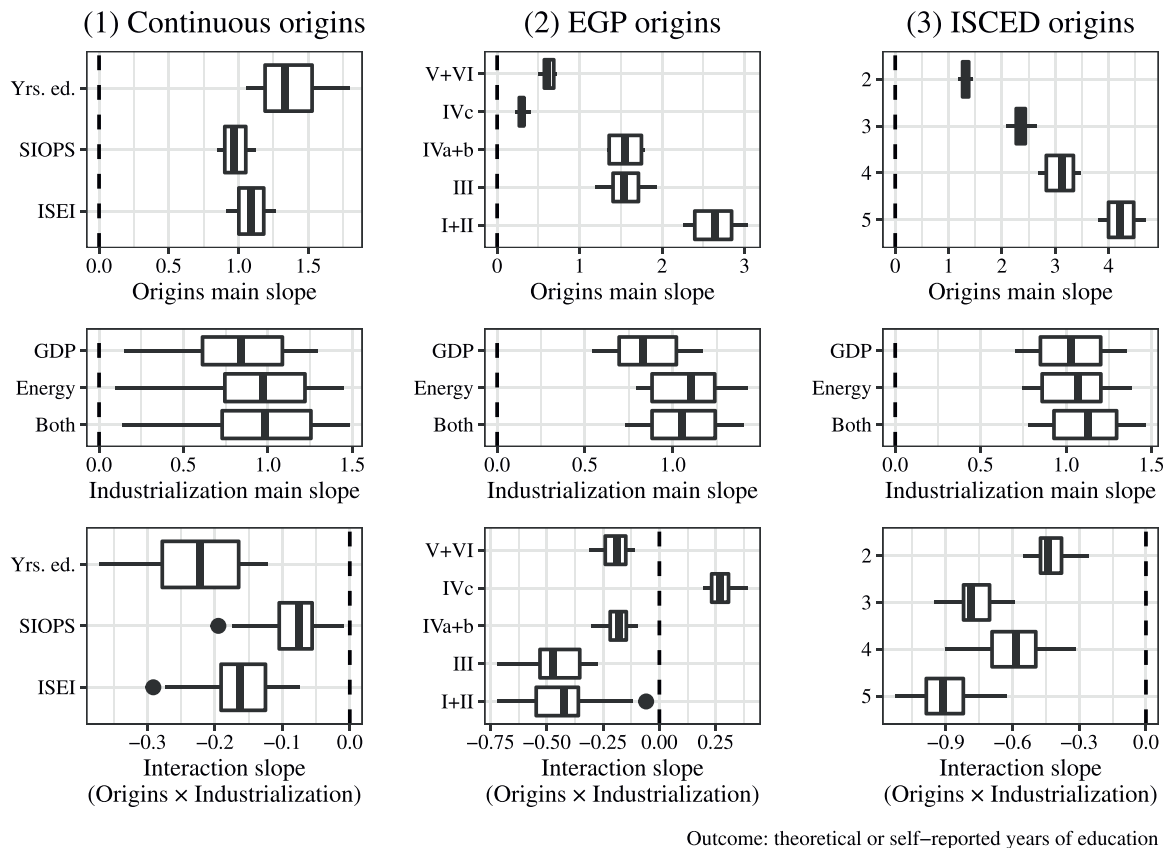
where i indexes individual-level observations and j indexes country-cohorts, *Duration* is either theoretical or self-reported years of education, *Origins* denotes the social origins of the respondent, *Gender* is a dummy control variable (1 = *Female*), the *Rounds* are dummy control variables that indicate the wave of the ESS survey, and *Industrialization* is the country-cohort's value on the macro-level indicator. In the universes with a categorical *Origins* predictor, there are in actuality multiple social origins slopes so that each makes a contrast to a reference group which is always the lowest origin group (EGP VII or ISCED 1). The intercept (β_{0j})

and the social origins slope(s) (β_{1j}) are let vary by country-cohort and the level of industrialization.

Since industrialization is associated with educational expansion, the main slope of industrialization, i.e. the γ_{01} on the intercept, should be positive. More important, modernization theory expects that the influence of social origins on the educational outcome declines with industrialization. Therefore, the cross-level interaction between *Origins* and *Industrialization*, as reflected in the interaction slope γ_{11} , should be negative. However, in the universes whose models contain multiple interaction slopes (i.e. when a categorical origins predictor is chosen), it is not sufficient to look at the signs of the coefficients to ascertain whether in total the groups' expectations are estimated to converge with industrialization. Therefore, the total variability and its change over industrialization is assessed with the kappa index which expresses the standard deviation of the origin group coefficients (Barone & Ruggera, 2018; Hout, Brooks, & Manza, 1995). A reduced standard deviation signals less origin-based variation in the expected outcome.

2.3.2. Logistic modeling

In the universes where either the completion of upper secondary education or the completion of tertiary education was chosen as the outcome of interest, the multilevel equations are otherwise similar to the above, but on the left hand side $\log\left(\frac{P_{\text{completion}_{ij}}}{1-P_{\text{completion}_{ij}}}\right)$ is substituted for *Duration*_{ij}. That is, the model coefficients relate to the (log) odds that an individual i of country-cohort j has completed the level of education contingent on the individual- and macro-level characteristics. Since the expectation of modernization theory is that the odds ratios among individuals with differing social origins are nearer to one with higher industrialization, the interaction slope γ_{11} should be negative. Once



Outcome: theoretical or self-reported years of education

Figure 1. Tukey-style box plots of coefficient estimates from the 384 universes with a durational educational outcome. Within-box segments are the interquartile ranges (IQR) of the estimates produced with different analytic choice combinations. Vertical bars denote median estimates. Whiskers cover the segments between the minimal and maximal estimates excluding individually plotted outliers. Outliers are estimates the values of which are at least $1.5 \times$ IQR away from the nearer end of the IQR.

Table 2

288 point estimates for the *Origins* × *Industrialization* interaction from the universes with a durational educational outcome and a continuous origins predictor. Each universe (cell) is uniquely identified by the analytic choice combination specified in the table margins. Negative coefficient implies that the association between the educational outcome and the measure of social origins (specified on the left) is estimated to decline with the measure of industrialization (top). Bold coefficient indicates that the slope is statistically significantly different from zero at $\alpha = 0.05$.

			GDP		Energy		Both		GDP		Energy		Both	
			Birth	After	Birth	After	Birth	After	Birth	After	Birth	After	Birth	After
Theoretical years of education														
Parental	CWC	ISEI	-0.12	-0.13	-0.10	-0.12	-0.12	-0.13	-0.11	-0.13	-0.10	-0.12	-0.12	-0.13
		SIOPS	-0.05	-0.06	-0.02	-0.03	-0.04	-0.05	-0.04	-0.06	-0.02	-0.03	-0.03	-0.05
		Yrs. ed.	-0.15	-0.15	-0.13	-0.15	-0.15	-0.17	-0.13	-0.15	-0.15	-0.12	-0.14	-0.14
CGM	CWC	ISEI	-0.17	-0.17	-0.15	-0.18	-0.17	-0.19	-0.16	-0.18	-0.15	-0.17	-0.17	-0.19
		SIOPS	-0.09	-0.09	-0.06	-0.08	-0.08	-0.09	-0.08	-0.09	-0.06	-0.07	-0.07	-0.09
		Yrs. ed.	-0.28	-0.29	-0.23	-0.30	-0.27	-0.32	-0.25	-0.27	-0.25	-0.29	-0.27	-0.31
Father's	CWC	ISEI	-0.11	-0.11	-0.11	-0.14	-0.12	-0.14	-0.10	-0.11	-0.12	-0.14	-0.12	-0.14
		SIOPS	-0.06	-0.06	-0.05	-0.07	-0.06	-0.07	-0.05	-0.06	-0.06	-0.08	-0.06	-0.08
		Yrs. ed.	-0.18	-0.17	-0.15	-0.18	-0.18	-0.19	-0.15	-0.16	-0.14	-0.16	-0.16	-0.18
	CGM	ISEI	-0.17	-0.17	-0.18	-0.21	-0.19	-0.21	-0.16	-0.17	-0.19	-0.21	-0.19	-0.21
		SIOPS	-0.10	-0.10	-0.10	-0.12	-0.11	-0.12	-0.09	-0.10	-0.10	-0.12	-0.11	-0.12
		Yrs. ed.	-0.26	-0.27	-0.21	-0.26	-0.25	-0.29	-0.24	-0.26	-0.22	-0.25	-0.25	-0.28
Self-reported years of education														
Parental	CWC	ISEI	-0.12	-0.10	-0.16	-0.18	-0.15	-0.15	-0.09	-0.09	-0.18	-0.19	-0.15	-0.16
		SIOPS	-0.03	-0.02	-0.07	-0.08	-0.06	-0.06	-0.01	-0.01	-0.09	-0.10	-0.06	-0.07
		Yrs. ed.	-0.14	-0.13	-0.18	-0.20	-0.17	-0.18	-0.13	-0.12	-0.19	-0.21	-0.17	-0.19
CGM	CWC	ISEI	-0.18	-0.16	-0.22	-0.24	-0.22	-0.22	-0.15	-0.15	-0.24	-0.25	-0.21	-0.23
		SIOPS	-0.07	-0.06	-0.12	-0.13	-0.11	-0.11	-0.05	-0.05	-0.13	-0.15	-0.10	-0.11
		Yrs. ed.	-0.28	-0.28	-0.30	-0.36	-0.31	-0.35	-0.25	-0.25	-0.33	-0.37	-0.31	-0.35
Father's	CWC	ISEI	-0.10	-0.08	-0.16	-0.19	-0.14	-0.15	-0.08	-0.07	-0.19	-0.21	-0.15	-0.17
		SIOPS	-0.03	-0.02	-0.09	-0.11	-0.07	-0.07	-0.02	-0.02	-0.12	-0.14	-0.08	-0.09
		Yrs. ed.	-0.17	-0.16	-0.21	-0.23	-0.20	-0.21	-0.15	-0.15	-0.22	-0.23	-0.20	-0.21
	CGM	ISEI	-0.17	-0.15	-0.24	-0.27	-0.22	-0.23	-0.16	-0.15	-0.27	-0.29	-0.23	-0.25
		SIOPS	-0.09	-0.07	-0.15	-0.17	-0.13	-0.13	-0.07	-0.06	-0.17	-0.19	-0.13	-0.15
		Yrs. ed.	-0.27	-0.26	-0.27	-0.32	-0.29	-0.32	-0.25	-0.26	-0.30	-0.33	-0.29	-0.33
Lenient exclusion criteria (1930s–1980s)							Strict exclusion criteria (1940s–1970s)							

again, when a categorical origins predictor is involved, the kappa index is used to summarize the industrialization-related change in total variability.

2.3.3. Final predictor adjustment

Continuous predictor variables are routinely centered to mean zero and standard deviation one as a final step before their inclusion in multilevel analyses to ease computation and interpretation of model coefficients (Aguinis, Gottfredson, & Culpepper, 2013, 1511). This operation was done in this study as well. However, for the centering of individual-level predictors (e.g. social origins), there are multiple ways to do this adjustment (Enders & Tofghi, 2007). On one hand, an individual-level variable may be centered at its grand mean (CGM). On the other hand, an individual-level variable may be centered at the group or cluster (e.g. country-cohort) means (CWC). In the present context, the choice of centering approach is not inconsequential. First, while CGM and uncentered social origins predictors return identical slopes that relate to deviations on scales that are equal among the country-cohorts, CWC social origins predictors return slopes that relate to deviations relative to other individuals within the same country-cohort (Enders & Tofghi, 2007, 123, 126). Secondly, and more importantly, since there is reason to expect that the indicators of industrialization are correlated with the social origins predictors, only the CWC variant ensures that the cross-level interaction coefficient (γ_{11}) does not mistake change in the distribution of social origins for change in IEO (Enders & Tofghi, 2007, 133). Prior analyses of the modernization thesis do not indicate their choice of centering approach and may have defaulted to CGM (e.g. Sieben & de Graaf, 2003; van Doorn et al., 2011). Thus, this choice may have exaggerated the cross-level interaction. The present study considers both options as reasonable, and investigates if the choice affects the conclusions.

3. Results

The multiverse of results is presented in three parts. The first part concerns the relation of industrialization and origin-based inequalities in durational measures of education. The latter two parts substitute binary measures of education for the durational outcomes and investigate the relation between industrialization and origin-based inequalities in completion of upper secondary and tertiary education respectively. Within the parts, each singular analytic scenario, or universe, is identified by its unique analytic choice combination to the extent that all possible combinations of the options discussed in Section 2 and summarized in Table 1 are exhausted.

Descriptive statistics for the model variables are available in the appendix's Table A.1. Here, it is briefly noted that, regardless of the analytic choice combination, the average sample offspring is observed to have remained in schooling for roughly twelve years, approximately three-quarters report completing at least upper secondary education, and roughly one in five report a completion at the tertiary educational level. Similarly, analyses of the relations between the educational outcomes and the various operationalizations of social origins reveal positive correlations and, as also expected, demonstrate that the offspring born to the more industrially developed societies tend to exhibit higher educational attainment. The multiverse analytical results expand on these basic observations by considering whether industrial development is, as predicted by modernization theory, also linked to reduced associations between the educational outcomes and the origins predictors.

3.1. Inequality in durational measures of education

Based on the multiverse specification, there were 384 possible analytic choice combinations for the universes that regressed one of the durational educational measures (theoretical or self-reported years of education) on the joint effects of social origins and industrialization. Of

Table 3

96 sets of point estimates for the *Origins* × *Industrialization* interaction from the universes with a durational educational outcome and a categorical origins predictor. Each universe is uniquely identified by the analytic choice combination specified in the table margins. There are three to five vertically stacked coefficients for every universe. Negative coefficient implies that, compared to the reference group, the origin group's (specified on the left) advantage in the educational outcome is estimated to decline with the measure of industrialization (top). Bold coefficient indicates that the slope is statistically significantly different from zero. Δ kappa indicates the corresponding change in the standard deviation of the origin group coefficients.

			GDP		Energy		Both		GDP		Energy		Both			
			Birth	After	Birth	After	Birth	After	Birth	After	Birth	After	Birth	After		
Theoretical years of education																
Father's	EGP	VII (ref.)														
		V+VI	-0.13	-0.13	-0.12	-0.16	-0.14	-0.16	-0.15	-0.15	-0.19	-0.20	-0.19	-0.20		
		IVc	0.25	0.23	0.39	0.36	0.34	0.31	0.20	0.20	0.33	0.29	0.28	0.26		
		IVa+b	-0.15	-0.15	-0.10	-0.17	-0.13	-0.18	-0.14	-0.15	-0.12	-0.18	-0.15	-0.18		
		III	-0.42	-0.41	-0.37	-0.46	-0.43	-0.48	-0.49	-0.52	-0.50	-0.56	-0.55	-0.60		
		I+II	-0.42	-0.40	-0.41	-0.49	-0.45	-0.49	-0.34	-0.34	-0.40	-0.45	-0.41	-0.45		
	ISCED	1 (ref.)	Δ kappa	-0.20	-0.20	-0.20	-0.23	-0.21	-0.23	-0.17	-0.18	-0.18	-0.21	-0.19	-0.21	
		2	-0.43	-0.45	-0.45	-0.55	-0.47	-0.53	-0.35	-0.36	-0.41	-0.49	-0.41	-0.46		
		3	-0.69	-0.73	-0.66	-0.79	-0.72	-0.81	-0.69	-0.74	-0.73	-0.79	-0.77	-0.83		
		4	-0.48	-0.59	-0.32	-0.51	-0.43	-0.59	-0.44	-0.55	-0.34	-0.47	-0.44	-0.55		
		5	-0.92	-0.95	-0.76	-0.88	-0.90	-0.99	-0.86	-0.94	-0.74	-0.79	-0.87	-0.94		
		Δ kappa	-0.31	-0.34	-0.24	-0.29	-0.29	-0.33	-0.29	-0.33	-0.23	-0.25	-0.28	-0.32		
		Parental	EGP	VII (ref.)												
				V+VI	-0.12	-0.16	-0.15	-0.19	-0.15	-0.19	-0.11	-0.12	-0.23	-0.20	-0.18	-0.19
III	-0.29			-0.28	-0.31	-0.36	-0.33	-0.36	-0.27	-0.28	-0.35	-0.34	-0.35	-0.36		
I+II	-0.37			-0.37	-0.43	-0.50	-0.44	-0.49	-0.18	-0.18	-0.40	-0.41	-0.32	-0.34		
Δ kappa	-0.16			-0.15	-0.18	-0.21	-0.19	-0.20	-0.07	-0.07	-0.16	-0.16	-0.13	-0.14		
ISCED	1 (ref.)		-0.36	-0.38	-0.44	-0.53	-0.43	-0.47	-0.26	-0.26	-0.35	-0.44	-0.33	-0.38		
	2		-0.65	-0.69	-0.66	-0.81	-0.70	-0.79	-0.59	-0.63	-0.66	-0.76	-0.68	-0.76		
	3		-0.50	-0.58	-0.40	-0.59	-0.49	-0.62	-0.42	-0.52	-0.34	-0.51	-0.42	-0.56		
	4		-0.83	-0.88	-0.67	-0.83	-0.80	-0.91	-0.72	-0.80	-0.62	-0.72	-0.73	-0.82		
	Δ kappa		-0.29	-0.32	-0.22	-0.28	-0.28	-0.32	-0.26	-0.30	-0.20	-0.25	-0.25	-0.30		
Self-reported years of education																
Father's	EGP	VII (ref.)														
		V+VI	-0.17	-0.16	-0.25	-0.25	-0.23	-0.24	-0.17	-0.15	-0.30	-0.30	-0.26	-0.26		
		IVc	0.21	0.23	0.31	0.28	0.28	0.26	0.19	0.21	0.32	0.24	0.27	0.23		
		IVa+b	-0.19	-0.18	-0.20	-0.27	-0.22	-0.25	-0.16	-0.16	-0.23	-0.30	-0.22	-0.26		
		III	-0.50	-0.49	-0.50	-0.61	-0.55	-0.60	-0.55	-0.58	-0.61	-0.70	-0.65	-0.72		
		I+II	-0.41	-0.36	-0.59	-0.67	-0.55	-0.57	-0.33	-0.30	-0.63	-0.68	-0.53	-0.57		
	ISCED	1 (ref.)	Δ kappa	-0.21	-0.19	-0.26	-0.30	-0.25	-0.27	-0.17	-0.17	-0.26	-0.29	-0.24	-0.26	
		2	-0.42	-0.43	-0.46	-0.55	-0.47	-0.51	-0.40	-0.41	-0.48	-0.55	-0.48	-0.52		
		3	-0.79	-0.80	-0.79	-0.89	-0.84	-0.91	-0.80	-0.82	-0.89	-0.93	-0.91	-0.95		
		4	-0.61	-0.69	-0.61	-0.79	-0.66	-0.79	-0.57	-0.65	-0.72	-0.88	-0.71	-0.83		
		5	-0.97	-0.97	-1.01	-1.13	-1.06	-1.12	-0.89	-0.91	-0.99	-1.06	-1.02	-1.09		
		Δ kappa	-0.34	-0.35	-0.35	-0.40	-0.37	-0.40	-0.30	-0.33	-0.35	-0.39	-0.35	-0.39		
		Parental	EGP	VII (ref.)												
				V+VI	-0.15	-0.17	-0.23	-0.28	-0.21	-0.25	-0.14	-0.13	-0.31	-0.31	-0.25	-0.26
III	-0.37			-0.35	-0.45	-0.52	-0.45	-0.50	-0.34	-0.33	-0.50	-0.52	-0.47	-0.50		
I+II	-0.36			-0.32	-0.64	-0.72	-0.55	-0.59	-0.12	-0.06	-0.64	-0.66	-0.41	-0.44		
Δ kappa	-0.16			-0.13	-0.27	-0.30	-0.23	-0.25	-0.04	-0.02	-0.25	-0.27	-0.16	-0.18		
ISCED	1 (ref.)		-0.38	-0.37	-0.47	-0.53	-0.46	-0.47	-0.32	-0.33	-0.44	-0.51	-0.42	-0.45		
	2		-0.71	-0.72	-0.77	-0.89	-0.79	-0.85	-0.68	-0.70	-0.81	-0.89	-0.81	-0.87		
	3		-0.54	-0.60	-0.63	-0.82	-0.63	-0.75	-0.56	-0.63	-0.75	-0.90	-0.71	-0.83		
	4		-0.88	-0.90	-0.93	-1.07	-0.97	-1.06	-0.79	-0.82	-0.95	-1.03	-0.94	-1.02		
	Δ kappa		-0.31	-0.33	-0.32	-0.39	-0.34	-0.38	-0.29	-0.31	-0.35	-0.39	-0.35	-0.38		
Lenient exclusion criteria (1930s–1980s)							Strict exclusion criteria (1940s–1970s)									

these universes, 288 applied a continuous origins predictor (Yrs. ed., SIOPS or ISEI) and 96 used a categorical predictor instead (EGP or ISCED). In the following, the results from these universes are aggregated, and the distributions of the estimates for the main slopes of social origins and industrialization are summarized along with a more detailed description of the results that concern the cross-level interaction between the two predictors.

Figure 1 summarizes the distributions of the coefficient estimates that are relevant to the modernization thesis. The positive main slopes for the origins predictors are consistent with there being durational IEO when the indicator of industrialization is fixed to its mean value across the country-cohorts. The positive main slopes of industrialization imply industrialization-related increase in the expected duration of education

for offspring with mean social origins (column 1) and for the offspring of the reference origin groups EGP VII and ISCED 1 (columns 2–3). Most important, the estimates for the interaction slopes skew to negative values, suggesting that industrialization is associated with reduced effects of the continuous origins predictors on the expected duration (column 1) and that the origin groups' additive advantages over the corresponding reference group decline with industrialization (columns 2–3). It is observed, however, that the offspring of the farmer class (IVc) stand out as benefiting more from industrialization than the reference offspring of unskilled blue collar workers (VII) or indeed any other origin group.

To obtain a more detailed understanding of the results that concern the cross-level interaction, Table 2 begins by providing all interaction

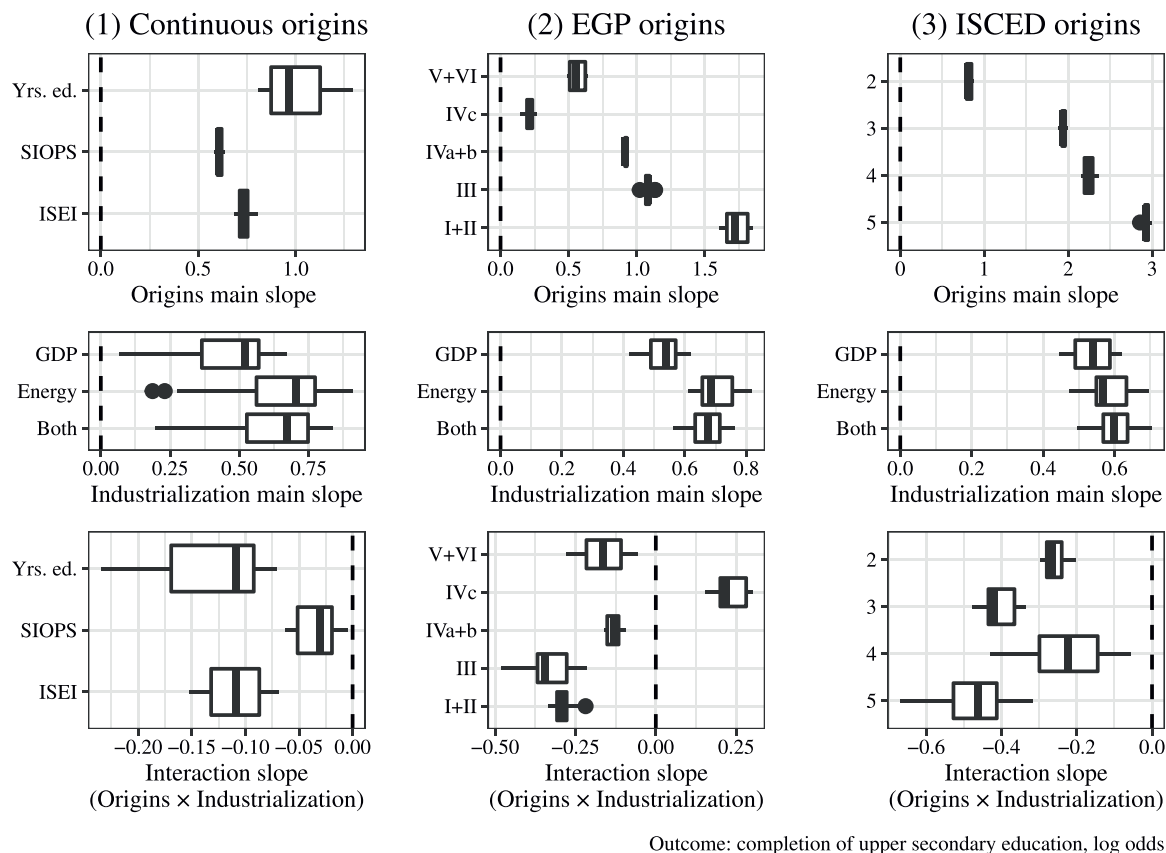


Figure 2. Tukey-style box plots of coefficient estimates from the 192 universes with completion of upper secondary education as the outcome. Refer to caption of Fig. 1 for explication of box plots.

estimates from the 288 universes that incorporated a continuous origins predictor (column 1 in Fig. 1). While all universes display a negative sign for the interaction, 33 (11.5%) of the slopes are non-significantly different from zero at $\alpha = 0.05$. These universes, whose estimates are consistent with a null effect of industrialization on durational IEO, are chiefly distinguished by their choice to use SIOPS as the origins predictor. Non-significant results are also somewhat more often observed with strict exclusion criteria. The universes that use GDP to indicate industrialization are very slightly overrepresented among the universes that indicate a non-significant interaction. Of little consequence are the choices that relate to picking one of theoretical and self-reported years of education as the outcome and to using either both parents' or only the father's information in the construction of the origins predictor. Comparison of the magnitudes of the slopes shows, however, that CGM estimates are consistently inflated in comparison to CWC. This is in accordance with the expectation that the former may conflate industrialization-related change in the distribution of social origins for change in IEO and thus exaggerate observed equalization. Despite this, the majority (81.9%) of the universes that chose the more conservative CWC return negative and statistically significant slopes that corroborate the modernization thesis.

Moving on to the interaction estimates that were produced with the categorical origins predictors (columns 2–3 in Fig. 1), Table 3 contains from each of the 96 universes the origin groups' interaction slopes on the durational expectation. The vast majority of the interactions are again negative and statistically significant. With respect to the highest origin groups (EGP I+II and ISCED 5), 95.8% of the universes' p-values for the interaction are below the 0.05 threshold. The corresponding proportion for the second-highest groups amounts to 96.9% (EGP III and ISCED 4). This is consistent with industrialization-related decrease in the durational distance between the offspring of the most disadvantaged and the

most advantaged origin groups, but does not preclude disequalization among the middling groups. To account for this, the table reports from each universe the corresponding change in the standard deviation of the origin groups' expected outcomes ($\Delta\kappa$). An industrialization-related decline in the kappa index is indicated in each universe. Therefore, for example, the growing distance between the offspring of the farmer class (IVc) and the offspring of unskilled blue collar workers (VII) does not overwhelm the overall trend of equalization. The results appear largely independent of the choice between theoretical and self-reported years of education, but the use of GDP and strict exclusion criteria are once again slightly more often involved when the evidence for the modernization thesis is weaker. There is no substantial change in conclusions if only the universes that incorporate both parents' information in the construction of the origins predictor are considered.

3.2. Inequality in completion of upper secondary education

The following 192 universes regressed the completion of upper secondary education on the individual and country-cohort level predictors for the purpose of assessing the influence of industrialization on the differential odds that offspring of varying social origins complete the level of education. Of the universes, 144 measured social origins in continuous terms, and 48 used one of the categorical predictors.

Similar to the previous part, Fig. 2 provides the distributions of the coefficient estimates across the analytic choice combinations. The estimated main slopes for social origins and industrialization are again limited to positive values. This suggests that at the country-cohorts' mean levels of industrialization there are origin-based inequalities in the completion of upper secondary education, and that above-mean industrialization is associated with increased proportion of completions for individuals with mean social origins (column 1) and for those belonging

Table 4

144 point estimates for the *Origins* × *Industrialization* interaction from the universes with completion of upper secondary education as the outcome and a continuous origins predictor. Each universe (cell) is uniquely identified by the analytic choice combination specified in the table margins. Negative coefficient implies that the association between the educational outcome and the measure of social origins (specified on the left) is estimated to decline with the measure of industrialization (top). Bold coefficient indicates that the slope is statistically significantly different from zero at $\alpha = 0.05$.

			GDP		Energy		Both		GDP		Energy		Both	
			Birth	After	Birth	After	Birth	After	Birth	After	Birth	After	Birth	After
Upper secondary education														
Parental	CWC	ISEI	-0.09	-0.09	-0.08	-0.07	-0.09	-0.09	-0.10	-0.11	-0.08	-0.08	-0.10	-0.10
		SIOPS	-0.02	-0.02	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	0.00	-0.01	-0.01	-0.02
		Yrs. ed.	-0.10	-0.09	-0.07	-0.07	-0.09	-0.09	-0.10	-0.11	-0.09	-0.08	-0.10	-0.10
CGM	CWC	ISEI	-0.15	-0.15	-0.13	-0.11	-0.15	-0.13	-0.14	-0.15	-0.12	-0.11	-0.14	-0.14
		SIOPS	-0.05	-0.05	-0.04	-0.04	-0.06	-0.05	-0.04	-0.05	-0.03	-0.03	-0.04	-0.04
		Yrs. ed.	-0.19	-0.18	-0.16	-0.20	-0.19	-0.23	-0.16	-0.17	-0.20	-0.21	-0.21	-0.21
Father's	CWC	ISEI	-0.08	-0.08	-0.07	-0.07	-0.08	-0.08	-0.09	-0.10	-0.08	-0.08	-0.09	-0.10
		SIOPS	-0.02	-0.02	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	-0.02	-0.03	-0.02	-0.03
		Yrs. ed.	-0.10	-0.10	-0.07	-0.07	-0.09	-0.09	-0.10	-0.11	-0.08	-0.08	-0.10	-0.10
	CGM	ISEI	-0.12	-0.13	-0.12	-0.12	-0.13	-0.13	-0.13	-0.14	-0.12	-0.12	-0.14	-0.14
		SIOPS	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06	-0.05	-0.06	-0.05	-0.06	-0.06	-0.06
		Yrs. ed.	-0.17	-0.16	-0.11	-0.11	-0.15	-0.16	-0.14	-0.16	-0.10	-0.11	-0.18	-0.18
Lenient exclusion criteria (1930s–1980s)							Strict exclusion criteria (1940s–1970s)							

Table 5

48 sets of point estimates for the *Origins* × *Industrialization* interaction from the universes with completion of upper secondary education as the outcome and a categorical origins predictor. Each universe is uniquely identified by the analytic choice combination specified in the table margins. There are three to five vertically stacked coefficients for every universe. Negative coefficient implies that, compared to the reference group, the origin group's (specified on the left) advantage in the educational outcome is estimated to decline with the measure of industrialization (top). Bold coefficient indicates that the slope is statistically significantly different from zero. $\Delta\kappa$ indicates the corresponding change in the standard deviation of the origin group coefficients.

			GDP		Energy		Both		GDP		Energy		Both	
			Birth	After	Birth	After	Birth	After	Birth	After	Birth	After	Birth	After
Upper secondary education														
Father's	EGP	VII (ref.)												
		V+VI	-0.11	-0.12	-0.06	-0.06	-0.09	-0.10	-0.22	-0.23	-0.17	-0.16	-0.21	-0.21
		IVc	0.22	0.23	0.30	0.29	0.30	0.28	0.15	0.15	0.20	0.21	0.21	0.20
		IVa+b	-0.12	-0.12	-0.09	-0.10	-0.11	-0.12	-0.15	-0.15	-0.15	-0.14	-0.16	-0.16
		III	-0.37	-0.38	-0.26	-0.29	-0.35	-0.36	-0.45	-0.48	-0.35	-0.34	-0.44	-0.44
		I+II	-0.29	-0.29	-0.25	-0.27	-0.29	-0.30	-0.32	-0.33	-0.28	-0.28	-0.33	-0.33
	ISCED	$\Delta\kappa$	-0.16	-0.16	-0.14	-0.15	-0.16	-0.16	-0.15	-0.16	-0.13	-0.13	-0.15	-0.16
		1 (ref.)												
		2	-0.27	-0.27	-0.27	-0.29	-0.28	-0.29	-0.23	-0.24	-0.26	-0.27	-0.26	-0.28
		3	-0.43	-0.44	-0.33	-0.34	-0.40	-0.42	-0.42	-0.48	-0.35	-0.34	-0.42	-0.44
		4	-0.23	-0.31	-0.06	-0.11	-0.15	-0.21	-0.32	-0.43	-0.19	-0.18	-0.28	-0.32
		5	-0.53	-0.53	-0.39	-0.41	-0.49	-0.51	-0.60	-0.67	-0.45	-0.47	-0.57	-0.61
		$\Delta\kappa$	-0.17	-0.18	-0.10	-0.11	-0.14	-0.16	-0.21	-0.25	-0.14	-0.14	-0.19	-0.21
Parental	EGP	VII (ref.)												
		V+VI	-0.15	-0.19	-0.08	-0.06	-0.12	-0.13	-0.25	-0.28	-0.22	-0.16	-0.26	-0.24
		III	-0.28	-0.27	-0.23	-0.22	-0.28	-0.28	-0.35	-0.37	-0.28	-0.21	-0.35	-0.32
		I+II	-0.27	-0.27	-0.29	-0.29	-0.30	-0.32	-0.22	-0.24	-0.32	-0.28	-0.29	-0.29
		$\Delta\kappa$	-0.11	-0.11	-0.13	-0.13	-0.13	-0.14	-0.08	-0.09	-0.13	-0.11	-0.11	-0.11
	ISCED	1 (ref.)												
		2	-0.24	-0.23	-0.30	-0.30	-0.29	-0.28	-0.20	-0.21	-0.23	-0.25	-0.23	-0.25
		3	-0.43	-0.44	-0.37	-0.38	-0.43	-0.43	-0.42	-0.47	-0.34	-0.36	-0.41	-0.44
		4	-0.27	-0.33	-0.09	-0.13	-0.19	-0.23	-0.30	-0.41	-0.06	-0.11	-0.19	-0.26
		5	-0.45	-0.47	-0.32	-0.35	-0.41	-0.44	-0.46	-0.53	-0.32	-0.37	-0.42	-0.48
$\Delta\kappa$	-0.15	-0.17	-0.07	-0.09	-0.12	-0.14	-0.17	-0.21	-0.08	-0.10	-0.13	-0.16		
Lenient exclusion criteria (1930s–1980s)							Strict exclusion criteria (1940s–1970s)							

to the reference origin groups (columns 2–3). Indeed, the distributions of these estimates are congruous with the ones observed with the durational measures of education. The congruity extends to the interaction slope distributions. Negative values for the interaction slopes suggest that the effects of the continuous origins predictors on the log odds of completion are reduced in the more industrially developed country-cohorts (column 1), as is the case for the advantages of the other origin groups (with again the exception of IVc) relative to the corresponding reference group (columns 2–3).

Table 4 contains from each universe that applied a continuous origins predictor (column 1 in Fig. 2) the interaction slope estimate together with the respective analytic choices. Of the 144 point estimates,

109 (75.7%) are negative and statistically significantly different from zero. The analytic choice that distinguishes the universes that do not detect equalization in the completion of upper secondary education is the choice to use the father's or both parents' SIOPS to measure origins. When equalization is detected, CGM again appears to inflate the estimate. Indeed, when the more conservative CWC is combined with SIOPS, not a single universe detects a statistically significant interaction. Other analytic choices are less consequential, as is apparent in the lenient and strict universes returning nearly identical slopes. GDP (Birth or After) is very slightly more often involved when a statistically non-significant interaction is indicated. Insofar as there is no reason to consider the outlier SIOPS universes the most authoritative, the

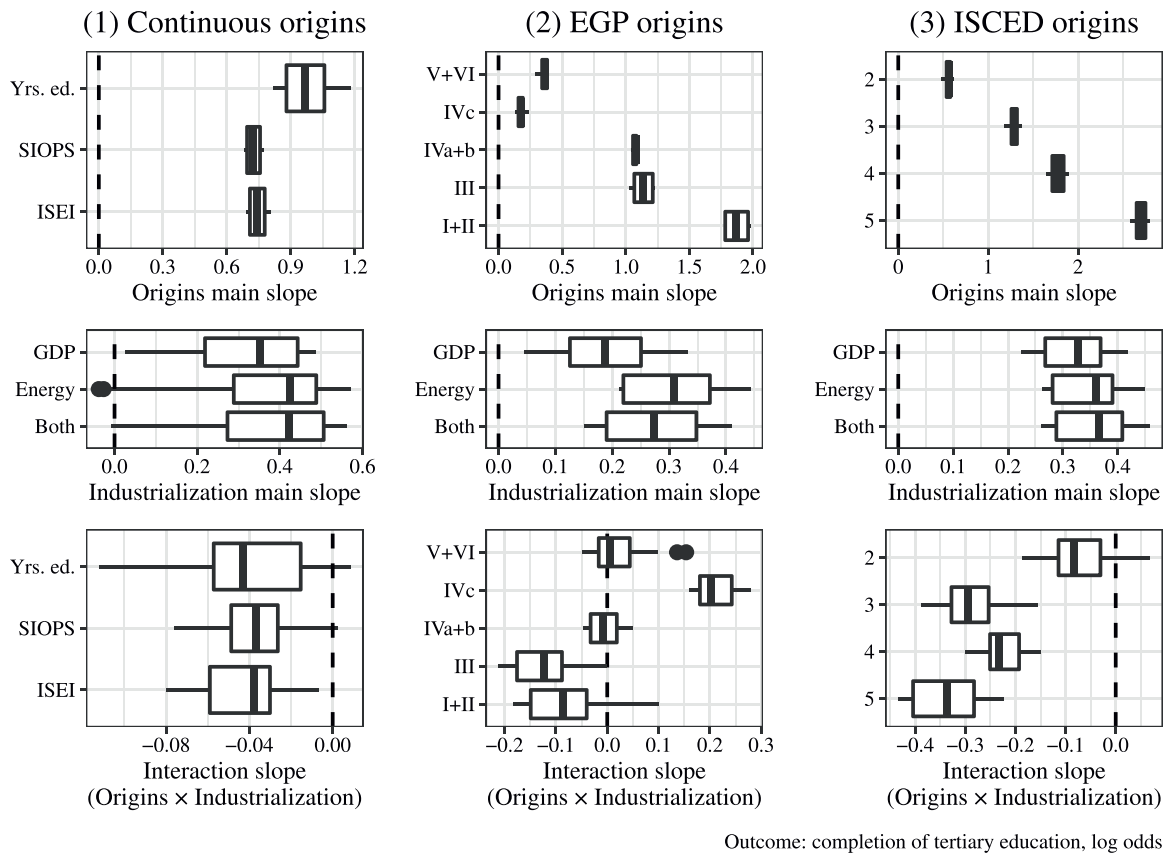


Figure 3. Tukey-style box plots of coefficient estimates from the 192 universes with completion of tertiary education as the outcome. Refer to caption of Fig. 1 for explication of box plots.

aggregate of these results corroborates the modernization thesis.

The 48 universes whose origins predictor was categorical (columns 2–3 in Fig. 2) present their interaction estimates in Table 5. Beginning with the comparison of the reference groups that are the least likely to complete upper secondary education at mean industrialization with the most advantaged groups (EGP I+II and ISCED 5), it is found that all universes detect a closing of the gap when the indicator of industrialization increases. When the comparison is to the second-most advantaged groups (EGP III and ISCED 4), the corresponding percentage amounts to 60.4% such that all of the 19 cases of non-significant interaction concern

the offspring of the post-secondary-non-tertiary-educated parents (ISCED 4). Once more, it is plausible that regardless of these signs of equalization there is disequalization among the middling groups with the consequence that the total variability in the chances of completing upper secondary education is not reduced. Nevertheless, the estimates for the kappa indices indicate in all universes an industrialization-related trend of convergence in the origin groups' log odds of completing upper secondary education. The conclusions appear quite robust to the variation in analytic choice. Considering both parents' information in the construction of the origins predictor is, however,

Table 6

144 point estimates for the *Origins* × *Industrialization* interaction from the universes with completion of tertiary education as the outcome and a continuous origins predictor. Each universe (cell) is uniquely identified by the analytic choice combination specified in the table margins. Negative coefficient implies that the association between the educational outcome and the measure of social origins (specified on the left) is estimated to decline with the measure of industrialization (top). Bold coefficient indicates that the slope is statistically significantly different from zero at $\alpha = 0.05$.

		GDP		Energy		Both		GDP		Energy		Both			
		Birth	After	Birth	After	Birth	After	Birth	After	Birth	After	Birth	After		
Tertiary education															
Parental	CWC	ISEI	-0.03	-0.03	-0.01	-0.01	-0.02	-0.02	-0.03	-0.04	-0.01	-0.01	-0.02	-0.03	
		SIOPS	-0.02	-0.03	0.00	0.00	-0.01	-0.02	-0.03	-0.04	0.00	-0.01	-0.02	-0.02	
		Yrs. ed.	-0.02	-0.02	-0.01	0.00	-0.01	-0.01	-0.03	-0.03	-0.01	-0.01	-0.02	-0.02	
CGM	CWC	ISEI	-0.06	-0.06	-0.04	-0.04	-0.05	-0.05	-0.05	-0.06	-0.03	-0.03	-0.05	-0.05	
		SIOPS	-0.05	-0.05	-0.03	-0.03	-0.04	-0.05	-0.04	-0.05	-0.02	-0.03	-0.04	-0.04	
		Yrs. ed.	-0.05	-0.09	0.01	0.00	-0.02	-0.03	-0.04	-0.05	0.00	0.00	0.00	-0.01	
Father's	CWC	ISEI	-0.03	-0.03	-0.03	-0.04	-0.03	-0.04	-0.02	-0.02	-0.04	-0.04	-0.03	-0.04	
		SIOPS	-0.03	-0.03	-0.03	-0.04	-0.03	-0.04	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	
		Yrs. ed.	-0.06	-0.05	-0.04	-0.04	-0.05	-0.05	-0.05	-0.06	-0.04	-0.04	-0.05	-0.06	
	CGM	CWC	ISEI	-0.07	-0.06	-0.07	-0.08	-0.08	-0.08	-0.05	-0.06	-0.07	-0.08	-0.07	-0.07
			SIOPS	-0.06	-0.06	-0.06	-0.08	-0.07	-0.07	-0.05	-0.05	-0.06	-0.07	-0.06	-0.07
			Yrs. ed.	-0.11	-0.11	-0.05	-0.06	-0.08	-0.08	-0.08	-0.11	-0.05	-0.06	-0.07	-0.08
Lenient exclusion criteria (1930s–1980s)							Strict exclusion criteria (1940s–1970s)								

Table 7

48 sets of point estimates for the *Origins* × *Industrialization* interaction from the universes with completion of tertiary education as the outcome and a categorical origins predictor. Each universe is uniquely identified by the analytic choice combination specified in the table margins. There are three to five vertically stacked coefficients for every universe. Negative coefficient implies that, compared to the reference group, the origin group's (specified on the left) advantage in the educational outcome is estimated to decline with the measure of industrialization (top). Bold coefficient indicates that the slope is statistically significantly different from zero. $\Delta\kappa$ indicates the corresponding change in the standard deviation of the origin group coefficients.

			GDP		Energy		Both		GDP		Energy		Both	
			Birth	After	Birth	After	Birth	After	Birth	After	Birth	After	Birth	After
Father's	EGP	VII (ref.)												
		V+VI	-0.01	0.00	-0.02	-0.03	-0.02	-0.02	0.01	0.01	-0.03	-0.05	-0.01	-0.02
		IVc	0.16	0.16	0.28	0.22	0.24	0.20	0.18	0.18	0.27	0.20	0.25	0.20
		IVa+b	-0.04	-0.03	0.01	-0.05	-0.02	-0.05	0.04	0.05	0.02	-0.03	0.03	0.00
		III	-0.19	-0.18	-0.13	-0.17	-0.18	-0.19	-0.15	-0.16	-0.16	-0.21	-0.18	-0.21
		I+II	-0.16	-0.14	-0.15	-0.18	-0.17	-0.18	-0.10	-0.09	-0.14	-0.16	-0.13	-0.15
		$\Delta\kappa$	-0.10	-0.09	-0.09	-0.11	-0.10	-0.11	-0.07	-0.07	-0.09	-0.10	-0.09	-0.09
	ISCED	1 (ref.)												
		2	-0.09	-0.10	-0.13	-0.19	-0.11	-0.14	-0.06	-0.06	-0.12	-0.17	-0.09	-0.11
		3	-0.29	-0.30	-0.31	-0.37	-0.32	-0.35	-0.29	-0.30	-0.35	-0.39	-0.34	-0.37
		4	-0.25	-0.29	-0.17	-0.28	-0.22	-0.30	-0.20	-0.23	-0.15	-0.25	-0.18	-0.25
		5	-0.42	-0.42	-0.36	-0.40	-0.41	-0.43	-0.39	-0.41	-0.36	-0.38	-0.40	-0.43
		$\Delta\kappa$	-0.16	-0.16	-0.12	-0.14	-0.15	-0.16	-0.15	-0.16	-0.12	-0.13	-0.14	-0.15
	Parental	EGP	VII (ref.)											
V+VI			0.06	0.05	0.01	0.00	0.04	0.03	0.14	0.15	0.00	0.03	0.07	0.10
III			-0.07	-0.05	-0.09	-0.11	-0.09	-0.09	-0.02	0.00	-0.12	-0.11	-0.09	-0.07
I+II			-0.02	-0.01	-0.06	-0.08	-0.05	-0.05	0.09	0.10	-0.06	-0.06	0.01	0.02
$\Delta\kappa$			-0.03	-0.02	-0.04	-0.04	-0.03	-0.04	0.01	0.02	-0.03	-0.04	-0.01	-0.02
ISCED		1 (ref.)												
		2	-0.01	0.00	-0.08	-0.11	-0.04	-0.05	0.05	0.07	-0.04	-0.09	0.01	-0.01
		3	-0.20	-0.20	-0.26	-0.32	-0.24	-0.27	-0.16	-0.15	-0.26	-0.32	-0.22	-0.26
		4	-0.24	-0.25	-0.19	-0.30	-0.23	-0.29	-0.19	-0.22	-0.16	-0.25	-0.19	-0.25
		5	-0.30	-0.31	-0.24	-0.29	-0.29	-0.32	-0.24	-0.26	-0.22	-0.27	-0.25	-0.29
	$\Delta\kappa$	-0.13	-0.14	-0.09	-0.12	-0.12	-0.14	-0.11	-0.12	-0.09	-0.11	-0.11	-0.13	
									Lenient exclusion criteria (1930s–1980s)					
									Strict exclusion criteria (1940s–1970s)					

associated with a less pronounced change in the kappa index, as is using energy consumption (Birth or After) as the indicator of industrialization.

3.3. Inequality in completion of tertiary education

Finally, there were 192 analytic choice combinations available for the purpose of investigating if industrialization is associated with equalization in the completion of tertiary education. As was the case in the analysis of upper secondary education, 144 of these universes applied a continuous origins predictor, and 48 chose a categorical predictor instead.

Figure 3 summarizes the distributions of the coefficient estimates produced with the different analytic choice combinations. The estimates that concern the main slopes are thoroughly positive with the implication that the odds of completing tertiary education are conditioned by origins and the level of industrialization. However, the distributions of the interaction slope estimates contained in the bottom row reflect considerably smaller interaction effects than were observed with upper secondary education. Only the universes that applied ISCED (column 3) give rise to distributions that, at first appraisal, firmly fit the modernization thesis. The offspring of the farmer class (IVc) are, however, again identified as benefiting the most from industrialization.

Table 6 enables a more detailed look at the interaction slopes that were produced with the continuous origins predictors (column 1 in Fig. 3). Seventy-five of the 144 point estimates (52.1%) are in accordance with there being equalization in the completion of tertiary education in the sense that the estimates are negative to a statistically significant degree. However, the half of the universes that corroborates the prediction of equalization consists predominantly of those analytic choice combinations that involved CGM as the centering approach or discarded maternal information in the construction of the origins predictor. Of the universes that chose the more conservative CWC, only 36.1% return a statistically significant and negative interaction. The percentage is 26.4% among the universes that exploit maternal information. A further fall to 5.6% is observed if only those universes that

apply both CWC and maternal information are selected. Relative to how sensitive the results are to the choices that relate to the operationalization of social origins, the choices that relate to the operationalization of industrialization appear negligible. Thus, insofar as the aggregated results of these universes corroborate any industrialization-related equalization in the completion of tertiary education, its observation is primarily dependent on making anticonservative analytic choices in the construction of the origins predictor.

Turning to the categorical origins predictors, Table 7 contains the remainder of the interaction slope estimates that relate to the completion of tertiary education (columns 2–3 in Fig. 3). Compared to the analysis of upper secondary education, there is now more disagreement among the 48 universes about the gap between the lowest origin groups and the highest origin groups closing over industrialization. Thirty-four (70.8%) of the universes indicate a negative and statistically significant interaction slope on the log odds of the highest origin group (EGP I+II or ISCED 5). The corresponding quantity is 24 (50.0%) when the comparison is to the second-most advantaged origin group (EGP III or ISCED 4). Yet, when both parents' information is exploited to construct the EGP, there is no analytic choice combination that detects statistically significant change in any group's relative advantage over the reference offspring of unskilled blue collar workers (VII). The same does not apply to ISCED, as is reflected in each of the analytic choice combinations producing a negative and statistically significant interaction slope for the offspring of tertiary-educated parents. However, the ISCED universes tend to indicate smaller reductions in the kappa indices of total variability than were obtained in the analysis of upper secondary education. While the other analytic choices again appear less consequential, the application of strict exclusion criteria is relatively often involved when non-significant interaction slopes or smaller changes in total variability are observed. Therefore, in aggregate the results give some indication of there being lesser effects engendered by parental education on the completion of tertiary education, but do not corroborate the notion that the more general effects of familial social class decrease with industrialization.

Table A.1

Descriptive statistics for model variables. Individual-level calculations are survey weighted with population size adjustment.

	Lenient exclusion criteria (1930s–1980s)			Strict exclusion criteria (1940s–1970s)		
	Mean	SD	N	Mean	SD	N
(1) Country-cohort level variables. continuous						
Energy consumption at birth (Mtoe per million persons)	2.11	1.33	156	1.92	1.09	104
Energy consumption decade after (Mtoe per million persons)	2.59	1.48	156	2.56	1.32	104
GDP at birth (\$2011 per capita)	10034.0	6460.0	156	9352.45	5311.64	104
GDP decade after (\$2011 per capita)	12616.7	7941.3	156	12561.03	6360.77	104
(2) Individual-level variables. continuous						
Offspring theoretical years of education	12.26	3.31	112209	12.40	3.15	83202
Offspring self-reported years of education	12.60	3.82	111555	12.80	3.66	82784
ISEI father	38.21	16.16	93782	38.27	15.99	70489
ISEI mean	38.07	15.51	101909	38.15	15.23	76107
SIOPS father	39.76	12.69	93782	39.70	12.58	70489
SIOPS mean	39.07	12.11	101909	39.03	11.93	76107
Yrs. ed. father	10.19	3.84	104213	10.18	3.80	77538
Yrs. ed. mean	9.86	3.51	109414	9.85	3.46	81254
(3) Individual-level variables. categorical						
EGP father	Proportion		N	Proportion		N
VII	0.30		92837	0.30		69843
V+VI	0.26			0.26		
IVc	0.09			0.09		
IVa+b	0.10			0.09		
III	0.06			0.06		
I+II	0.20			0.20		
EGP dominance			39116			30573
VII	0.20			0.20		
V+VI	0.21			0.22		
III	0.19			0.19		
I+II	0.40			0.39		
ISCED father			104213			77537
1	0.30			0.30		
2	0.19			0.20		
3	0.31			0.31		
4	0.02			0.02		
5	0.18			0.17		
ISCED dominance			102102			76003
1	0.27			0.26		
2	0.17			0.18		
3	0.32			0.33		
4	0.02			0.02		
5	0.22			0.21		
Offspring completion of education			112209			83202
Upper secondary (ISCED 3 or above)	0.76			0.78		
Tertiary (BA or above)	0.22			0.22		
Offspring gender			112582			83476
Male	0.48			0.48		
Female	0.52			0.52		

4. Discussion

This study applied the multiverse analytical approach to testing the modernization thesis in the context of IEO research. Aggregating estimates from 768 multilevel models that nested individual-level observations of education and social origins on the basis of country and birth cohort, it was investigated whether variation in analytic choice has substantial effect on observing the industrialization-related decline in IEO predicted by modernization theory. It was found that the conclusions varied substantially with the educational outcome and the approach to operationalization of social origins while other analytic choices were less consequential.

Earlier research has provided mixed support for industrial development being associated with social origins having lesser effects on durational measures of education (e.g. Momo et al., 2019; Treiman & Yip, 1989; van Doorn et al., 2011) and has been unable to detect the equalization when the binary outcomes completion of upper secondary education and completion of tertiary education are considered instead (Bar Haim & Shavit, 2013). The findings of this study give robust support to two notions: first, that origin-based differences in the expected duration of education decline with increase in the indicators of industrialization and, secondly, that the origin effects on the odds of completing upper secondary education do so as well. However, the

observation of industrialization-related equalization in the completion of tertiary education was particularly sensitive to the variation in analytic choice. More specifically, in the analysis of tertiary education anti-conservative analytic options such as the decision to discard maternal information were associated with the observation of equalization, whereas the most stringent portions of the multiverse of results seldom contained any such indications.

The weaker level of evidence for the equalization extending to tertiary education is at least *prima facie* problematic to modernization theory. That is, even if the durational expectations and the odds of completing upper secondary education increase in similarity throughout industrialization, the observations of persistent origin effects at the higher end of education have to be explained. To this end, it must in subsequent research be investigated whether it is plausible that in the relatively modernized society the mechanisms that constitute the unequal outcomes at the more demanding educational levels differ from the ones at lower levels to the extent that, despite expanding opportunities and merit-based selection, expecting equalization at these levels is unwarranted. A disparity of this sort could obtain, for example, if the characteristics that tertiary education meritocratically selects for (e.g. cognitive ability) are subject to genetic inheritance such that the opening up of opportunities may be offset by the compacting of these characteristics in the offspring of the higher social strata (Marks, 2014,

31–32, 236). Since conventional IEO models such as those considered in this study cannot readily partition the origin effects into environmental and genetic components, they cannot observe if and how the interplay of the distributions of parental status and relevant inheritable characteristics influence the estimates. This implies that further research, including assessment of variation in the role of genetically inheritable characteristics, is required to determine if modernization theory is able to stand the evidence for persisting differentials in the completion of tertiary education.

Despite the above-mentioned issue to modernization theory, the results of this study are more compatible with the modernization thesis than they are with conflict theoretical theses of wholly or mostly persistent educational inequality (e.g. Bowles & Gintis, 2011; Bourdieu & Passeron, 1990) or the multiple modernists' thesis that the trajectories to modernity are disjoint to the extent of unpredictability (Eisenstadt, 2000; Schmidt, 2010). It does not appear that origin-based differentials in education are constant over industrial development, nor does it appear that the variation is arbitrary. This implies, at the very least, that modernization theory should not be discarded in the investigation of macrosociological regularities in IEO (cf. Hout & DiPrete, 2006, 8). If the theory proves successful in accounting for outliers and providing increasingly elaborate hypotheses for future observations, as for example formulated in Marks (2014), it may advance as a worthwhile research framework for analyzing the broad mechanisms that underlie social stratification. As regards these broader themes, however, it is significant that the present study did not analyze post-education outcomes, and hence the findings cannot directly contribute to the analysis of modernization theory's adequacy for these aspects of social mobility.

In addition to the primary purposes of testing the modernization thesis and investigating the robustness of the overall conclusions to variation in analytic choice, this study identified the analytic choices that relate to the operationalization of social origins as being particularly consequential to the observed results. For each educational outcome, the choices made in the construction of the origins predictor accounted for the majority of the substantial variation in the estimates. These choices included selecting among the alternative measures of social origins, choosing between using only the father's or both parents' information, and electing an approach to centering the resulting predictor. More specifically, the SIOPS measure was vastly overrepresented among the universes that did not detect equalization, the decision to discard maternal information was often involved when steeper equalization was found, and centering the origins predictor at the grand mean (CGM) tended to result in inflated estimates. The other analytic choices that related, for example, to the operationalization of industrialization and the exclusion of observations were, in comparison, negligible. This suggests that subsequent IEO research should be especially mindful of the possible consequences the chosen approach to the operationalization of social origins may have on the conclusions and, when applicable, consider multiple alternatives.

Finally, limitations of the study are noted. First, the analyzed data came solely from European countries. While prior research indicates that at least the results that concern the durational measures of education may generalize to other continents (Momo et al., 2019), the present study cannot answer to the empirical adequacy of the modernization thesis outside of the European context. Secondly, the number of available indicators of industrialization was limited due to the requirement that comparative data exists for all of the countries and birth cohorts. Subsequent research could obtain a more accurate portrayal of industrialization in the IEO model by investigating only the countries and birth cohorts for whom more varied macro-level data are available. Lastly, despite the multiverse analysis considering hundreds of analytic choice combinations on the basis of analytic choices that have been considered in the previous literature, there are certainly other justifiable analytic choices that were not encompassed by the multiverse of results. In light of the present analytic choice combinations producing clear patterns of results, it is, however, quite unlikely that the inclusion of

more options would have gravely affected the overall conclusions.

Declaration of Competing Interest

None

Appendix A. Appendix

Table A.1

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