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Rationality and Society 2009 21: 459
DOI: 10.1177/1043463109348987

The online version of this article can be found at:
http://rss.sagepub.com/content/21/4/459

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STRATIFICATION THEORY, SOCIOECONOMIC BACKGROUND, AND EDUCATIONAL ATTAINMENT

A FORMAL ANALYSIS

Samuel R. Lucas

ABSTRACT

Three proposals explicate the social origins/education transitions association. Maximally maintained inequality (MMI) (Raftery and Hout 1993) claims the association declines only at transitions high origin persons universally or nearly universally make. Relative risk aversion (RRA) (Breen and Goldthorpe 1997) suggests broader inequality reduction is possible and depends on changing costs and norms. Effectively maintained inequality (EMI) (Lucas 2001) contends meaningful inequality reduction is elusive because qualitatively different types of education maintain consequential inequality, even at universal transitions. Each proposal has evidentiary support, yet because proposals highlight different association indices, most are described informally, and their distinctiveness is disputed, comparative evaluation requires a prior, clarifying, formal analysis. Formal analysis reveals that MMI is non-falsifiable. RRA and EMI are falsifiable and are potentially but not necessarily complementary. Future research should investigate whether and why RRA, EMI, both, or neither, apply.

KEY WORDS • education transitions • Gates gambit • MMI • RRA • EMI

The analysis of a sequence of education transitions has become the primary approach for studies of educational attainment. In this approach, also known as the Mare model, analysts estimate one regression equation for each year of schooling studied, obtaining social background coefficients for each transition. Depending on the data used, the Mare model is especially illuminating because it allows analysts to observe several different patterns simultaneously, including: (1) the possibly

 Vol 21(4): 459–511. http://rss.sagepub.com DOI: 10.1177/1043463109348987

changing association between socioeconomic background and educational attainment across transitions (cross-grade patterns); (2) the possibly different association between socioeconomic background and any given transition across cohorts (cross-cohort patterns); and (3) the possibly different association with socioeconomic background and any given transition across nations (cross-national patterns).

Substantively, the original research revealed that the higher the grade of the transition, the lower the socioeconomic coefficient (Mare 1980). Subsequent research replicated this finding in Israel (Shavit 1993), France (Garnier and Raffalovich 1984), Japan (Treiman and Yamaguchi 1993), Sweden (Jonsson 1993), Taiwan (Tsai and Chiu 1993), and elsewhere (Shavit and Blossfeld 1993). With a few notable exceptions (e.g. Erikson and Jonsson 1996), researchers have also tended to find stable associations across cohorts in the same country (e.g. Shavit and Blossfeld 1993). At least five proposals have been offered to explain one or both of the patterns.

Two of those proposals – *selective attrition* (Mare 1980) and the *life-course perspective* (Müller and Karle 1993) – were subsequently rejected (Mare 1993; Shavit and Blossfeld 1993; Lucas 2001). Three proposals, however, remain viable contenders for explaining the patterns: *Maximally Maintained Inequality* (MMI) (Hout, Raftery, and Bell 1993), *Relative Risk Aversion* (RRA) (Breen and Goldthorpe 1997), and *Effectively Maintained Inequality* (EMI) (Lucas 2001).

The proposals appear to have disparate implications. For example, MMI claims that if educational expansion makes a transition nearly universal for upper classes, educational inequality will decline at that transition. This implies expanding schools is a route to reducing educational inequality. RRA, pointing to changing costs of schooling as well as changing norms and expectations of students and the wider culture, argues that there are multiple levers, and complex prospects, of inequality-reducing change. Thus, RRA implies that educational expansion is not the only route to reducing the effect of social background. In contrast, EMI is least sanguine, suggesting that even when social background effects on making a transition decline, qualitative differences at that transition, differences associated with additional advantages later, will maintain consequential socioeconomic inequality. According to EMI, educational expansion will likely be ineffective because it will not eradicate, and may exacerbate, important qualitative inequality.

Despite the proposals' disparate implications, analysts have reported findings supporting MMI (e.g. Gerber and Hout 1995), RRA (e.g. Need and de Jong 2001; Davies, Heinesen, and Holm 2002), and EMI

(e.g. Ayalon and Yogev 2005). However, with the exception of a few studies comparing EMI and other perspectives (e.g. Ayalon and Shavit 2004; Ayalon and Yogev 2005), multiple perspectives have rarely been considered simultaneously. Thus, most studies really only demonstrate empirical patterns consistent with a focal proposal, rather than test multiple perspectives on the same data. Consequently, whether any of the three perspectives is preferable remains unclear. Research has placed three proposals under consideration; further advance requires researchers to test the proposals against each other in different contexts so as to probe the limits and value of each.

However, pursuing this task will be difficult because the perspectives highlight different processes, reference different association indices, and only one of the three perspectives – RRA – is expressed precisely. Because different processes may simultaneously operate, it is possible that the proposals do not conflict even though they may appear to. Because different indices of association may highlight different aspects of the social background/educational attainment relation, it is possible that although the parameters the proposals highlight differ, the social facts of inequality, the facts of interest to the proposals, do not. And, because two of the three have been described using informal means, the proposals differ in their precision, making it difficult to be sure how the proposals disagree. Consequently, assessing the perspectives comparatively requires some preparatory theoretical effort that clarifies the processes they treat, assesses the indices they highlight, and identifies areas analysts might examine to adjudicate between the perspectives – if such adjudication proves possible. That theoretical effort is the focus of this paper. At the conclusion it should be clear whether any of the proposals provide distinct, viable, non-tautological, non-contradictory theories. Establishing these findings may help focus empirical research while improving our understanding of the theoretical claims currently under consideration.

I proceed as follows. First, I briefly describe three epistemological problems a set of claims must avoid to constitute a viable theory. I describe this troika at the outset because after each proposal is conveyed I will use these criteria to assess whether the proposal qualifies as a theory. Immediately after relating these criteria I describe MMI, re-expressing MMI in formal analytic terms. Next, I use the three criteria to formally evaluate MMI. I repeat this process for RRA and EMI. Afterwards I compare the proposals, clarifying their points of agreement and disagreement. This culminating section is an essential precursor to empirical efforts at adjudication. I conclude by summarizing results and

suggesting future research directions. The path to that future goes through articulation of the three criteria outlined briefly below.

Tautology, self-contradiction, and evaluative infeasibility: three threats to socio-theoretic work

Analysts have not universally embraced the Mare model; in rejecting the model, some have questioned the need for a sociological explanation for the findings. Indeed, a vigorous debate has ensued concerning whether the approach produces biased results at later transitions (e.g. De Graaf and Ganzeboom 1993; Mare 1993), whether the differences of focus are identified (e.g. Cameron and Heckman 1998), how one may identify those differences (e.g. Lucas 2001), how one might more effectively test the differences estimated (e.g. Hauser and Andrew 2006), and whether the sequential binary decision approach masks important path-dependence (e.g. Breen and Jonsson 2000). This is an important debate that has greatly illuminated the strengths and limitations of the education transitions approach. However, the present analysis is not an effort to assess the Mare model; instead, the aim is to subject three social explanations for patterns of social background effects to formal analysis. Certainly, one way to assess those proposed explanations requires one to identify the parameters of interest while estimating education transitions models. My approach, however, is to pose a different question: setting aside the question of whether and how to identify the Mare model, could one assess the specific explanations for the association that MMI, RRA, or EMI provide? Thus, the aim here is not to offer further commentary on the Mare model *per se*; instead, the aim is to discover through formal analysis whether the internal logic of these explanations is coherent. This task is different from that which has concerned analysts debating the merits of the Mare model.

As noted above, empirical research has produced support for each proposal and also non-support for some. Thus, one might contend that the empirical research makes formal analysis unnecessary. Yet, as Lieberson (1998) persuasively indicates, there are many ways a proposal may match or fail to match empirical observation, such that empirical research cannot substitute for formal analysis. Both are needed.

In terms of formal analysis, to illuminate the social world a proposed theory must meet two fundamental conditions of logic. First, the proposed theory must not be tautological, i.e. its statements must not be

necessarily true, must not by definition be true. Accordingly, by itself the statement X≡X is tautological; it is tautological to state 'Happy people are happy people.'

Second, the proposal must not be internally contradictory, i.e., must not make claims whose truth implies the falsity of other proposal claims. It is contradictory to state both 'Happy people are contented people' and 'Happy people are discontented people'; the statements X≡Y and X≡Y are contradictory.[1]

The two conditions above constitute the minimal epistemological conditions for having the possibility of ever rejecting a proposed theory. Most proposals are complex enough that determining whether these conditions are met takes effort. If they are met, then the proposal is *logically contingent*; i.e. it is logically possible for the claims to be true, *and* logically possible for the claims to be false. Because logic can establish only the possibility, not the veracity, of a proposal, empirical research is needed to determine whether the proposal describes reality. Yet, if logical contingency is lacking, then falsifiability is impossible because the claims are either tautological (and thus impossible to reject) or self-contradictory (and thus impossible to accept).

The third criterion further addresses the crucial empirical dimension. Do the means of investigating the proposed theory allow one to evaluate the veracity of the proposed theory? In other words, is the proposal *evaluatively feasible*? A myriad of ways exist to make a proposal fail to meet this third challenge. Some proposals are permanently evaluatively infeasible, but others may become evaluatively feasible or infeasible as technology changes. For example, a theory whose evaluation requires access to particular data will only be evaluatively feasible where it has been, is, or will be possible to obtain that data.

A proposal that meets all three of these challenges is a scientific theory. Proposals that do not meet these challenges are not scientific theories.

Three proposals for understanding socioeconomic background and educational attainment have been offered. What do these proposals say, formally? And, once formalized, can we determine whether any or all of these proposals are really scientific theories?

Maximally maintained inequality

Adrian Raftery and Michael Hout propose a theory of *maximally maintained inequality*. This proposal is part of a general argument that claims children and families decide on school continuation based on

costs and benefits, and that school expansion that opens education to the disadvantaged does not concern the advantaged once the advantaged have secured the transition that is made available by expansion (Raftery and Hout 1993). Given that claim, MMI has four qualitative tenets which describe this process (Hout, Raftery, and Bell 1993; Raftery and Hout 1993), tenets I convey while attempting to faithfully translate them into formal analytic terms.

The first tenet states that:

> All else being equal, growth in the capacity of secondary and higher education will reflect the increased demand occasioned by population growth (if any) and the gradual upgrading of social origins over time (if any). In this case, origin-specific transition rates remain the same over time.
>
> (Raftery and Hout 1993, p. 56)

Thus, education demand is a result of population size and social origins, as in equation M1:

$$\text{M1)} \qquad D_y = f(\alpha P_y + \beta O_y)$$

where D reflects the level of demand for education, f is some function, P is the population size, O indicates social origins, y indexes time, and α and β are parameters or scaling factors that mathematically and/or sociologically translate the substantive factors of origins and population size into demand.

Two quick observations are needed. First, it may seem odd that equation M1 lacks lags on the origin variable, but lags are unnecessary as the origins at issue are those of persons at-risk of schooling. Second, MMI does not explicitly specify coefficients α and β. I introduce them because otherwise the proper expression of the relation of P_y and O_y to demand would be:

$$\text{M2)} \qquad D_y^* = g(\mathrm{a}P_y, \mathrm{b}O_y)$$

where g is some function and a = b = 1. This is a stringent proposition because one would need to find a function g that lacks coefficients to scale the impact of population size and social origins on the resulting demand, but applied cross-time, across-place, and met any other plausible requirements of association parameters for bounded outcomes (e.g. produced demand estimates that asymptotically approach zero and one when translated into probabilities or proportions). The simplest alternative posits coefficients as in M1. Thus, the coefficients seem a useful addition and should not harm the assessment of whether or not the propositions constitute a theory.

Note that the first tenet refers to both demand and school capacity. However, the tenet does not specify their relation. Equation M3 provides one way to reflect this linkage:

$$\text{M3)} \qquad C = \eta D$$

where C is school capacity. One might expect that when demand is expanding η is less than 1 as institutional capacity lags behind, when demand is stable η is equal or nearly equal to 1, and when demand is declining η exceeds 1. These possibilities imply that capacity and demand differ.

The second proposition states that:

> If the expansion raises enrollments faster than demand because of the redistribution of social origins, then transition rates for all social origins increase, but in such a way as to preserve all the transition by class odds-ratios.
>
> (Raftery and Hout 1993, p. 56)

This tenet notes that demand is higher than one would expect given the former population and social origins composition. Consider equation Z1 which, using many of the quantities discussed by MMI so far, expresses a set of possible relations we can then use to write the claims of MMI:

$$\begin{aligned} f(\alpha P_{y-r_p} + \beta O_{y-r_o}) = D_y < A_y = f[(\alpha+\lambda)P_y + (\beta+\gamma)O_y]. \\ P_y = P_{y-r_p} + P_\delta \\ \text{Z1)} \qquad O_y = O_{y-r_o} + O_\varepsilon \end{aligned}$$

Equation Z1 states attendance (A), i.e., satisfied demand, exceeds the demand one would have expected given population size, origins, and the stable parameters of α and β. Attendance is a function of demand D (i.e. a function of α, β, P_{y-r_p} and O_{y-r_o}), *and* the change in the population (P_δ), change in the population effect (λ), change in social origins (O_ε), and change in the origin effect (γ). Population at time y is the sum of population at time $y–r_p$ (where r signifies an appropriate or relevant time interval, and p indicates the interval is appropriate or relevant for the population variable (i.e. not necessarily the same as the interval for the origins variable)) and the gain in population since that time, denoted P_δ. Analogous relations exist for origins; origins at time y is the sum of origins at time $y–r_o$ (where r signifies an appropriate or relevant time interval, and o indicates the interval is appropriate or relevant for the origins variable(s) and is not necessarily the same as r_p) and the change in origins since that time, denoted O_ε. We re-write Equation Z1:

$$\text{Z2.1)} \quad A = f[\alpha P_{y-r_p} + \alpha P_\delta + \lambda P_{y-r_p} + \lambda P_\delta + \beta O_{y-r_o} + \beta O_\varepsilon + \gamma O_{y-r_o} + \gamma O_\varepsilon]$$
$$\text{Z2.2)} \quad = f[(\alpha + \lambda) P_{y-r_p} + (\alpha + \lambda) P_\delta + (\beta + \gamma) O_{y-r_o} + (\beta + \gamma) O_\varepsilon]$$
$$\text{Z2.3)} \quad = f[\alpha(P_{y-r_p} + P_\delta) + \lambda(P_{y-r_p} + P_\delta) + \beta(O_{y-r_o} + O_\varepsilon) + \gamma(O_{y-r_o} + O_\varepsilon)]$$

Equations Z2.1–Z2.3 are equivalent, but Equation Z2.1 is especially clarifying. The first and fifth right hand side terms of Z2.1 (αP_{y-r_p} and βO_{y-r_o}) reflect demand in an earlier epoch.[2] The second and sixth terms (αP_δ and βO_ε) reflect the impact of changes in population size and social origins composition *only* – changes in effects are not reflected in these terms. The third and seventh terms (λP_{y-r_p} and γO_{y-r_o}) reflect the impact of changes in the *effect* of population size and social origins *only* – changes in variables are not reflected in these terms. The fourth and eighth terms (λP_δ and γO_ε) reflect the interaction of changes in effects and variables.

Tenet two references changes in population size and socioeconomic composition, not changes in effects of either, so that $\gamma = \lambda = 0$. Thus, using the Z1–Z2 specification, tenet two states:

$$\text{M4.1)} \quad A = f[\alpha P_{y-r_p} + \alpha P_\delta + \beta O_{y-r_o} + \beta O_\varepsilon]$$
$$\text{M4.2)} \quad = f[\alpha(P_{y-r_p} + P_\delta) + \beta(O_{y-r_o} + O_\varepsilon)]$$

Tenet two mentions odds-ratios, and refers to transition by class odds-ratios, a measure of association. Given this formulation, and given that β and γ *also* relate origins to attendance, then β and γ also measure the association between origins and transitions, implying that:

$$\text{M5.1)} \quad \omega_1 = h(\beta + \gamma)$$

i.e., that the odds-ratio ω is a function of the sum $(\beta + \gamma)$. Thus, tenet two, by concluding that odds-ratios will not change, concludes that γ will be zero, i.e., the effect of origins will be stable.

However, MMI also states 'by way of summary ... a hypothesis of *maximally maintained inequality* ... means that transition rates and inequality (as measured by odds ratios) remain constant unless forced to change by increasing enrollments' (Raftery and Hout 1993, p. 42). This implies that the relevant odds-ratio is not indexed by the sum $\beta + \gamma$ but is, instead:

$$\text{M5.2)} \quad \omega_2 = h((\beta + \gamma), (\alpha + \lambda))$$

because this is the only conceivable way that the margin-free odds-ratio could be forced to change. The claim means that non-zero λ will force a change in ω_2, while γ remains zero.

It remains unclear whether the odds-ratio of interest to MMI is best expressed as in Equation M5.1 or M5.2. Setting this indeterminacy aside temporarily, tenet three states:

> If the demand for a given level of education is saturated for the upper classes, that is, if some origin-specific transition rates approach or reach 100 percent, then the odds-ratios decrease (the association between social origin and education is weakened). This diminished inequality of opportunity occurs only if the expansion in enrollment cannot be accommodated in any other way.
>
> (Raftery and Hout 1993, p. 57)

To convey this tenet we need to doubly expand the equations; one dimension of expansion writes equations for each origin; a second writes equations for each transition. I illustrate by using three transitions, three class origins, and the Z2.3 expression:

$$\text{M6.1a)} \quad D_1 \leq A_1 = f[\alpha_a(P_1 + P_{1,\delta}) + \lambda_a(P_1 + P_{1,\delta}) + \beta_a(O_1 + O_{1,\varepsilon}) + \gamma_a(O_1 + O_{1,\varepsilon})]$$
$$\text{M6.1b)} \quad D_2 < A_2 = f[\alpha_b(P_2 + P_{2,\delta}) + \lambda_b(P_2 + P_{2,\delta}) + \beta_b(O_2 + O_{2,\varepsilon}) + \gamma_b(O_2 + O_{1,\varepsilon})]$$
$$\text{M6.1c)} \quad D_3 < A_3 = f[\alpha_c(P_3 + P_{3,\delta}) + \lambda_c(P_3 + P_{3,\delta}) + \beta_c(O_3 + O_{3,\varepsilon}) + \gamma_c(O_3 + O_{3,\varepsilon})]$$

$$\text{M6.2a)} \quad D_4 < A_4 = f[\alpha_a(P_4 + P_{4,\delta}) + \lambda_a(P_4 + P_{4,\delta}) + \beta_a(O_4 + O_{4,\varepsilon}) + \gamma_a(O_4 + O_{4,\varepsilon})]$$
$$\text{M6.2b)} \quad D_5 < A_5 = f[\alpha_b(P_5 + P_{5,\delta}) + \lambda_b(P_5 + P_{5,\delta}) + \beta_b(O_5 + O_{5,\varepsilon}) + \gamma_b(O_5 + O_{5,\varepsilon})]$$
$$\text{M6.2c)} \quad D_6 < A_6 = f[\alpha_c(P_6 + P_{6,\delta}) + \lambda_c(P_6 + P_{6,\delta}) + \beta_c(O_6 + O_{6,\varepsilon}) + \gamma_c(O_6 + O_{6,\varepsilon})]$$

$$\text{M6.3a)} \quad D_7 < A_7 = f[\alpha_a(P_7 + P_{7,\delta}) + \lambda_a(P_7 + P_{7,\delta}) + \beta_a(O_7 + O_{7,\varepsilon}) + \gamma_a(O_7 + O_{7,\varepsilon})]$$
$$\text{M6.3b)} \quad D_8 < A_8 = f[\alpha_b(P_8 + P_{8,\delta}) + \lambda_b(P_8 + P_{8,\delta}) + \beta_b(O_8 + O_{8,\varepsilon}) + \gamma_b(O_8 + O_{8,\varepsilon})]$$
$$\text{M6.3c)} \quad D_9 < A_9 = f[\alpha_c(P_9 + P_{9,\delta}) + \lambda_c(P_9 + P_{9,\delta}) + \beta_c(O_9 + O_{9,\varepsilon}) + \gamma_c(O_9 + O_{9,\varepsilon})]$$

Equations M6.1a–c concern highest level origins, M6.2a–c concern middle origins, and M6.3a–c concern lowest origins. Further, equations M6.1a, M6.2a, and M6.3a pertain to the highest transition, and M6.1c, M6.2c, and M6.3c pertain to the lowest transition. D is demand as defined in equation M1. Subscripts apply to all coefficients and variables because values may differ across transitions, origins, and variables (owing to changes in those at risk). M6.1a–M6.3c provide a full expression; using M4.2 sets $\gamma = \lambda = 0$ and thus invokes MMI tenet two:

$$\text{M7.1a)} \quad D_1 \leq A_1 = f[\alpha_a(P_1 + P_{1,\delta}) + \beta_a(O_1 + O_{1,\varepsilon})]$$
$$\text{M7.1b)} \quad D_2 < A_2 = f[\alpha_b(P_2 + P_{2,\delta}) + \beta_b(O_2 + O_{2,\varepsilon})]$$
$$\text{M7.1c)} \quad D_3 < A_3 = f[\alpha_c(P_3 + P_{3,\delta}) + \beta_c(O_3 + O_{3,\varepsilon})]$$

$$\text{M7.2a)} \quad D_4 < A_4 = f[\alpha_a(P_4 + P_{4,\delta}) + \beta_a(O_4 + O_{4,\varepsilon})]$$
$$\text{M7.2b)} \quad D_5 < A_5 = f[\alpha_b(P_5 + P_{5,\delta}) + \beta_b(O_5 + O_{5,\varepsilon})]$$
$$\text{M7.2c)} \quad D_6 < A_6 = f[\alpha_c(P_6 + P_{6,\delta}) + \beta_c(O_6 + O_{6,\varepsilon})]$$

$$\text{M7.3a)} \quad D_7 < A_7 = f[\alpha_a(P_7 + P_{7,\delta}) + \beta_a(O_7 + O_{7,\varepsilon})]$$
$$\text{M7.3b)} \quad D_8 < A_8 = f[\alpha_b(P_8 + P_{8,\delta}) + \beta_b(O_8 + O_{8,\varepsilon})]$$
$$\text{M7.3c)} \quad D_9 < A_9 = f[\alpha_c(P_9 + P_{9,\delta}) + \beta_c(O_9 + O_{9,\varepsilon})]$$

The fourth tenet states that falling effects of origins can reverse and become rising effects of origins (Hout, Raftery, and Bell 1993, p. 26). Although an explicit tenet, it appears to follow from tenets 1–3, in that P_δ and O_ε can be negative because population size or origins can decline. Even so, Equations M1 and M4–M7 pertain, entailing lower levels of D and A which, under MMI, ramify through either the variables and/or parameters in the equations to alter the odds-ratio. Thus, the particular articulation of tenet four appears to offer no information not contained in tenets 1–3. However, one may read tenet four as saying the odds-ratio is not sticky on the downside; if so, then tenet four explicitly denies asymmetric causation. Lieberson (1985) argued that change in one direction (e.g. education expansion) might have a different magnitude of effects than might equal change in the opposite direction (i.e. education contraction). Tenet four can be seen as denying this possibility, although magnitudes are not explicitly referenced. However, any other plausible interpretation makes tenet four redundant with tenets 1–3.

Key MMI parameters are γ, β, ω_1, ω_2, α, and λ. β reflects the social background effect while γ reflects change in that effect. The odds-ratios, ω_1 and ω_2, are the focal parameters for MMI, while α and λ reflect the effect of population size and change in that effect, respectively.

Examining MMI: Tautology? Contradiction? Evaluative feasibility?

The above summary translates MMI into precise equations; below I assess the implications of the theory as revealed in the precise specification.

Evaluating MMI Via ω_2

The core of MMI is articulated in Equations M4.1 and M4.2. The focal association measures are in M5.1 and M5.2. M7 is written at the level of the origins group. Using an appropriate functional form we may plug in values and obtain predicted attendance rates. I translate M7 into logistic regressions because the original MMI work used logistic regression models:

$$\text{M8.1a)} \quad D_1 \leq A_1 = \frac{e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}}{1+e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}}$$

$$\text{M8.1b)} \quad D_2 < A_2 = \frac{e^{\alpha_b(P_2+P_{2,\delta})+\beta_b(O_2+O_{2,\varepsilon})}}{1+e^{\alpha_b(P_2+P_{2,\delta})+\beta_b(O_2+O_{2,\varepsilon})}}$$

$$\text{M8.1c)} \quad D_3 < A_3 = \frac{e^{\alpha_c(P_3+P_{3,\delta})+\beta_c(O_3+O_{3,\varepsilon})}}{1+e^{\alpha_c(P_3+P_{3,\delta})+\beta_c(O_3+O_{3,\varepsilon})}}$$

$$\text{M8.2a)} \quad D_4 < A_4 = \frac{e^{\alpha_a(P_4+P_{4,\delta})+\beta_a(O_4+O_{4,\varepsilon})}}{1+e^{\alpha_a(P_4+P_{4,\delta})+\beta_a(O_4+O_{4,\varepsilon})}}$$

$$\text{M8.2b)} \quad D_5 < A_5 = \frac{e^{\alpha_b(P_5+P_{5,\delta})+\beta_b(O_5+O_{5,\varepsilon})}}{1+e^{\alpha_b(P_5+P_{5,\delta})+\beta_b(O_5+O_{5,\varepsilon})}}$$

$$\text{M8.2c)} \quad D_6 < A_6 = \frac{e^{\alpha_c(P_6+P_{6,\delta})+\beta_c(O_6+O_{6,\varepsilon})}}{1+e^{\alpha_c(P_6+P_{6,\delta})+\beta_c(O_6+O_{6,\varepsilon})}}$$

$$\text{M8.3a)} \quad D_7 < A_7 = \frac{e^{\alpha_a(P_7+P_{7,\delta})+\beta_a(O_7+O_{7,\varepsilon})}}{1+e^{\alpha_a(P_7+P_{7,\delta})+\beta_a(O_7+O_{7,\varepsilon})}}$$

$$\text{M8.3b)} \quad D_8 < A_8 = \frac{e^{\alpha_b(P_8+P_{8,\delta})+\beta_b(O_8+O_{8,\varepsilon})}}{1+e^{\alpha_b(P_8+P_{8,\delta})+\beta_b(O_8+O_{8,\varepsilon})}}$$

$$\text{M8.3c)} \quad D_9 < A_9 = \frac{e^{\alpha_c(P_9+P_{9,\delta})+\beta_c(O_9+O_{9,\varepsilon})}}{1+e^{\alpha_c(P_9+P_{9,\delta})+\beta_c(O_9+O_{9,\varepsilon})}}$$

Writing M7 as logistic regression equations makes each β a logistic regression coefficient that measures the association between social origins and probability of making the transition. Indeed, only β (and γ when it is included as in the full specification of Z2) reflect the effect of social background.

Brief notice of an alternative index of the relation between origins and transitions will prove useful. It is well known that marginal effects in nonlinear models are a function not only of the focal coefficient but also of the other coefficients and values of the other regressors (e.g. Stolzenberg 1980; Roncek 1993). The marginal effects for the variables in M8.1a are:

$$\text{M9.1)} \quad b = \frac{e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}}{1+e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}} \times \left[1 - \frac{e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}}{1+e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}}\right] \times \beta_a;$$

$$\text{M9.2)} \quad a = \frac{e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}}{1+e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}} \times \left[1 - \frac{e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}}{1+e^{\alpha_a(P_1+P_{1,\delta})+\beta_a(O_1+O_{1,\varepsilon})}}\right] \times \alpha_a;$$

reflecting that the marginal effect is a function of the other determinants and the levels of all the variables in the model. Note that Equations M9.1–M9.2 contain the formulas for the predicted probabilities of making the transition.

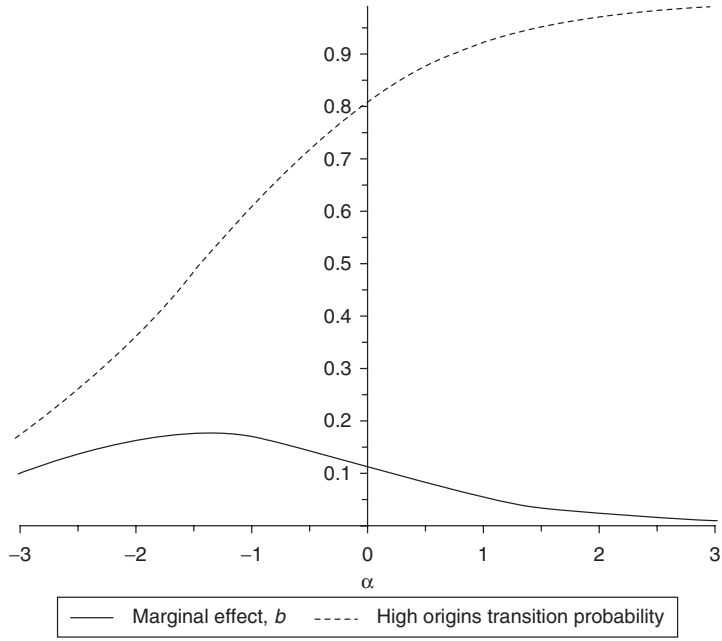

Figure 1. Marginal effect *b* and transition probability for changing α and fixed β = 0.7

Figure 1 plots the marginal effect of social origins, *b*, as α varies from –3 to 3, and β remains fixed at 0.7; the probability of high origins persons making the transition is included to clarify that at the far right of the graph higher origin persons approach certainty of making the transition. Figure 1 reveals the expected result; the marginal effect *b* can decline even though β is stable. I have used change in α to illustrate how marginal effects of social origins change even though β is stable, but the result would have been the same had *P* changed while α remained stable. The example of the marginal effect reiterates that margin-sensitive indices are margin-contaminated indices.

Recall the odds-ratio of Equation M5.2, ω_2, which was a function of β, α, and λ. MMI claims that ω_2 is 'constant unless ***forced*** *to change by increasing enrollments*' (Raftery and Hout 1993, p. 42, emphasis added). Because 'increasing enrollments' entail changing marginal distributions, this means that Raftery and Hout (1993) describe ω_2 as a margin-contaminated measure of the social background effect. The key changing marginal is the distribution of the binary variable of making the transition or not. Seen in this way, MMI maintains that marginal distributions of the dependent variable will change the odds-ratio.

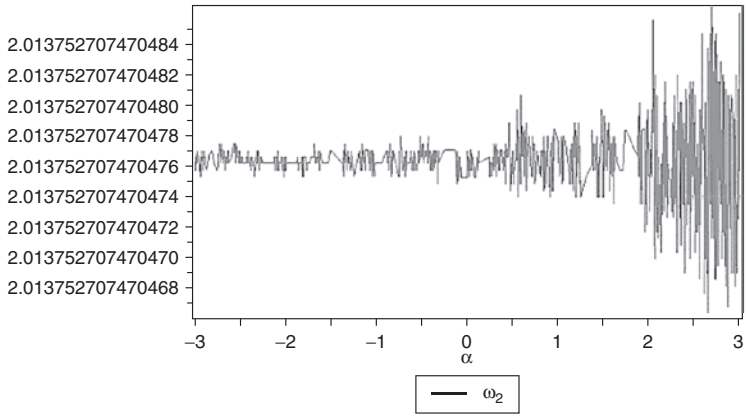

Figure 2. Oscillating odds-ratio estimate as α varies for fixed β = 0.7

Figure 2 plots the behavior of ω_2 when we fix $\beta = 0.7$ and allow α to vary between –3 and 3. The $\lim_{\alpha\to\infty} \omega_2 \approx 2.013752707$, i.e. $e^{0.7}$, referencing the fixed value of β. The estimate of ω_2 *is* pushed around by α, but the oscillation resembles rounding error, not the social impact of enrollment. Notably, ω_2 does not drop as α rises, and seems margin-free, not contaminated.

Thus, use of ω_2 makes MMI a contradiction, makes MMI claim that a margin-free measure of association is *not* margin-free. If MMI were correct about ω_2, however, tautology would follow because MMI would reduce to saying essentially that if those of higher (or other) social origins complete (or fail to complete) a transition, for whatever reason (e.g. marginal distributions on other variables), then MMI's focal indicator of the effect of social origins is affected (and MMI says it declines). In short, if we accept both ω_2 and MMI claims about ω_2, we implicitly accept that any factor that leads to the completion or non-completion of a transition is appropriately included in our index of the social background effect. This reduces to tautology, for the reasoning would ultimately lead us to conclude that those who are more likely to make transition *t* are, *ipso facto*, more likely to make transition *t*. This is an uninformative way to proceed. Fortunately, both the tautology and the contradiction can be avoided by rejecting ω_2.

Evaluating MMI Via ω_1

Rejecting ω_2 leaves ω_1. Consider tenet three, which states that if 'origin-specific transition rates approach or reach 100, then the odds-ratio

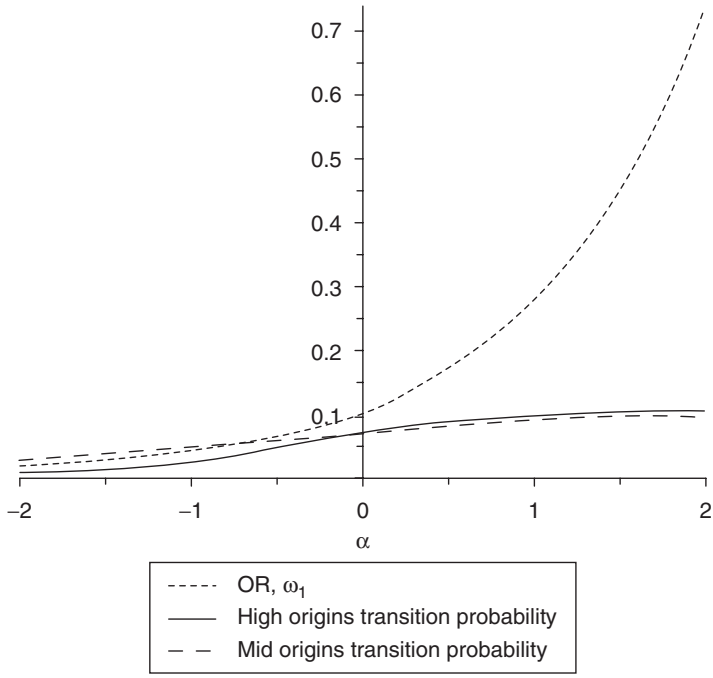

Figure 3. ω_1 for varying β and fixed $\alpha = 0.7$

declines (the association between social origin and education is weakened)' (Raftery and Hout 1993, p. 57). Reference to 'origin-specific transition rates' suggests ω_1.

Figure 3 plots ω_1 and the predicted probability that high and mid origin persons make the transition, as β changes and α is fixed. The graph indicates that ω_1 varies directly with β. Note also that, with all else constant, rising β produces predicted probabilities of transition that increase toward the asymptote of 1 for both origin groups. Figure 3 graphically illustrates the ω_1, β connection; the question now is whether ω_1 will be forced downward as attendance of those of advantaged origins approaches 100 percent.

Figure 4 plots the odds-ratio, ω_1, as we vary the high origins transition probability, for three different probabilities that a mid origins person will make the transition. The graph makes clear that as $\Pr(Y = 1|\text{origins} = \text{Hi}) \rightarrow 1$, the odds-ratio is *not* forced down; indeed, $\lim_{\Pr(Y = 1|\text{origins} = \text{Hi}) \rightarrow 1} \omega_1 = +\infty$. Thus, using ω_1 renders MMI evaluatively infeasible, as ω_1 is infinite for MMI's focal condition, the condition that higher origin persons universally make a transition.

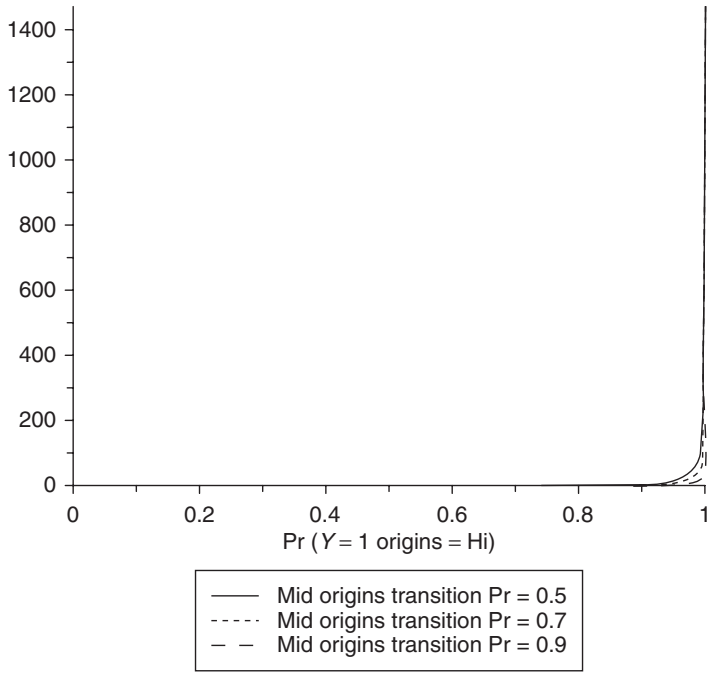

Figure 4. ω_1 as Pr($Y = 1 \mid$ origins = Hi) changes, for different levels of Pr($Y = 1 \mid$ origins = Mid)

I use [Pr($Y = 1|X =$ Hi) (1 − Pr($Y = 1|X =$ Mid))] / [(1 − Pr($Y = 1|X =$ Hi)) (Pr($Y = 1|X =$ Mid))] for odds-ratios; [(1 − Pr($Y = 1|X =$ Hi)) (Pr($Y = 1|X =$ Mid))] / [Pr($Y = 1|X =$ Hi)) (1 − Pr($Y = 1|X =$ Mid))] also suffices. If we call the first formula ω_{1H} and the second ω_{1M}, ω_{1M} would seem to have a limit of 0 as Pr($Y = 1|X =$ Hi)$\rightarrow$1. This limit exists for fixed Pr($Y = 1|X =$ Mid) < 1, but fixing this value is usually incorrect. Recall that β is a multiplier in the predicted probability calculation such that higher β reflects increased transition chances for all persons where $X \neq 0$ (as Figure 3 suggests for middle origin persons). Fixing Pr($Y = 1|X =$ Mid) implies β must change, because the gap between fixed Pr($Y = 1|X =$ Mid) and changing Pr($Y = 1|X =$ Hi) will change. However, with more than two values of X, X cannot equal zero for all for whom $X \neq$ Hi, and thus β should *not* change if Pr($Y = 1|X =$ Mid) is fixed, for β enters into the calculation of Pr($Y = 1|X =$ Mid). But, how can the multiplier β be fixed to calculate fixed Pr($Y = 1|X =$ Mid) yet change to reflect the changing gap between fixed Pr($Y = 1|X =$ Mid)

and varying Pr($Y = 1|X = \text{Hi}$)? It cannot generally do both for multi-valued X. Thus, fixing Pr($Y = 1|X = \text{Mid}$) is generally incorrect, usually producing self-contradiction by requiring β to both change and not change.

This realization is consequential, because constraining Pr($Y = 1|X = \text{Mid}$) < Pr($Y = 1|X = \text{Hi}$) (to match the queuing logic of MMI), and allowing both terms to vary, the limit of ω_{1M} is undefined. Thus, in the general case, MMI is evaluatively infeasible, regardless of whether one uses ω_{1H} or ω_{1M}.

There is one specific case where these problems appear to dissolve, and one might erroneously generalize this specific case to a broader claim about the odds-ratio's behavior. If one fixes Pr($Y = 1|X = \text{Mid}$) *and* has a dichotomous origin variable (as one might have if one specified multiple 0/1 contrasts for a nominal classification scheme of origins), fixing Pr($Y = 1|X = \text{Mid}$) does not force a contradictory state of affairs for ω_{1M}, and the limit of ω_{1M} under this condition is 0. However, this only appears to be an appropriate approach, and only if one has or constructs categorical indicators of origins, for in such cases β reflects the gap between the two categories, not the impact of origins on transition probabilities of both. Indeed, in such a dummy variable case the absolute impact of origins is unidentified but the relative impact is identified. For such cases one may fix Pr($Y = 1|X = \text{Mid}$) in calculating the limit of ω_{1M} because doing so still lets β vary. However, any scaled origin measure, such as number of siblings, parents' years of schooling, family earnings, wealth, or any other non-categorical factor creates a contradiction should one consider the evaluative feasibility of MMI by fixing Pr($Y = 1|X = \text{Mid}$). One could respond by using only categorical origins or by transforming all non-categorical origins to categorical ones, but the next section indicates that this is insufficient.

Odds ratios, direction of change, and non-effects of social background

A fundamental question is raised by the narrow basis upon which MMI's remaining evaluative feasibility seems to hang. Formulas show that ω_{1H} and ω_{1M} are inversely related and thus their qualitative implications should agree. If the implication varies according to which formula one uses, then falsifiability pivots on the arbitrary issue of to which category one assigns the labels of zero and one. Such a role for nominal terms would mean a theory was falsifiable when Pr($Y = 1|X = \text{Hi}$) $\rightarrow 0$ (e.g. likelihood of *not* graduating from high school), but non-falsifiable

when $\Pr(Y = 1|X = \text{Hi}) \rightarrow 1$ (e.g. likelihood of graduating from high school), simply because of the assignment of labels rather than, say, because of explicit affirmation of asymmetric causation à la Lieberson (1985).[3] Falsifiability cannot turn on such nominal trivialities or our entire intellectual enterprise is doomed.

Falsifiability does not turn on such a nominal triviality. One property of odds-ratios is that $1/\omega_{1H} = \omega_{1M}$ (e.g. Agresti 1990, pp. 15–16). Thus, odds-ratios of zero actually signify an unmeasurable degree of association, for the reciprocal of an odds-ratio of zero, which is equivalent, is undefined. To find zero effects of social background, as MMI predicts once the most advantaged class is fully enrolled, one must obtain an odds-ratio of 1, regardless of whether one uses ω_{1H} or ω_{1M}. But, approaching saturation, both forms of ω produce the same inability to evaluate MMI. Thus, MMI is not falsifiable.

Concluding remarks concerning the falsifiability of MMI

The foregoing has considered several indices of the relation between social origins and education transitions, including ω_1, ω_2, b, and β, and their implications for researching MMI. We have shown that using ω_2 renders MMI a contradiction or a tautology. Yet, rejecting ω_2 means that there is no way to ascertain whether expansion forces a reduction in the social origins/education transition association, because the limit of ω_1 as attendance approaches 100 percent is undefined. Thus, using ω_1 makes MMI evaluatively infeasible.

The analysis makes some simplifying assumptions, such as equal populations for both groups. Although these assumptions are not stated by MMI, relaxing these assumptions only exacerbates the difficulties shown above (e.g. ω_2 no longer oscillates around e^{β}; indeed, it has no limit). Space precluded presentation of those results.

The only association measures that remain are b and β. The marginal effect b is margin-sensitive and thus does not clearly isolate the impact of social background. And, β is directly related to ω_1. In this case, with the limit of ω_1 as attendance approaches 100 percent undefined, so is the limit of β. Consequently, MMI cannot be evaluated, and thus is not falsifiable.

One may wonder, then, how have some analysts found support for MMI while others have not. This likely occurs for two reasons. First, some claims of MMI are observable. One may or may not observe a reversal as suggested in tenet four, e.g., an increase in the association between origins and later transitions, and such results have been

interpreted as relevant to assessing MMI (e.g. Lucas 2001). However, this is not the only MMI claim; once the proposal is considered *in toto*, it is apparent that it cannot be evaluated.

Second, the indices of association all have different properties. Marginal effects are forced to decline simply for mathematical reasons having to do with the marginal distribution, ω_{1H} is unbounded, ω_{1M} is bound by zero which actually signifies an undefined odds-ratio, and ω_2 oscillates owing to rounding and is also generally unbounded. Thus, as analysts focus on different indices, employ different variable specifications, and implement other modeling decisions, some will likely find evidence that appears consistent with MMI while others will not. The diversity of methods and foci creates divergent findings and, ancillarily, the illusion that MMI is falsifiable.

Stepping back from data, however, reveals grave problems with MMI. All odds-ratios violate MMI claims, failing to have finite limits at transitions high origins persons universally make. The marginal effect, *b*, matches MMI expectations for it must decline as predicted attendance probabilities depart from 0.5 precisely because it is partly a function of the marginal distribution. But MMI did not reference the marginal effect and, even if it did, doing so would only be tautologous, for all marginal effects for logistic regression models are forced to decline as predicted values depart from 0.5.

Of course, many indices break down when an origin category lacks outcome variation. The fault lies not in the indices but in the focus on saturation. No other focus seems defensible, however, for any proportion short of saturation would seem to entail an ad hoc adjustment, not a principled one. In the end, one cannot falsify a proposal whose terms shift without principle.

Thus, MMI asserts either a tautology or a contradiction and is, in any case, evaluatively infeasible. Ergo, MMI is not logically contingent, therefore it is not falsifiable, and thus MMI does not constitute a scientific theory.

Relative risk aversion[4]

Richard Breen and John H. Goldthorpe (1997) propose a theory of *relative risk aversion* to explain stable class differentials across cohorts, declining class effects across transitions, and rapidly changing gender effects. The proposal claims that children and their parents consider costs and benefits in choosing whether or not to continue school, whether

to take an academic or non-academic course of study, and more. Most important, the proposal denies that persons are 'subject to systematic influences of a (sub)cultural kind' (Breen and Goldthorpe 1997, p. 278).

Our position is considerably stronger in relating RRA, because unlike EMI to follow, and MMI above, RRA was conveyed in formal language. However, we will need to write the theorems of RRA in terms conducive to further analysis here.

The entire proposal labelled Relative Risk Aversion (RRA) is actually a collection of several separable components. Only one part of one component reflects individual differences in aversion to risk. Two components describe structural and micro-level factors that set the stage for risk aversion to operate, and two other parts of one component provide additional mechanisms of class differentiation that also explain class differences in educational attainment. To keep matters clear here, therefore, henceforth I will use RRA to refer to the full collection of claims, offering the name Relative Risk Mechanism (RRM) for Breen and Goldthorpe's mechanism of class-related risk profiles.

The remaining elements also provide possibly clarifying contributions. One component sketches the structure of opportunities and relations (SOAR) between positions and pathways on the one hand, and the decisions and variables that enter into the cost/benefit analysis that guides navigation of those positions on the other. A second component posits the determinants of the subjective parameters (DSP) that are inputs to the structural model, providing the micro-foundational link through which some mechanisms of class differentiation operate. Two other mechanisms, resource differences and ability differences, join with the relative risk mechanism to create patterns of class-differentiated behavior that produce an association between class and educational attainment. I refer to these three as class differentiation mechanisms (CDM). Collectively SOAR, DSP, and CDM constitute Breen and Goldthorpe's original proposal, RRA.

SOAR

SOAR posits a structure that probabilistically links school pathways to a hierarchically ordered labor market. Breen and Goldthorpe (1997) note that the system of education they study 'should possess a diversified structure that provides options not just for more or less education but also for education of different kinds, and that in turn entails individuals making choices at certain "branching points" that they may not be able to later modify, or at least not in a costless way' (Breen and Goldthorpe 1997, p. 278). Although they note that many may regard this scope condition

as limiting their proposal to systems similar to the European educational model, they cite U.S. research showing the presence of diversified curricula even there (e.g. Arum and Hout 1995). Thus, they doubt the scope condition severely limits the applicability of the proposal.

To fix ideas, Breen and Goldthorpe (1997) provided an example with three occupational outcomes called top, middle, and underclass. Further, they focused on the movement of two children through the system, one whose parents had a top-stratum occupation, and one whose parents had a middle-stratum occupation. Two education branching points also exist; persons may stay or leave, and if they stay, they may pass or fail. Breen and Goldthorpe (1997) sketch that structure, a structure that implies the following system of subjective outcome probabilities:

S1.1) $\Pr(\mathit{OccupationalDestination}_i = \mathit{Top}) = [(\pi_i)(\alpha_{T,i}) + (1 - \pi_i)(\beta_{T,i}) + (\gamma_{T,i})]$

S1.2) $\Pr(\mathit{OccupationalDestination}_i = \mathit{Middle}) = [(\pi_i)(1 - \alpha_{T,i}) + (1 - \pi_i)(\beta_{M,i}) + (\gamma_{M,i})]$

S1.3) $\Pr(\mathit{OccupationalDestination}_i = \mathit{Underclass}) = [(1 - \pi_i)(1 - \beta_{T,i} - \beta_{M,i}) + (1 - \gamma_{T,i} - \gamma_{M,i})]$

where π_i is person i's subjective probability of succeeding in school or the particular program (e.g. passing an examination) if they stay in the school/program while $1-\pi_i$ is their subjective probability of failing. The α, β, and γ coefficients are subjective probabilities of attaining top or middle occupational positions, as reflected in the subscripts T and M. α pertains were one to succeed in the school/program, β pertains were one to stay in the school/program but fail, and γ pertains were one to leave the school/program prior to examination. An α term is missing from Equation S1.3, reflecting the theoretical claim that those who succeed in school have zero subjective chance of falling to the bottom. To clarify, while I often refer to staying in school or dropping out, every example also applies to entering or continuing possibly demanding programs.

DSP

DSP, by stating how student beliefs are produced, provides the central link between students' perceptions and the structured relationships of SOAR. DSP stipulates that:

D1) $\pi_i = g[A_i]$

i.e. ability, A, is a determinant of student beliefs of their likelihood of educational success.

Equation D1 is a key claim of DSP. However, Breen and Goldthorpe (1997, pp. 281–282) also contend that a societal, inter-subjective consensus is reflected in the following relations:

$$\text{D2.1)} \quad \alpha_T > 0.5 > 1 - \alpha_T$$

$$\text{D2.2)} \quad \alpha_T > \beta_T$$

$$\text{D2.3)} \quad \alpha_T > \gamma_T$$

$$\text{D2.4)} \quad \gamma_T + \gamma_M > \beta_T + \beta_M$$

$$\text{D2.5)} \quad \frac{\gamma_M}{\gamma_T} > 1 \Rightarrow \gamma_M > \gamma_T$$

$$\text{D2.6)} \quad \frac{\gamma_M}{\gamma_T} \geq \frac{\beta_M}{\beta_T}$$

Inequality D2.1 states that the chance of entering the top occupational stratum is greater than the chance of entering the middle occupational stratum for those who succeed in school. Inequality D2.2 states that those who stay in school and pass the exam have a higher chance of entering the top stratum than do those who stay in school but fail the exam, while Inequality D2.3 states that those who stay in school and pass the exam have a higher chance of entering the top stratum than do those who leave school prior to the exam. Inequality D2.4 states that staying in school and failing exposes one to a higher chance of entering the underclass than does leaving school prior to the exam. Inequality D2.5 contends that those who leave school prior to the exam have a better chance of entering the middle occupational stratum than of entering the top stratum. Relatedly, Equation D2.6 states that the relative chance of entering middle positions versus higher positions for those who leave school prior to the exam will equal or exceed that for those who stay in school but fail. No claim is made concerning the relation of β_M and β_T.

CDM

Three class-linked mechanisms of differentiation match three factors that matter for successful navigation of education systems – goals, abilities, and resources.

Goals

Breen and Goldthorpe (1997) posit that all children (and families) have the *same* occupational goal:

$$\text{C1)} \quad \textit{Occupational Destination} - \textit{Occupational Origin} \geq 0$$

However, because families are differently positioned in the occupational hierarchy, this same goal has implications that vary by class. Equations C2.1 and C2.2 show that maximizing the chance of equaling

or exceeding one's origins leads to different maximization aims depending upon one's origins:

$$\text{C2.1)} \quad \max(Pr(Occ_{it} = Top)) = \max[\pi_{it}\alpha_{T,it} + (1 - \pi_{it})\beta_{T,it} + \gamma_{T,it}]$$

$$\text{C2.2)} \quad \max(Pr(Occ_{im} = Top\ or\ middle)) = \max[\pi_{im}\alpha_{T,im} + (1 - \pi_{im})\beta_{T,im} + \gamma_{T,im} + \pi_{im}(1 - \alpha_{T,im}) + (1 - \pi_{im})\beta_{M,im} + \gamma_{M,im}]$$

Equation C2.1 states that persons originating in the top stratum (as signified by the lowercase subscript, *t*) need to maximize their chance of staying there. However, C2.2 states that those with middle stratum origins maximize the sum of their chances of: (1) staying in the middle, and (2) rising into the top stratum. Equation C3 summarizes the situation of middle origin youth:

$$\text{C3)} \quad [1/(\max(Pr(Occ_i = Top\ or\ middle)))] \propto \min(Pr(Occ_i = Bottom)) = \min[(1 - \pi_i)(1 - \beta_{T,i} - \beta_{M,i}) + (1 - \gamma_{T,i} - \gamma_{M,i})].$$

Middle origin students may satisfy their occupational goals by placing in either the top stratum *or* the middle stratum. The subjective value of staying in school versus leaving school, therefore, is calculated as the ratio P_{it} for those of top origins, and P_{im} for those of middle origins:

$$\text{C4.1)} \quad P_{it} = \frac{\pi_i\alpha_{T,i} + (1 - \pi_i)\beta_{T,i}}{\pi_i\alpha_{T,i} + (1 - \pi_i)\beta_{T,i} + \gamma_{T,i}}$$

$$\text{C4.2)} \quad P_{im} = \frac{\pi_i\alpha_{T,i} + (1 - \pi_i)\beta_{T,i} + \pi_i(1 - \alpha_{T,i}) + (1 - \pi_i)\beta_{M,i}}{\pi_i\alpha_{T,i} + (1 - \pi_i)\beta_{T,i} + \gamma_{T,i} + \pi_i(1 - \alpha_{T,i}) + (1 - \pi_i)\beta_{M,i} + \gamma_{M,i}}.$$

The numerator states the likelihood of satisfying one's occupational goal if one enters school, while the denominator states the total likelihood of satisfying one's occupational goal. The only differences between the numerator and the denominator are the γ terms, which appear in the denominator and reflect the chance of reaching the occupational goal by not attending school.

Breen and Goldthorpe (1997) state that if the ratio exceeds 0.5, then staying in school will be occupationally advantageous. Given that the γ terms are the only difference between the numerator and the denominator, the condition for exceeding 0.5 can be written as:

$$\text{C5.1)} \quad P_{it} > 0.5 \quad if \quad \pi_i\alpha_{T,i} + (1 - \pi_i)\beta_{T,i} > \gamma_{T,i}$$

$$\text{C5.2)} \quad P_{im} > 0.5 \quad if \quad \pi_i\alpha_{T,i} + (1 - \pi_i)\beta_{T,i} + \pi_i(1 - \alpha_{T,i}) + (1 - \pi_i)\beta_{M,i} > \gamma_{T,i} + \gamma_{M,i}.$$

Breen and Goldthorpe (1997) show that if $\pi < 1$, then the relations of equations D2.1–D2.6 mean that even if all parameters are equal across classes:

$$\text{C6)} \qquad P_{it} > P_{im}$$

Because students act on this ratio, this feature alone – a feature they term *relative risk aversion* – will produce different behavior with respect to education continuation, with those of higher classes being more likely to obtain more schooling.

Abilities

Equation D1 states that one's subjective belief about one's chances of graduating is a function of one's ability. Breen and Goldthorpe also state that:

$$\text{C7)} \qquad \bar{A}_t > \bar{A}_m$$

i.e. mean ability differences advantage higher origin persons. Combining D1 and C7 produces:

$$\text{C8)} \qquad g[\bar{A}_t] = \bar{\pi}_t > \bar{\pi}_m = g[\bar{A}_m].$$

which states that simply on the basis of ability those of higher origins will average higher subjective expectations of educational success. And, because higher subjective expectations of educational success produce higher likelihood of pursuing education, ability differences propagate through to produce higher levels of educational attainment for higher origin persons.

Another way that abilities matter is that often one may only continue in school if:

$$\text{C9)} \qquad a_i > k$$

Those with higher ability will be more likely to exceed any such threshold, k. Thus, ability has an effect both through children's expectations, as shown in Equations C7–C8, and through children's ability to exceed admissions thresholds, as reflected in Equation C9.

Resources

RRA recognizes that schooling takes resources. If persons can continue in school only if:

$$\text{C10)} \qquad r_i > c$$

and:

$$\text{C11)} \qquad \bar{r}_t > \bar{r}_m$$

then those of higher origins have more resources on average and thus will be more likely to be able to continue school.

CDMs

Origin differences entail systematically different ways of reaching the goal of avoiding downward mobility, thus entailing higher likelihood of school continuation for those of higher origins. Further, on average persons of higher origins have higher levels of ability, and this raises their subjective assessment of their likelihood of succeeding in school (π) and their chance of obtaining admission to additional education. Finally, if schooling has costs, then because those of higher origins have greater resources, those of higher origins will be more likely to continue with school.

Note that Breen and Yaish (2006) re-express RRA in simpler terms, generalize SOAR to any parental characteristic (e.g. education, occupation) as the basis of youths' aims (Breen and Yaish 2006, p. 235), and extend Breen and Goldthorpe's (1997) examination of the necessity of the DSP assumptions to reiterate that RRA still produces class differences in educational attainment when DSP assumptions are relaxed. The simpler expression is of value. However, I retain the original formulation because, as I show below, intriguing results follow from the strong version of RRA.

Examining RRA: Tautology? Contradiction? Evaluative feasibility?

Again, we are ahead of the game in evaluating RRA because Breen and Goldthorpe precisely conveyed their proposal. However, we still need to assess the proposal for falsifiability.

The proposal has three key components: (1) a description of the structure of decisions and link into the economy (SOAR) – although this is stylized, it captures major features of the process; (2) a set of relations that produce and constrain the relative levels of subjective probabilities persons will develop (DSP); and (3) a set of class-linked mechanisms of differentiation (CDM). The third, CDM, contains within it the relative risk mechanism.

If we take SOAR as a context-setting structure, our attention turns to DSP, CDM, and the relationship between them. Recall that C5.1 and C5.2 reveal the conditions for continuing in school; persons with higher origins continue in school if $P_{it} > 0.5$; this condition is satisfied if $\pi_i \alpha_{T,i}$

$+ (1 - \pi_i)\beta_{T,i} > \gamma_{T,i}$. Recall also that D2.1–D2.3 states $\alpha_T > 0.5$, $\alpha_T > \beta_T$, and $\alpha_T > \gamma_T$. Given these relations and any $\pi > 0$, Equation C5.1 implies that high origin persons continue school if:

$$\text{C12)} \qquad \frac{-\beta_T + \beta_T\pi + \gamma_T}{\pi} < \alpha_T$$

Thus, the question: Are there values that satisfy D2.1–D2.3 that do not satisfy C12? In other words, can those of high origins discontinue their schooling? If we set $\beta_T = \gamma_T$ then these terms cancel in the numerator, making C12 become $\beta_T < \alpha_T$. By D2.2 $\beta_T < \alpha_T$, meaning that if $\beta_T = \gamma_T$ then higher origin persons stay in school. And, if $\beta_T > \gamma_T$, then $\beta_T > 0$ must be true, which means that $((-\beta_T + \beta_T\,\pi + \gamma_T)/\,\pi) < (\beta_T\pi/\pi)$ is also true. Hence, if $\beta_T > \gamma_T$, higher origin persons stay in school.

However, if $\beta_T < \gamma_T$, then $((-\beta_T + \beta_T\,\pi + \gamma_T)/\,\pi) > \alpha_T$ is possible, meaning that if $\beta_T < \gamma_T$, then higher origin persons may discontinue school. Thus, $\beta_T < \gamma_T$ is a necessary but not sufficient condition for higher origin persons to quit school. Concretely, this means that the only condition under which those of high origins may quit school is if they subjectively regard their chances of reaching top occupations to be better if they leave school than if they stay in school and fail. Not every such high origin student will leave school, for the ratio must exceed their subjective assessment of their chance of reaching top occupations after succeeding in school, α_T. But, the only way a high origin student will leave school is if they believe their chances of economic success are higher by leaving. Further, they are the only high origin persons for whom the subjective probability of reaching the top should they succeed in school (α) and the subjective beliefs in their likelihood of succeeding in school (π) remain relevant for the school continuation decision. Thus, we might label this the *Gates gambit*.[5]

A similar analysis of P_{im} reveals that C5.2 simplifies to:

$$\text{C13)} \qquad \frac{-\gamma_M - \gamma_T + \beta_M + \beta_T}{\beta_M - 1 + \beta_T} < \pi$$

For most high origin students π proves irrelevant; here α drops out of the equation. Thus, for middle origin students, their chance of reaching the top occupations after succeeding in school (α) is not a relevant subjective parameter. In contrast to most high origin students, a key parameter for middle origin students' school continuation decision is their estimate of their likelihood of school success. The higher that likelihood, the higher their chance of continuing (because the greater difficulty the left-hand side of Equation C13 will have of exceeding π).

Equations C12 and C13 are consistent, in a deep sense, with the term 'relative risk aversion' in that, regardless of origins, a focal factor in the school continuation decision is the ratio of the chance of reaching the target occupation(s) assuming failure in school versus the chance of reaching the target occupation(s) if one discontinues school. In other words, the theory states that, regardless of origins, persons compare the result of failing in school and the result of dropping out prior to failing, and select the path that minimizes chances of downward mobility.

Additional insights might be visible were one to continue the assessment, but the key issue of falsifiability concerns whether P_{it} and P_{im} are contradictory or tautologous given SOAR and DSP. They are not. Thus, at present, it appears that RRA is falsifiable. Consequently, Breen and Goldthorpe (1997) have proposed a scientific theory, and analysts may usefully study the degree to which the theory matches empirical reality.

Effectively maintained inequality[6]

Lucas (2001) proposes a theory of *effectively maintained inequality* (EMI) whose postulates are qualitative statements. EMI was proposed in the context of an argument that the advantaged act, both as individuals and as a class, to secure advantages for themselves and their children. These actions were seen to occur in an environment amidst widespread yet varying student myopia and gatekeeper discretion concerning the allocation of advantageous in-school positions. EMI contends that one result of these conditions is stickiness in the parameters that keeps those parameters within parts of the parameter space that systematically advantage the advantaged.

Lucas (2001) provided neither numbered tenets à la Raftery and Hout (1993) nor specific equations à la Breen and Goldthorpe (1997), complicating the task. Thus, I first transform EMI claims into numbered postulates, then I discuss the scope conditions for EMI. Afterwards, I endeavor to faithfully translate the postulates into formal analytic terms.

EMI posits the following:

1) Socioeconomically advantaged actors secure for themselves and their children some degree of advantage wherever advantages are commonly possible.
2) If quantitative differences are common the socioeconomically advantaged will obtain quantitative advantage.
3) If qualitative differences are common the socioeconomically advantaged will obtain qualitative advantage.

4) Postulates 2 and 3 could be true in that when a good is not universal, the socioeconomically advantaged use their advantages to secure that good. Once that good becomes nearly universal, however, the socioeconomically advantaged seek out whatever qualitative differences there are *of that good*, and use their advantages to secure quantitatively similar amounts of qualitatively better goods.
5) Alternatively, it is possible that even when quantitative differences are common qualitative differences are also important; if so, the socioeconomically advantaged will use their socioeconomic advantages to secure both quantitatively and qualitatively better outcomes.
6) To evaluate EMI, analysts need to determine whether their categorical predictions for theoretically focal persons differ on the basis of socioeconomic status. If the category with the highest probability differs on the basis of socioeconomic status, this is evidence of EMI.

Scope conditions

An important ambiguity in EMI must be addressed at the outset. EMI refers to differences being 'common' or 'commonly possible' in postulates 1–3 and 5. However, postulate 4 refers to goods being 'universal' or 'nearly universal.' There is much ambiguity in the terms 'common' and 'commonly possible,' and ambiguity also attends the relation between common and commonly possible on the one hand, and universality and near universality on the other. The consequence of this ambiguity is that the scope conditions for EMI are unclear, fostering the possibility that investigation of EMI will devolve into irresolvable debate as to whether analyses satisfy the scope conditions of EMI. As noted earlier, one cannot falsify a proposal whose terms shift without principle; thus, ambiguity in the scope conditions threatens to render EMI non-falsifiable. Hence, it is important to determine what is meant by these terms.

To that end, we begin by noting the relation between the variance of X (σ^2_X) and universality of X (υ_X). We define universality as pertaining for a good when all i receive some good, denoting $\upsilon_X = 1$ when X is universal and $\upsilon_X = 0$ when X is not universal. Given this understanding, setting $\sigma^2_X = 0$ is a stronger condition than setting $\upsilon_X = 1$, as reflected in Equations Z3.1–Z3.4:

Z3.1) $X \in R_0^+; D = 1 \text{ if } X > 0; D = 0 \text{ if } X = 0; \upsilon_X = 1 \text{ if } \sum D_i = n \text{ or } \sum D_i = 0;$

Z3.2) $\text{if } X_i > 0 \ \forall_i \Rightarrow \sum D_i = n_x \therefore \upsilon_X = 1$

Z3.3) $\text{and if } \sigma^2_X = 0 \Rightarrow \sum D_i = n \text{ or } \sum D_i = 0 \therefore \upsilon_X = 1$

Z3.4) $\text{but if } \upsilon_X = 1, \Rightarrow \sum D_i = n \text{ or } \sum D_i = 0 \ \neg \ \Rightarrow \sigma^2_X = 0$

Z3.1 defines a variable X which takes on non-negative real values, a dichotomous variable D that equals 1 if X is greater than zero and equals zero if X equals zero, and the states of D that imply $\upsilon_X = 1$. Given Z3.1, Z3.2 states that if all X_i are non-zero, then we know that all D_i=1 and thus υ_X=1; X is universal. Z3.3 states that if we know $\sigma^2_X = 0$, then we know $\upsilon_X = 1$; X is universal. However, Z3.4 states that even if we know a good is universal ($\upsilon_X = 1$), we do not know σ^2_X and thus we do not know whether X is equally distributed. Consequently, universality is a weaker condition. In sum, universality can pertain without equal distribution of a good, but equal distribution of a good implies universality of the good.

Concretely, assume that X signifies the size of a federal grant for college tuition available to all admittees. There are four possibilities. First, if the grant is of equal size for all admittees, then the grant is universal ($\upsilon_X = 1$) and equally distributed ($\sigma^2_X = 0$). Second, if the grant amount varies but exceeds zero for all i, then the grant is universal ($\upsilon_X = 1$) but unequally distributed ($\sigma^2_X > 0$). Third, if the grant amount varies and is zero for some i, then the grant is not universal ($\upsilon_X = 0$) and is also unequally distributed ($\sigma^2_X > 0$). Finally, it is impossible to have a grant that is non-universal ($\upsilon_X = 0$) yet is equally distributed ($\sigma^2_X = 0$).[7] Hence, knowing a good is universal does not answer whether a good is equally distributed, but knowing a good is equally distributed is to know a good is universal.

Taken together, Equations Z3.1–Z3.4 imply that universality cannot be the scope condition for EMI, because EMI ambiguously refers to whether advantages are commonly possible. Establishing the universality of a good does not tell us the variance is or is not zero, and thus does not tell us whether quantitative advantages are or are not possible. Thus, it seems EMI claims are only coherent if we highlight the variance of the good, not universality or the lack thereof.[8]

Given the above, we can identify two different scope conditions for EMI. It is clear that if a good lacks variance, advantages are not possible. Interpreting commonality as referencing the variance, one set of scope conditions Lucas (2001) implies is that EMI applies if the variance is not zero. As it is the rare good that lacks variation, EMI would generally apply. The general applicability extends beyond education outcomes, because Lucas (2001) claimed that EMI offered ‘a general explanation for social background related inequality’ (p. 1642).

A more narrow scope condition for EMI states that if the variance is not small, EMI applies. The narrow scope condition is more challenging; clearly, an empirical answer is available concerning whether there

is any variation, but once we know $\sigma^2_X > 0$ the condition that a variance be larger than small is difficult to assess. While offering a general theory of inequality, Lucas (2001) provided only an example focused on education which conveyed an empirical (though, unfortunately, inexplicit) response to the ambiguity. This may not be a generally possible strategy and, in any case, may have problems; thus, we return to this issue when evaluating EMI. Here, however, we note the two different scope conditions: (1) a broad one which says EMI almost always applies, and (2) a narrow one which says EMI applies only if the variance is not small.

Describing the postulates in formal terms

Postulate 1 states:

$$\text{E1.1)} \quad A = f(\lambda O, \eta Z)$$
$$\text{E1.2)} \quad \textit{if } \sigma^2_A > 0$$
$$\text{E1.3)} \quad \textit{or if } \sigma^2_A > \iota$$

Equation E1.1 states that advantage, A, is a function of social origins, O, and other factors, Z, with coefficients λ and η. E1.2 states the broad scope condition for E1.1, that variance of A must exceed zero; E1.3 states the narrower scope condition for E1.1, that the variance of A must exceed some small constant, ι (iota).

Postulate 1 does not explicitly state that factor Z should be included, but the reference to 'theoretically focal persons' in Postulate 6 implies that some set of focal persons must be identified. One way to do so is to include covariates and then specify values of the covariates to identify theoretically focal persons. That is the approach used in the original EMI analysis, thus supporting the inclusion of Z here.

Postulates 2 and 3 decompose a good into quantitative (QN) and qualitative (QL) dimensions:

$$\text{E2.1)} \quad \textit{If } \sigma^2_{QN_A} > 0 \Rightarrow QN_A = f(\beta O, \kappa Z)$$
$$\text{E2.2)} \quad \textit{If } \Delta_{QL_A} > 0 \Rightarrow QL_A = g(\phi O, \psi Z)$$
$$\beta \stackrel{?}{=} \phi; \beta \stackrel{?}{=} \kappa; \beta \stackrel{?}{=} \psi; \phi \stackrel{?}{=} \kappa; \phi \stackrel{?}{=} \psi; \kappa \stackrel{?}{=} \psi; f(x) \stackrel{?}{=} g(x)$$

In E2, QN_A references the quantitative dimension of the good, QL_A references the qualitative dimension of the good, β captures the association between social origins and the quantitative dimension of the good in question, and ϕ captures the association between the social origins and the qualitative dimension of the good in question. Coefficients κ and ψ capture the association between all other included factors and the quantitative

and qualitative dimensions of the good in question, respectively. Thus, E2 reflects a decomposition of the effect of origins, λ, into a component connected to quantitative variation (β) and a component connected to qualitative variation (ϕ). An analogous decomposition breaks η, the effect of non-origin covariates, into components reflecting an association with quantitative variation (κ) and qualitative variation (ψ).

The quantitative/qualitative distinction is central to EMI. Concretely, Lucas (2001) noted that education has both a quantitative element (e.g. number of transitions completed) and a qualitative element (e.g. type of education). He noted that secondary school tracking in the United States allows potentially consequential qualitative inequality in schooling even for persons who complete the same number of transitions. Lucas (2001) suggested that many other areas of social science interest could have the same character, in which inequality can be decomposed into quantitative and qualitative dimensions (e.g., health care).

Lucas (2001) estimated one parameter to capture the association between each origin variable and overall variation in the outcome, but then re-expressed that parameter in terms of quantitative and qualitative inequality. Because one parameter may be used in this manner, no restrictions on the equality or inequality of the coefficients or functions exist in E2.

E2 uses the broad scope condition such that E2 applies if $\sigma^2_{QN_A} > 0$ or $\Delta_{QL_A} > 0$, where $\sigma^2_{QN_A}$ references variation in the quantitative dimension while Δ_{QL_A} references variation in the qualitative dimension. E3 reiterates the relations noted in E2, except the narrow scope condition is invoked:

$$\text{E3.1)} \quad \textit{If } \sigma^2_{QN_A} > \iota_{QN_A} \Rightarrow QN_A = f(\beta O, \kappa Z)$$

$$\text{E3.2)} \quad \textit{If } \Delta_{QL_A} > \iota_{QN_A} \Rightarrow QL_A = g(\phi O, \psi Z)$$

$$\beta \stackrel{?}{=} \phi; \beta \stackrel{?}{=} \kappa; \beta \stackrel{?}{=} \psi; \phi \stackrel{?}{=} \kappa; \phi \stackrel{?}{=} \psi; \kappa \stackrel{?}{=} \psi; f(x) \stackrel{?}{=} g(x)$$

such that if quantitative variation exceeds some small value ι_{QN_A}, origins will matter for the quantity persons obtain, and if qualitative variation exceeds some small value ι_{QL_A}, origins will matter for the quality persons obtain.

In both E2 and E3, whether origins matter for the quantitative dimension depends solely on variance in the quantitative dimension, and whether origins matter for the qualitative dimension depends solely on variation in the qualitative dimension. Both E2 and E3 separate the issue of whether origins matter for quantity from the issue of whether origins matter for quality. This separation allows for the possibility that both qualitative and quantitative dimensions could be important

simultaneously and thus also expresses Postulate 5, which asserts that when assessing whether scope conditions for EMI are satisfied one may treat the qualitative and quantitative dimensions as independent.

Postulate 4, however, relates quantitative and qualitative dimensions differently:

E4.1) $$If\ \sigma^2_{QN_A} > 0, then\ QN_A = f(\beta_1 O, \kappa_1 Z), QL_A = g(\phi_1 O, \psi_1 Z);$$

E4.2) $$else\ If\ \sigma^2_{QN_A} > 0, then\ QN_A = f(\beta_2 O, \kappa_2 Z), QL_A = g(\phi_2 O, \psi_2 Z);$$
$$\phi_1 = 0 = \beta_2$$

or

E5.1) $$If\ \sigma^2_{QN_A} > \iota_{QN_A}, then\ QN_A = f(\beta_1 O, \kappa_1 Z), QL_A = g(\phi_1 O, \psi_1 Z);$$

E5.2) $$else\ If\ \sigma^2_{QN_A} > \iota_{QN_A}, then\ QN_A = f(\beta_2 O, \kappa_2 Z), QL_A = g(\phi_2 O, \psi_2 Z);$$
$$\phi_1 = 0 = \beta_2$$

where E4 uses the broad scope condition and E5 uses the narrow one. All four equations state that quantity variation alone determines whether EMI scope conditions are satisfied. E4.1 states that if the quantity variation exceeds zero, then the quantity obtained is determined (in part) by origins and the quality obtained is not ($\phi_1 = 0$). However, E4.2 states that if quantity variation is zero, then origins (in part) determine the quality of goods obtained, and origins do not matter for quantity ($\beta_2 = 0$). Similar observations follow in the case of the narrow scope condition as reflected in E5. Both E4 and E5, which express Postulate 4, assert that only the quantitative dimension is relevant for assessing whether scope conditions for EMI are satisfied. Odd though this assertion may appear, and setting aside the question of its empirical accuracy, the assertion is a straightforward implication of the alternative articulated in Postulate 4.

Postulate 6 requires analysts to assess predicted probabilities, thus requiring the equations be translated into statistical terms. EMI claims to require predicted probabilities for two reasons. A statistical reason reflects concerns voiced in the debate on identification in the Mare model. One observation in that debate was that coefficients from models for categorical outcomes reflect both the association of interest and the identifying assumptions of the model. However, identifying assumptions do not affect Pr(y = j | **x**) (where **x** is a matrix of independent variables and y is a J-category dependent variable) (Long 1997, p. 49). Because EMI responded to De Graaf and Ganzeboom (1993) and Cameron and Heckman (1998), both of which argue there is no theoretical basis for any specific functional form of education transitions analyses, Lucas (2001, pp. 1657– 8) conceives the postulates of EMI in

terms of predicted probabilities in order to insulate the analysis from dependence on functional form assumptions.

However, a second, more substantive, basis for the approach is that EMI, adopting the econometric interest in interpreting $\Pr(y = j|\mathbf{x})$ rather than the statistical interest in describing $\Pr(y = j|\mathbf{x})$ (Manski 1992, p. 202), considers whether advantaged persons exceed pivotal thresholds to enter categorical positions that provide advantages. Odds-ratios and regression coefficients do not answer that question because they do not convey predicted values directly. Whether persons exceed pivotal thresholds depends on how close they are to the threshold, and whether the extra push their origins provide is enough to take them over. Hence, the isolated effect of origins (β and ϕ) is necessary but insufficient, and EMI concern centers on whether the coefficient is substantively important in a specifiable context (i.e. for theoretically focal persons), not on whether the coefficient is large or small in an absolute sense. This idea was part of the basis for the term *effectively* in effectively maintained inequality. Consequently, the approach is defended on both substantive and statistical grounds.

Lucas (2001) specified an ordered probit model to accommodate censoring in the latter outcome, college entry. For consistency with MMI and RRA here, however, the translation uses an ordered logit specification; as noted above, this will not matter because while coefficients are sensitive to the identifying assumption (e.g., probit or logit), predicted probabilities are not. Assuming one transition and four possible categories, we can re-state E2 (or E3, E4, or E5) as:

$$\text{E6.1)} \qquad Pr(Y=1) = \frac{1}{1+e^{\lambda O+\eta Z-\delta_1}}$$

$$\text{E6.2)} \qquad Pr(Y=2) = \frac{1}{1+e^{\lambda O+\eta Z-\delta_2}} - \frac{1}{e^{\lambda O+\eta Z-\delta_1}}$$

$$\text{E6.3)} \qquad Pr(Y=3) = \frac{1}{1+e^{\lambda O+\eta Z-\delta_3}} - \frac{1}{e^{\lambda O+\eta Z-\delta_2}}$$

$$\text{E6.4)} \qquad Pr(Y=4) = 1 - \frac{1}{1+e^{\lambda O+\eta Z-\delta_3}}$$

where λ is a coefficient on origins that aggregates social origin coefficients β and ϕ from equations E2–E5, η is a coefficient on all other factors that aggregates the effect of other factors as reflected in coefficients κ and ψ in equations E2–E5, and δ_j is a threshold dividing category j from category j+1 in a latent, logistically distributed variable underlying the observed categorical variable Y (Long 1997). Given this translation, postulate 6 indicates that if EMI is accurate the category

with the highest predicted probability will differ by origins. Put differently, Postulate 6 of EMI states:

$$\begin{aligned} &\max\ [Pr(Y_{O=high}=1), Pr(Y_{O=high}=2), Pr(Y_{O=high}=3), Pr(Y_{O=high}=4)] = J_{\max \Pr(Y=j),O=high} \\ &\neq J_{\max \Pr(Y=j),O=low} = \max[Pr(Y_{O=low}=1), Pr(Y_{O=low}=2), Pr(Y_{O=low}=3), Pr(Y_{O=low}=4)] \end{aligned} \quad \text{E7)}$$

If so, one has found evidence of EMI. If not, EMI is rejected.

Examining EMI: tautology? Contradiction? Evaluative feasibility?

Evaluative feasibility is so central to determining the falsifiability of EMI that we consider it first, before turning to assess whether EMI is tautological or contradictory. Indeed, resources developed in the discussion of evaluative feasibility bear directly on the possibility that EMI is tautologous or contradictory.

Statistical analysis and the evaluative feasibility of EMI

One notable threat to evaluative feasibility concerns the EMI claim to offer a specific pattern of prediction. EMI asserts that for a qualitative outcome predictions will vary for theoretically focal persons on the basis of their origins. Establishing who is theoretically focal itself could be a matter of contention, depending greatly on the substantive area studied. Lucas (2001) calculated predicted values for two illustrative cases at the mean on several covariates, but differing in various ways on social origins. A sensitivity analysis that calculates probabilities based on setting covariates at their mean, and then at their median, and then at other plausible and theoretically interesting locations, might prove illuminating. Note, however, that analysts are at risk of inadvertently searching to find some constellation of covariates for which origins do or do not make the crucial difference, depending on their desire to affirm or reject EMI. Thus, the constellation of covariate values should, ideally, be defended on theoretical grounds. In this context, setting covariates at their central values (mean, median) may be the EMI analogue to the non-informative prior in Bayesian analysis, with the added benefit of likely reducing the chance of drawing inferences off the support (with the proviso that categorical variables must be given a plausible value in the probability calculations).

Once the theoretically focal are identified, one may ask: Does the calculation of predicted values and categorical predictions provide any information not already provided by the test of statistical significance?

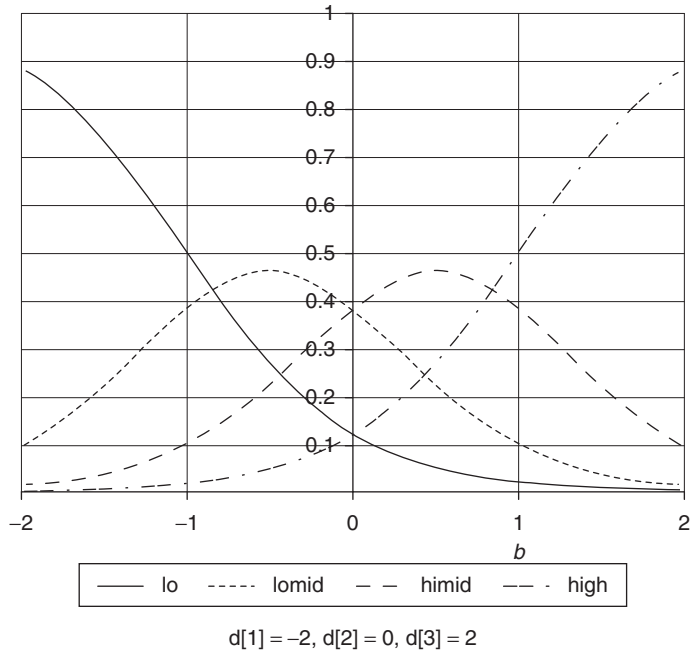

Figure 5. Illustrative predicted probability of outcome, high origins

If statistically significant coefficients always lead to disparate categorical predictions, then the procedure offers no new information.[9] And, if calculating predicted values adds no information, then EMI collapses into simply asserting that origins are positively associated with outcomes, a ubiquitous finding that has virtually no dispute. EMI claims that categorical predictions are illuminating, and thus EMI is a sharper, more precise hypothesis. Does the claim hold up to scrutiny?

Figures 5 and 6 provide illustrative predicted probabilities for high and low origins persons, respectively, assuming a 4-category ordinal logit model with thresholds of -2, 0, and 2, with ϕ varying from -2 to 2. The plot addresses the issue of whether the predicted value calculation adds information, and reveals other features of EMI. As for the utility of calculating predicted values, when $\phi = 0.5$ the best categorical prediction is the same. When $\phi = 1$ categorical predictions vary by origins. When $\phi = 2$ categorical predictions are the same, but the predicted category for both groups when $\phi = 2$ is not the category predicted for both groups when $\phi = 0.5$.

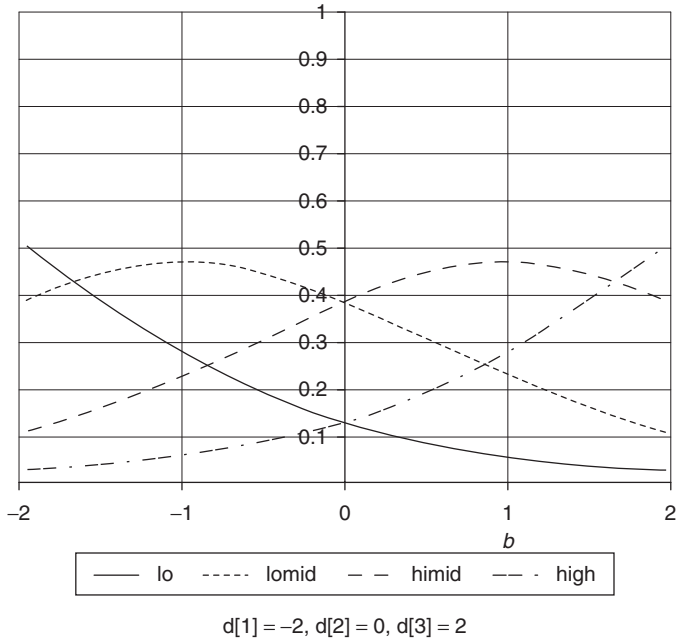

Figure 6. Illustrative predicted probability of outcome, low origins

A simple ordered logistic regression coefficient of 0.5 will be statistically significant at $\alpha = 0.05$ (with power equal to 0.90) (Walters 2004) if $N \geq 1293$, an N smaller than that used in many education transitions analyses (e.g. Mare 1980; Breen and Jonsson 2000; Hauser and Andrew 2006). Hence, one may reject EMI even with a statistically significant coefficient.[10] Of course, with large enough N any coefficient will be statistically significant, indicating that the predicted value assessment EMI advises does provide more information, and test a sharper thesis.

Note that as ϕ increases, the best guesses for those of different origin classes change back and forth from being the same, to being different, to being the same (to being different, to being the same). This pattern of predictions reflects that EMI is not concerned with the size of the coefficient but, instead, concerns the part(s) in the distribution of ϕ where positional advantages likely accrue to advantaged but not disadvantaged persons. Note, however, that the example shows that when $\phi = 2$, both groups likely accrue advantages. Yet, a higher proportion of high origins persons obtain the top positions, a result that itself could be an important aspect of inequality. Notably, EMI ignores that aspect.

Scope conditions and the evaluative feasibility of EMI

EMI offers two sets of scope conditions – broad and narrow – and two ways in which the quantitative and qualitative dimensions may be related – independently, or with the quantitative dimension as determinant. To establish the falsifiability of EMI one need find only one combination of scope condition and the way in which the two dimensions relate that allows falsifiability. It is apparent that there is at least one such case – if one uses the broad scope conditions, and asserts the independence of the quantitative and qualitative dimensions, then if a variable has any variation – quantitative or qualitative – then EMI can be investigated. If such an investigation does not reveal an EMI pattern, then EMI is rejected (and thus falsified in that domain).

However, matters are a bit more complex. EMI is composed of six postulates, which I translated into seven equations. The seven equations appear to produce twelve cases of possible outcomes owing to the multiple scope conditions, multiple dimensions of inequality, and multiple ways in which those dimensions are said to relate. Thus, the simple qualitative claims of EMI appear to manifest a great deal of complexity when considered formally. One question to assess is whether this complexity reduces to a smaller set of possibilities.

Table 1 lists the twelve cases, and suggests it is the rare pattern that makes EMI inapplicable. We may consider the table as an analyst might. Moving from left to right, an analyst could select a preferred way of relating the quantitative and qualitative dimensions. Then the analyst could select a preferred set of scope conditions, broad or narrow. If broad scope conditions are preferred, the analyst may then determine whether there is quantitative or qualitative variation in their outcome. If there is neither quantitative nor qualitative variation, then EMI does not apply (Case D). However, regardless of the analyst's view of the relation of the quantitative and qualitative dimensions, if there is variation on either the quantitative or qualitative dimension, conditions for assessing EMI hold and thus EMI can be rejected if evidence for it is not found. The analyst's view of how the quantitative and qualitative dimensions are related remains relevant, however, for the pattern of social origin effects EMI predicts (sketched in the far right column) depends in part on how one sees the relation between the two dimensions of inequality.

If, alternatively, the analyst prefers the narrow scope conditions, matters are a bit more challenging, for the narrow scope conditions require one to assess whether quantitative and/or qualitative variation in the outcome is small or not. Just as determining when an association is large

Table 1. Variants of effectively maintained inequality as reflected in Equations E1–E7 (only the cells assessed contain entries)

Case	Relation of QN & QL in scope assessment	Broad scope conditions			Narrow scope conditions			EMI	
		$\sigma^2_{QN_A}>0$	$\Delta_{QL_A}>0$	$\sigma^2_{QN_A}=0$	$\sigma^2_{QN_A}>\iota_{QN_A}$	$\Delta_{QL_A}>\iota_{QL_A}$	$\sigma^2_{QN_A}\leq\iota_{QN_A}$	Applicability	Prediction
A	Independent	Yes	No					In scope	$\beta\neq0$
B	Independent	No	Yes					In scope	$\phi\neq0$
C	Independent	Yes	Yes					In scope	$\beta\neq0$, $\phi\neq0$
D	Independent	No	No					Out of scope	—
E	Independent				Yes	No		In scope	$\beta\neq0$
F	Independent				No	Yes		In scope	$\phi0$
G	Independent				Yes	Yes		In scope	$\beta\neq0$, $\phi\neq0$
H	Independent				No	No		Out of scope	—
I	QN determines	Yes		No				In scope	$\beta\neq0$, $\phi=0$
J	QN determines	No		Yes $\Leftarrow$ Yes				In scope	$\beta=0$, $\phi\neq0$
K	QN determines				Yes		No	In scope	$\beta\neq0$, $\phi=0$
L	QN determines				No		Yes $\Leftarrow$ Yes	In Scope	$\beta=0$, $\phi\neq0$

Note: QN = Quantitative Dimension; QL = Qualitative Dimension; β captures the effect of origins on the quantitative dimension of the outcome; $\phi = 0$ signifies $J_{max(PrY=j|O=Hi)} = J_{max(PrY=j|O=Lo)}$; $\phi \neq 0$ signifies $J_{max(PrY=j|O=Hi)} \neq J_{max(PrY=j|O=Lo)}$.

is a judgment call, determining whether a variance is small is a judgment call. However, strategies to ground analysts' judgment exist.

Ideally one can find a means of persuasively, ideally theoretically, and most important *a priori* establishing threshold values ι_{QN_A} and ι_{QL_A}, for these thresholds are key to determining whether the variance in the qualitative and quantitative dimensions is small. One means that approaches the ideal uses historic variation in the outcome to assess the size of the variation. Another uses a criterion that lies beyond the specific study to demonstrate that the outcome variable has sufficient variation to matter for other outcomes – if the variable satisfies this condition, then the variation is consequential and the outcome is deemed to have enough variation to meet the narrow scope conditions of EMI. This approach, especially when applied to the qualitative dimension, is consistent at a deeper level with EMI, which claims the advantaged obtain qualitative positions that eventuate in *other* advantages. Consequently, linking the outcome studied to advantages outside the area studied is appropriate.

The foregoing applies directly in the case of independent dimensions of inequality and narrow scope conditions. However, if one assumes quantitative variation is determinative, an important implication of that assumption is the denial of completely homogenous goods. Denying completely homogenous goods has important implications; if goods are heterogeneous, then the scope conditions of EMI are satisfied directly, because E4.2 implies that $\Delta_{QL_A} > \iota_{QL_A}$ if $\sigma^2_{QN} = 0$ and E5.2 implies the equivalent assumption that $\Delta_{QL_A} > \iota_{QL_A}$ if $\sigma^2_{QN} \leqslant \iota_{QN_A}$. Thus, denying completely homogenous goods implies that even under the narrow scope condition EMI always applies.

Thus, for the purposes of assessing whether EMI applies, the twelve cases in Table 1 reduce to fewer possibilities. EMI is applicable, except when a variable has neither quantitative nor qualitative variation (Case D) or when a variable has very small quantitative and qualitative variation (Case H). All other constellations of quantitative and qualitative variation fall within the scope of EMI, such that failing to find predicted patterns of effects means that analysts may reject EMI.

Is EMI tautological? Is EMI contradictory?

With respect to contradiction, the postulates appear to produce equations that are not self-contradictory. EMI is not hounded by contradiction so much as by the danger that its key claim – the advantaged obtain advantage – is obvious and may add little, because we already know that

persons with higher incomes, more education, and better jobs obtain many other advantages. EMI concerns the translation of advantage in one set of goods into advantages in another. And EMI offers a predicted pattern analysts should be able to observe if EMI is true, a pattern that is more specific than simply a prediction that the association is non-zero. Thus the EMI claim, obvious though it may appear, does not produce a contradiction for EMI.

EMI's key claim – the advantaged obtain advantage – may also appear tautologous. What breaks the apparent tautology is the existence of multiple goods. It may appear tautological to see advantage with respect to one good conveying advantage in obtaining another good, but nothing in principle requires that to be so. Societies may arrange matters in different ways. Indeed, the core of social stratification research concerns whether and how the distribution of one good is associated with the distribution of other goods. Given that the assessment takes investigation, this claim does not render EMI tautologous.

EMI does have one visible tautology; it appears that Case J in Table 1 entails a tautology. In Case J the quantitative dimension is determinative, the broad scope conditions are considered, and $\sigma^2_{QN_A} = 0$. Under these conditions EMI predicts that $\beta = 0$. This prediction is a tautology, for it follows directly from the claim that $\sigma^2_{QN_A} = 0$; if variance in the quantitative dimension is zero, there can be no association between origins and the outcome. Thus, this is a tautological contention. Still, Case J is not completely tautological; EMI's expected finding for ϕ for Case J is not a tautological assertion, such that Case J remains a pathway to falsifying EMI. Further, the analogous narrow scope case, Case L, is not tautologous in expecting $\beta = 0$, for in that case it is possible to find $\iota_{QN_A} \geq \sigma^2_{QN_A} > 0$, in which case $\beta \neq 0$ is possible.

Juxtaposing Cases J and L vividly illustrates that determining whether scope conditions are met is consequential for assessing evidence bearing on EMI, while also demonstrating that determining whether and how EMI may apply is not as straightforward as making such an assessment for other proposals. At the detailed level EMI is complicated, and the complications appear to follow from the specificity of its predictions. Analysts will, as always, have to determine whether the complications produce greater clarity or greater confusion and error.

That determination is possible because, in sum, it appears that the strategy proposed for evaluating EMI is feasible and adds information. Further, the proposal appears logically contingent and therefore is falsifiable. Thus, accepting the complexities developed herein, EMI satisfies the criteria for a scientific theory, even though there are judgment calls

analysts must make and defend in any particular empirical investigation of EMI contentions. EMI may prove correct or incorrect, but investigation is needed to make that assessment. Most important, assessment is possible and informative.

Jointly considering the theories and claims

Some have seen MMI as a special case of RRA, some have conflated MMI and EMI, and some have described MMI/EMI as one theory. Because MMI is not falsifiable, interest in the relation of MMI to RRA and EMI may wane. Ending our concern with MMI at this juncture, however, would miss an opportunity to evaluate RRA and EMI. For, if either RRA or EMI are consistent with MMI, then, at least in that particular, they too might be non-falsifiable. Alternatively, consistency with MMI may suggest ways to salvage some of the content of MMI without the associated non-falsifiability. Either way, it remains important to assess the relation of RRA to EMI, and of these theories to MMI.

MMI and RRA

Both MMI and RRA were articulated in a larger argument that de-emphasized collective action. Thus, they may have some points of contact.

Breen and Goldthorpe (1997) see MMI as a special case of RRA in which costs decline across-the-board for all classes. RRA claims that if costs decline differentially for different classes, the patterns highlighted by MMI may not occur. For example, Breen and Goldthorpe (1997) point to Sweden, a case in which class effects declined with educational expansion prior to saturation owing to narrowing economic resource differences by class. This case is an anomaly for MMI but is explained by RRA. On the other hand, RRA can explain cases that are consistent with MMI. Thus, they reason, MMI is a special case of RRA.

Changes in costs can be understood as either moving a threshold or as altering the resources families possess. Under RRA one could see the supplementation of resources of some but not all families, or the reduction in thresholds for some but not all children, as perhaps allowing relatively disadvantaged persons to continue schooling more than previously. Such a change would affect the effect of social background, all else equal. Thus, MMI's implicit 'one threshold for all' assumption becomes visible as an assumption RRA relaxes.

One reason RRA remains falsifiable in relaxing this assumption is that RRA does not emphasize extreme points in the marginal distribution of a binary outcome variable. Indeed, by highlighting diverse branching points and complex structure, RRA also brings in a fuller range of key education outcomes. Thus, translating MMI into RRA salvages whatever useful insights MMI provides without importing the non-falsifiability. Yet, the translation also rejects MMI conclusions – RRA claims diverse possibilities exist, and thus denies both that expansion is the sole route to reduced origin effects and that inequality is always at the maximum possible level.

Can MMI and EMI be distinguished?

Scholars have not confused RRA and MMI, so identifying commonalities and differences is straightforward. In contrast, confusion exists concerning whether EMI and MMI are the same or different and, if different, which is which. For example, Tolsma, Coenders, and Lubbers (2007, p. 326) claim that 'Raftery's effectively maintained inequality (EMI) proposition (Raftery and Hout 1993) states that whenever inequality cannot be maintained quantitatively between educational levels, the basis for differentiation shifts to the qualitative nature of educational tracks.' Alas, Raftery and Hout (1993) propose MMI, not EMI, and qualitative distinctions, absent from MMI, are a prominent concern of EMI. Such examples suggest a fuller treatment of the relation between MMI and EMI is necessary for, as the excerpt suggests, confusion exists.

Confusion may occur because neither approach was formally conveyed. Indeed, proposal authors disagree, with Lucas (2001) claiming that 'for some levels MMI implies the maximum amount of background-related inequality is virtually zero, whereas EMI implies that for those very same levels inequality will not only be non-zero but also non-trivial, i.e., the background-related inequality will be consequential' (Lucas 2001, p. 1653). Hence, Lucas sees MMI and EMI as different.

Hout (2006), however, disagrees, arguing that:

> In response to deviation of the U.S. case from the MMI pattern, Lucas (2001) proposed the essentially [sic] maintained inequality (EMI) model. He noted that in the United States and the Netherlands, MMI failed because the effect of background decreased before the strong condition of saturation was achieved. Yet, inequality of opportunity was effectively maintained because the decrease in the association between background and achievement came about as the proportion of successful students from privileged backgrounds exceeded 80 percent – near saturation (p. 239).

Hout (2006) continues, stating that, 'MMI and EMI propose a specific institutional change – less social selection as the lower tail of the educational distribution is eliminated – that reduces inequality of educational opportunity' (p. 240) and 'The MMI/EMI perspective points to universal access as a key to removing class barriers' (p. 249).[11] Thus, Hout (2006) sees MMI and EMI as complementary, a view differing from Lucas (2001). Which is more apt?

Each proposal's imagery is distinct. MMI self-consciously disavows class-based action (e.g. Hout 2006, pp. 237– 8), while EMI was articulated as a way to understand the sum total of class- and individual-based action of the advantaged (Lucas 2001, p. 1650). Consequently, the imagery underlying the proposals is very different.

Setting imagery aside, the foundational works do not support complementarity, for the perspectives fundamentally disagree. As is well known, MMI states that for nearly universal transitions the social origin association will be low and social conflict will be low, too (Raftery and Hout 1993, pp. 60–1). EMI directly contests this claim, stating that conflict may occur at universal transitions, may be intense, and will concern qualitative dimensions that matter for ultimate attainment. EMI points to contestation around high school tracking in the United States as one example of intense class-linked contestation at a near-universal transition (Lucas 2001, p. 1680). Thus, MMI and EMI disagree on the crucial sociological point of what occurs when a transition is universal or nearly universal. This point is crucial in the 'crucial experiment' sense, because MMI states that policies to universalize a transition will reduce inequality, whereas EMI states that universalizing a transition may do nothing to reduce inequality because advantaged actors will discover or elaborate qualitative differences within the universalized transition and secure access to better quality. And, if better quality confers advantage, then qualitative differences will effectively maintain inequality. The disagreement is consequential; if EMI is correct, would-be egalitarian reformers face a much more difficult challenge than they would were MMI correct. The implication here is that synthesizing perspectives that disagree on such crucial points will likely only produce an ad hoc mélange. Hout (2006) offers a synthesis of the two but it is a synthesis that draws no content from EMI.

A coherent synthesis of MMI and EMI is challenging, for at least two reasons: (1) MMI's focus on unevaluable points in the distribution of goods and (2) the qualitative contradictions in the theories. As for the first issue, one could write MMI terms within the qualitative strata EMI highlights, essentially specifying MMI relations between qualitative

strata. However, the synthesis would be non-falsifiable, for it will have grafted MMI infeasibility onto EMI. Little is gained, and much is lost by that effort.

Second, and more generally, any illuminating synthesis would need to reconcile the qualitative contradictions between the two. For example, would the synthesis regard conflict as likely at universal transitions, as EMI states, or not, as MMI maintains? As another example, would the synthesis see educational expansion as a route to lowering social origin effects, as MMI concludes, or not, as EMI asserts? It does not seem possible to reconcile such contradictions. Thus, any synthesis would seem to require suppression of one or the other. However, a synthesis obtained through suppression is unenlightening, a synthesis in name only, destroying rather than nurturing theoretical possibilities.

Consequently, we conclude that EMI and MMI are not only distinct, they actually conflict. This is important because, as we have seen, MMI is non-falsifiable. Were MMI and EMI connected, then EMI might be surreptitiously undermined. But there is no reason to see EMI as connected to MMI.

Despite the disconnection, however, EMI has a feature that would seem to reproduce for EMI the same problem MMI encountered. It is in this way that perhaps our analysis of MMI sheds light on EMI. As was shown above, some of the problems MMI encounters flow from the role of marginal distributions in the proposal. EMI also is concerned with marginal distributions, for it highlights the predicted probabilities of making a transition for persons with different origins, calling on analysts to consider persons who occupy theoretically focal positions. The advised calculation cannot be made without including information on the other variables in the model. Does the inclusion of such information in its focal statistics create problems for EMI?

The answer turns on realizing the different foci of MMI and EMI. While MMI focuses on the size of the social background effect, EMI concerns not the size of the effect of social background but, instead, whether the effect of social background is effective at moving persons over thresholds. Because of this focus, EMI must consider: (1) the location of the thresholds and (2) the other factors that determine individuals' proximity to the thresholds in social space (analytically) prior to adding the social background effect to the predicted value of one's categorical outcome. This necessarily makes the marginal distribution relevant for the theoretical claims of EMI, a point also implied by the scope conditions EMI articulates. EMI, thus, is focused on the experience of the theoretically focal; the belief, it appears, is that such persons

are pivotal, i.e., the social space pivots around them, and thus analyzing those locations will reveal important aspects of the operation of social stratification systems. This may or may not be true, but it does appear a feasible way to proceed. Key, of course, is that EMI is not attempting to assess whether the effect of social background on a transition is larger or smaller than the effect of social background on another transition, or the same transition at another time. Such assessments must treat marginal distributions very differently than EMI does.

Are EMI and RRA discordant, complementary, or otherwise related?

EMI and RRA differ in many respects. For example, the theories differ on how to theorize cognitive performance. RRA regards ability as important for determining students' expectations and students' likelihood of exceeding admissions thresholds. In this view, ability is directly implicated in producing the subjective parameters of the model. In contrast, EMI is silent on the role of achievement in expectations and goals, but regards achievement as a determinant of educational success for which the analyst must account prior to assessing the impact of social origins. In this view, achievement is another factor to control, and thus enters into the predicted value, but equally so for all theoretically focal persons. Thus, achievement is not implicated in the very parameters of interest to the EMI model.

These claims do not appear to be essential. One might maintain a commitment to RRA even were one unable to demonstrate a role for ability as opposed to achievement. After all, measurably distinguishing ability and achievement is notoriously difficult. Thus, failure to support a role for ability as opposed to achievement seems a weak basis for rejecting RRA. Similarly, one might maintain a commitment to EMI even were one to find an origins/achievement interaction effect on transitions. The simplest translation of EMI specifies no such interaction, but the theory does not turn on the existence or absence of the interaction.

More important is that consideration of the theories together reveals that it is possible to read EMI in RRA terms; thus, the theories are commensurable, even when they substantively disagree. This is a real advantage for developing an empirical, adjudicatory agenda. From this observation, we can identify four key insights that follow from joint consideration of RRA and EMI.

First, reading EMI in RRA terms reveals that EMI augments the determination of π, remaining agnostic on the role of achievement but

adding prior placement and origins as determinants. Thus, one important investigation for assessing RRA and EMI would assess whether prior education placements and social origins matter for expectations of educational success – EMI says yes, while RRA seems silent and thus may not regard such matters as important – and whether achievement matters for expectations – RRA says yes, while EMI seems silent and thus may not regard such matters as important.

Second, we note that RRA denies the existence of relevant subcultural groups. Yet, EMI suggests that those of advantaged origins use their resources to secure gatekeeper action that will place them into advantaged education positions. If this occurs, it is possible that some qualified students are displaced from opportunities they would otherwise obtain. Depending upon who is displaced and whether patterns of displacement develop, such action might lead to the emergence of subcultural norms over time. Thus, it is quite possible that the discretionary acts of gatekeepers feed back onto the development of subjective beliefs about possibilities over and above whatever role prior achievement and persons' socioeconomic origins might play. EMI is consistent with this narrative, and seeing RRA through the lens of EMI makes the emergence of sub-cultures a possibility, worthy of empirical study. Such study might be relevant for assessing the rational choice implications of and relationship between RRA and EMI.

Third, Lucas (2001), while contending that students were variably myopic, and while suggesting that coefficients in the model might partially reflect myopia, did not integrate myopia directly into the tenets of EMI. Thus, myopia is a mentioned yet undeveloped resource in EMI. However, reading EMI in RRA terms reveals a sign of myopia in RRA's equations. RRA implies that α, the subjective chance of reaching a top position should one succeed in school, drops out of the analysis for middle origin students. For all high origin students except those subject to the Gates gambit, α can be estimated but is irrelevant, not because they lack an estimate of α but because no possible value for α will allow them to drop out. In contrast, low origin students need (and have?) no estimate of α but possibly decide to drop out. α is irrelevant to the decision for low origin persons because they satisfy their occupational goal if they succeed in school, because Pr(Destination = Underclass | Educational Success = Yes) = 0 (by SOAR assumption). However, the irrelevance of α is also consistent with EMI's undeveloped suggestion that myopia is differentially distributed – in this case, the equations imply that low origin students behave as if they have no information on α, i.e. no information on their chances of reaching top positions should

they succeed in school. In other words, low origin students appear myopic, whereas high origin students do not. Thus, RRA may provide a vehicle for integrating myopia into EMI.

The previous two observations suggest that resources in one theory can be integrated into the other. Yet a fourth insight implies that EMI and RRA may be complementary, such that advantages may accrue to a synthesis of the two. A route to complementarity is provided by the Gates gambit. The Gates gambit indicates that the only high origin students who will possibly drop out of the school/program are those who believe their chances of reaching destinations that match their high origins are higher by leaving the school/program than by continuing. What this also means is that high origin students who do not believe they will be better off by leaving the school/program will seek to stay in the school or enter advantageous programs regardless of their level of achievement.

In fact, the equations imply such students will not consider their subjective chances of succeeding, because for such students π drops out of the equation. Thus, a key question concerns how high origin students who are not academically superior to others obtain access to high-level education (e.g. demanding high school programs, top colleges)? According to the EMI narrative, they and their parents bring to bear the full weight of their resources to secure those positions, even if it means crowding out other equally (or perhaps even better) qualified persons. Thus, the Gates gambit helps us understand just how prevalent the processes EMI highlights may be, for these processes potentially involve any placement or education decision involving high origin students who believe their chances of maintaining their origins will be enhanced or, at least, not lowered by attending school or the program at issue. Thus, the Gates gambit, likely applying to a few high origin youths, implies that EMI processes may be ubiquitous. The theories would be complementary, therefore, because RRA specifies conditions for the Gates gambit (the DSP equations), shows that the set of high origin students not subject to the Gates gambit is likely large, and implies that for that set of students subjective beliefs of the likelihood of educational success are irrelevant. EMI augments the analysis by noting that although RRA implies the modal high origin student will continue in school or the program at issue, by basing admission and placement only on achievement and cost constraints that we can presume the advantaged would often satisfy (e.g. there is no tuition charge for entering honors classes in U.S. comprehensive schools) RRA offers no means for mediocre high origin persons to actually stay in school or enter the advantageous

programs needed to maintain occupational success. Thus, RRA implies a behavior, but offers no way for the behavior to actually occur, producing a contradiction. EMI resolves the contradiction by asserting that such persons, resistant to accepting a spot lower in the educational hierarchy, will bring non-academic and/or non-meritocratic resources to bear to secure educational advantage, resources (or threats) they will use to encourage gatekeepers to tip the scales in favor of mediocre, socioeconomically advantaged youths.

The possibility of complementarity likely exists because the theories emphasize different aspects while not denying the de-emphasized as well. RRA highlights voluntarism but does not ignore constraints; EMI highlights constraints but does not ignore voluntarism. Because neither ignores the other side of the action equation, together they may provide grounds for illuminating sociological work. Perhaps the foregoing, by suggesting a possible commensurability, may aid such efforts.

Concluding remarks

Analysts have articulated three proposals to explain social origin effects on educational attainment. Yet, empirical research has rarely compared their explanatory power. Reasons that might explain the lack of comparative analysis include that the proposals highlight different association indices, most were described informally, and their distinctiveness has been contested. To render the proposals potentially commensurable I undertook a formal analysis, in order to translate the informally related proposals into formal language, assess the falsifiability of each proposal, and probe their similarities and differences.

What do we learn from this effort? We learned that maximally maintained inequality is non-falsifiable. Also, we confirmed that RRA and EMI are falsifiable. These findings are important for they mean that analysts can abandon MMI and focus their attention elsewhere, including on the scientific theories of RRA and EMI.

We discovered that RRA implicitly posits the Gates gambit as the only route to dropping out of school or programs for those of high origins, meaning that high origin youth will continue in school or programs unless they believe their chances of reaching high occupations are higher by dropping out. What this also implies is that low- and moderate-achieving high origin youth will enter and stay in school and demanding programs without considering their levels of achievement. At the same time, middle origin youth will not reference estimates of

their likelihood of reaching top positions should they succeed in school. But, in contrast to most of their high origin peers, middle origin students will reference their expectations of succeeding in school.

We graphically determined that one implication of EMI's disinterest in the absolute size of the association between origins and qualitative outcomes is that EMI essentially posits a stickiness in the parameters that keep them at values in the parameter space that positionally advantage the socioeconomically advantaged. This view transforms the question and the means of addressing it. Further, we found that although analysts seeking to evaluate EMI's veracity need to attend carefully to whether and which scope conditions are satisfied because different predictions flow from different scope conditions, scope conditions imply EMI is almost always operative.

Considering the scientific theories together, we can see RRA as positing a structure that families and children navigate based on their goals, expectations, risk-tolerance, ability, and resources. Although EMI does not explicitly deny this vision, it also notes that persons navigate a structure peopled by people who *also* make decisions that break ties. EMI essentially asks – is there a systematicity to the way that ties are broken, i.e., at the margin? EMI points to the possibility of gatekeeping behavior that excludes academically qualified but socioeconomically disadvantaged persons, exclusionary behavior that is spurred along as well by both individual and collective actions of the advantaged to maintain structures that allow advantage and to place themselves or their children in the positions of advantage. The gate-keeping behavior also occurs amidst myopia for youths of low social origins, as posited by Lucas (2001) and revealed by RRA.

Taken together, RRA tells us that unqualified high origin persons will avoid downward mobility by staying in school and/or advantageous positions in school, but does not tell us how they will secure such schooling because RRA emphasizes meritocratic processes and voluntaristic placement. If merit alone were key, unqualified high origin persons could not obtain such positions. However, RRA equations suggest they will. EMI augments the RRA narrative by showing how unqualified high origin persons will secure continued schooling and/or advantageous school positions; they will do so by deploying non-academic resources, possibly crowding out other more qualified candidates. These conclusions flow from joint consideration of the equations of RRA and EMI. Empirical evidence should be brought to bear to assess these claims, but that they follow from these theories taken together is evident.

These summary observations are not to deny that further questions remain. For example, RRA links subjective assessments to a general structure persons must navigate, in this way providing an intriguing source of exploration. However, the model is not dynamic and, considering dynamics, what would RRA see as the relation between the subjective parameters of the model and the actual chances of success for different pathways? Further, if subjective parameters and actual chances of success disagree, does this disjuncture persist and, if so, how? Might the myopia revealed in the equations be relevant for this issue, or are other resources needed?

Questions also remain for EMI. For one, EMI describes the patterns it identifies as, in part, a result of a class-based process, yet EMI offers no clear conduit for collective action to occur and be consequential. Thus, how might EMI integrate a true, collective action pathway into its model?

Even considering the two perspectives together, questions remain. For example, is EMI simply a particular manifestation of the structural theory Breen and Goldthorpe describe, which I here call SOAR? Is EMI, with its larger contextual discussion of access to information, a particular manifestation of values for DSP parameters? Or, reversing the relation, is RRA an educational attainment translation of EMI's more general theory of stratification? Were we to answer these questions, how might we come to see EMI, RRA, and the effort to understand patterns of social background effects on education transitions?

These questions suggest further research is needed. Yet, the results produced here have value nevertheless. We have written each proposal in formal terms. We evaluated each against the three criteria of contradiction, tautology, and evaluative infeasibility and thus eliminated one proposal from further consideration – elimination of MMI is a key outcome of our study, allowing analysts to abandon efforts to falsify what is in truth a non-falsifiable proposal. We then compared the proposals, assessing their points of connection and disagreement, making clear where crucial investigations as well as possibilities for complementary theoretical development exist. These efforts made visible important phenomena, such as the Gates gambit, the discretion of gatekeepers, and the myopia of middle origin students. Notably, we indicated how RRA and EMI complementarily suggest that and how high-origin middle-achieving youths will ignore their chances of educational success, deploy non-meritocratic resources to secure opportunity, and thus may crowd deserving middle origin youth out of advantageous curricula.

These results and others serve to identify key patterns for study, facilitating comparative research of the remaining theories. However, illuminating

though these results are, their value will only be fully realized through comparative empirical investigation. It is hoped that such research can be positively influenced by the foregoing theoretical analysis.

Acknowledgments

I thank Carl Mason and Susan Gruber for assistance, and two anonymous reviewers and the editor for helpful comments. Errors are solely the responsibility of the author.

NOTES

1 I draw criteria from Boolean logic which rejects tautologies and contradictions; however, some traditions see tautologies and contradictions as pointing to deeper truths (e.g. the koans of Zen Buddhism). Some see such traditions as consistent with fuzzy logic (e.g. Laughlin 1993; Collins 2005) which does not require either/or classification. Still, I adopt a Boolean logic approach because it is more familiar and more stringent; as Arfi (2006) suggests in showing the Boolean approach as a limiting case of a fuzzy logic approach, a proposal that satisfies Boolean logic criteria for a scientific theory will also satisfy any coherent criteria provided by fuzzy logic.

2 That epoch might never have really existed but it exists analytically, a situation similar to origins in social mobility studies. Analysis of the origin–destination table might entail analysis of an origins distribution that never existed, for origins (e.g. first jobs) may have occurred at varied times. The origin distributions are analytically important but need not match an observed case.

3 The discussion of tenet four noted that MMI seems to deny asymmetric causation.

4 The terms, relations, and definitions in the preceding equations no longer apply.

5 Bill Gates is a famous college drop-out of high social origins who scored 1590 out of 1600 on his pre-renormed SATs and attended Harvard. These achievements might have led to a high π. Still, the theory implies these achievements were more than balanced by the extent to which γ_T exceeded β_T, producing Gates' decision to quit school to pursue another route to occupational and economic success.

6 The terms, relations, and definitions in the preceding equations no longer apply.

7 The perverse case of everyone receiving a grant of zero is intriguing but need not undermine the claims above. Z3 sees such a grant as universal, for everyone receives nothing. Alternatively, one may avoid defining the reception of nothing as the reception of something by adding the condition, $\Sigma X \neq 0$, thus restricting universality to goods for which one or more persons obtain something. Either way, the perverse case does not negate the overall relation of universality and variation.

8 We may proceed in this manner because EMI referenced multiple non-synonymous terms. Had EMI clearly based its claims on universality, then assessments of its coherence and evaluative feasibility would reference universality. There may be value in considering a variant of EMI in which scope conditions reference universality

rather than commonality, but as that variant is not a clear translation of Lucas (2001) owing to its repeated reference to commonality, and as our aim is to assess, not revise, proposals, that task will not occupy our attention.

9 If the coefficient is not statistically significant the direction of the association is unclear, making predicted values based on the point estimate or the confidence interval less illuminating.

10 Because $N < 1293$ is possible, it is clear it is possible to obtain an estimate that is not statistically significant that, on the basis of categorical prediction, does not support EMI.

11 Many attributions of Hout (2006) contradict the literature. Hout (2006) claims that Breen and Goldthorpe (1997) 'propose that students progress through the educational system *without sorting or selection until they reach their parents' level. Then they are sorted and selected.* Lower-class students reach that level first, then middle-class students, and finally upper-class students' (Hout 2006, pp. 249–50, emphasis added). Yet Breen and Goldthorpe (1997, pp. 278–9), citing Arum and Hout (1995), argue that RRA requires a diversified system of education with different kinds of training and several branching points and, after relating a simplified single-decision case, explicitly show how RRA treats multiple decision points on pp. 287–9. Breen and Goldthorpe (1997) do not posit a single selection point for each student occurring at the level of their parents' occupations. On EMI, contra Hout (2006), Lucas (2001) does not reference failure of MMI in the U.S. nor elsewhere, nor claim less social selection will occur as some lower tail of the education distribution is eliminated, nor claim universality is key to reduced social origin effects. These and other Hout (2006) attributions are puzzling.

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