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American Sociological Review, Vol. 46, No. 1 (Feb., 1981), 72-87.

Stable URL:
http://links.jstor.org/sici?sici=0003-1224%28198102%2946%3A1%3C72%3ACASIES%3E2.0.CO%3B2-R

American Sociological Review is currently published by American Sociological Association.

CHANGE AND STABILITY IN EDUCATIONAL STRATIFICATION*

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The effects of parental socioeconomic characteristics on highest grade of formal school completed are stable over cohorts born during the first half of the twentieth century. Mathematical analysis and empirical findings based on the 1973 Occupational Changes in a Generation Survey show that linear models of the educational attainment process are stable over cohorts because their coefficients depend upon quantities which vary over time in offsetting directions. The coefficients are weighted sums of the associations between socioeconomic background and school continuation decisions where the weights are functions of the school continuation probabilities. Intercohort increases in school continuation rates by themselves imply declining background effects on educational attainment, but, over cohorts, the associations between background and continuation increase to offset the dampening effect of the changing marginal distribution of schooling. Stable linear model effects are the result.

INTRODUCTION

In most societies, formal schooling is a scarce and unequally distributed resource and a key way through which parents transmit their socioeconomic levels, values, political behaviors, and lifestyles to their offspring. Across societies and through time, however, the extent of educational inequality is affected by the institutional and demographic milieu wherein schooling occurs. If differential access to schooling is mutable, to understand the nature and sources of its changes is an important task for social theory and policy.

Contemporary research on social stratification in the United States, however, emphasizes the *stability* of the process of stratification in general and the effects of parental socioeconomic background on the formal schooling of offspring in particular. During the twentieth century, average schooling levels have increased dramatically over cohorts while the dispersion of the schooling distribution has lessened. Racial and regional schooling differentials have also diminished. Differences in attainment among persons from different *socioeconomic* origins, however, show little trend. The effects of fathers' schooling and occupational standing upon how far sons go in school apparently change very little over cohorts born during the first half of the twentieth century (Duncan, 1965, 1967; Hauser and Featherman, 1976).

Although educational stratification with respect to socioeconomic origins appears stable, the reasons for stability in the educational attainment process are largely unknown. Research to date has lacked models of the mechanisms giving rise to the observed patterns. Research so far has also not shown how the observed stability turns on the specific measures and statistical models commonly used in empirical analyses. In addition, it has not explored the kinds of hypothetical demographic and behavioral changes which *could* modify the existing regime of social influences on educational attainment. Instead, though it

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A version of this report was read at the meeting of the American Sociological Association, Boston, Massachusetts, August 1979. This research was supported by the National Science Foundation (SOC 76–80450) and by funds granted to the Institute for Research on Poverty, University of Wisconsin–Madison, by the Department of Health, Education, and Welfare pursuant to the Economic Opportunity Act of 1964. The Occupational Changes in a Generation Survey was supported by the National Science Foundation (GI-31604). I am grateful to David Featherman and Robert Hauser for making available the OCG II data; to Warren Kubitschek, Ann Kremers, and Cheryl Knobeloch for research assistance; and to the editor and referees of the *ASR* for editorial suggestions. I also benefitted from conversations with William Mason, Gary Chamberlain, Mark Day, Robert Hauser, and Robert Kaufman.

is possible to identify stable statistical relationships between family background and educational attainment, current understanding of trends in educational stratification is, in the main, atheoretical.

Although most research demonstrates invariant relationships between socioeconomic origins and formal school attainment, there have, nonetheless, been conflicting views of the trend in equality of educational opportunity. Boudon (1974) argued that inequality of educational opportunity *declines* steadily over time. For some levels of schooling, Spady (1967) found intercohort *increases* in attainment differences among socioeconomic groups. These discrepant findings result from differences in how formal schooling is measured (Hauser, 1976; Boudon, 1976). There has been little attempt, however, to show explicitly how conclusions about the trend in educational inequality depend on the measurement of schooling and models of social background effects. There has also been little attempt to elucidate which aspects of inequality are tapped by alternative models and measures of educational inequality. Given these ambiguities, do empirical studies of the educational attainment process adequately represent aspects of educational inequality of greatest interest? How should discrepant findings be interpreted in light of a broader understanding of stability and change in social stratification?

This article addresses these questions through an analysis of both the meaning of and the relationships among alternative statistical models of educational attainment as well as through further statistical analysis of the trend in socioeconomic background effects on formal school attainment. In so doing it casts light upon the observed stability of parental socioeconomic effects on educational attainment. Moreover, the effects on socioeconomic background on formal schooling are shown to vary systematically over cohorts born during the twentieth century. The article has a two-fold purpose: to complement previous descriptions of intercohort changes in the effects of social background on formal schooling, and to interpret the patterns revealed by alternative analyses.

The first part of the article discusses the concept of educational inequality, with reference to interpreting trends in the effects of socioeconomic background characteristics on educational attainment, and reviews and interprets alternative statistical models of the relationships between socioeconomic background and schooling. In addition, it shows the formal relations among the models of the background-schooling relationship, and—insofar as the models have structured previous research—reviews their implications for observed trends in background effects on school attainment. The second part shows empirically that the effects of social background on grade progression change across cohorts born during the twentieth century and illustrates the consequences of these changes. The article concludes by recapitulating its main arguments and discussing their implications.

MODELS OF EDUCATIONAL STRATIFICATION

There are two aspects to formal educational stratification. One is the dispersion of the formal schooling distribution—that is, the variance of the marginal distribution of formal schooling. The other aspect is the extent to which, for a given degree of dispersion of the formal schooling distribution, some sociodemographic groups are allocated more schooling than others—that is, the association between formal educational attainment and other social statuses. The allocation and distribution of schooling are conceptually independent and, over time, may change in response to distinct demographic and behavioral changes. For example, regardless of whether schooling is allocated at random or on the basis of ascriptive criteria such as race or socioeconomic background, schooling may be more or less unequally distributed. Over cohorts, even if the principles by which schooling is allocated are invariant, the distribution of schooling may become more equal. Conversely, even if the degree of variation in the formal schooling distribution were completely fixed over cohorts, the principles by which individuals are allocated

places in the distribution could radically change. The distinction between the allocation and distribution of schooling is analogous to the distinction between the process of occupational recruitment and the marginal distribution of occupational positions typically made in the analyses of occupational mobility (e.g., Hauser et al. [1975]; Parkin [1971]).

Because educational stratification consists of two conceptually independent aspects, models of change in educational inequality should be specified with respect to the aspect for which they are designed to account, and the ways in which selected measures of educational stratification reflect that distribution and allocation of schooling should be made explicit. The main concern here is to understand further changes in socioeconomic differentials in formal schooling—that is, to explain change in the way that formal schooling is allocated to persons from various socioeconomic groups. It is important, therefore, not to confound changes in the distribution of formal schooling with changes in the principles upon which schooling is allocated among groups.

This section reviews several statistical models of the relationship between social background and formal schooling. It first considers the logistic response model of school continuation (grade progression) which is used in the analyses reported below, and then reviews the linear probability model of school continuation (grade progression) and the linear model of highest grade of school completed, which are two models of the background-schooling relationship used in past research. This review reconciles apparently contradictory findings on changes in the effects of social origins on schooling. In addition, it illuminates the stability of educational stratification by showing how linear social background effects on highest grade completed depend upon a changing underlying regime of grade progression rates and background effects on progression rates.

Logistic Response Model of School Continuation

A useful way to conceptualize formal schooling is as a sequence of transitions between grades. School attainment can be measured by a set of school continuation (grade progression) probabilities which denote the chances that an individual will continue to a given level of schooling given that he/she has completed the immediately previous level. Dividing the schooling process into separate grade transitions permits analysis of trends and differentials in schooling at various stages (Fienberg and Mason, 1978; Mare, 1977, 1980).

An appropriate specification for examining intercohort change in socioeconomic effects on school continuation is the logistic response model. Let p_{ijt} denote, for the *ith* individual in the *tth* birth cohort, the probability of continuing from the $(j-1)st$ to the *jth* schooling level ($i = 1, \ldots, I$; $j = 1, \ldots, J$; $t = 1, \ldots, T$). Let X_{ist} denote the value on the *sth* social background variable for the *ith* variable for the *ith* individual in the *tth* cohort ($s = 1, \ldots, S$). Then the model is

$$\log_e\left(\frac{p_{ijt}}{1-p_{ijt}}\right) = \lambda_{jt} + \sum_s \lambda_{sjt} X_{ist} \qquad (1)$$

where λ_{jt} is a constant and λ_{sjt} denotes the effect of a unit change in X_{st} on the log odds of grade progression. If the model is properly specified, estimates of the λ_{sjt} are invariant under changes in the marginal distributions of the variables in the model (Bishop et al., 1975:9–15). Thus, social background effects on school continuation do not depend upon the average continuation rate. On the other hand, if the probability of grade progression were the dependent variable, then social background effects would depend upon the average continuation rate. Under the logistic response model, differences in background effects, either over school transitions or over cohorts, cannot result from changing marginal distributions of either independent or dependent variables because such changes do not affect the λ_{sjt}. Because differences in effect result from genuine differences in the associations between measured variables over populations, Equation 1 permits intercohort comparisons of the effects of socioeconomic origins.

Corresponding to the technical issue of

model specification is the substantive issue just discussed. To document change in the allocation of formal schooling among socioeconomic groups independent of changing schooling distributions requires estimates of the effects of social origins on school continuation that are unaffected by the overall proportion of persons who continue from one level to the next. Because Equation 1 denotes social background effects that reflect the association between background and grade progression at each schooling level and not the schooling distribution itself, it is an empirical counterpart to the aspects of educational stratification of interest. Analyses reported here use estimates of the λ_{sjt} to indicate the true effects of socioeconomic background on school attainment.

The logistic response model also illuminates the observed stability of social background—schooling relationships measured by other models. This will be shown by considering the relations among alternative models of background effects on schooling.

Linear Probability Model of School Continuation

Previous analyses of socioeconomic background effects on school continuation have not formulated explicit models, but a model is typically implicit. This is the linear probability model. Using the same notation as for Equation 1, the model is

$$p_{ijt} = b_{ojt} + \sum_s b_{jst} X_{ist} + e_{ijt} \qquad (2)$$

where b_{ojt} is a constant, b_{jst} denotes the effect of a unit change in X_{st} on the probability of school continuation, and e_{ijt} is a stochastic disturbance. The model posits an invariant linear effect on grade progression over the full interval of p_{ijt}.

This model is implicit in Boudon's (1974) analysis of published and simulated data on cohort-specific school continuation probabilities for a number of socioeconomic background levels. Boudon notes that the differences among background-specific continuation probabilities decline over cohorts, since continuation probabilities increase more rapidly for persons from lower than from higher social origins. Since the origin-specific continuation probabilities converge, Boudon concludes (p. 102) that "inequality of educational opportunity decreases steadily over time." Although one can question the representativeness or quality of Boudon's data or the wisdom of using simulated data (Hauser, 1976), these conclusions would likely follow from high-quality data on grade progression trends by social background for most Western societies.

The observed decline in inequality of educational opportunity, however, is dictated by secular increases in school continuation probabilities and the assumptions of Equation 2. The continuation probabilities of *all* socioeconomic groups increase over cohorts, but increases are relatively small for higher-background strata because the probabilities for these strata are closer to a ceiling of unity. Thus, difference in continuation probabilities between higher- and lower-status groups declines over cohorts. This decline in background-continuation differentials need not reflect a change in the principles by which formal schooling is allocated to persons from differing socioeconomic backgrounds. Instead, it reflects changes in the marginal distribution of formal schooling. Even were the true association between social background and school continuation invariant over cohorts, by this formulation the estimated effects of background decline because of increasing continuation probabilities. To see this formally, consider the following reexpression Equation 1:

$$p_{ijt} = \frac{\exp\left(\lambda_{ojt} + \sum_s \lambda_{sjt} X_{ist}\right)}{1 + \exp\left(\lambda_{ojt} + \sum_s \lambda_{sjt} X_{ist}\right)}, \qquad (3)$$

which implies

$$\frac{\partial p_{ijt}}{\partial X_{ist}} = \lambda_{sjt}\, p_{ijt}\,(1 - p_{ijt})\ ; \qquad (4)$$

whereas, from Equation 2,

$$\frac{\partial p_{ijt}}{\partial X_{ist}} = b_{jst}\ . \qquad (5)$$

Therefore,

$$b_{jst} = \lambda_{sjt}\, p_{ijt}\,(1 - p_{ijt})\,. \qquad (6)$$

Thus, the linear probability effects b_{jst} depend both upon the associations between background and school continuation λ_{sjt} and upon the continuation probabilities p_{ijt}. This reexpression of the linear probability effects permits two conclusions. First, suppose that over cohorts λ_{sjt} is invariant ($\lambda_{sjt} > 0$). The effect of school continuation rate changes on the linear probability effect, b_{jst}, is

$$\frac{\partial b_{jst}}{\partial p_{jt}} = \lambda_{sjt}\,(1 - 2p_{ijt})\,. \qquad (7)$$

When grade progression proportions exceed 0.5, as they do for most school transitions in the twentieth-century United States, the righthand side of Equation 7 is negative and the linear effect of background declines over cohorts as grade progression proportions increase. Thus, Boudon's finding of a decline in inequality of educational opportunity follows straightforwardly from increases in grade-progression rates, in the absence of changes in the association between background and grade progression.

Second, if the λ_{sjt} are, in fact, increasing over cohorts, then increases in λ_{jt} need not reduce the b_{jst}. If grade-progression proportions are as high as, say, 0.9, changes in λ_{sjt} large enough to offset the negative effect denoted by Equation 7 would have to be very large. Moderate increases in λ_{sjt} would be obscured by focusing on estimates of Equation 2.

Approaches to change in educational inequality which focus on differences in grade-progression probabilities reflect changes in progression rates rather than the extent to which, for a given schooling distribution, educational opportunities are allocated on the basis of socioeconomic origins. Therefore, while Boudon's conclusions are not incorrect, they may obscure important changes in the effects of socioeconomic status on attainment.

Linear Model of Highest Grade Completed

The linear model of family-background effects on highest grade of schooling is the standard conceptual tool for studying educational stratification (for example, Blau and Duncan [1967]; Duncan et al. [1972]; Sewell and Hauser [1975]; Jencks et al. [1972, 1979]) and has been used to measure change in social background effects on attainment (Duncan, 1965, 1967; Hauser and Featherman, 1976). The linear model is

$$Y_{it} = \beta_{ot} + \Sigma_s \beta_{st} X_{ist} + \epsilon_{it} \qquad (8)$$

where Y_{it} is the highest grade of schooling for the *ith* individual in the *tth* cohort, β_{st} is the effect of a unit shift in X_{ist} on Y_{it}, β_{ot} is a constant, ϵ_{it} is a stochastic disturbance, and the remaining notation is as in Equations 1 and 2. Changes in the β_{st} over cohorts, therefore, represent changes in inequality of educational opportunity. Available evidence shows that parental socioeconomic characteristics and family size have stable effects on educational attainment over cohorts for American men born during the twentieth century. By contrast, the effects of other background factors—such as family stability, farm origin, southern origin, and race—decline (Hauser and Featherman, 1976:109).

Table 1 reports regressions of highest grade of school completed on selected socioeconomic social background factors for white males born 1907–51. The estimates are based on the 1973 Occupational Changes in a Generation Survey (OCG), a supplement to the March Current Population Survey, which covered civilian noninstitutional males aged 20 to 65 (Featherman and Hauser, 1975). Variable descriptions are given in the note to Table 1. The estimates are consistent with the pattern of parental socioeconomic-background effects emphasized by Duncan (1965, 1967), Hauser (1970, 1976), and Hauser and Featherman (1976). The effects of mother's schooling and family income, not examined in previous analyses, have no trend, though several intercohort fluctuations are statistically significant. The effect of father's occupational socioeconomic index declines slightly from early cohorts to the more recent ones. On balance, however, the calculations indicate little change in the educational attainment process.

Table 1. Regression Analysis of Highest Grade of School Completed, White Males Born 1907–51

Year of Birth	Father's Occupation	Parental Income	Father's Schooling	Mother's Schooling	R^2	S.E.E.
1907–11	0.02	0.10	0.13	0.21	0.363	2.90
	(3.8)	(7.7)	(4.2)	(6.7)		
1912–16	0.02	0.06	0.11	0.15	0.349	2.72
	(5.0)	(5.7)	(4.6)	(6.2)		
1917–21	0.02	0.03	0.11	0.16	0.324	2.64
	(6.2)	(3.8)	(5.1)	(7.7)		
1922–26	0.02	0.04	0.11	0.19	0.343	2.66
	(4.6)	(4.9)	(5.4)	(9.4)		
1927–31	0.02	0.07	0.11	0.14	0.326	2.64
	(6.4)	(7.3)	(5.6)	(6.6)		
1932–36	0.02	0.06	0.11	0.20	0.362	2.59
	(5.2)	(4.7)	(4.9)	(9.2)		
1937–41	0.02	0.07	0.07	0.25	0.352	2.37
	(5.5)	(6.3)	(3.4)	(12.3)		
1942–46	0.01	0.08	0.10	0.18	0.349	2.79
	(4.8)	(8.1)	(6.2)	(10.3)		
1947–41	0.01	0.06	0.10	0.13	0.291	1.95
	(4.9)	(6.9)	(6.5)	(7.7)		

Note: Father's occupation is measured as his Duncan socioeconomic index when respondent was 16; parental income, as thousands of constant (1967) dollars when respondent was 16; mother's and father's schooling, as grades completed. Each equation also includes respondent's number of siblings; whether or not he was born in the South; and whether or not he lived on a farm when he was 16. Ratios of coefficients to their standard errors are in parentheses.

What is the source of this stability in the effects of parental socioeconomic characteristics? To answer this, a useful strategy is to examine the linear model of highest grade completed in more detail and to explore the demographic forces which determine the observed linear relationship. In particular, it is possible to derive the formal relationship between the linear model parameters β_{st}, the logistic response model parameters λ_{sjt}, and the grade-progression proportions p_{jt}. Given this relationship and known trends in grade-progression proportions, it is possible to infer offsetting trends in the components of β_{st} which result in inter-cohort stability of the linear model.

The effect of the *sth* background variable on highest grade completed is, from Equation 8,

$$\frac{\partial Y_t}{\partial X_{st}} = \beta_{st} \, . \tag{9}$$

Each cohort has a set of grade-progression proportions, p_{jt}, which measure progression from the (j-1) *st* to the *jth* schooling level—that is, the proportion of persons who complete the *jth* level of schooling out of those who complete at least j-1 levels. Thus, the proportion of a cohort completing *at least* k levels of schooling (k = 1, . . ., K) is

$$c_{kt} = \prod_{j=1}^{k} p_{jt} \; ; \tag{10}$$

and the mean grade of schooling completed for the *tth* cohort is

$$Y_t = \sum_{k=1}^{K} c_{kt} = \sum_{k=1}^{K} \prod_{j=1}^{k} p_{jt} \; .^{1} \tag{11}$$

From Equation 3, this expression for highest grade completed is related to the parameters of the logistic response model of grade progression, as follows:

$$Y_t = \sum_{k=1}^{K} \prod_{j=1}^{k} \frac{\exp\left(\lambda_{ojt} + \sum_s \lambda_{sjt} X_{st}\right)}{1 + \exp\left(\lambda_{ojt} + \sum_s \lambda_{sjt} X_{st}\right)} \; . \tag{12}$$

Thus, the effect of the *sth* background variable in terms of grade progression proportions is, using Equation 3.

$$\frac{\partial Y_t}{\partial X_{st}} = \sum_{k=1}^{K} \left[\sum_{j=1}^{k} \lambda_{sjt} \, p_{jt} \, (1 - p_{jt}) \prod_{l \neq j}^{k} p_{lt} \right] , \tag{13}$$

[1] Expression 11 assumes that graded schooling occurs in single-year intervals and that all students enter school at grade one.

Table 2. Partial Derivatives of Linear Effects of Socioeconomic Background Factors with Respect to Grade Progression Proportions

Transition	Parental Income	Father's Schooling	Mother's Schooling	Father's Occupation
0–8	−0.0056	−0.62	−0.83	−0.0200
8–9	−0.0015	−0.29	−0.36	0.0100
9–12	−0.0008	−0.10	−0.03	−0.0002
12–13	0.0005	0.07	0.09	0.0001
13–16	0.0005	0.05	0.09	0.0001
16–17	0.0002	0.02	0.04	0.0001

which, since Equations 9 and 13 both denote the effect of X_s on Y, is simply an approximation for β_{st}. Thus, the linear effects of background on highest grade completed are weighted sums of the logistic response-model parameters for grade progression, where the weights are functions of the grade-progression proportions.

Equation 13 shows that linear effects of socioeconomic background on highest grade of schooling completed (β_{st}) reflect both the associations between background factors and grade progression (λ_{sjt}) and the proportions making each school transition (p_{jt}). Hence, the linear model of highest grade completed, commonly used to measure educational stratification, is affected by both the extent that schooling is allocated differentially by socioeconomic background and the dispersion of the schooling distribution.

Over cohorts it is not clear how the λ_{sjt} vary—empirical results on this are presented below. The p_{jt}, however, have increased considerably over cohorts born during the first half of this century. (See, for example, Table 3 and Duncan [1968].) Because the changes in the p_{jt} have been large, it is appropriate to ask what their partial effect on β_{st} has been. The effect of the *vth* grade progression proportion on the relationship between Y_t and X_{st} is

$$\frac{\partial^2 Y_t}{\partial X_{st}\,\partial p_{vt}} = \frac{\partial \beta_{st}}{\partial p_{vt}} = \sum_{k=v}^{K}\Big[\sum_{j\neq v}^{k} \lambda_{sjt}\, p_{jt}\,(1 - p_{jt}) \prod_{l\neq v,j} p_{lt} + (1 - 2p_{vt})\lambda_{vst} \prod_{l\neq v} p_{lt}\Big], \quad (14)$$

which is too complex to show whether, for fixed λ_{sjt}, variations in the p_{jt} have sufficiently balanced effects to ensure that Equation 14 is zero. Thus, it is necessary to evaluate Equation 14 numerically.

Table 2 presents the partial derivatives Equation 14 for four parental socioeconomic factors using the p_j for six school transitions. These calculations use estimates of the λ_{sj} and the p_j for white males born 1907–51 as reported in the first row of Table 3 (discussed later).[2] (For discussion and interpretation of the 1907–51 estimates in Table 3, see Mare [1980].) The derivatives denote the impact of a 0.01 change in the probability of grade progression on the linear effect of each parental socioeconomic variable on highest grade of school completed. For example, 0.01 change in the proportion of persons completing eighth grade would, assuming constant λ_{sj}, decrease the effect of parental income on highest grade completed by 0.0056. The estimates in Table 2 strongly imply that Equation 14 is negative for parental income and mother's and father's schooling effects. At precollege schooling levels, where socioeconomic background effects are strongest and the increases in grade progression rates have been greatest (Mare [1977; 1980], and Table 3), the effects of grade-progression rates on the linear effects of these socioeconomic factors are negative. To see the quantitative importance of these effects, compare their

[2] Expression 14 assumes that schooling is measured in one-year intervals and the p_{jt} denote transitions between adjacent grades. The transitions used in the computations reported here assume, by contrast, seven intervals: 0–7, 8, 9–11, 12, 13–15, 16, and 17 or more grades. These intervals can be assigned the scores 6, 8, 10, 12, 14, 16, and 18, respectively, and, thus, measure schooling in two-year intervals. The derivatives in Table 2 are twice the quantities denoted by equation 14 to reflect the two-year interval assumption.

Table 3. Effects of Social Background Factors on School Continuation Decisions, White Males Born 1907–51

Year of Birth	Parental Income	Father's Schooling	Mother's Schooling	Father's Occupation	R^2	p
			Completes Elementary			
1907–51	0.11	0.12	0.17	0.01*	0.27	.93
1907–11	0.22	0.13	0.12	−0.01*	0.22	.83
1912–16	0.08	0.15	0.05*	0.03	0.20	.88
1917–21	0.11	0.09	0.17	0.03	0.24	.91
1922–26	0.10	0.12	0.20	0.01*	0.26	.93
1927–31	0.17	0.17	0.12	0.01*	0.29	.93
1932–36	0.11	0.17	0.11	0.02*	0.27	.94
1937–41	0.15	0.06*	0.16	−0.01*	0.19	.96
1942–46	0.20	0.24	0.13	0.03*	0.40	.98
1947–51	0.16	0.14	0.12	0.00*	0.27	.98
			Attends High School, Given Elementary Completion			
1907–51	0.06	0.09	0.12	0.00*	0.18	.93
1907–11	0.08	0.04*	0.10	0.02	0.13	.79
1912–16	0.00*	0.05*	0.07	0.01*	0.08	.84
1917–21	0.04*	0.04*	0.12	0.02	0.14	.90
1922–26	0.03*	0.03*	0.14	0.03	0.16	.92
1927–31	0.09	0.09	0.04*	0.00*	0.15	.94
1932–36	0.09	−0.03*	0.16	0.02*	0.20	.96
1937–41	0.17	0.07*	0.11	0.01*	0.20	.97
1942–46	0.17	0.16	0.07*	0.00*	0.17	.98
1947–51	0.08*	0.10*	0.13	0.01*	0.21	.99
			Completes High School, Given High School Attendance			
1907–51	0.07	0.08	0.08	0.02	0.12	.83
1907–11	0.08	0.02*	0.08	0.01	0.08	.70
1912–16	0.04	0.06	0.09	0.02	0.09	.72
1917–21	0.03	0.05	0.06	0.02	0.07	.80
1922–26	0.04	0.07	0.04	0.01	0.08	.80
1927–31	0.06	0.05	0.07	0.03	0.10	.83
1932–36	0.05	0.01*	0.10	0.02	0.09	.86
1937–41	0.05	0.05*	0.14	0.02	0.14	.87
1942–46	0.08	0.10	0.10	0.01	0.14	.89
1947–51	0.11	0.10	0.09	0.02	0.17	.91
			Attends College, Given High School Completion			
1907–51	0.04	0.04	0.09	0.01	0.09	.55
1907–11	0.05	0.05*	0.04*	0.01	0.07	.50
1912–16	0.03	0.05	0.01*	0.01*	0.04	.41
1917–21	0.03	0.04*	0.05	0.01	0.08	.46
1922–26	0.04	0.05	0.08	0.01	0.08	.51
1927–31	0.04	0.03*	0.05	0.01	0.07	.53
1932–36	0.04	0.04	0.08	0.02	0.09	.55
1937–41	0.07	0.06	0.14	0.01	0.12	.56
1942–46	0.05	0.07	0.11	0.01	0.10	.58
1947–51	0.06	0.07	0.11	0.02	0.12	.64
			Completes College, Given College Attendance			
1907–51	0.01	0.01*	0.04	0.01	0.03	.55
1907–11	−0.01*	0.05*	−0.03*	0.01*	0.01	.58
1912–16	0.02	0.01*	0.04*	0.01*	0.04	.46
1917–21	0.00*	0.03*	0.02*	0.01	0.03	.50
1922–26	0.00*	−0.02*	0.07	0.01	0.02	.59
1927–31	0.03	0.05	−0.03*	0.01	0.03	.60
1932–36	0.02*	0.06	0.06	0.01*	0.05	.61
1937–41	0.01*	−0.02*	0.13	0.01	0.05	.58
1942–46	0.02*	−0.04*	0.08	0.02	0.04	.59
1947–51	0.01*	0.07	0.03*	0.01	0.03	.44

Table 3. Continued

Year of Birth	Parental Income	Father's Schooling	Mother's Schooling	Father's Occupation	R^2	p
		Attends Post-College, Given College Completion				
1907–51	−0.01	−0.01*	0.04	0.01	0.01	.50
1907–11	−0.02*	0.07*	−0.01*	0.01*	0.03	.45
1912–16	−0.01*	0.01*	−0.01*	0.00*	0.01	.41
1917–21	−0.01*	−0.01*	−0.07*	0.02	0.03	.39
1922–26	−0.02*	−0.07	0.08	0.01*	0.01	.49
1927–31	−0.01*	0.00*	0.04*	0.00*	0.00	.51
1932–36	0.00*	0.02*	−0.01*	0.00*	0.01	.54
1937–41	−0.02*	−0.01*	0.15	0.01	0.04	.58
1942–46	−0.12*	−0.02*	0.04*	0.01	0.01	.53
1947–51	0.00*	0.02*	0.04*	0.01*	0.01	.47

* Coefficient is less than twice its estimated standard error.

Note: Father's occupation is measured as his Duncan socioeconomic index when respondent was 16; parental income, as thousands of constant (1967) dollars when respondent was 16; mother's and father's schooling, as grades completed. Each equation also includes respondent's number of siblings; whether or not a parent was absent from his family most of the time up to age 16; whether or not he was born in the South; and whether or not he lived on a farm when he was 16. For definition of "R^2," see footnote 4. p denotes proportion successfully making a school transition.

values to the regression coefficients reported in Table 1. For example, the .0056 decrement in the family income effect in response to a one-percentage-point rise in the proportion completing eighth grade is between 5% and 10% of the income coefficients shown in the second column of Table 1. At that transition, changes in the linear effects of father's schooling, mother's schooling, and father's occupation implied by the derivatives are approximately 5, 5, and 1%, respectively. At the transitions between eighth and ninth grades and between ninth and twelfth grades, the derivatives are smaller and imply smaller decrements in the linear effects. If, however, the derivatives represent the impact of changes in progression proportions over a half century, then the *total* effect of progression rate changes would, in the absence of offsetting forces, be substantial. For example, the partial derivative of the father's schooling effect with respect to the progression proportion for eighth to ninth grade implies a .0029 decrement in the father's schooling effect per one percentage-point change in the proportion continuing. This is only about 2% of the linear effect of father's schooling on highest grade completed. Over cohorts born 1907–1951, however, the progression proportion increases from 0.79 to 0.98, implying almost a 40% decline in the linear effect.

Of course, the effects of parental socioeconomic characteristics on highest grade completed have *not* undergone the massive decline that the derivatives in Table 2 and growth in progression rates imply. Computations based on Equation 14 merely show that, in the absence of offsetting changes, growth in progression rates, combined with the cross-sectional pattern of declines in background effects from lower to higher schooling levels, *would* reduce linear effects of background on highest grade completed. Evidently, there are other sources of change in β_{st} which offset these effects. The associations between background and grade progression, λ_{sjt}, may increase over cohorts to offset the negative effects of increases in p_j on the β_s.

That the λ_{sjt} for parental socioeconomic characteristics may increase means that socioeconomic factors are becoming more important in determining who continues from one schooling level to the next. No theoretical claim that this occurs has been presented, but the accounting Equations 13 and 14, cross-sectional observations, the observed stability of parental socioeconomic effects on highest grade completed, and the secular increase in grade-progression rates imply that increases in the associations between background and grade progression may be necessary to preserve stable linear effects. The trend in

the association between socioeconomic background and grade progression is documented next.

CHANGES IN SOCIOECONOMIC EFFECTS ON GRADE PROGRESSION

The estimated trends in the effects of socioeconomic background on grade progression for selected school transitions are based on the 1973 OCG Survey for white males. Analysis and interpretation of trends are provided in Mare (1977; forthcoming). The transitions are: (1) elementary school completion (8th grade); (2) high school attendance, given elementary completion (8th to 9th grade); (3) high school graduation, given high school attendance (9th to 12th grade); (4) college attendance, given high school graduation (12th to 13th grade); (5) college graduation, given college attendance (13th to 16th grade); and (6) graduate school attendance, given college graduation (16th to 17th grade). The socioeconomic background factors are those considered in the analyses reported earlier—father's occupational status, parental income, and mother's and father's grades of schooling. The estimates of socioeconomic background effects were obtained in equations which also estimated the effects of respondent's number of siblings, and whether or not he was born in the South, grew up on a farm, and suffered the absence of a parent during childhood. Variable definitions are given at the bottom of Table 3.

The effects of socioeconomic background on grade progression were estimated using a sequence of logistic response models (see Equation 1) which were estimated by maximum-likelihood procedures for individual-level observations (DuMouchel, 1976; Hanushek and Jackson, 1977). The coefficients denote the change in the log odds (or percentage change in the odds) of grade progression per unit change in an independent variable.[3]

Table 3 reports the logistic response model estimates. Each row reports the parameters and goodness-of-fit measure ("R^2") for an equation.[4] The columns show the trends in socioeconomic background effects over nine five-year cohorts. The "R^2's" show considerable evidence of increasing socioeconomic-background effects at some school transitions. For elementary completion there is little trend in the statistic. By contrast, for the transitions from 8th to 9th grade and from 9th to 12th grade, the explanatory power of social background increases substantially. For the transition from high school to college, the effect of background also rises, but not as strongly as for the previous two transitions. Finally, at the highest two transitions, where the effects of background are small, the effect of background is stable.

The changes in the several parental socioeconomic effects generally follow the same pattern. The effects of father's and mother's schooling and parental income are stable for eighth grade completion; increase markedly at the second, third, and fourth transitions; and change little at the highest schooling levels where background effects are limited. For example, a $1,000 difference in parental income for cohorts born between 1907 and 1921 implies an average difference of about 5% in the odds of high school graduation, given high school attendance. For cohorts born

[3] Equations were estimated using the program DREG, which is contained in the OSIRIS statistical package (DuMouchel, no date).

[4] "R^2" measures the proportion of predictive error under the null hypothesis (that all coefficients λ_{sjt} are zero) which is explained by the estimated model. The predictive error under the null hypothesis is

$$\Pi_y = 1-p^p(1-p)^{1-p}$$

where $p = p(y=1)$ and y is a binary random variable equaling one if the individual makes the school transition and zero, otherwise. Under the estimated model the predictive error is

$$\Pi_\epsilon = 1- \left[\prod_{\substack{i\\y=1}} \hat{p}_i \prod_{\substack{i\\y=0}} (1-\hat{p}_i)\right]$$

where p_i is the probability of school continuation for the *ith* individual predicted by the model (see equation [3]). Then, "R^2" is

$$(\Pi_y - \Pi_\epsilon)/\Pi_y$$

(DuMouchel, 1976).

after 1937, it implies approximately an 8% difference in the odds of graduation. There are upward trends in family income and, to a lesser extent, father's schooling effects on the transitions from 8th to 9th grades, 9th to 12th grades, and 12th to 13th grades—the largest changes occurring for the transition from high school attendance to high school graduation. For mother's schooling, on the other hand, changes are slight except for the transition from high school to college, where the impact of a year of mother's schooling on the continuation odds increases threefold from 3.5% to 10.5%. In contrast to the parental income and education effects, however, father's occupational status effects on grade progression are unchanged.[5]

IMPLICATIONS FOR THE STABILITY OF THE EDUCATIONAL ATTAINMENT PROCESS

Parental socioeconomic effects on educational attainment in linear models are stable in the face of significant downward pressure on inequality of educational opportunity, resulting from compression of the educational distribution. This suggested that increases in the associations between background and grade progression offset this downward pressure, stabilizing models of the educational attainment process. There are, indeed, appreciable increases in the associations between background and grade progression, at least for some parental socioeconomic indicators and at some school transitions. With the estimates of the associations between socioeconomic background and grade progression in hand, it is possible to show directly the implications of trends in grade progression rates and in the effects of background on grade progression for the linear model parameters.

Regression coefficients in schooling models are approximately weighted sums of logistic response model parameters, the weights being functions of the grade progression proportions (see Equation 13). This result permits calculation of the expected change in the effects of background on highest grade of school completed using observed grade progression rates but holding constant any associations between background and grade progression. For the t*th* cohort this hypothetical linear effect is

$$\beta_t^* = \sum_{k=1}^{K} \left[\sum_{j=1}^{k} \lambda_{sj}\, p_{jt}\, (1 - p_{jt}) \prod_{l \neq j}^{k} p_{lt} \right] \qquad (15)$$

where the p_{jt} and $p_{\ell t}$ denote the proportions of the t*th* cohort making the j*th* and ℓ*th* school transitions respectively, and λ_{sj} denotes the effect of the s*th* background variable on the log odds of making the j*th* school transition held constant over cohorts. Conversely, one can also calculate the expected background effects on highest grade completed using observed associations between background and grade progression (λ_{sjt}) and holding constant grade progression proportions (p_j). This hypothetical linear effect is

$$\beta_t^{**} = \sum_{k=1}^{K} \left[\sum_{j=1}^{k} \lambda_{sjt}\, p_j\, (1 - p_j) \prod_{l \neq j}^{k} p_l \right] . \qquad (16)$$

Expressions 13, 15, and 16 can be used to show the offsetting influences of p_{jt} and

[5] As noted, the trends in socioeconomic effects on grade progression are examined in detail elsewhere. In brief, the trends in Table 3 result from the diminished selectivity of the educational process. *Within cohorts,* socioeconomic effects on grade progression decline from the earliest to the latest school transitions. This reduction in socioeconomic effects results from differential dropout rates, which systematically reduce differences among children from different socioeconomic levels on unmeasured determinants of grade progression (for example, ability, motivation, etc.). Greater homogeneity on unmeasured factors at higher levels of schooling reduces the effects of observed socioeconomic variables. See Mare (1980) for fuller elaboration of this argument. *Between cohorts* the impact of differential attrition changes because the degree of attrition at any schooling level is smaller in more recent than in earlier cohorts. That is, in more recent cohorts, larger fractions of each cohort remain in school at each schooling level. Thus, in recent cohorts there is greater heterogeneity on unmeasured variables at each level of schooling. This greater heterogeneity results in there being larger effects of observed socioeconomic factors in recent than in earlier cohorts. See Mare (1977; forthcoming) for fuller presentation of this argument and empirical evidence in support of it.

the λ_{sjt} on the linear background effects on educational attainment.

For the effects of parental income, father's grades of schooling, and mother's grades of schooling, estimates of linear model parameters which (1) hold the p_{jt} constant and allow the λ_{sjt} to change, (2) allow the p_{jt} to change and hold the λ_{sjt} constant, and (3) allow both the p_{jt} and the λ_{sjt} to change are plotted in Figure 1.[6] (The effects of father's occupational status have not been plotted because their λ_{sjt} change so little over cohorts.) The three socioeconomic effects follow the hypothesized patterns. Except for a few outliers, the changes in the associations between background and grade progression imply, in the absence of changes in grade progression rates, substantial *increases* in linear model effects. Conversely, changes in the grade progression proportions imply, in the absence of changes in the λ_{sjt}, substantial *decreases* in the linear model effects. The linear effects implied by changes in both the p_{jt} and λ_{sjt} show little trend. The hypothesized pattern is particularly clear for the parental income effects where, apart from an unusually large effect for the 1907–11 cohort, trends in the p_{jt} and λ_{sjt} are clearly offsetting. For the mother's and father's schooling effects, this pattern is somewhat less clear because the high correlations between mother's and father's education make the estimated effects unstable. To take account of this, the λ_{sjt} for these two variables were summed to approximate a total parental educational effect. The implied values of β_t are also plotted in the graph of Father's and Mother's schooling which shows a similar pattern to that for parental income: a downward trend in β_t, implied by trends in grade progression rates; an upward trend, implied by trends in background effects; and approximately stable parameters, implied by the actual changes in grade progression rates and background effects.

[6] The estimates of β_t for changing p_{jt} and changing λ_{sjt} are based on Equation 13 rather than on the observed β_t in Table 1. The two series of estimates are highly correlated, although they differ, roughly, by a constant. This discrepancy arises because Equation 13 varies with X_{st}, whereas the linear effect of X_{st} on Y_t is by definition constant. In the calculations reported here, the former estimates of the effects of X_{st} are evaluated at levels of X_{st} which predict the observed p_{jt}. These levels are chosen for computational convenience.

CONCLUSION

Statistical models of educational stratification embody assumptions about the meaning of inequality of educational opportunity. This article has distinguished two facets of educational inequality, the univariate dispersion of formal schooling and the multivariate association between school attainment and socioeconomic background characteristics. Simple differences of proportions continuing in school among background groups change over cohorts primarily in response to the average level of the proportions, rather than in response to changes in the principles by which schooling is allocated. By contrast, statistical models that measure the association between school continuation and social background, net of the marginal distribution of schooling, are sensitive to changes in the principles by which schooling is allocated and not to changes in the dispersion of the schooling distribution.

Linear models of educational attainment conflate the two aspects of educational inequality, because regression coefficients depend mathematically on both the marginal schooling distribution and its association with social background. This article has shown logically and empirically that the stability of the stratification process, as represented by linear models, results from the offsetting influences of, on the one hand, decreased variance in the schooling distribution that exerts downward pressure on estimated linear effects and, on the other hand, increased associations between socioeconomic background and grade progression that tend to increase the linear effects. The linear model, therefore, summarizes two offsetting trends, and thereby conceals important social change.

No model or measure is the best or the correct way to represent inequality of educational opportunity. Theories of stratification are, typically, too imprecise about the meaning of social mobility to

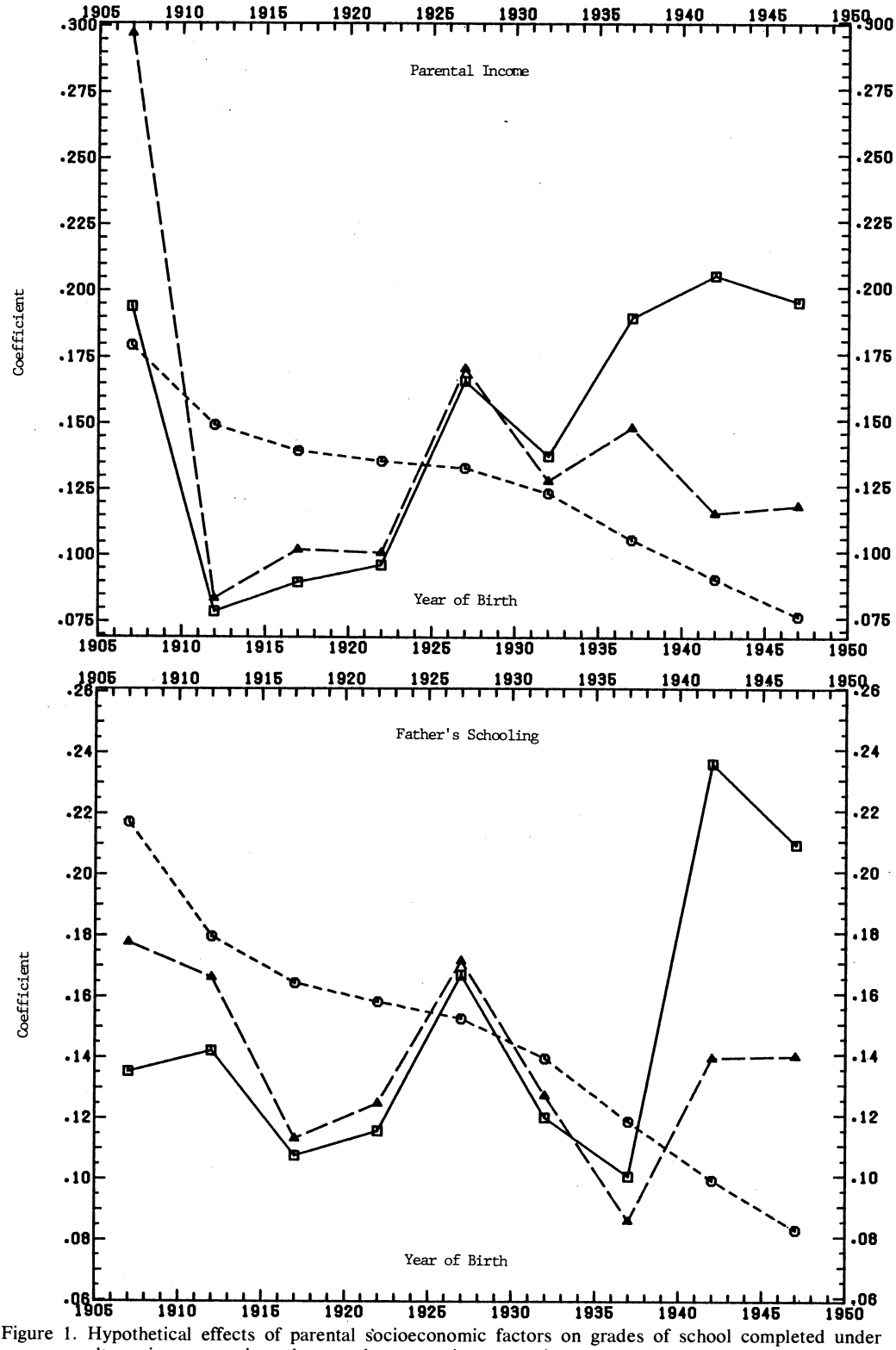

Figure 1. Hypothetical effects of parental socioeconomic factors on grades of school completed under alternative assumptions about grade progression proportions (p_{jt}) and background effects on grade progression (λ_{st}).

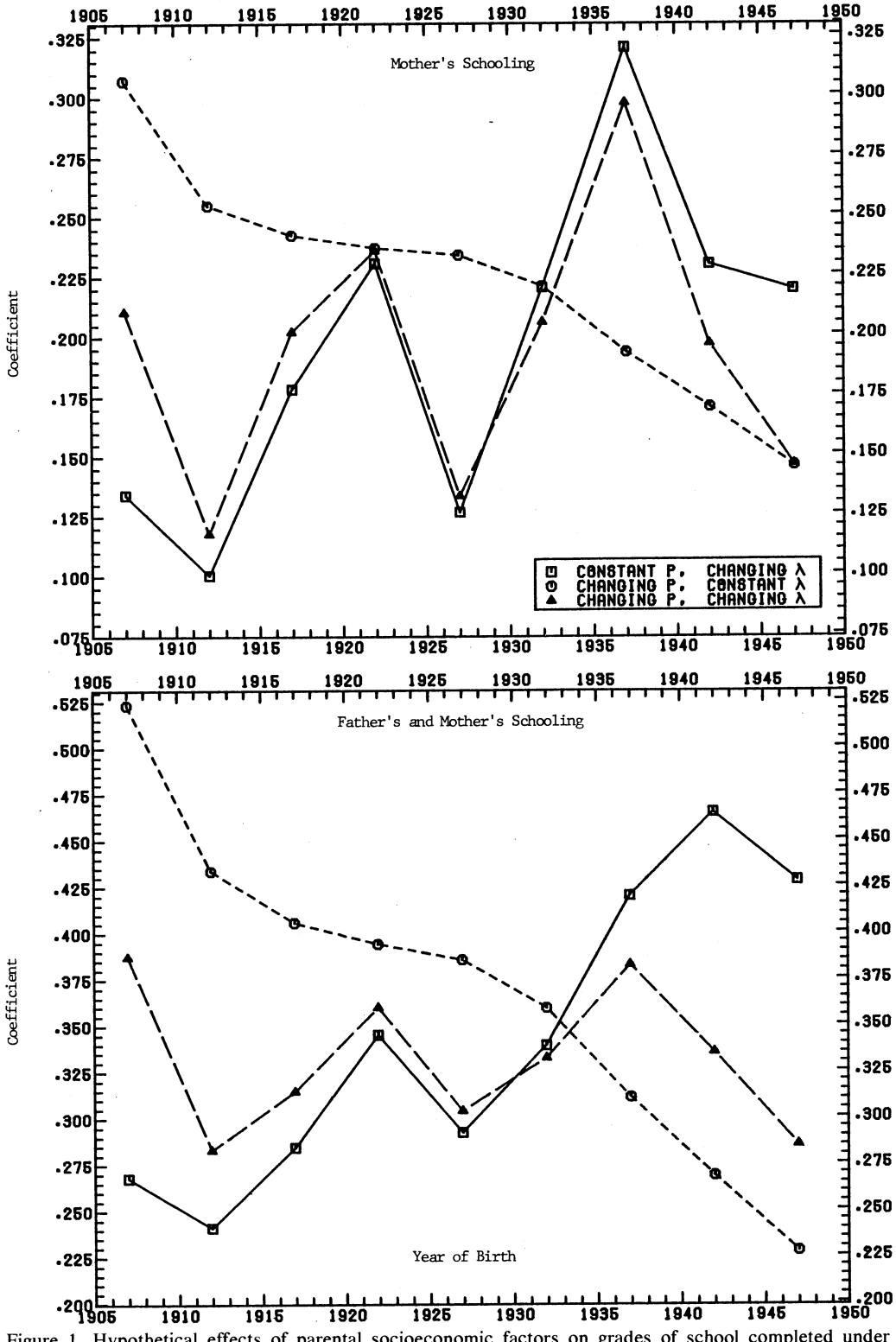

Figure 1. Hypothetical effects of parental socioeconomic factors on grades of school completed under alternative assumptions about grade progression proportions (p_{jt}) and background effects on grade progression (λ_{st}).

dictate one model over another. Alternative models nonetheless imply distinct conceptions of inequality and are highly sensitive to well-known social trends, especially trends in the level and variance of formal schooling. Hence, conjectures about the rigidification, loosening, or stability of the stratification system depend upon conceptions of stratification and statistical models assumed for measurement purposes.

Similarly, with regard to determining the degree of inequality of opportunity and formulating policies to remedy it, no single model or measure will suffice. One's model should correspond to one's concept of equity. The parameters of the logistic response model measure—in a sense—"pure" inequality of opportunity because they separate the distribution and allocation of schooling, and measure the latter explicitly. One can, nonetheless, ignore this distinction and conclude that if, say, 95% of a cohort completes a level of schooling, the chances of completing that level are highly equally distributed, and social background matters very little. This would be reflected in a small linear effect on the probability of school completion. By this conception, the appropriate remedy for inequality of opportunity is to raise the overall cohort proportion continuing in school. On the other hand, such a conception ignores the degree to which that small percentage of the cohort who fail to complete the schooling level is selected from the poorest families. Moreover, it ignores the increasing degree to which school continuation depends on socioeconomic origins over cohorts in the twentieth-century United States, despite the increasing availability of schooling to all persons.

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