Methodologist as Arbitrator

Five Models for Black-White Differences in the Causal Effect of Expectations on Attainment

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When progress in applied research slows because opposing coalitions of investigators privilege their favored models, methodologists can contribute by addressing a tractable unresolved question that is relevant to all competing positions. In this article, the literature on educational attainment is addressed, broadly by focusing on alternative positions on the need to model students' own beliefs and more narrowly by attempting to answer a classic question that emerged in debates over the power of status attainment approaches: Why is the relationship between educational expectations and subsequent educational attainment weaker for Blacks than for Whites? Five complementary models of the causal effect of expectations on attainment are offered: a traditional path model, an average effects instrumental variable model, a counterfactual analysis of bounds, a rational expectations forecasting model, and a panel data model of updated expectations.

Keywords: *educational expectations; educational achievement; causal effects; Black-White differences; multimodel research*

Advocates for multimethod approaches to sociological inquiry abound (see Brewer and Hunter 1989; Tashakkori and Teddlie 1998), and the promised liberation of their pleas has borne some impressive fruit (e.g., Waters 1990). In contrast, advocates for multimodel approaches have been comparably quiet in the recent methodological and applied literature, even though there is good reason to believe that multimodel studies have potential to clarify and extend established research findings as well. The comparative advantage of multimethod

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research lies in its potential to help generate novel hypotheses. Thus, the adoption of multimethod approaches can be expected to enhance the diversity of potential theoretical explanations for sociological phenomena. The comparative advantage of multimodel research lies in its potential to reconcile competing theoretical explanations in mature areas of study, primarily by separating the empirical evidence from the modeling assumptions embraced by the proponents of alternative theoretical positions.[1]

The methodological agenda of this article is therefore to demonstrate one way in which multimodel research can be pursued. Inspired by classic multimodel articles (e.g., Bush and Mosteller 1959; Duncan, Haller, and Portes 1968), the approach I will advocate requires the invocation of a range of plausible theoretical assumptions considerably more broad than is customarily entertained in sociology. The central methodological claim of the article is that the comparison of empirical results derived from formal models grounded on divergent assumptions is potentially more illuminating than the common practice of reporting only slight variations on a single preferred model.

Although rhetorically effective and editorially palatable, the single-model approach that dominates empirical research does not allow for sufficiently explicit examination of the consequences of (often unstated) motivating assumptions. As a result, consequential assumptions about causal order, cross-equation correlations between unmeasured variables, constant coefficients, monotonic causal response, individual foresight, and homogeneity of response thresholds—all of which will be addressed below—receive less attention than the linearity and measurement error assumptions that are sometimes probed in discussions of the possible misspecification of a single preferred model.

To determine how consequential such motivating assumptions are in any particular area of research, I will argue (primarily by demonstration) that it is necessary to jointly estimate and then explicitly compare the results of alternative models. Leaving such meta-examinations to the broader integrative literature (as, for example, is often published in the *Annual Review of Sociology*) is less effective since most such attempts at understanding the relationship between alternative conclusions and specific motivating assumptions are undermined by complications arising from the estimation of separate models on alternative data sources and from more mundane but no less consequential data-analytic choices (e.g., procedures for handling item-specific missing data, weighting, sample attrition, outliers, and variable scaling).

These methodological claims are developed by contrasting the results obtained from the estimation of five separate models in an attempt to address a classic unresolved question in the status attainment literature (see Kerckhoff and Campbell 1977a, Table 1; Portes and Wilson 1976, Table 2): Why is the relationship between educational expectations and subsequent educational attainment weaker for Blacks than for Whites?

Because the sociological literature on the formation of expectations and the relationship between expectations and attainment is well known, I will discuss the directly relevant past literature only in the context of the five models that I offer. But, to forestall any concerns that this question is no longer worthy of our attention and hence not in need of resolution, I first discuss the continuing theoretical importance and policy relevance of studying the expectations and attainment relationship.

Attention to students' beliefs about the educational attainment process has varied over the past three decades, and the vicissitudes of research on racial differences is partly responsible for the fluctuation of interest. In the 1960s, early research on students' college plans (e.g., Educational Testing Service 1957; Kahl 1953) was superseded by a comprehensive model of the status attainment process, later known as the Wisconsin model (Sewell, Haller, and Portes 1969). For this model, the relatively simple operational variable of college plans was conceptualized as an indicator of a more fundamental latent achievement orientation and accordingly labeled an educational aspiration (see Sewell and Hauser 1980). When survey research then focused more narrowly on racial differences in the educational attainment process (e.g., Kerckhoff and Campbell 1977a, 1977b; Portes and Wilson 1976), the Wisconsin model lost much of its initial appeal as a comprehensive explanation for the status attainment process, in large part because estimates of the correspondence between college plans and educational attainment differed for Whites and Blacks.

Following on the arguments of Kerckhoff (1976), the educational attainment literature then gradually shifted toward structural allocation models that focused primarily on institutions (e.g., Arum 1998; Gamoran and Mare 1989; Raftery and Hout 1993), demographic effects (e.g., Kuo and Hauser 1995; Mare and Tzeng 1989), and variation in resources other than stable family background characteristics (e.g., Duncan, Yeung, Brooks-Gunn, and Smith 1998; Hofferth, Boisjoly, and Duncan 1998; Mayer 1997). Although these structural and demographic models generated important empirical results, for the most part they did not elucidate the micro-mechanisms with which prior status socialization models were appropriately concerned. As a result, in recent research, sociologists from a variety of theoretical and methodological orientations have returned to students' beliefs as an important area of inquiry likely to yield important insight (see Breen 1999, 2000; Schneider and Stevenson 1999), and racial differences have again generated interest (see Morgan 1998; Wilson 1995). Even some economists have recently broken with the tradition of revealed preference analysis and directly engaged mechanisms of expectation formation (see Cameron and Heckman 1999).[2]

As for the policy relevance of the following analysis, racial differences in the educational attainment process have always been an important concern. Most recently, students' beliefs have become the explicit focus of policy interventions. In his presidential address to the American Sociological Association, Sewell urged the development of programs for the "stimulation of educational and occupational aspirations" of low-socioeconomic status (SES) and non-White children to reduce inequality of educational opportunity (Sewell 1971:803). Today, the programs envisioned by Sewell exist, such as the federal program Gear Up launched in 1998, which selects as one of its primary goals measurable increases in the expectations of low-income and non-White middle school and high school students (see www.ed.gov/offices/OPE/gearup). Given the continuing theoretical and policy importance of expectation formation processes, it would seem an opportune time to revisit the issue of how best to interpret the relationship between expectations and attainment, particularly whether one should develop different interpretations for Blacks than for Whites, as has been argued in the past.

Pursuing this substantive agenda alongside the methodological agenda sketched above, this article proceeds as follows. After providing a description of the data that are analyzed, I invoke a structural equations framework, replicating the basic race difference in the expectations and attainment relationship using a path model specification. Still within the structural equations framework, I then offer a new average causal effect instrumental variable model. The third and fourth models, a counterfactual analysis of bounds and a rational expectations forecasting model, then probe the range of permissible conclusions that can be sustained under entirely different motivating assumptions than those that undergird the traditional structural equations framework. Finally, a panel data model of updated expectations demonstrates how expectations unfold independently of the processes specified by the Wisconsin model. These final results are suggestive of important unspecified belief revision mechanisms that are, nonetheless, consistent with an augmented form of status socialization theory that grants scope to belief-based responses to anticipated structural constraints. In the Discussion section, alternative interpretations of the models are gathered together into four distinct sets of conclusions, and implications for how explicit models of belief formation should be constructed and evaluated are offered.

To frame the separate pieces of analysis developed below, an omnibus characterization of the results should be foreshadowed. The empirical results demonstrate that the modest support for the classic finding of a Black-White difference in the expectations and attainment relationship rests on assumptions that are only weakly grounded in specific theoretical mechanisms. Moreover, since extant explanations for the difference invoke omitted variables that determine both expectations and attainment, it remains unclear whether these explanations imply that race differences would persist (or possibly even change direction) if the hypothesized unmeasured variables were observed and specified. Thus, explanations of the apparent race difference generate more questions than they answer: Do educational expectations cause educational attainment? If so, are they self-fulfilling prophecies based on incorrect component beliefs? If not, are they noncausal, best-possible forecasts? All these questions are addressed below, in Models 3 through 5.

Taken together, the five models presented below are consistent with the assertion that students' own beliefs do matter. The models do not, however, support the common assertion that beliefs are less important for Blacks than for Whites because structural constraints are more important for Blacks than for Whites. Thus, racial differences in the expectations and attainment relationship do not provide a basis for arguing that structural allocation models of educational attainment should be privileged over models that focus primarily on how the socially structured nature of students' own expectations determine their attainments. Just as important, the models also provide support for a unifying research agenda that may help to generate new progress in the modeling of educational attainment.

DATA AND VARIABLES

Data were drawn for White and Black non-Hispanic respondents from the base year through fourth follow-up waves of the High School & Beyond (HS&B) survey, a two-stage stratified random sample of students nested within high schools (U.S. Department of Education 1995). All respondents were high school sophomores for the base year survey in 1980 and were subsequently resurveyed in 1982, 1984, 1986, and finally in 1992, by which time most respondents were 28 years old. The HS&B data were chosen for analysis because the same measure of educational expectations is available in the first four waves of the survey, thereby enabling the modeling of how educational expectations are updated over time.

Table 1 presents all variables used in empirical analysis. *Educational attainment* is the level of education that respondents completed by 1992 when they were, on average, 28 years old. *Educational expectations* is measured by the self-reported plans of respondents, prompted by the following question: "As things stand now, how far in school do you think you will get?" As shown in Table 1, both educational expectations and educational attainment will be analyzed as interval-scaled measures that range from 10 to 20 years of education and as dummy variables for the attainment of a 4-year college degree (i.e., 16 years or more on the interval-scaled measure).

Socioeconomic status is measured by five separate variables: *father's education*, *mother's education*, *father's occupational prestige*, *mother's occupational prestige*, and the natural logarithm of *family income*. Family structure is represented by two separate dummy variables for single-parent households, *mother only* and

TABLE 1: Means and Standard Deviations of Variables

Variable	*Mean*	*Standard Deviation*
Educational attainment:		
Years of education completed by 1992 (10/20)	13.661	1.996
Bachelor's degree	.324	
Educational expectations:		
Years of education expected in 1980 (10/20)	14.997	2.502
Years of education expected in 1982 (10/20)	15.007	2.369
Years of education expected in 1984 (10/20)	14.864	2.263
Years of education expected in 1986 (10/20)	15.127	2.363
Expected a bachelor's degree in 1980	.458	
Expected a bachelor's degree in 1982	.452	
Expected a bachelor's degree in 1984	.462	
Expected a bachelor's degree in 1986	.504	
Gender:		
Male	.470	
Female	.530	
Race:		
White non-Hispanic	.877	
Black non-Hispanic	.123	
Socioeconomic status:		
Mother's education in years (10/20)	12.765	2.033
Father's education in years (10/20)	13.150	2.586
SEI score of mother's occupation (29.44/64.38)	42.557	10.629
SEI score of father's occupation (29.44/64.38)	40.220	10.547
Natural logarithm of yearly family income (8.78/10.88)	10.095	.556

(continued)

father only. *Test scores* is a linear composite of item response theory scaled test scores in verbal aptitude, reading, and mathematics. *Significant others' influence* is a linear composite of five separate dummy variables for whether a student thinks that his or her father, mother, guidance counselor, teachers, and friends feel that he or she should go to college after high school. Both *significant others' influence* and *test scores* are measured separately for the sophomore and senior years of high school, respectively, in 1980 and 1982. *Best friends' expectations* is a cross-classified set of four dummy variables, derived from questions in both the sophomore and senior years, which asked respondents to indicate whether their best friend plans to go to college.

TABLE 1 (continued)

Variable	*Mean*	*Standard Deviation*
Family structure:		
Mother only family	.116	
Father only family	.012	
Standardized test scores:		
Sophomore year composite IRT-scaled test scores (1980)	31.999	17.360
Senior year composite IRT-scaled test scores (1982)	37.614	18.891
Significant others' influence:		
Sophomore year composite SOI (1980) (0/1)	.466	.342
Senior year composite SOI (1982) (0/1)	.580	.384
Best friends' expectations (IV for expectations):		
Less than bachelor's degree in 1980 and 1982	.167	
Less than bachelor's degree in 1980 and bachelor's or more in 1982	.149	
Bachelor's degree or more in 1980 and less than bachelor's in 1982	.111	
Bachelor's degree or more in 1980 and 1982	.573	
Missing data propensity:		
Predictive probability of having missing data on educational attainment, educational expectations, and/or the instrument (.017/.843)	.227	.150

SOURCE: High School & Beyond Sophomore Cohort.
NOTE: $N = 6193$. Data are weighted by the fourth follow-up panel weight (panel5wt). IRT = item response theory; SOI = significant others' influence; SEI = socioeconomic index.

Finally, *missing data propensity* is the predictive probability, estimated from a logit model using the full sample, of being included in the final analysis sample of students who did not have missing data for the variables educational attainment, educational expectations, and best friends' expectations. Missing data for all other variables were imputed with separate best-subset linear and logit regression models.

EXPLANATIONS FOR THE DIVERGENCE IN EXPECTATIONS AND ATTAINMENT

Is there a causal effect of educational expectations on educational attainment, and does it vary by race? Figure 1 presents a graphical

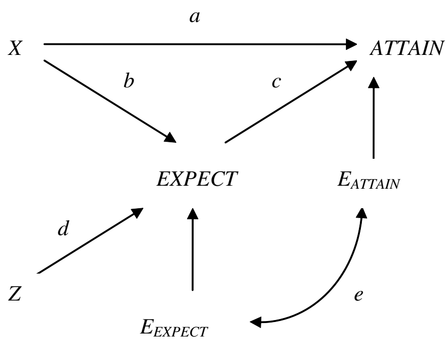

Figure 1: A Structural Equations Model for the Effect of Expectations on Attainment

depiction of the structural equation system that has traditionally been invoked to answer this question. The first two models presented below are constrained specifications of this system—a traditional path model and an instrumental variable model. Both models are grounded on assumptions of temporal causal order (see Davis 1985): Variables in *X* cause both expectations and attainment, and expectations cause attainment.

MODEL 1: A TRADITIONAL PATH MODEL FOR THE CAUSAL EFFECT OF EXPECTATIONS ON ATTAINMENT

For a path model specification of the structural equation system, an identifying assumption is asserted: None of the unobserved variables that determine attainment, E_{ATTAIN}, are correlated with those that determine expectations, E_{EXPECT}. Under this assumption, e is assumed equal to 0, and simple regression techniques can be used to estimate a set of coefficients for a, b, and c. With these coefficients, the causal effects of variables in X can be decomposed into direct effects on attainment and indirect effects that are mediated by expectations (see Alwin and Hauser 1975). Most important for the research question investigated here, the temporal causal order assumption allows the coefficient estimate of c to be interpreted as the direct causal effect of expectations on attainment. Although maintained for Models 1 and 2, this temporal order assumption will be finessed in Models 3 through 5.

Separately for White male, White female, Black male, and Black female HS&B respondents, the two panels of Table 2 present path model estimates of the causal effect of sophomore year and senior year expectations on attainment by age 28. Expectations and attainment are scaled in years, and estimation is by ordinary least squares (OLS). For the estimates reported in the first column of each panel, socioeconomic status, family structure, and test scores are included as variables in X. For the estimates reported in the second column of each panel, the central variable of the Wisconsin model, significant others' influence, is added to the variables in X.

The point estimate of the direct causal effect of expectations on attainment is larger for Whites than for Blacks for each sex in all four sets of models. For example, each additional year of education expected in the sophomore year is associated with .182 and .080 years of attained education, respectively, for White males and Black males. When significant others' influence is added to X, these estimates fall to .133 and .068, respectively, just as in the Wisconsin model. Nonetheless, the same pattern of race differences persists.

Model interpretation. Four explanations for these race differences exist in the literature, the first three of which are closely related:

1. The *differential socialization* explanation is based on the assumption, developed for the Wisconsin model, that educational expectations are an operationalization of latent achievement ambition (see Spenner and Featherman 1978). Many status attainment articles of the 1970s demonstrated that status socialization models explain relatively less of the variance of Black students' educational expectations (e.g., Hout and Morgan 1975). Within the status attainment framework, this finding was interpreted as evidence that the socialization of Black students differed from that of White students. In particular, because Black students have access to a less powerful socialization process, their motivational orientations are less effectively targeted at the crucial levers of advancement in the educational system. As a result, the correspondence between their expectations and future attainments is lower because they are more likely to adopt expectations that they are less compelled to follow.
2. The *misperception of opportunity constraint* explanation is based on the assumption that educational expectations reflect perceptions of

TABLE 2: Traditional Path Model Estimates of the Effect of Educational Expectations on Educational Attainment by Age 28 for Four Race and Sex Groups

	Path Model Estimates of c in Figure 1 for Sophomore Year Educational Expectations (1980)		*Path Model Estimates of c in Figure 1 for Senior Year Educational Expectations (1982)*		
	Family Background and Test Scores as X^a	*Family Background, Test Scores, and Significant Others' Influence as* X^b	*Family Background and Test Scores as* X^c	*Family Background, Test Scores, and Significant Others' Influence as* X^d	*n*
White males	.182 (.024)[e]	.133 (.026)	.303 (.024)	.221 (.026)	2,444
White females	.159 (.020)	.138 (.021)	.252 (.021)	.205 (.023)	2,860
Black males	.080 (.057)	.068 (.059)	.181 (.095)	.155 (.099)	350
Black females	.120 (.037)	.112 (.036)	.069 (.031)	.029 (.030)	539

SOURCE: High School & Beyond Sophomore Cohort data (1980 through 1992 follow-up).
NOTE: Data are weighted by the fourth follow-up panel weight (panel5wt).
a. Exogenous variables that are specified as having direct effects on both expectations and attainment are socioeconomic status, family structure, 1980 test scores, and the predictive probability of being included in the analysis sample of those who do not have missing data on either expectations, attainment, or the instrument (see Table 1 for specific variables).
b. Additional exogenous variables for these models include 1980 significant others' influence.
c. Exogenous variables that are specified as having direct effects on both expectations and attainment are socioeconomic status, family structure, 1980 test scores, 1982 test scores, and the predictive probability of being included in the analysis sample of those who do not have missing data on expectations, attainment, or the instrument (see Table 1 for specific variables).
d. Additional exogenous variables for these models include 1980 significant others' influence and 1982 significant others' influence.
e. The standard errors in parentheses are robust heteroscedastic-consistent standard errors, further adjusted for clustering of students within schools.

opportunity constraints in addition to latent achievement ambition. Because Black students are more often subject to opportunity constraints that they do not recognize at the time their expectations are formed, Black students find it relatively more difficult to realize the achievement motivation into which they have been socialized.[3] Foreshadowed within the early status attainment literature (e.g., Duncan 1969; Kerckhoff 1976), this explanation is perhaps the most popular theme of subsequent literature on the expectations and attainment relationship that emphasizes "lost talent" (see Hanson 1994).

3. The *underachievement* explanation focuses on the self-regulation of academic performance in high school. For this explanation, it is assumed that the expectations of White and Blacks alike are shaped by a powerful and universal abstract attitude that educational attainment is of paramount importance for socioeconomic advancement. But because Black college graduates earn considerably less than White college graduates, Black high school students, on average, develop a less positive concrete attitude toward performance in schooling (see Mickelson 1990).[4] This explanation assumes that while concrete attitudes are inconsequential for educational expectations, they nonetheless lead Blacks to underachieve in everyday school performance. This daily underachievement, by way of reduced college preparation, lowers resulting levels of educational attainment.
4. The *measurement error explanation* attributes the racial difference to a statistical artifact. If there is relatively more random measurement error in the expectations of Black students and all else is equal, the estimated effect for Blacks will be attenuated relative to the estimated effect for Whites (see Fuller 1987 for the general argument). There is some evidence of relatively greater measurement error in reports of family background for Blacks (e.g., Bielby, Hauser, and Featherman 1977), but from these studies, one cannot easily infer patterns of measurement error for expectations.[5]

Model assessment. The best testament to the utility of the simple path model specification is the three substantive explanations that it has inspired. These explanations are theoretically interesting, consistent with the empirical results, and permit the incorporation of supporting qualitative, contextual, and historical evidence into their proposed narratives.

But the existence of three plausible alternative explanations also indicates the inherent weakness of the path model specification. All three explanations appeal to unmeasured variables, and none of the explanations necessarily implies that the true causal effect of expectations on attainment varies by race. Instead, as best I can determine, their implicit assumption is precisely the opposite: If the hypothesized omitted variables—differential socialization processes, misperceived opportunity constraints, and unmeasured concrete attitudes—had been observed and specified in the models, the path model estimates of the effect of expectations on attainment would not vary by race. But that is only one possibility since it could also be the case that if these omitted variables were specified, the net effect of expectations would actually be larger for Blacks than for Whites. Thus, it may be that a more narrowly defined relationship between expectations and attainment is greater for Blacks than for Whites, implying, in contrast to the three traditional explanations, that changes in core educational expectations are more consequential for final levels of educational attainment for Blacks than for Whites.[6]

Even more deeply, these explanations undermine the claim that expectations cause attainment for any group of students. When it is assumed that omitted variables are potentially of great importance, the claim that expectations cause attainment (and hence that students' beliefs matter) rests almost entirely on the temporal order assumption that expectations necessarily proceed and thus cause educational attainment. But, as will be discussed below for Model 4, there is a plausible theoretical basis for questioning the temporal causal order assumption, on the alternative assumption that expectations are noncausal, best-possible forecasts.

MODEL 2: AN INSTRUMENTAL VARIABLE MODEL FOR THE AVERAGE CAUSAL EFFECT

Suppose that we could brainwash students, either erasing or creating their educational expectations at will. If we could then show that changes in expectations induced by this manipulation are associated with later educational attainment, we would be able to claim that educational expectations should be regarded as a cause of educational attainment. This would be powerful evidence that students' beliefs do matter. And if, in performing this experimental manipulation, we also uncovered race differences in the causal effect of expectations on attainment in the same direction as suggested by the path model estimates above, we would then appropriately conclude that beliefs are probably more important for Whites than for Blacks.

Although effective experimental manipulation of expectations is infeasible, we can attempt to take account of naturally occurring random variation. This is the goal of instrumental variables analysis, which, in its classic form, is an alternative to path model identification of a structural equations system (Duncan 1975; see also Bollen 1989:415). For Figure 1, if a variable denoted by Z is available that predicts expectations but has no direct effect on attainment, then even in the presence of a correlation, e, between omitted variables that determine expectations and attainment, the causal effect of expectations on attainment, c, can be consistently estimated.

Are there any available instruments for expectations? There is a long tradition in sociology of interpreting the positive correlation between the educational expectations of students and their best friends as evidence of a causal social influence process (e.g., Cohen 1983; Davies and Kandel 1981; Duncan et al. 1968).[7] If we assume that friendship formation is in part a random process, net of the usual homophily predictors such as race and family background (see Hallinan and Williams 1990), then there is scope to regard some portion of the endogenous correlation as a source of quasi-experimental variation. Based on the assumption that, when conditioning on family background, test scores, and significant others' influence, best friends' expectations have no direct effect on a student's own educational attainment and only an indirect effect by way of a student's expectations (as with Z in Figure 1), the quasi-experimental component of expectations can then be used to identify the causal effect of expectations on attainment by estimating a two-stage least squares (2SLS) model (see Greene 2000).

Table 3 presents 2SLS estimates of the effect of senior year educational expectations on educational attainment, using best friends' expectations as an instrument for students' expectations. The 2SLS estimates are positive and considerably larger than the corresponding ordinary least squares (OLS) estimates reported in the fourth column of Table 2. Moreover, the 2SLS estimates provide no evidence of substantial race differences in the expectations and attainment relationship. In comparison to the path model estimates, the 2SLS point estimates are similar for Whites and Blacks and, if anything, are larger for Blacks.

TABLE 3: Two-Stage Least Squares (2SLS) Regression Estimates of the Effect of Senior Year Educational Expectations on Educational Attainment for Four Race and Sex Groups With Best Friends' Expectations as an Instrument for Respondent's Educational Expectations

	2SLS Estimates of c in Figure 1[a]	*n*
White males	.342 (.170)[b]	2,444
White females	.459 (.179)	2,860
Black males	.392 (.488)	350
Black females	.462 (.670)	539
	100.00	100.00

SOURCE: High School & Beyond Sophomore Cohort data (1980 through 1992 follow-up).
NOTE: Data are weighted by the fourth follow-up panel weight (panel5wt).
a. Exogenous variables that are specified as having direct effects on both expectations and attainment are socioeconomic status, family structure, 1980 test scores, 1982 test scores, 1980 significant others' influence, 1982 significant others' influence, and the predictive probability of being included in the analysis sample of those who do not have missing data on expectations, attainment, or the instrument (see Table 1 for specific variables).
b. The standard errors in parentheses are robust heteroskedastic-consistent standard errors, further adjusted for clustering of students within schools.

Model interpretation. Two interpretations of these results based on the classical instrumental variables literature can be offered:

1. The true causal effect of expectations on attainment is positive but does not vary by race. Race differences in the path model estimates are observed because the path model identifying assumption that *e* is equal to 0 is unreasonable. Accordingly, the path model evidence that the causal effect of expectations on attainment is stronger for Whites than for Blacks indicates that the correlation between omitted factors, *e*, is larger for Whites than for Blacks. For example, if the size of the effect of unmeasured opportunity constraints on attainment is the same for Whites and for Blacks, the path model estimate of the effect of expectations on attainment will be larger for Whites than for Blacks if, as is suggested by the misperceived opportunity constraint explanation, the correlation between unmeasured opportunity constraints and educational expectations is stronger for Whites than for Blacks. Thus, these results are consistent with all three traditional explanations for the observed race difference in the path model estimates, as well as their common hidden assumption that if relevant omitted variables were explicitly modeled in a path model framework, race differences in estimates of the causal effect would disappear.
2. Instrumental variable estimators are not susceptible to attenuation bias, primarily because they are ratios of covariances that can be

consistently estimated, even in the presence of random measurement error (see Greene 2000, sec. 9.5). Thus, the 2SLS estimates suggest that race differences in the path model estimates can be attributed to larger amounts of random measurement error in the expectations of Blacks. To sustain this interpretation, it must be assumed that there are distinct race differences in orientations to the survey questions (as will be discussed below for Model 4) and that any greater variability in the responses of Blacks is not on its own substantively meaningful.

There is a serious limitation to these traditional interpretations. Classical instrumental variable models assume that the causal effect of interest is absolutely constant across all individuals. For example, under the classical interpretation, the estimates of Table 3 suggest that the causal effect of expectations on attainment is equal to .342 years of attainment for every year of education expected for every White male in the sample. Fortunately, a new instrumental variables literature has arisen that relaxes the overly restrictive constant coefficient assumption by introducing a monotonicity condition on individuals' induced responses to the instrument (see Angrist, Imbens, and Rubin 1996). For this application, one would instead assert that the effect of best friends' expectations on students' own expectations is greater than or equal to zero for all students. In other words, if students change their expectations in response to their best friends' expectations, they only change their expectations to make them more similar to their best friends' expectations. Under this monotonicity assumption, the 2SLS estimator identifies the average causal effect for the subset of students who would change their expectations in response to their best friends' expectations (Angrist and Imbens 1995). Thus, the new literature on instrumental variables offers a third interpretation:

3. Among those students who would change their expectations in response to a change in the expectations of their best friends, the average causal effect of expectations on attainment is positive and does not vary by race.

Model assessment. The claim that the true causal effect of expectations on attainment is positive is based on the instrumental variable identifying assumption that, net of family background, test scores, and significant others' influence, peers affect each others' attainment only by shaping each others' expectations. If there is a residual direct effect of best friends' expectations on attainment, net of students' own expectations and significant others' influence, then the 2SLS estimates are inconsistent and (asymptotically) biased upward. For this reason, causal claims based on instrumental variables invariably remain controversial, even though in this case, such claims are no more controversial than the path-model-based claims of causality of the last section.

Given the possibility that these models may overstate the size of any causal effect of expectations on attainment, is there any reason to believe that possible violations of the identifying assumption have suppressed a true race difference analogous to the one suggested by the path model estimates? For this to be the case, the residual direct effect of best friends' expectations on students' own attainment would have to be considerably more serious for Blacks than for Whites. Although possibly consistent with the underachievement explanation of Mickelson (1990), such a difference in residual peer effects on attainment contradicts the ethnographic literature (e.g., Fordham and Ogbu 1986) that stresses the self-conscious rejection of school performance by Black adolescents.

In light of the new instrumental variable literature and the third interpretation of the 2SLS estimates offered above, there is a more subtle and yet also more serious threat to the conclusion that the true effect of expectations on attainment does not vary by race. Consider the best-case scenario: If we had many available instrumental variables, all of which satisfied analogous monotonicity conditions and also yielded the same pattern of coefficients—a positive effect that does not vary by race—then we would have confidence that there is no race difference in the expectations and attainment relationship that needs to be explained.

What might such a set of instruments be? Educational expectations are a summary measure of underlying beliefs about the costs and benefits of educational attainment and about the availability of resources to meet the costs of postsecondary education. If some of these underlying beliefs are incorrect, then students' forecasts differ from the forecasts that they would have instead formed if all of their underlying beliefs had been correct. And if students' college preparatory commitment decisions while still in high school are regulated by their forecasts of their own future behavior, then educational expectations can be treated as if they are a cause of educational attainment. Variation in a set of component underlying beliefs could be treated as a set of instrumental variables for educational expectations.

We do not have a set of such instruments. As a result, the single set of 2SLS estimates presented in Table 3 does not reveal enough information about how much expectations would respond to shifts in underlying beliefs, and the average causal effect interpretation of the 2SLS estimates is thus quite limited. In particular, it does not rule out the possibility that with other instruments, it might be shown that there is indeed a case to be made that there are important race differences in the expectations and attainment relationship.

Nonetheless, the average causal effect interpretation points the way toward future profitable research objectives, notably the explicit modeling of component belief formation processes on which expectations are based. This objective is entirely consistent with the research objectives entailed by further attempts to directly model the differential socialization practices, misperceived opportunity constraints, and concrete attitudes stressed in the existing literature. But, unlike the path model estimates, these estimates also compel us to directly model the potential individual-level heterogeneity of causal effects and to explicitly model the potential impact of omitted variables, as in the next section.

MODEL 3: COUNTERFACTUAL BOUNDS FOR THE AVERAGE CAUSAL EFFECT

Although assessing the impact of omitted variables is not beyond the scope of empirical analysis under the structural equations framework, since one can overidentify the model in Figure 1 by assuming theoretical values for e and then adopting a full-information approach to parameter estimation (see Bollen 1989), the consequences of omitted variable bias can be examined more completely by embracing a specific counterfactual framework for thinking about causality. This framework also allows for a more intuitive examination of individual-level, causal-effect heterogeneity. With this approach, I show in this section that common assumptions invoked above about temporal order and omitted variables are strong, consequential, and potentially inherently misleading.

The starting point for a rigorous analysis of a claim of causality, and hence of an analysis of group differences in any such causal effect, is the careful definition of the causal effect of interest. For the effect of expectations on attainment, causal effects are most clearly defined using counterfactual-conditional statements of the following form: “If a student who expected not to graduate from college and subsequently did not graduate from college had instead expected to graduate from college (and all else remained the same), then he or she would have graduated from college.”

Before introducing the specifics of the counterfactual framework that formalizes statements such as this one, I first provide a more basic representation of the relationship between expectations and attainment, one that is liberated from the interval-scaling assumptions of Models 1 and 2 above and one that more easily facilitates a discussion of the actions of individuals rather than the partial associations of measured variables. As shown above in Table 1, I dichotomize the yearly educational attainment variable into a dummy variable A that equals 1 if a respondent attains a college degree. Likewise, I dichotomize the yearly expectations variables into dummy variables E that equal 1 if a respondent expects to complete college.[8]

Column 1 of Table 4 presents the mean values of E for distinct strata of HS&B respondents delineated by race, sex, and a dichotomous variable for whether each student has at least one parent who completed college. Columns 2 and 3 present mean values of A conditional on alternative values of E. For example, the value .666 in the first row of column 2 indicates that 66.6 percent of White males who have a college-educated parent and who expected to graduate from college in their sophomore year actually did graduate from college by age 28.

The counterfactual model of causality. Whereas the structural equations model presented above relies primarily on a logic of temporal order for measured variables (see Davis 1985), the counterfactual framework asserts the theoretical existence of abstract timeless potential outcomes that have distributions over all individuals in the population of interest.[9] For this application, potential outcomes are defined as A^{ea}, a dichotomous attainment outcome for the action “complete college” under the theoretical state “expect to attain a college degree,” and A^{ef}, a dichotomous attainment outcome under the alternative state “expect to fail to attain a college degree.” The individual-level causal effect of expectations on attainment is then defined as the

TABLE 4: Mean Educational Expectations on Educational Attainment for Four Race and Sex Groups and Level of Parents' Education

		Proportion of Students Who Completed College		
	Proportion of Students Who Expected to Complete College	*Expected to Complete College*	*Did Not Expect to Complete College*	*n*
Sophomore year expectations:				
White males				
Parent with college degree	.632	.666	.193	744
No parent with college degree	.211	.399	.075	1700
White females				
Parent with college degree	.595	.644	.239	827
No parent with college degree	.208	.314	.065	2,033
Black males				
Parent with college degree	.673	.234	.101	84
No parent with college degree	.275	.281	.099	266
Black females				
Parent with college degree	.506	.344	.033	93
No parent with college degree	.339	.183	.023	446
Senior year expectations:				
White males				
Parent with college degree	.642	.685	.147	744
No parent with college degree	.217	.495	.046	1700
White females				
Parent with college degree	.613	.668	.182	827
No parent with college degree	.206	.409	.041	2,033

(continued)

TABLE 4 (continued)

	Proportion of Students Who Expected to Complete College	*Proportion of Students Who Completed College*		
		Expected to Complete College	*Did Not Expect to Complete College*	*n*
Black males				
Parent with college degree	.480	.381	.015	84
No parent with college degree	.243	.274	.109	266
Black females				
Parent with college degree	.600	.260	.085	93
No parent with college degree	.341	.150	.040	446

SOURCE: High School & Beyond Sophomore Cohort data (1980 through 1992 follow-up).
NOTE: Data are weighted by the fourth follow-up panel weight (panel5wt) multiplied by the probability of having missing data on the expectations and attainment variables (estimated from separate race and sex specific logit models).

difference for each individual between the following two potential outcomes:

$$\delta_i = A_i^{\text{ea}} - A_i^{\text{ef}}, \quad (1)$$

where i indexes all individuals in the population. Individuals for whom δ_i equals 1 would be induced to complete college by an increase in their expectation from expect to fail to expect to attain. Individuals for whom δ_i equals 0 or –1 would not be induced to complete college by the same change in their expectations. Unfortunately, because individuals cannot simultaneously be observed in both theoretical states, δ_i cannot be calculated for any individual, and this observational reality is often referred to as the fundamental problem of causal inference (see Holland 1986).

Progress is possible when individual-level potential outcomes are aggregated to the population level to form the population-level analog to equation (1):

$$\bar{\delta} = \bar{A}^{\text{ea}} - \bar{A}^{\text{ef}}, \quad (2)$$

where the bar above each term denotes the population-level mean.[10] By aggregating to the population level, the fundamental problem of causal inference can be reduced to the more tractable challenge of estimating two population-level means.

To understand how difficult estimation can be, let E be a theoretical subset of the population that includes all individuals who, if observed, would report that they expect to attain a college degree. Accordingly, all individuals in the population are either members of E (denoted $i \in \text{E}$) or are not members of E (denoted $i \notin \text{E}$). Now, let π equal the true proportion of individuals in the population who are in E and decompose the population-level means of the potential outcomes in equation (2) across inclusion in the subset E:

$$\bar{\delta} = [\pi \bar{A}^{\text{ea}}_{i\in\text{E}} + (1-\pi)\bar{A}^{\text{ea}}_{i\notin\text{E}}] - [\pi \bar{A}^{\text{ef}}_{i\in\text{E}} + (1-\pi)\bar{A}^{\text{ef}}_{i\notin\text{E}}]. \quad (3)$$

Which terms on the right-hand side of equation (3) can we effectively estimate with survey data on expectations and attainment? The proportion π of individuals who are in E is consistently estimated by the sample mean of the dichotomous educational expectations variable, E. Likewise, $\bar{A}^{\text{ea}}_{i\in\text{E}}$ and $\bar{A}^{\text{ef}}_{i\notin\text{E}}$ are consistently estimated by the sample means of the observable attainment variable A, respectively, for those who are observed expecting to attain a college degree and for those who are observed expecting to fail to attain a college degree (i.e., those for whom $E = 1$ and $E = 0$, respectively). Unfortunately, no consistent estimator of $\bar{A}^{\mathrm{ea}}_{i \notin \mathrm{E}}$ and $\bar{A}^{\mathrm{ef}}_{i \in \mathrm{E}}$ is available for observational survey data because these counterfactual means are population-level means of individual-level potential outcomes that exist in theory but that are not observable.

Within this framework, in the remainder of this section, I first offer naive estimates of the average causal effect defined by equation (2) for different race and sex groups. I then assess the permissible range of the true average causal effect under three sets of theoretically grounded but inherently untestable alternative assumptions about the unobservable population-level means $\bar{A}^{\mathrm{ea}}_{i \notin \mathrm{E}}$ and $\bar{A}^{\mathrm{ef}}_{i \in \mathrm{E}}$.

Naive estimates of the average causal effect. Assume for the rest of this section that the population of interest is any one of the subpopulation strata defined for Table 4 based on race, sex, and parents' level of education. The naive estimator of the average causal effect $\bar{\delta}$ is

$$\hat{\bar{\delta}} = \hat{\bar{A}}^{\mathrm{ea}}_{i \in \mathrm{E}} - \hat{\bar{A}}^{\mathrm{ef}}_{i \notin \mathrm{E}}. \quad (4)$$

Separately for distinct strata, estimates corresponding to equation (4) are presented for HS&B respondents in column 1 of Table 5. Operationally, these estimates are formed by subtracting the conditional means in column 3 from those in column 2 of Table 4. For example, the naive estimate of the effect of sophomore year expectations for White males with a college graduate parent is .473, implying that if we were to shift the expectations of a sample of such respondents from not expecting to attain a college degree to instead expecting to attain a college degree, an additional 47.3 percent of students would complete college. Note, however, that the corresponding conditional mean in column 3 of Table 4 suggests that 19.3 percent of these respondents would complete college anyway, regardless of their educational expectations.

Although very simple and hence "naive," these estimates convey the same story as the path model results.[11] The estimates of the average causal effect are larger for Whites than for Blacks for all similarly defined strata of students. Nonetheless, asserting that these differences are evidence of variation in a true causal effect requires

TABLE 5: Estimates and Bounds for the Average Causal Effect of Expectations on Attainment for Four Race and Sex Groups and Level of Parents' Education

		No-Assumptions Bound for the Average Causal Effect		*Bound for the Average Causal Effect, Assuming Monotone Causal Response*		*Bound for the Average Causal Effect, Assuming Monotone Causal Response and Monotone Causal Selection*		
	Naive Estimate of the Average Causal Effect	*Ignoring Sampling Error*	*Conservative Bootstrapped Bounds*	*Ignoring Sampling Error*	*Conservative Bootstrapped Bounds*	*Ignoring Sampling Error*	*Conservative Bootstrapped Bounds*	*n*
Sophomore year expectations:								
White males								
Parent with college degree	.473	[−.282, .718]	(−.331, .767)	[0, .718]	(0, .767)	[0, .473]	(0, .570)	744
No parent with college degree	.324	[−.186, .814]	(−.211, .839)	[0, .814]	(0, .838)	[0, .324]	(0, .382)	1,700
White females								
Parent with college degree	.405	[−.308, .692]	(−.355, .739)	[0, .692]	(0, .737)	[0, .405]	(0, .494)	827
No parent with college degree	.249	[−.194, .806]	(−.216, .828)	[0, .806]	(0, .828)	[0, .249]	(0, .297)	2,033
Black males								
Parent with college degree	.132	[−.549, .451]	(−.778, .680)	[0, .451]	(0, .681)	[0, .132]	(0, .472)	84
No parent with college degree	.181	[−.270, .730]	(−.347, .807)	[0, .730]	(0, .808)	[0, .181]	(0, .324)	266
Black females								
Parent with college degree	.311	[−.348, .652]	(−.547, .850)	[0, .652]	(0, .846)	[0, .311]	(0, .512)	93
No parent with college degree	.159	[−.293, .707]	(−.354, .769)	[0, .707]	(0, .766)	[0, .159]	(0, .240)	446

(continued)

TABLE 5 (continued)

		No-Assumptions Bound for the Average Causal Effect		*Bound for the Average Causal Effect, Assuming Monotone Causal Response*		*Bound for the Average Causal Effect, Assuming Monotone Causal Response and Monotone Causal Selection*		
	Naive Estimate of the Average Causal Effect	*Ignoring Sampling Error*	*Conservative Bootstrapped Bounds*	*Ignoring Sampling Error*	*Conservative Bootstrapped Bounds*	*Ignoring Sampling Error*	*Conservative Bootstrapped Bounds*	*n*
Senior year expectations:								
White males								
Parent with college degree	.538	[−.255, .745]	(−.302, .793)	[0, .745]	(0, .793)	[0, .538]	(0, .628)	744
No parent with college degree	.449	[−.146, .854]	(−.167, .875)	[0, .854]	(0, .877)	[0, .449]	(0, .509)	1,700
White females								
Parent with college degree	.486	[−.274, .726]	(−.319, .772)	[0, .726]	(0, .771)	[0, .486]	(0, .571)	827
No parent with college degree	.368	[−.154, .846]	(−.174, .866)	[0, .846]	(0, .867)	[0, .368]	(0, .420)	2,033
Black males								
Parent with college degree	.365	[−.305, .695]	(−.493, .882)	[0, .695]	(0, .896)	[0, .365]	(0, .584)	84
No parent with college degree	.165	[−.259, .741]	(−.340, .821)	[0, .741]	(0, .822)	[0, .165]	(0, .323)	266
Black females								
Parent with college degree	.174	[−.478, .522]	(−.696, .739)	[0, .522]	(0, .738)	[0, .174]	(0, .433)	93
No parent with college degree	.110	[−.316, .684]	(−.385, .753)	[0, .684]	(0, .748)	[0, .110]	(0, .185)	446

SOURCE: High School & Beyond Sophomore Cohort data (1980 through 1992 follow-up).

NOTE: Data are weighted by the fourth follow-up panel weight (panel5wt) multiplied by the probability of having missing data on the expectations and attainment variables (estimated from separate race and sex specific logit models). Bounds in brackets ignore sampling error. Bounds in parentheses are conservative bootstrapped bounds that take into account possible sampling error (1,000 replicated samples of size N with lower/higher end of the 95 percent confidence interval of the bootstrap distribution given for the lower/upper bound).

additional assumptions, introduced below, about the unobservable population-level means $\bar{A}^{\text{ea}}_{i\notin \text{E}}$ and $\bar{A}^{\text{ef}}_{i\in \text{E}}$.

No-assumptions bounds on the average causal effect. Although with observational data, no consistent estimator of the counterfactual population means $\bar{A}^{\text{ea}}_{i\notin \text{E}}$ and $\bar{A}^{\text{ef}}_{i\in \text{E}}$ is available, each of these population means is no less than 0 and no greater than 1 because the individual-level potential outcomes are themselves no less than 0 and no greater than 1. If, for example, all individuals in the population who did not expect to complete college would have completed college if they had instead expected to complete college, $\bar{A}^{\text{ea}}_{i\notin \text{E}}$ would equal 1. And if none of these same individuals would have completed college given an increase in their expectation, then $\bar{A}^{\text{ea}}_{i\notin \text{E}}$ would equal 0. Thus, because the potential outcomes are bounded by 0 and 1, we can express the permissible range for the true value of $\bar{\delta}$ by substituting into equation (3) the values for $\bar{A}^{\text{ea}}_{i\notin \text{E}}$ and $\bar{A}^{\text{ef}}_{i\in \text{E}}$ that would make $\bar{\delta}$ alternatively as small and as large as it could possibly be (see the derivation in the appendix).

Column 2 of Table 5 presents no-assumptions bounds for the average causal effect that ignore sampling error in the estimates of $\bar{A}^{\text{ea}}_{i\notin \text{E}}$, $\bar{A}^{\text{ef}}_{i\in \text{E}}$, and π. Conservative bootstrapped bounds that take account of possible bias due to sampling error are presented in column 3.[12] Without making any assumptions about the counterfactual population means $\bar{A}^{\text{ea}}_{i\notin \text{E}}$ and $\bar{A}^{\text{ef}}_{i\in \text{E}}$, these bounds imply, for example, that $\bar{\delta}$ is no smaller than –.282 and no larger than .718 (or, if we allow for sampling error, no smaller than –.321 and no larger than .768) for White males with a college graduate parent.

Although indisputably true, the no-assumptions bounds are relatively uninformative as, by definition, they always include 0. And, as shown in comparisons across levels of parental education, introducing additional variables into the analysis and forming yet more carefully defined strata would only shift the bounds up and down throughout the (–1,1) interval. Nonetheless, the no-assumptions bounds are a starting point, the estimation of which Manski (1995) effectively argues should precede the application of additional assumptions that generate stronger conclusions.

Bounds under a monotone causal response assumption. The no-assumptions bounds can be narrowed only by asserting additional assumptions. One such assumption is monotone causal response

(Manski 1997). In this context, the assumption is operationalized by asserting the claim that educational expectations can do no harm. More specifically, shifting a student's educational expectation from "expect to fail" to "expect to attain" cannot make him or her less likely to attain a college degree. This monotone response assumption is useful because it narrows the lower bound of the no-assumptions bound for the average causal effect, thereby eliminating all negative values as permissible values for the average causal effect (see the derivation in the appendix).[13]

Bounds for the average causal effect under an assumption of monotone response are presented in column 4 of Table 5, alongside corresponding bootstrapped bounds in column 5. For White males with a college-educated parent, the bound for the average effect is narrowed from the no-assumptions bound of [–.282, .718] to [0, .718] (ignoring sampling error). As can be seen across all of the strata, an assumption of monotone causal response does not eliminate 0 as a plausible value for the average causal effect.

Bounds under monotone causal response and monotone causal selection assumptions. In addition to monotone causal response, we can also assert (with perhaps a bit more hesitation) a monotone causal selection assumption. For this application, monotone causal selection stipulates that the college completion rate of those who do not expect to complete college, if they had instead expected to complete college, would still be no higher than the college completion rate of those who do expect to complete college. Or, in the opposite direction, individuals who expect to complete college, if they had instead not expected to complete college, would nonetheless complete college at a rate at least as high as those who do not expect to complete college. In constructing a bound for the average causal effect, monotone causal selection tightens the upper bound of the no-assumptions bound (see derivation in the appendix).

Joint bounds for the average causal effect under assumptions of both monotone response and monotone selection are presented in column 6 of Table 5, alongside corresponding bootstrapped bounds in column 7. For White males with a college-educated parent, the permissible range of the average effect is narrowed from the no-assumptions bound of [–.282, .718] to [0, .473] (ignoring sampling error). Again, as can be seen across all of the strata, these assumptions do not eliminate 0 as a plausible value for the average causal effect. Furthermore, the upper bound is what I labeled above the naive estimator of the average causal effect, as can be seen from a comparison of columns 1 and 6.

The leap of faith: Strong ignorability. What additional assumptions could tighten these bounds to establish the naive estimator in equation (4) as a consistent estimator of the average causal effect in equation (2)? Often labeled a strong ignorability assumption (Rosenbaum and Rubin 1983), the assumption that $\bar{A}^{\text{ea}}_{i\in\text{E}} = \bar{A}^{\text{ef}}_{i\notin\text{E}}$ and $\bar{A}^{\text{ef}}_{i\notin\text{E}}$ and $\bar{A}^{\text{ef}}_{i\in\text{E}}$ would suffice. Unfortunately, the only research design for which such assumed equalities can be easily justified is random assignment of students to the two states "expect to attain" and "expect to fail." Because such a design is infeasible for this application, the only available justification for asserting such equalities is "faith" (Clogg and Haritou 1997:105; also see Lieberson 1985).

Model interpretation. For the bounds estimated in this section, the strong assumptions inherent in structural equations models have been replaced by weaker, more narrowly defined assumptions about educational expectations and their relationship with attainment. Two important interpretations of the results should be underlined:

1. None of the permissible weak assumptions about expectations and attainment can eliminate 0 from among the credible values for the average causal effect, and such elimination is what would be necessary to establish a firm claim of causality on the justification that, for at least some students, the counterfactual-conditional statement at the beginning of this section is true.
2. Because bounds for the average causal effect of expectations on attainment cannot eliminate a wide range of plausible estimates for both Whites and Blacks, no strong claims can be sustained about what race differences might remain in path model estimates of the causal effect of expectations on attainment if all relevant omitted variables were measured and properly specified. Indeed, it may be the case that if differential socialization practices, misperceived opportunity constraints, and concrete attitudes were all observed and explicitly specified, the residual direct effect of expectations on attainment would be stronger for Blacks than for Whites.

Model assessment. In contrast to the structural equations models, the estimated bounds presented in this section are maximally defendable, and yet this epistemic security is purchased at a high price (perhaps too high, since no strong conclusions can then be asserted). One could, for example, adhere strictly to the counterfactual framework and claim that there is no irrefutable evidence that there is a causal effect of expectations on attainment. And if there is no evidence that there is a causal effect of expectations on attainment for any student, then there is no race difference to be explained.

Although this model conveys a stark message by revealing the limitations of observational survey data, as well as symmetrically the dependence of all conclusions based on traditional structural equations models on strong assumptions, all hope should not be abandoned.[14] In the next section, I use a similar analytic strategy to demonstrate that there is even weaker support for the only theoretical justification for treating expectations as universally noncausal—and hence of dismissing the well-studied race difference on grounds that the survey data are simply uninformative.

MODEL 4: A MODEL OF EDUCATIONAL EXPECTATIONS AS BEST-POSSIBLE FORECASTS

Counterposed against the Wisconsin model, there is an influential contrarian strand of sociological literature that argues educational expectations are survey-induced utterances that have no true salience to adolescents in their everyday lives. In this vein, Bourdieu (1973:83) criticizes "functionalist sociologists" who maintain that educational expectations cause educational attainment when it is shown with survey data that "individuals have hoped for nothing that they have not obtained and obtained nothing that they have not hoped for." Relatedly, Alexander and Cook (1979:202) raise the possibility that students' educational expectations are analogous to a "meteorologist's anticipation of fair or foul weather." The crux of these characterizations is the implicit claim that expectations and educational attainment are, for all practical purposes, two indicators of the same thing. As a result, the temporal causal order assumption depicted in Figure 1 is entirely inappropriate.

Alexander and Cook (1979) make some progress in evaluating this position, but no explicit framework has been adopted to formally test its plausibility. Since the limiting case of the contrarian position is that educational expectations are best-possible forecasts, rational expectations models of forecasting can provide such a framework.[15]

When educational expectations are best-possible forecasts, the association between expectations and attainment cannot be given a causal interpretation. Likewise, race differences in path model estimates of the effect of expectations on attainment would reflect little more than the systematic predictability of the educational attainment trajectories typically traversed by Whites and Blacks. In this section, I test for whether expectations and resulting attainment conform to the analytic bounds implied by a best-possible forecast conjecture, after first introducing a crucial threshold response framework.

Latent expectations and threshold response. The rational expectations forecasting framework must first be grounded on an assumption that individuals have latent probabilistic expectations. In response to a survey question—such as the HS&B question, "As things stand now, how far in school do you think you will get?"—the assumption is that a student will select the level "finish college" or a higher level only if his or her ex ante probability judgment of completing college, denoted $\hat{\Pr}(A = 1)_i$, exceeds a threshold value τ_i. Forecasting frameworks assume that a threshold is a function of an individual's latent loss function (see Chernoff and Moses 1959). In this application, the response threshold is based on a student's subjective evaluation of the consequences of his or her prediction error for false-positive and false-negative forecasts:

$$\tau_i = \frac{Loss(E = 1|A = 0)_i}{Loss(E = 1|A = 0)_i + Loss(E = 0|A = 1)}. \tag{5}$$

If the expected subjective consequences of false-positive forecasts and false-negative forecasts are equal, students will set their response threshold equal to .5. I proceed to empirical analysis under the assumption that this is the case and thus that for all individuals, τ_i is equal to .5. I will nonetheless interpret the results with recognition that this assumption may be violated and in race-specific ways.

However, before proceeding to the empirical analysis, consider a basic group-level implication of the threshold response framework. Suppose that a group of students has a common response threshold equal to .5 and that all students expect that their probability of graduating college is .51. In this case, all students will set E equal to 1. Nonetheless, if their probabilistic expectations are exactly correct, then only 51 percent of students will graduate from college, thereby rendering 49 percent of dichotomized forced-choice forecasts false-positive predictions. In general, even if students formulate their best-possible forecasts, the observed correlation between variables such as E and A may be moderate to small because of the coarse nature of forced-choice response categories posed in survey instruments.[16]

Bounds under a rational expectations conjecture. Formal forecasting models in the rational expectations literature are based on the delineation of overlapping sets of information on which to base a forecast of the future. The main issue in all such forecasting models is whether individuals use all available information when forming their forecasts and whether they accurately judge the relative likelihood of the occurrence of information-generating events that are at risk of occurring between the time when expectations are formed and modeled behavior is enacted.

Invoking a rational expectations framework, Manski (1990) derives permissible bounds on the range that subsequent aggregate behavior must be observed to obey if respondent-reported expectations are best-possible forecasts. The appendix provides a derivation of the following claim that is implied by a rational expectations assumption, using implied restrictions on the attainment process, knowledge of available information I, and knowledge of the true probability distribution of unknown information U that determines attainment but that is unknowable at the time expectations are formed. The framework implies the following implication for each individual i,

$$\begin{aligned} E_i = 0 &\Rightarrow \Pr(A = 1)_i \leq .5, \\ E_i = 1 &\Rightarrow \Pr(A = 1)_i \geq .5, \end{aligned} \tag{6}$$

where .5 is the assumed common response threshold. If all individuals have rational expectations, then in the notation introduced for the counterfactual model,

$$\bar{A}^{\text{ef}}_{i \notin \text{E}} \leq .5 \leq \bar{A}^{\text{ea}}_{i \in \text{E}}. \tag{7}$$

Equation (7) holds true for subsets of students defined by any set of characteristics X, such as the strata analyzed for Tables 4 and 5.

The modeling strategy for this section is thus the mirror image of the bounds analysis of the last section. The rational expectations assumption fixes a middle point that conditional means cannot cross if the assumption is valid. Accordingly, the assumption can be evaluated by determining whether, for every group of students with identical characteristics X, at least 50 percent of students who expect to graduate from college do graduate from college and no more than 50 percent of students who expect not to graduate from college do graduate from college.

As shown in columns 2 and 3 of Table 4, the educational expectations maintained by many groups of students violate the bound in equation (7). While the percentage of students from all eight strata who complete college having expected not to do so conforms to the bound, ranging from a low of .015 to a high of .239, rates of college completion for those who expect to graduate from college do not uniformly conform to the bound. Only for White students with a college graduate parent is the proportion of students who graduated from college having expected to do so greater than 50 percent. Likewise, for no group of Black students who expected to graduate from college is the college completion rate greater than 50 percent, ranging from a low .149 to a high of .380.[17]

Model interpretation. Violations of the bounds based on the rational expectations conjecture suggest the following interpretation of the expectations and attainment relationship:

1. It is not permissible to treat the educational expectations of all students as noncausal, best-possible forecasts that can be ignored when data on educational attainment are available.

And since expectations predict attainment, at least one of two qualifications must be accepted:

2a. For at least some students, expectations are causes of attainment.
2b. For at least some (but not all) students, expectations are noncausal, best-possible forecasts.

If qualification 2a could be favored over qualification 2b, this model would be powerful evidence that students' own beliefs do matter. Unfortunately, qualification 2a cannot be so favored, and hence there is no ironclad proof that, for at least some students, educational expectations are causes of educational attainment.

Model assessment. Because we have no information about how students weigh the subjective consequences of false-positive and false-negative forecasts, assuming the existence of a common response threshold equal to .5 may be unreasonable. If so, we cannot infer from these results that expectations are not best-possible forecasts since, if it were the case that τ is equal to .25, then mean levels of educational attainment for HS&B respondents would in almost all cases conform to the bound in equation (7).

When might τ equal a value such as .25? As shown in equation (5), students will set τ equal to .25 if they associate three times as much subjective loss with reporting a false-negative prediction. Students would maintain such a loss function if they believe that they will be judged negatively by survey researchers or others who might have access to their answers if they underestimate their own future level of educational attainment.[18]

When focusing on interpretations of the group differences revealed in Table 4, it must be recognized that subjective loss functions and corresponding response thresholds may vary by race. Black students may associate more costs than White students with mistakenly underestimating their own future educational attainment, for it is possible that Black students fear that their answers will confirm a stereotype that Black students are less committed to schooling. Steele's theory of stereotype threat would, in some survey administration contexts, suggest that such a hypothesis is worth investigation (see Steele and Aronson 1995; Steele 1997).

Nonetheless, there is still no strong evidence that the relationship between expectations and attainment can be completely ignored and hence that race differences in this relationship should not be subjected to explanatory effort. And although these results do not provide any evidence to adjudicate between the alternative explanations for race differences in the expectations and attainment relationship outlined earlier, the explicit attention to response thresholds formalizes the contention of Alexander and Cook (1979) that Whites and Blacks may respond in fundamentally different ways to the same survey question. Thus, to the explanations offered in prior sections, an additional explanation should be delineated: the *differential response threshold* explanation implied above.

If, across both Whites and Blacks, educational expectations are too optimistic in the aggregate to be best-possible forecasts in general, is there any evidence that the expectations of some students are persistent and salient enough that they become self-fulfilling prophecies? In other words, is there any evidence that expectations are based on relatively stable incorrect component beliefs that would cause students to shift their college preparatory commitment decisions while still in high school? Although submerged within relatively vague socialization mechanisms, I regard this as the central claim of the Wisconsin model. The final model presented in the next section addresses this possibility.

MODEL 5: A PANEL DATA MODEL OF UPDATED EDUCATIONAL EXPECTATIONS

Because educational expectations are reported by HS&B respondents as high school sophomores in 1980 and then subsequently in surveys in 1982, 1984, and 1986, a panel data model of updated educational expectations is feasible. The goal of this final piece of analysis is to determine whether, after observable information is specified, net educational expectations are serially correlated across time as individuals progress along attainment trajectories. Autoregressive patterns of serial correlation are the signature of an underlying dynamic process, one that is inconsistent with a socialization-based claim that expectations are a stable indicator of latent achievement motivation. If expectations are serially correlated in this way, then this is at least some evidence that educational expectations may be dynamically linked across time in an underlying causal process that generates forward-looking commitment decisions that are consequential for final levels of educational attainment.

Each individual's time-specific educational expectation, E_{it}, can be defined as a departure from a time-invariant projection onto variables specified as X. As detailed in the notes to Table 6, for the analysis reported below, these variables will be the same Wisconsin model variables used for the path models estimated above. The difference here is that the coefficients on the variables in X, analogous to those labeled b in Figure 1, will be weighted averages of four different time-specific variables for expectations projected onto a single set of stable characteristics in X. As a result, departures from the stable predicted values based on the variables in X and their estimated coefficients, collectively denoted by time-specific error terms e_{it}, represent that portion of individuals' time-specific expectations that cannot be accounted for by the variables specified in X.

Most important, because these residualized expectations exist for all four time periods, we can estimate the correlation between error terms across time, $\rho(e_{it}, e_{it+1})$. These estimated correlations then allow us to examine whether the effects of omitted variables (such as the differential socialization practices, misperceived opportunity constraints, and concrete attitudes invoked for the explanations of race differences earlier) collectively persist from one time period to the next and, if so, if in any particular pattern.

Using the panel data models of Liang and Zeger (1986), the expectations variables can be either dichotomous or interval scaled. For consistency with the models presented in the last two sections, I will offer models for dichotomous expectations variables, again equal to 1 if an individual expects to obtain a bachelor's degree. Models with years of education expected as the dependent variable yield substantively similar findings (and even more consistency across race than I will claim below).

For separate race and sex groups, Table 6 presents estimated correlation coefficients between error terms from panel data models of college completion expectations in 1980, 1982, 1984, and 1986 regressed on observed information in X available to sophomores in 1980.[19] Although there may be a different pattern for Black males (to be discussed below), the correlations follow the same pattern for Whites and for Black females. They are positive and strongest between adjacent survey years, declining regularly with distance between years as in an autoregressive time-series model. Net of the effects of stable characteristics in X, a high expectation in one time period is more likely to be followed by a high expectation in the next period and then by a slightly less high expectation in the following period.

Model interpretation. The common estimated pattern of correlations between residualized expectations suggests two related interpretations:

1. The positive correlations between net expectations at all years suggest that important component beliefs generate educational expectations that are not contained within the variables in X suggested by status socialization theory.
2. The autoregressive structure of the correlations is consistent with the existence of an underlying dynamic causal process relating expectations to each other across time. A speculative interpretation of this pattern suggests the following line of reasoning. Initially incorrect component beliefs unaccounted for by X persist from time period

TABLE 6: Estimated Correlations Between Error Terms From Panel Data Models of Educational Expectations in 1980, 1982, 1984, and 1986

	Males				*Females*			
	e_{1980}	e_{1982}	e_{1984}	e_{1986}	e_{1980}	e_{1982}	e_{1984}	e_{1986}
Whites	–				–			
	.277	–			.240	–		
	(.029)				(.047)			
	.281	.389	–		.146	.359	–	
	(.037)	(.032)			(.022)	(.037)		
	.225	.382	.579	–	.118	.340	.585	–
	(.032)	(.033)	(.038)		(.022)	(.038)	(.048)	
Blacks	–				–			
	.024	–			.306	–		
	(.057)				(.062)			
	.102	.207	–		.243	.342	–	
	(.070)	(.075)			(.055)	(.066)		
	.074	.057	.452	–	.256	.325	.490	–
	(.073)	(.079)	(.097)		(.064)	(.079)	(.065)	

SOURCE: High School & Beyond Sophomore Cohort data (1980 through 1992 follow-up).
NOTE: Data are weighted by the fourth follow-up panel weight (panel5wt). Numbers of respondents are 2,444 for White males, 2,860 for White females, 350 for Black males, and 539 for Black females. Information considered available in 1980 and specified as *X* for all models: socioeconomic status, family structure, sophomore year test scores, and significant others' influence. The predictive probability of being in the analysis sample is included as an independent variable in all models. Bootstrapped standard errors in parentheses.

> to time period before being corrected by the arrival of a sufficient amount of correct information. These new corrected beliefs grow in relative importance to beliefs predicted by X, such that the correlations between net expectations increase in time. Under an additional assumption that incorrect component beliefs have effects on concurrent preparatory commitment decisions relevant to different courses of educational attainment, this dynamic relation of time-specific expectations to each other could then be considered evidence that dynamic expectation formation is a causal process that partly determines final levels of educational attainment.

Is this interpretation equally applicable to the expectations of Black males? As shown in the lower left panel of Table 6, there may be some evidence of a different pattern. The point estimates of the correlation coefficients are in general smaller, and the estimate of the net correlation between expectations in 1980 and 1982 is too small to conform to an overall claim of an autoregressive structure. But these estimates are quite imprecise, as indicated by the bootstrapped standard errors in parentheses. It may simply be too much to ask only 350 cases, in contrast to 539 cases for Black females, to clearly reveal the error structure of net educational expectations. Nonetheless, if a larger sample size revealed the same sort of pattern, it would be necessary to amend the interpretation above for Black males, indicating that the omitted variables that account for the variation in the expectations of Blacks are less correlated across time and implying that there is less scope for expectations being interpreted as dynamically causal and more scope for expectations being regarded as either best-possible forecasts or unpredictable fantasies.

Model assessment. The panel data models of this section are useful because they provide a way to examine whether omitted variables may be important by modeling gross correlations between them across time. The main threat to the substantive claim that they reveal an important dynamic causal process is that the omitted variables correlated across time are merely features of measurement or model misspecification. Although a genuine threat, I regard this possibility as yet further motivation for investment of research resources in understanding how students respond to the typical survey instruments employed and, by direct implication, how students form the beliefs they would report under flawless measurement conditions.

If the correlations are not produced by trivial measurement errors, the panel data models point toward the need for addressing a fundamental question: Does the persistence of incorrect beliefs generate a trajectory of college preparatory commitment decisions that renders educational expectations, as carriers of all such underlying component beliefs, self-fulfilling prophecies? This is the important question that the research agenda I outline below is designed to address. First, however, I summarize in the next section four alternative main conclusions based on distinct combinations of the interpretations offered above for each of the five models.

CONCLUSIONS

In this article, I offer five models to investigate a classic unresolved question in the status attainment literature: Why is the estimated effect of expectations on attainment stronger for Whites than for

Blacks? Each model generates its own set of interpretations, and in this section, I categorize these interpretations into four main candidate conclusions.

Conclusion 1. Educational expectations cause educational attainment, and the effect of expectations on attainment is larger for Whites than for Blacks (see interpretations 1, 2, and 3 of Model 1 and the discussion of interpretation 3 of Model 2). This conclusion implies that students' beliefs matter more for Whites than for Blacks. The crucial assumption driving this conclusion is the claim that even if all relevant omitted variables were observed and properly specified, the path model estimates of the effect of expectations on attainment would not only remain positive for all groups but also remain larger for Whites than for Blacks.

Conclusion 2. Educational expectations cause educational attainment, but the effect of expectations on attainment does not vary by race (see interpretation 4 of Model 1; the critique of interpretations 1, 2, and 3 of Model 1; interpretations 1, 2, and 3 of Model 2; and interpretation 2 of Model 3). This conclusion implies that beliefs do not matter more for Whites than for Blacks. Rather, the path model estimates simply suggest that there are additional belief-based effects for Blacks that operate outside of traditional status socialization models.

Conclusion 3. Educational expectations do not cause educational attainment for any group of students (see Model 3). This conclusion implies that there is no evidence that the importance of beliefs varies by race and, strictly speaking, no evidence that students' beliefs matter for any group of students.

Conclusion 4. Because there is no evidence that expectations are universally non causal, best-possible forecasts and yet some evidence that expectations are serially correlated across time in a way consistent with an underlying dynamic causal process, the educational expectations of some students may be based on relatively stable incorrect component beliefs about structural constraints (see interpretations 1 and 2a of Model 4 and interpretations 1 and 2 of Model 5). And because educational expectations may be systematically incorrect, educational expectations may be self-fulfilling prophecies that compel students to pursue courses of behavior they would have rejected as possible if their educational expectations had been based on component beliefs that were absolutely correct. This conclusion suggests that students' beliefs are neither perfectly noncausal nor inconsistent with a causal claim and hence at least indirectly supportive of the assertion that students' beliefs do matter for at least some students.

One could easily envision an article that promotes only one of these four sets of candidate conclusions, derived after the presentation of a subset of the models reported in this article. In contrast, I have placed models based on established assumptions about temporal causal order, no omitted variables, and constant coefficients in a broader framework that includes models based on other debatable assumptions. Accordingly, I have developed a set of alternative conclusions, none of which can be rejected out of hand. Only with such an approach can we gain enough perspective on both the empirical evidence and the assumptions that generate the empirical evidence to understand when one conclusion should be privileged over another.

Which of the candidate conclusions am I prepared to endorse? None of them. Because Conclusion 3 cannot be dismissed, at this stage of research, adherence to Conclusion 1 seems untenable even though it is the favorite explanation in the existing literature (e.g., see Hanson 1994). However, because the test of the best-possible forecast conjecture combined with the results from the panel data model cast enough doubt on the wisdom of strictly adhering to Conclusion 3, and because the average effect interpretation of the instrumental variable estimates is at least as compelling as the path model interpretation, Conclusions 2 and 4 may have relatively more merit.

If forced to assert a working set of conclusions that can be stipulated to justify further research on students' beliefs, I would offer the following: On balance, the evidence indicates that students' beliefs do matter, but there is no evidence that beliefs matter more for Whites than for Blacks. As a result, there is no evidence that the Wisconsin model is fundamentally flawed and can be outperformed by a structural model that does not explicitly model students' own beliefs. Rather, race differences in the path model estimates simply indicate that important belief-based effects operate independently of the significant others' influence mechanism on which the Wisconsin model is primarily based. Thus, belief-based effects must be more generally modeled to determine whether Conclusions 2 and 4 have genuine merit or, rather, whether Conclusion 3 will ultimately prevail.

DISCUSSION

In mature areas of study such as the sociology of education, modeling assumptions can become deeply entrenched through widespread use; in the process, the range of findings deemed methodologically acceptable can become artificially narrowed. A corresponding complacency with the power (or lack thereof) of available data then emerges, and research focuses ever more narrowly on simply developing the best descriptive fit to the available data, often by generating simple narrative stories to account for subgroup differences within the population initially investigated. The multimodel approach I adopt in this article allows for an examination of these assumptions and hence for a reexamination of the fundamental grounding of established research findings in the literature.

Many sociological models of educational attainment are based on belief-based mechanisms, not just the Wisconsin model and its status attainment variants. For example, Bourdieu (1973:83) rejects status attainment explanations as functionalist ideology and instead argues that educational attainment should be modeled at the aggregate social class level as an "anticipation, based upon the unconscious estimation of the objective probabilities of success." Bourdieu then folds these class-determined beliefs into the dispositions he labels the *habitus*. Likewise, Willis (1977:172), in his study of why an oppositional culture emerges for only some working-class youths, appeals for a related but individual-level framework that "gives the social agents involved some meaningful scope for viewing, inhabiting and constructing their own world" based on their own observations of adult working-class culture and typical institutional trajectories into it. Finally, and most recently, Wilson (1995:535) has drawn on theories of perceived self-efficacy to argue that "self-beliefs in one's ability to take the steps or courses of action necessary to achieve the goals required in a given situation" are a function of the influence of others and of self-identification with reference groups who are differentially attached to established trajectories through the educational system and into the labor force.

Nonetheless, despite this widespread recognition that students' beliefs may be important, we have not devoted enough explicit attention to theoretical mechanisms of belief formation that yield new methods for measuring the impact of beliefs on subsequent action.

To make further progress in modeling educational attainment, new models of belief formation mechanisms need to be constructed. These models must also specify what sort of data must be collected to evaluate them. And to realize such evaluations, new methods for belief elicitation must be developed.

The two main categories of beliefs we should first model are expectations about opportunities and constraints and forecasts of one's own subjective probability of achieving successful outcomes in goal-directed behavior. The first category includes beliefs about tuition costs of postsecondary education, the availability of financial aid, the labor market returns to different levels of educational attainment, and forecasts of short-term fluctuations in the demand for differentially educated labor. The second category includes subjective personal probabilities of securing employment given alternative levels of educational attainment, subjective probabilities of scoring well on college entrance exams not yet taken, and subjective probabilities of graduating from postsecondary courses of instruction if initially enrolled. Certainly, other types of beliefs are worthy of attention, but this list is a starting point and should allow us to better examine the vexing race differences highlighted in this article.

Elaborating models for the formation of these beliefs will surely present challenges. And although a wide variety of perspectives may yield insight, including attempts to decompose Bourdieu's (1973) notion of habitus, demonstrable progress will most likely emerge from attempts to determine whether adolescents and their significant others can be modeled as Bayesian probabilists (e.g., as in Breen 1999) and, if not, what revisions to the decision-theoretic framework must be adopted to enable similarly explicit modeling. It would seem obvious that a bounded rationality approach to belief formation and belief revision may have much to offer, grounded on empirical examination of the distribution of easily accessible information and the costs of analyzing accessible information and acquiring better information (see Morgan 2002).

For evaluation and eventual calibration of belief formation and belief revision mechanisms, new forms of data collection must be developed. Two methods should be mounted: scenario-based questioning and graphical belief elicitation.

Although there are qualitatively oriented studies of students' beliefs about their futures, none of these studies seems to ask students to evaluate the permissibility of a standardized series of hypothetical scenarios, either for themselves or for abstracted sets of actors. In sociology, vignettes have been used to effectively elicit status judgments and equity beliefs of adults (e.g., Jasso and Rossi 1977; Nock and Rossi 1978). In studies of decision making, similar scenario-based questioning has yielded considerable insight into how practitioners arrange and revise relevant information (see Bell, Raiffa, and Tversky 1988, chaps. 26-29). Especially since Manski (1999) has developed a formal framework for assessing variation in responses to alternative scenarios, these techniques should be applied to a sample of adolescents. For the question investigated in this article, it would, for example, be illuminating to know whether Black adolescents are more or less likely than White adolescents with similar characteristics to indicate that a hypothesized unprepared and underfinanced high school student will make a mistake if he or she enrolls in a four-year college.[20]

A more demanding set of data collection techniques must also be attempted: graphical belief elicitation. In Bayesian statistics, in which the specification of a prior distribution of a parameter is necessary to compute a posterior distribution for subsequent inference, a literature exists on alternative methods to elicit the subjective probability distributions of nonstatisticians (see Kadane and Wolfson 1998; O'Hagan 1998). There are well-developed and extensively tested computer packages available that pose sets of questions to actors as predictive exercises that are supplemented by graphical feedback. In the social sciences, the preliminary successes of Dominitz (1998) and Dominitz and Manski (1996, 1997) in eliciting nonexperts' probability distributions are encouraging, especially since these studies use relatively demanding elicitation algorithms, closer to what Bayesian statisticians define as structural elicitation. Fortunately, as survey methodology moves further toward computer-assisted data collection techniques, graphical belief elicitation is increasingly feasible.

With new measures of beliefs, all five models presented in this article can be used to evaluate the consequences of differences in beliefs on subsequent educational attainment. For example, beliefs can be specified as instruments (as in Z in Figure 1) and then used to estimate new average effect instrumental variable models. Moreover, they can be specified as time-varying pieces of information on which expectations are based in more sophisticated versions of the panel data models offered above. With such augmented models, we may finally be able to determine how best to incorporate structural dynamics into models of the educational attainment process as structure that is rigidly imposed by inflexible constraints on actual behavior, as structure that determines action through individual forecasts of perceived structural constraints, or more likely both.

APPENDIX

No-assumptions bound for the average causal effect. $\bar{A}^{\text{ea}}_{i\notin \text{E}}$ and $\bar{A}^{\text{ef}}_{i\in \text{E}}$ are bounded on both sides by 0 and 1. The no-assumptions lower bound on the average causal effect is derived by substituting for $\bar{A}^{\text{ea}}_{i\notin \text{E}}$ and $\bar{A}^{\text{ef}}_{i\in \text{E}}$ the values of 0 and 1, respectively, into the definition of the average causal effect on the right-hand side of equation (3):

$$[\pi \bar{A}^{\text{ea}}_{i\in \text{E}} + (1-\pi)\{0\}] - [\pi\{1\} + (1-\pi)\bar{A}^{\text{ef}}_{i\notin \text{E}}] \leq \bar{\delta}. \qquad \text{(A1)}$$

The upper bound is derived by substitutions of 1 and 0, respectively:

$$\bar{\delta} \leq [\pi \bar{A}^{\text{ea}}_{i\in \text{E}} + (1-\pi)\{1\}] - [\pi\{0\} + (1-\pi)\bar{A}^{\text{ef}}_{i\notin \text{E}}]. \qquad \text{(A2)}$$

Combining and simplifying equations (A1) and (A2) yields the following no-assumptions bound:

$$\begin{aligned} &\pi \bar{A}^{\text{ea}}_{i\in \text{E}} - (1-\pi)\bar{A}^{\text{ef}}_{i\notin \text{E}} - \pi \\ &\quad \leq \bar{\delta} \leq \pi \bar{A}^{\text{ea}}_{i\in \text{E}} - (1-\pi)\bar{A}^{\text{ef}}_{i\notin \text{E}} + (1-\pi). \end{aligned} \qquad \text{(A3)}$$

With dichotomous potential outcomes, the bound is, by definition, of width 1 because the lower bound and the upper bound differ only by two complementary probabilities, $-\pi$ and $1-\pi$.

Bound for the average causal effect assuming monotone causal response. Monotone causal response is an assumption about individual-level potential outcomes. In this context, the assumption is that for every individual i, $A^{\text{ea}}_i \leq A^{\text{ef}}_i$, which is tantamount to assuming that the individual-level causal effect in equation (1) can take on values of 0 or 1 but not –1. This monotone response assumption tightens only the no-assumptions lower bound, and it does so by requiring the substitution of observable population-level means instead of the more extreme values of 0 and 1 in equation (A1):

$$[\pi \bar{A}^{\text{ea}}_{i\in \text{E}} + (1-\pi)\{\bar{A}^{\text{ef}}_{i\notin \text{E}}\}] - [\pi\{\bar{A}^{\text{ea}}_{i\in \text{E}}\} + (1-\pi)\bar{A}^{\text{ef}}_{i\notin \text{E}}] \leq \bar{\delta}. \qquad \text{(A4)}$$

Combining this tighter lower bound with the unaltered upper bound in equation (A2) and then simplifying yields the following bound:

$$0 \leq \bar{\delta} \leq \pi \bar{A}^{\text{ea}}_{i \in \text{E}} - (1 - \pi)\bar{A}^{\text{ef}}_{i \notin \text{E}} + (1 - \pi). \tag{A5}$$

Bound for the average causal effect assuming monotone causal response and monotone causal selection. Monotone causal selection is a population-level assumption about cross-individual patterns of expectation formation and attainment propensity. In this context, the assumption entails two cross-group inequalities: $\bar{A}^{\text{ea}}_{i \in \text{E}} \leq \bar{A}^{\text{ea}}_{i \notin \text{E}}$ and $\bar{A}^{\text{ef}}_{i \notin \text{E}} \leq \bar{A}^{\text{ef}}_{i \notin \text{E}}$. This monotone causal selection assumption only tightens the no-assumptions upper bound, and it does so by requiring the substitution of observable population-level means instead of the more extreme values of 1 and 0 in equation (A2):

$$\bar{\delta} \leq [\pi \bar{A}^{\text{ea}}_{i \in \text{E}} + (1 - \pi)\{\bar{A}^{\text{ea}}_{i \in \text{E}}\}] - [\pi\{\bar{A}^{\text{ef}}_{i \notin \text{E}}\} + (1 - \pi)\bar{A}^{\text{ef}}_{i \notin \text{E}}]. \tag{A6}$$

Simplifying equation (A6) and combining it with equation (A5) results in the joint bound for the average causal effect, assuming both monotone causal response and monotone causal selection:

$$0 \leq \bar{\delta} \leq \bar{A}^{\text{ea}}_{i \in \text{E}} - \bar{A}^{\text{ef}}_{i \notin \text{E}}. \tag{A7}$$

Derivation for the bounds on the expectations and attainment relationship implied by a rational expectations assumption. Let the set of all information that determines attainment and that can be known at the time expectations are formed be I. Elements of I may include, for example, the main independent variables of status socialization theory—socioeconomic status, ability, and significant others' influence—and structural variables such as the cost and availability of college education. Similarly, let U be the set of unavailable information that determines attainment but that will be revealed after expectations are formed and before attainment is determined. In this context, the elements of U include pieces of information that are contingent on events that have not yet occurred by the time expectations are formed, such as scores on standardized college entrance exams not yet taken. Because I and U mutually exhaust all information that determines attainment, the function $A(I, U)$ completely characterizes attainment.[21]

Similar to Manski (1990), if we let $\Pr_U|I$ denote the true objective probability distribution of U conditional on discrete combinations of elements in I, the educational attainment probability for all individuals subject to the same set of information $\Pr(A = 1|I)$ can be given the explicit expression $\Pr_U(A = 1|I)$. With this notation, individuals can then be said to have rational educational expectations if the two following necessary conditions are satisfied: (a) Individuals know the information in I and the exact function $A(I, .)$ that relates attainment to all known information in I and all knowable information in U that will be realized in the future, and (b) individuals know the exact probability distribution of all relevant future events and therefore the probability distribution of all unknown future information, $\Pr_U|I$.

When individuals have rational expectations, they can form $\Pr_U(A = 1|I)$ and therefore, by definition, know their true value for $\Pr(A = 1)$. Accordingly, when confronted with the question, "Do you expect to graduate from college?" they set their latent probabilistic expectation equal to this value and compare it to a threshold τ. If their value for $\Pr(A = 1)$ is greater than τ, then they set E equal to 1.

Manski (1990) shows that even if an outside observer can only observe a subset of I labeled X, in a best-case scenario in which there are no aggregate shocks (see Note 21) and students think hard enough in the survey administration context to provide the best-possible estimate they are cognitively able to provide, a rational expectations assumption can give a bound for the conditional probability $\Pr(A = 1|X, E)$. The crucial idea is this: If expectations conform to a rational expectations assumption, then E is a function of all of the relevant information in I and U that determines attainment but that is not contained in the information X that a researcher observes. In other words, expectations function as an omnibus proxy for consequential pieces of information that determine attainment but that are unobserved by the researcher.

More formally, if $\Pr_I|X, E$ is the probability distribution of I conditional on the researcher's observed information X and the respondent-reported rational expectation E, then

$$\begin{aligned} &\int \Pr_U[A(I, U) = 1|I]\, d\Pr_I|X, E \\ &= \int \Pr(A = 1|I)\, d\Pr_I|X, E \\ &= \Pr(A = 1|X, E), \end{aligned} \tag{A8}$$

by the definition of $\Pr(A = 1|I)$ and the law of iterated expectations. Together with the threshold response assumptions stated above, equation (A8) implies the following bound:

$$\Pr(A = 1|X, E = 0) \leq \tau \leq \Pr(A = 1|X, E = 1), \tag{A9}$$

which, in the counterfactual notation adopted in the main text, can be written

$$\bar{A}^{\text{ef}}_{i \notin \text{E}} \leq \tau \leq \bar{A}^{\text{ea}}_{i \in \text{E}}. \tag{A9a}$$

NOTES

1. Multimodel research is not, however, a mere hypothesis evaluation regime. Rigorous assessment of the plausibility of alternative theoretical explanations stimulates the sociological imagination, and as a result, multimodel research also has the potential to generate new hypotheses and research agendas.

2. For example, Cameron and Heckman (1999:85) write, "Children who grow up in inferior environments may expect less of themselves and may not fully develop their academic potential because they see little hope for ever being able to complete college or use their schooling in any effective way."

3. These unrecognized constraints are both retrospective and prospective.

4. This view of the labor market, though perhaps grounded in a slowly shifting cultural orientation, is nonetheless an incorrect belief about race-specific rates of return to education. Since the 1970s, the racial gap in earnings has been larger among high school graduates.

5. Moreover, if there is relatively more random measurement error in family background reports for Blacks, and if measurement error in expectations is invariant by race, then the estimates of the effects of expectations for Whites are attenuated relatively to those of Blacks.

6. Indeed, this last possibility is consistent with the results of Portes and Wilson (1976), especially if one considers the additional variable they include, self-esteem, to be a (rather indirect) proxy for the omitted variables highlighted in the main text. The general line of reasoning followed here is emphasized in a number of methodological pieces (e.g., Berk 1988; Clogg and Haritou 1997), but it has recently found a particularly simple expression in the do(.) function of Pearl (2000).

7. There is an econometric literature that clarifies the nature of this assumption (see Manski 1995, chap. 7).

8. I rely on this coding for three reasons. First, it is now generally recognized that years of education do not form a wholly satisfactory metric, as a unit difference of 16 years instead of 15 years is likely more consequential for most outcomes than an equivalent unit difference of 14 years instead of 13 years. Second, the acquisition of a bachelor's degree is, I assume, how high students evaluate the decision of whether to go on to college after high school, which is still the educational transition of greatest analytic interest. Thus, I assume that forward-looking beliefs about the acquisition of variations in 12 versus 14 years or 16 versus 20 years of education are of less interest. Third, confining analytic treatment to a single binary outcome eases the presentation of the counter-factual framework and is also

more consistent with the coding of college plans in both of the most important Wisconsin model articles (Sewell, Haller, and Portes 1969; Hauser, Tsai, and Sewell 1983). The counterfactual framework is of course applicable to nondichotomous variables as well (e.g., Manski 1997).

9. Winship and Morgan (1999) provide a review of the relevant foundational literature on counterfactual causality, and, as is especially relevant for this application, Sobel (1998) offers a didactic application of the framework in a reinterpretation of status attainment research.

10. Because of the obvious terminological confusion between educational expectations and the expectation operator from probability theory, I will use *population average* and *population mean* when, in other contexts, one might prefer to use the term expectation from probability theory.

11. The average effect estimates could be more directly related to the path model estimates by further stratifying the sample based on additional Wisconsin model variables in *X* and then averaging over strata in proportion to the distribution of cases across the strata.

12. As the method of bounds was only recently formalized, there is no generally accepted procedure to estimate bootstrapped bounds. I used STATA to draw (with replacement) 1,000 replicated samples of size *N* and then calculated bootstrapped distributions of the upper and lower bounds using these 1,000 samples from which standard errors can be calculated. The bootstrapped bounds reported in parentheses are the upper/lower end of a 95 percent confidence interval for the upper/lower bound.

13. For other binary codings of educational expectations, monotone causal response may be less defendable. For at least some students, increases in one's expectation from "obtain a B.A." to "obtain a Ph.D." may actually decrease the probability of graduating from college if frustration emerges.

14. Assuming that *e* in Figure 1 is equal to different extreme values and then estimating an overidentified structural equations model is analogous to this analysis of bounds.

15. See Sheffrin (1996) for an introduction to rational expectations assumptions in economics.

16. For a sample of students, half of whom have rational latent expectations of .49 and half of whom have rational latent expectations of .51, if the threshold is .5 and there are no intervening aggregate shocks, the product moment correlation between *E* and *A* would be only .02.

17. These conclusions are based on theoretical bounds that ignore sampling error. Bootstrapping the conditional means (analogous to what was executed for Table 5) would change the conclusions only slightly, suggesting that it may be the case that in the senior year, White males without a parent with a college degree have rational expectations, and in the sophomore year, Black females with a parent with a college degree have rational expectations (i.e., the upper end of the 95 percent bootstrapped confidence interval for the graduation rate among those who expect to graduate is .555 and .544, respectively, instead of the theoretical values of .495 and .343).

18. It is an interesting question whether wishful thinking can be thought of as lowering the response threshold to protect oneself from the negative self-evaluation one might generate by underestimating one's future potential.

19. Analogous models for expectations reported in 1982, 1984, and 1986, which use all information available by the senior year (including additional test score and updated significant others' influence), yield the same autoregressive error structure, although the correlations are about 60 to 80 percent the size of those for the models reported in Table 6. Moreover, including as ex post information in *X* a variable for educational attainment also yields the same autoregressive structure, although the correlations are between about 50 and 97 percent of the size of analogous correlations from models without attainment in *X*.

20. Rouse (2002) provides additional evidence that such beliefs can be elicited from low-income, minority students.

21. Attainment is a function of more than just available information I and individually contingent unavailable information in U. Attainment is also a function of aggregate shocks, implicitly embedded in U but that can be denoted separately by S. These shocks might include shifts in the market-level benefits of college education, changes in college costs, or exogenous events such as an intervening military draft in response to the outbreak of war. Accordingly, even though attainment is a function only of I and U, it is sometimes useful to more completely specify attainment as $A(I, U \notin S, S)$.

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