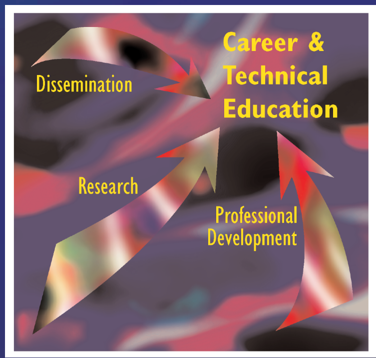

Dropping Out of High School and the Place of Career and Technical Education:

A Survival Analysis of Surviving High School

CTE

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DROPPING OUT OF HIGH SCHOOL AND THE PLACE OF CAREER AND TECHNICAL EDUCATION:

A SURVIVAL ANALYSIS OF SURVIVING HIGH SCHOOL

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TABLE OF CONTENTS

List of Figures

List of Tables

ABSTRACT

Data from the *National Longitudinal Survey of Youth 1997* are used to examine the association between the CTE-to-academic-coursetaking ratio and the likelihood of dropping out. Descriptive statistics are presented for 1,628 individuals born in 1980. Transcript and survey data are then used in estimating nonproportional hazards models with time-varying covariates for a subsample of 846 youth. The research found a highly significant curvilinear effect of the coursetaking ratio on the likelihood of dropping out for youth who were less than 15 years old upon entering 9th grade. For them, a CTE:academic course ratio of 1:2 was beneficial. For youth who were 15 or older upon high school entry, factors other than coursetaking predicted their high rates of dropping out.

DROPPING OUT OF HIGH SCHOOL AND THE PLACE OF CAREER AND TECHNICAL EDUCATION:

A SURVIVAL ANALYSIS OF SURVIVING HIGH SCHOOL

The high school curriculum can be viewed as a socially structured set of opportunities and constraints. An individual course may represent an opportunity for inspired learning, establishing or strengthening social contacts, boredom, discouragement, or many other outcomes. Beyond an individual class, the combination of all courses taken throughout an entire high school career define, to a considerable degree, a student's place within a fuller landscape of opportunities—and constraints.

In order to gain some understanding of students' curricular experiences, we focus on the balance struck between career and technical education (CTE) and core academic courses. Using the National Longitudinal Survey of Youth 1997, we find students combining CTE and academic courses in many ratios and qualitative patterns. As such, we do not limit ourselves to notions of a purely academic (or college prep) curriculum, as contrasted with a strictly CTE (or vocational) curriculum. Rather, we examine curricular exposure and outcomes for students at many points along a continuum of CTE and academic coursetaking.

Our primary aim is to examine dropping out of high school and any association it might have with CTE coursetaking. Guided by prior research, we view dropping out as being, most often, a culminating event in a process of disengagement from education (Alexander, Entwisle, & Kabbani, 2001; Finn, 1989). To acknowledge that dropping out is a process, it is important to account for the experiences, achievements, and traits an individual brings to the first day of high school. In turn, it is important to examine high school experiences, including curricular exposure and achievement, as they unfold over time.

Guided by these priorities, we present hazards (or survival, or event history) models of high school dropout events. Hazards models come from a family of statistical models that are useful for describing the timing of life course events and for building statistical models of the risk of an event's occurrence over time (Willett & Singer, 1991). By examining individuals' coursetaking patterns along with other relevant factors, we hope to gain insight into processes of engagement and disengagement from formal schooling. We aspire to add to the body of knowledge about the push and pull factors existing in and around high schools. We make a case for understanding curricular offerings and experiences as being parts of socially patterned and institutionalized structures leading to engagement for some adolescents and disengagement for others.

Career and Technical Education

Career and technical education has evolved from what has traditionally been called vocational education. Whether this evolution has been dramatic or relatively minor is open to debate (DeLuca, Plank, & Estacion, 2005; Stone, 2000). Historically most vocational education programs were designed to prepare students for work and help them enter the workforce shortly after high school. During the past 10 or 15 years, there have been efforts to enhance and modify vocational education programs so that they not only prepare students for jobs but also increase educational attainment—both by raising students' probability of completing high school and by increasing the number of students entering and completing postsecondary programs.

Recent federal legislation, as well as the professional association dedicated to CTE, present a vision of CTE that involves not only the development of practical skills needed in the workplace, but also an integration of CTE and academic subjects, an erasure of the stigma often attached to vocational education, and pathways to both postsecondary education and employment (Castellano, Stringfield, & Stone, 2003; Lynch, 2000). Stone (2000) describes an ideal for CTE by which students are prepared for the contemporary workplace through three nonexclusive approaches: (a) education that uses work as a context for developing broader general skills, (b) education that uses work as a context for developing more widely recognized skills required for long-term occupational and career success, and (c) education that uses work as a context for developing occupationally specific skills. These three approaches can be referred to as education through work, education about work, and education for work.

Formal high school courses typically categorized as career and technical education include (1) family and consumer sciences, (2) general labor market preparation, and (3) various courses in 10 specific labor market preparation (SLMP) areas (National Center for Education Statistics, 1999). Family and consumer sciences courses would include (among many) the following specific titles: (a) home economics, (b) child development, (c) foods and nutrition, and (d) family relations. General labor market preparation courses would include the following titles: (a) basic keyboarding, (b) exploratory industrial arts, (c) college and career planning, and (d) introduction to technology.

The 10 SLMP areas are

- agriculture and renewable resources
- business
- marketing and distribution
- health care
- public and protective services
- trade and industry
- technology and communications
- personal and other services
- food service and hospitality
- child care and education

SLMP courses are a combination of classroom-based learning experiences, cooperative education, and other workplace learning.

While not every United States high school offers courses across the full range of CTE, most schools offer some CTE courses (National Center for Educational Statistics, 2001). Furthermore, the great majority of high school students take some CTE. In recent years, between 90 and 96% of United States high school graduates have taken at least one CTE course during high school (DeLuca, Plank, & Estacion, 2005; Levesque, Lauen, Teitelbaum, Alt, & Liebrera, 2000). The average number of Carnegie units earned in CTE among graduates in the year 2000 was 3.8 (National Center for Educational Statistics, 2004).

CTE is not without its critics, and its place within the American high school is not especially secure. Recent federal budget debates, taking place at a time when increased emphasis is being placed on testing and core academic areas, have questioned the effectiveness and merit of CTE (Cavanagh, 2005). Proponents, however, view CTE as an important part of the high school environment and a valuable source of attachment, motivation, and learning for some students (Arum, 1998, 2003; Castellano, Stringfield, & Stone, 2003). Before discussing potential links between CTE and the likelihood of dropout events, we first turn to a more general summary of research and issues that surround dropping out of high school.

Research on Dropping Out

The phenomenon of students dropping out of high school is a matter of great concern and has received considerable research attention (e.g., Fine, 1991; Finn, 1989; Orfield, 2004). The reasons for dropping out involve a web of sociological, psychological, economic, and institutional factors. The consequences of dropping out are dramatic and costly—both for individuals and for society.

Rumberger (2001) reports that, despite a long-term upward trend in high school completion in the United States, approximately 5% of all high school students drop out of school in any given year.[1] Furthermore, a substantially higher proportion of students leave school for a significant span of time sometime during the educational career before receiving a high school credential. Klerman and Karoly (1994) estimated that 37% of a national sample of young men who were 14 to 21 years of age in 1979 quit high school for at least a 3-month period sometime before high school completion. Rumberger and Lamb (1998) reported that 21% of students from the NELS:88 cohort dropped out of school at some point after eighth grade but before high school completion. In both studies, many of those with spells of dropping out ultimately returned to complete a high school credential. Often, however, they earned a GED rather than a traditional diploma. And, as past research has shown and the present analysis reiterates, any time away from high school increases the risk of never completing that level of schooling.

The consequences or negative outcomes associated with dropping out of high school include a higher rate of unemployment, a greater likelihood of living below the poverty line and relying on public assistance, more frequent and severe health problems, and increased criminal activity (Educational Testing Service, 1995; McDill, Natriello, & Pallas, 1986; Mishel & Bernstein, 1994; National Research Council, 1993; Rumberger, 1987; U.S. Department of Education, 1999). As the economy of the United States demands a higher skilled labor force year by year, individuals without a high school credential will find it increasingly difficult to thrive or survive economically. Further, failure to complete high school virtually precludes attendance at institutions of higher learning, so that avenue toward higher social and economic status and mobility is blocked for the high school dropout.

Research into the causes of dropping out, as well as the search for practical solutions to reduce the dropout rate, have focused on both individual and institutional factors. Further, they have focused on both *push* and *pull* factors. Finn (1989) offered two social–psychological perspectives.

[1] This number (“approximately 5%”) follows from the event dropout rate calculation employed by the National Center for Education Statistics as described in Kaufman, Kwon, Klein, and Chapman (1999). See also Kaufman, Alt, and Chapman (2004). The event dropout rate for a given year is the proportion of youth ages 15–24 who were enrolled in high school in one October but who had left high school without successfully completing a high school program (whether traditional diploma, GED, or other credential) by the next October. For discussions of alternative ways to calculate dropout rates and/or high school completion rates, see Swanson and Chaplin (2003), Balfanz and Legters (2004), and Miao and Haney (2004).

Following a *frustration–self-esteem* model, Finn posited that a record of poor performance would cause students to question their competence and weaken their attachment to school; at the extreme, this process can lead to the ultimate disengagement—dropping out. Under a *participation–identification* model, it is posited that positive experiences encourage a sense of belonging and thus strengthen attachment to school. Alexander, et al. (2001) have noted that these two parallel models or images ultimately imply the same conclusion, at least at a certain level of abstraction. They write, "Affective detachment from school is the immediate impetus to dropout, but whether children's school attachment is strong or weak develops over time as a result of their cumulative experience there: Are they fitting in comfortably and realizing success or are they struggling and not measuring up academically?" (p. 763).

Rumberger (2004) finds it useful to draw upon both individual and institutional perspectives to understand decisions to quit school. The individual perspective focuses on a students' values, attitudes, and behaviors, and considers dropping out of school to be the final stage in a dynamic and cumulative process of disengagement from school—both academic and social disengagement (see also Newmann, Wehlage, & Lamborn, 1992; Wehlage, Rutter, Smith, Lesko, & Fernandez, 1989). Rumberger's institutional perspective situates individual attitudes and behaviors within the broader settings or contexts in which students live—most notably families, schools, and communities.

CTE and Possible Links to Dropping Out

If participation in career and technical education has some relationship to dropping out of high school, we need to understand the nature of this relationship better. Research in this area can have implications for our conceptual understanding of what helps students find attachment to high school. Additionally, research in this area could have policy or practical implications for secondary education, as decisions are made about where dollars should be invested and how curriculum should be organized.

Is CTE part of a persistent pattern of tracking and stratification within American high schools, whereby some students are inspired to develop increasingly strong attachments to schooling and to prepare themselves for postsecondary educational endeavors, while other students are gradually discouraged or disengaged from formal schooling? Or is there a model of CTE in the American high school that is markedly different from what vocational education might have been (or, at least, might have been perceived to have been) in past decades? Are some schools integrating core academic curricula with CTE in ways that motivate and inspire students? Can CTE be a source of greater attachment to school, higher rates of high school completion, and successful transitions to postsecondary education and/or satisfying careers?

The question of whether vocational, or career and technical, education can help prevent students from dropping out of high school has been posed by researchers periodically for several decades (e.g., Agodini & Deke, in press; Bishop, 1988; Catterall & Stern, 1986; Coombs & Cooley, 1968; Grasso & Shea, 1979; Mertens, Seitz, & Cox, 1982; Perlmutter, 1982; Pittman, 1991; Rasinski & Pedlow, 1998; Weber, 1988). Despite fairly frequent attempts to address the issue, a clear and consistent answer still has not emerged. Kulik (1998) provides a useful review of most of the relevant studies from the late 1960s until the early 1990s. After considering simple descriptive studies and also studies with experimental designs and/or statistical controls, he concluded that participation in vocational programs increased the likelihood that non-college-bound youth would complete high school. Specifically, he estimated that participation (as a dichotomous, yes–no proposition) decreased the dropout rate of such youngsters by about 6%. One important point made by Kulik is that the conclusions we draw about dropout likelihoods for vocational students depend greatly on how we identify these students. The various studies reviewed used a combination of student self-categorizations of curricular placement (as stated either early or late in high school) and official transcript records of coursetaking. Kulik concluded that transcript records of students' courses provide the best indicator of their contact with vocational education.

Despite Kulik's (1998) overall conclusion of a positive direct effect of vocational education on high school completion, some studies find no such effects (e.g., Agodini & Deke, in press; Pittman, 1991). There is a clear need for rigorous analyses of data that are rich in detail about the occurrence and timing of dropout events, as well as students' locations within the high school curriculum. There is also a need for clear thinking about why we might expect certain forms or admixtures of career and technical education (or vocational education) to reduce likelihoods of dropping out. A recent study by Bishop and Mane (2004) provides a succinct statement of one line of reasoning. Bishop and Mane quote a 2003 report of the Advisory Committee for the National Assessment of Vocational Education as follows:

> Career and technical education empowers students by providing a range of learning opportunities that serve different learning styles. CTE relies on a powerful mode of teaching and learning that cognitive scientists call "contextual" or "situated" learning, both in classrooms and in workplaces. For many students, applying academic and technical skills to real-world activities, using computers and other tools, and being able to see how their learning is related to the world of work make CTE classes more interesting and motivating, and more educationally powerful than standard academic classes. A career focus often gives students a sense of direction and motivates them to achieve and to stay in school. Practically inclined students can be hooked on academic learning through CTE study. . . . Just having the option of being able to concentrate in CTE in high school results in more young people staying in school because more individually relevant choices are available to them. (Advisory Committee for the National Assessment of Vocational Education, 2003, p. 2)

It would seem that the advisory committee's statement is an article of faith or belief as much as it is a summary of established knowledge based upon rigorous research. In any case, however, it is an accurate representation of an argument offered by many CTE advocates. When educators or commentators argue for the importance of CTE in the high school curriculum, they generally offer some combination of the following reasons for why CTE classes can reduce dropout rates: (a) students may find CTE classes more interesting than academic classes; (b) some students may be more likely to see the value of CTE classes than of academic classes in preparing them for careers of interest; (c) CTE classes can clarify the value of academic classes by specifying the skills needed to succeed in careers of interest, and thereby lead students to see a greater value associated with staying in school; and (d) CTE classes may encourage some students to define career goals, and thereby keep them more engaged in school.[2]

Four Competing Possibilities

For any academic term (i.e., semester, quarter, year), or for a high school career cumulatively, a student's ratio of CTE credits to core academic credits can be computed (assuming the number of academic credits is not zero).[3] Past research has found this coursetaking ratio to be a significant predictor of high school dropout rates, and also a convenient way to summarize a student's location

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[2] We thank an anonymous reviewer for helping us articulate these four arguments.

[3] Throughout this report, CTE courses and core academic courses are defined in the calculation of the curricular ratio as follows: CTE includes all courses in family and consumer sciences, general labor market preparation, and the specific labor market preparation (SLMP) areas; core academics include all courses in mathematics, science, English or language arts (though not foreign language), and social studies (including history).

within the high school curriculum in an era in which rigid track definitions (e.g., college-prep, purely vocational) do not always apply (Plank, 2001).

Figures 1 through 4 illustrate four competing hypotheses about the relationship between the CTE-to-academic-coursetaking ratio and the likelihood of dropping out.[4] Each of these figures is intended to display a possible relationship between the coursetaking ratio and the likelihood of dropping out once other relevant factors (i.e., prior test scores, high school grade point average, gender, race, socioeconomic status) have been controlled.

Figure 1 shows a positive linear relationship consistent with the assertion that higher levels of CTE are harmful. Critics of the vocational track in United States high schools might subscribe to this expectation, claiming that increased levels of CTE (or vocational) coursetaking represent a student being pushed toward the periphery of the high school's core mission and receiving uninspiring instruction and learning opportunities that raise the likelihood of that student deciding to leave school.

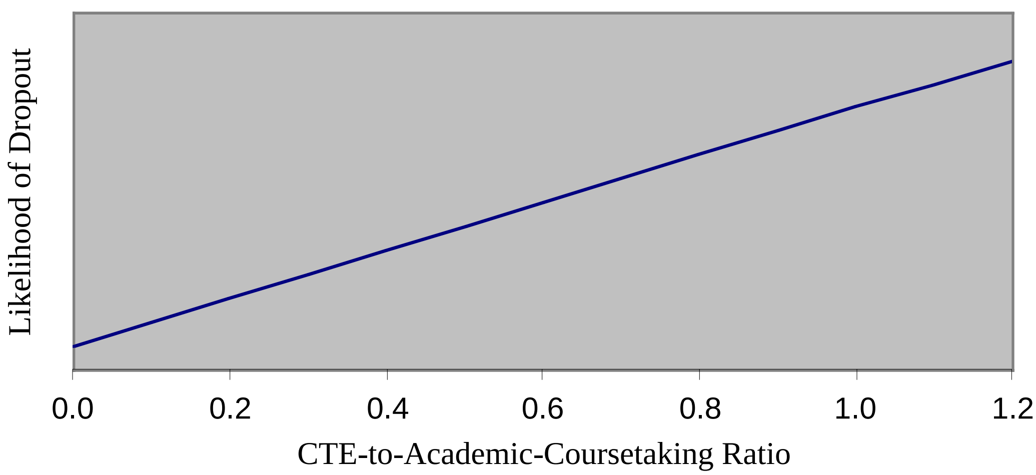

Figure 1. Hypothesis of positive linear association.

Figure 2 shows a negative linear relationship consistent with the expectation that higher levels of CTE are beneficial. This hypothesis is plausible if we imagine that some students attend high schools with few CTE offerings while other students attend high schools with considerably greater CTE offerings, and that in both types of high schools there are some students who would find CTE courses to be motivating and a source of attachment to school. Following the logic of the Advisory Committee for the National Assessment of Vocational Education (quoted earlier), the hypothesis is that just having the option of being able to concentrate in CTE in high school results in more young people staying in school because more individually relevant choices are available to them.

[4] The vertical axis in each figure is labeled *likelihood of dropping out*, but in practice this axis would measure log-odds or log-hazards.

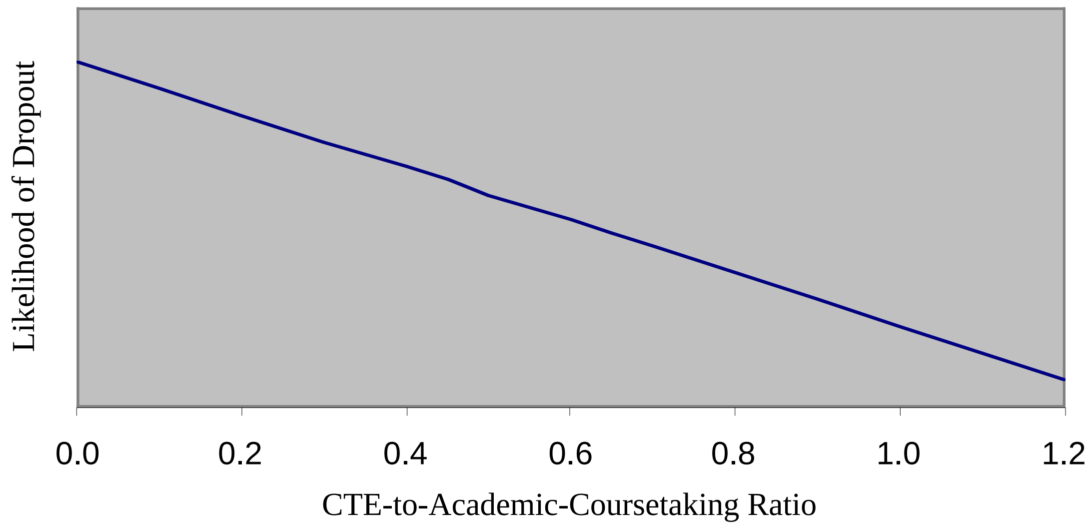

Figure 2. Hypothesis of negative linear association.

Figure 3 represents a hypothesis of *no effect*. This hypothesis is consistent with the idea that the substance of coursetaking itself has no independent effect on dropout likelihood. That is, it might be the case that the CTE-to-academic ratio has no significant independent effect on dropout likelihood once other relevant factors have been controlled.

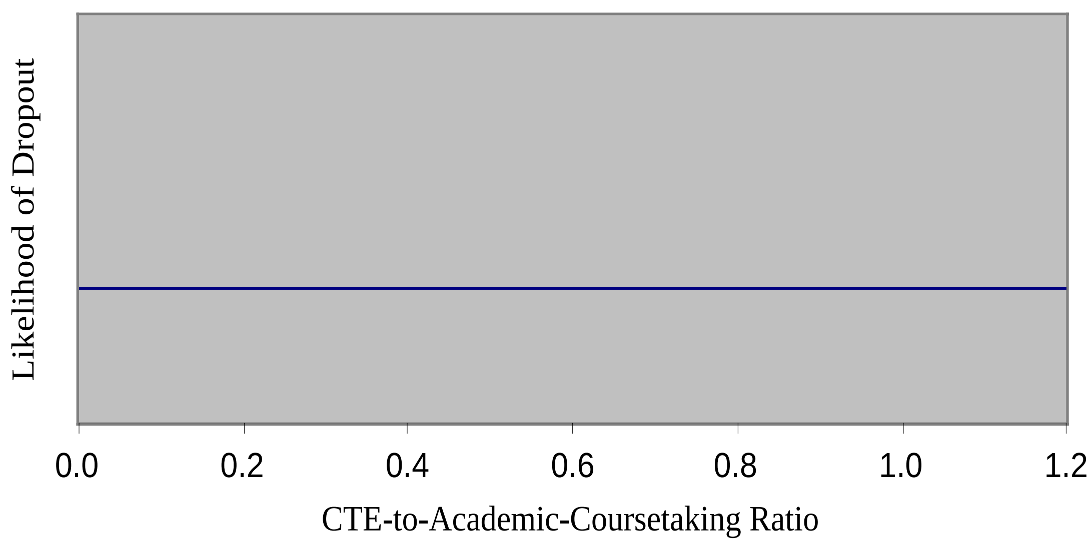

Figure 3. Hypothesis of no association.

Finally, Figure 4 depicts a curvilinear relationship by which the likelihood of dropping out initially decreases as the CTE-to-academic ratio increases, but only until some point of inflection. Beyond this point of inflection, the likelihood of dropping out increases as the CTE-to-academic ratio increases. Plank (2001), using a logistic regression framework, found a pattern similar to Figure 4. In that article, he reported a highly significant and intriguing nonlinear association between the ratio of CTE-to-academic courses taken during the high school career and the risk of dropping out. Specifically, a ratio of approximately three CTE courses for every four core academic courses (defined as math, English, science, social studies, and history) was associated with the lowest odds of dropping out of high school. Ratios either higher or lower than 3-to-4 were associated with an increased risk of dropping out. The association was especially salient for individuals whose pre-high-school test scores and high school grades were low (and who, thereby, had relatively high *baseline* risks of dropping out independent of any coursetaking effects). Plank speculated—but could not conclude definitively—that the high school experiences of students exposed to this middle-range mix of CTE and core academic courses were more satisfying, inspiring, and conducive to a strong attachment to school than were the experiences of other students.

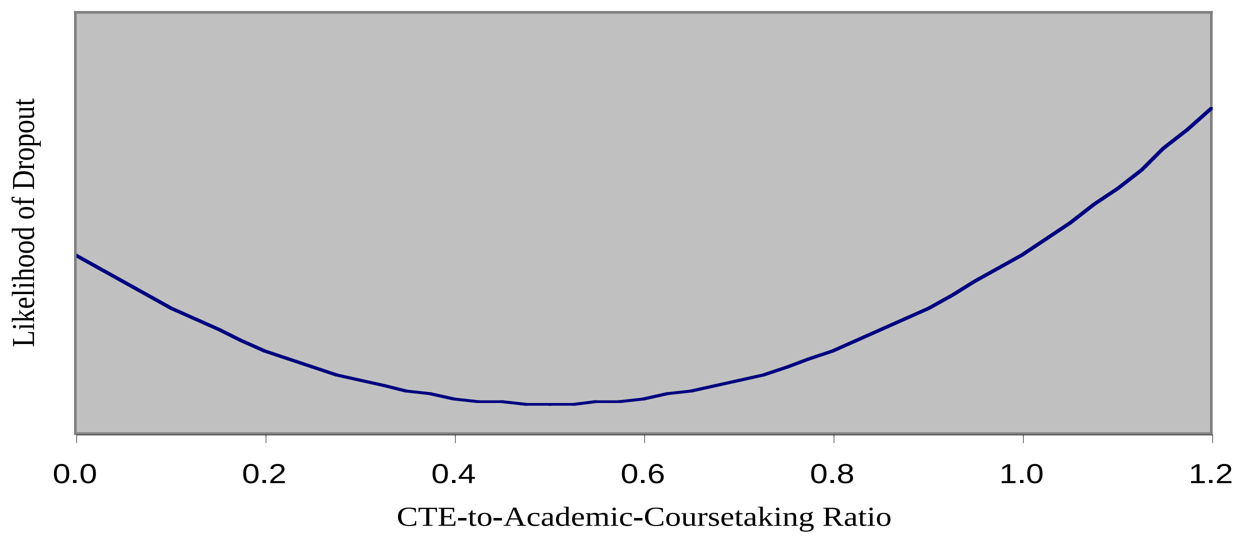

Figure 4. Hypothesis of curvilinear association.

While this earlier finding is intriguing, there are certain methodological shortcomings that need to be addressed. The models in Plank's (2001) study were standard logit models, as have been most models of dropping out of high school presented in journals in the past several decades (Willett & Singer, 1991). When studying effects of coursetaking (and many other variables of interest), there is a potential problem of reverse-causality. It is a fact that students tend to take more CTE courses in the last 2 years of high school than in the first 2 years (Levesque et al., 2000). The observed association might have been driven by the fact that only those who persisted to the final years of high school (i.e., did not drop out) were appropriately situated to attain a relatively high (or, at least, middle-range) CTE-to-academic ratio. If this account reflects reality, it is not the middle-range curricular ratio that prevents dropping out; rather, it is the absence of dropping out that allows some students to attain the middle-range curricular ratio.

A well-specified hazards model with time-varying covariates reflecting the curricular mix experienced up to a given month (or semester) can help to disentangle these questions about causal ordering. More generally, a hazards model can offer insights into the unfolding process of engagement or disengagement, of attachment or detachment, of decreasing or increasing risk of dropping out over time. In the present report, we determine whether the earlier finding of an association between curricular mix and the likelihood of dropping out stands up to more rigorous and appropriate analytic methods. More generally, we want to continue the line of inquiry involving the relationship between CTE (as one part of students' broader high school experiences) and dropping out.

Data Source

Our data come from the National Longitudinal Survey of Youth (NLSY97). NLSY97, sponsored by the Bureau of Labor Statistics (U.S. Department of Labor), tracks a nationally representative sample of 8,984 youths living in the United States who were 12 to 16 years old as of December 31, 1996. There are currently seven rounds of NLSY97 data available.[5] The study collects detailed information about youth labor market, educational, and developmental experiences.

It also provides contextual information through parent interviews and transcript data gathered as the youths leave high school.

We focus on a subsample of the oldest NLSY97 participants—those born in 1980. Although seven rounds of data are currently available, we limit our attention to whether an individual had experienced a spell of dropping out between the time of initial entry into ninth grade and the time of the NLSY97 Round 3 (R3) interview. Therefore, information collected as a part of the R1, R2, and R3 interviews, and reports of events that occurred in the periods leading up to these interviews, are central to our analyses. The R1 interview is generally known as the 1997 interview, R2 as 1998, and R3 as 1999, although we give more precise detail on survey dates in the coming paragraphs. We use student interview data from three rounds, parent data from R1, and high school transcript data on course titles, credits, grades, and the dates of academic terms. We also use information from Rounds 4 and 5 (Years 2000 and 2001, respectively) to establish dates of high school diploma receipt or GED receipt, which sometimes occurred after the time of the R3 interview.

The R1 interviews were conducted during a rather wide window (actually two windows) of data collection. These interviews were conducted between February 1997 and October 1997 for most individuals, and between March 1998 and May 1998 for a smaller set. Thus, as reflected in Figure 5, an individual born in 1980 could have been anywhere between 16-years-and-2-months (194 months) and 18-years-and-3-months (219 months) of age at the time of the R1 interview.

The R2 interviews were conducted between October 1998 and April 1999, encountering the members of the 1980 birth cohort when they were between ages 17-years-and-10-months and 19-years-and-4-months. The R3 interviews were conducted between October 1999 and April 2000, when the cohort members were between 18-years-and-10-months and 20-years-and-3-months. These dates and ages are important to keep in mind as we construct our dropout indicator. Ultimately, we analyze whether an individual had a dropout spell (defined as 30 days or more away from school for a reason other than vacation) between the time of initial entry into high school and the time of the R3 interview (or high school graduation, whichever came first).[6] With this goal in mind, we note that following the 1980 cohort members until they were between 18.83 years and 20.25 years allows for a quite comprehensive analysis of high school careers, dropping out, and degree completion without severe problems of censoring.

[5] The present analyses primarily use data from Rounds 1 through 3, and extend to Round 5 only for a few aspects of variable construction or back-filling of information missing in earlier rounds.

Modeling Strategy

After some initial descriptive statistics, we present estimates from Cox regression models—the most commonly used variant of hazards models (Allison, 1995). We aspire to develop a well-specified hazards model of the process of dropping out to improve upon standard logit models. Numerous authors have noted that dropping out is best conceptualized as a process rather than an event (Alexander et al., 2001; Finn, 1989). Nuanced issues of the influence of early experiences on later decisions or behaviors, the time-varying nature of key predictors, the nonconstant level of risk that individuals may experience over time, and varying lengths of exposure to risk among the various subjects in a study are addressed by hazards models in ways that a standard logit model with one record (or observation) per study subject simply cannot address (Allison; Willett & Singer, 1991).

The final models presented within this report are nonproportional hazards with time-varying covariates.[7] The models were estimated using SAS PROC PHREG, and specifying the "exact" method for dealing with tied event times—i.e., instances in which two or more individuals dropped out of high school after the same number of months had elapsed from their initial entry into ninth grade (Allison, 1995, chap. 5). The general model can be written as

$$h_i(t) = \lambda_0(t)\exp\{\boldsymbol{\beta X_i} + \boldsymbol{\beta X_i(t)}\}.$$

This equation indicates that the hazard for individual *i* dropping out of school at time *t*, given that he or she has not dropped out before time *t*, is the product of two factors: (a) a baseline hazard function $\lambda_0(t)$ that is left unspecified, except that it cannot be negative, and (b) a linear function of a set of fixed and time-varying covariates, which is then exponentiated.

For our analyses, the period of observation (the observed risk period) begins with the 1st month in which an individual begins ninth grade. The "event" of interest is a dropout event. Therefore, the observation period ends when an individual experiences this event for the first time, but can also end with (a) the receipt of a high school diploma, or (b) right-censoring via the occurrence of the R3 interview.[8] Our unit of analysis is the person-month, with varying start months, lengths of risk period, and method of leaving the risk set.

[6] For individuals who did not participate in the R3 interview (i.e., participated only in the R1 and possibly R2 interviews), the observed *risk period* will be censored by a dropout event, high school graduation, or the last available interview—whichever occurred first.

[7] For our models, it is the presence of time-dependent covariates that makes them nonproportional hazards models (Allison, 1995). Proportional hazards models are characterized by the ratio of any two individuals' hazards being constant over time. Thus, if one would graph the log hazards for any two individuals against time, the hazard functions would be strictly parallel. In contrast, in our nonproportional models, the time-dependent covariates change at different rates for different individuals, so the ratios of their hazards do not (cannot) remain constant. We do not include interactions of nonvarying covariates with time in our models, which is another situation in which nonproportional models are being estimated by others. We did investigate such interactions with time, but they were not generally significant.

[8] Or the R1 or R2 interview, if later interviews were not completed.

Variables

The dependent variable indicates the event of being away from school for 30 days or more for a reason other than a vacation at some time after the initial enrollment in ninth grade. Information about a spell away from school—and the reason for such a spell—came from youth and parent reports.[9,10]

Independent variables in the hazards models treated as ***not*** *varying with time* include the following:

- an indicator of *female*, with *male* as the excluded reference category
- indicators of *Black*, *Hispanic*, *Asian*, and *"other race/ethnicity,"* with *White* as the excluded reference category
- the *highest grade completed by a residential parent*
- the *natural log (n/) of household income*
- indicators of family structure for *living with biological mother only*, for *living with biological father only*, for *living with one biological parent and one step parent*, and for *"other" household arrangement*, with *living with both biological parents* as the excluded reference category
- an indicator of living in an *urban* area, with *non-urban* areas as the excluded reference category
- the *age (in months) at initial enrollment in ninth grade*
- the *Mathematics Knowledge subscore* from the computer-adaptive form of the Armed Services Vocational Aptitude Battery (*CAT–ASVAB*)

Independent variables treated as *time-varying*, and measured for each month an individual was in the risk set for dropping out, include the following:

- the grade point average achieved *during the most recently completed academic term*
- the ratio of CTE credits to academic credits earned *during the most recently completed term*
- the square of the CTE-to-academic ratio *for the most recently completed term*

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[9] Details of the programming and decision rules used in variable construction are available upon request from the authors.

[10] For the great majority of identified dropout events, information provided by the youth could be used and a precise month of the event was known. When information provided by a parent had to be used (which was true for some of the events identified as occurring before the R1 interview), only the grade within which the event occurred was known. In these situations, to allow for analyses that maintained the *person-month* as the basic unit of analysis, a random draw was conducted to impute in which month within the school year indicated by the parent the event occurred. We believe that this imputation technique does not impose any serious problems upon our analyses or conclusions.

In addition to the time-varying covariates that describe grade point average and coursetaking ratio in the most recently completed term, we also examined models that included grade point average and coursetaking covariates that were cumulative for high school up to the present time, *t*. We investigated both versions of the variables in order to contrast images of dropping out as a very long-term and cumulative process with images of adolescents having relatively short social and psychological memories (as reacting to the here-and-now instead of to the longer-term past). We were somewhat surprised to find that the variables capturing grade point average and coursetaking in the most recently completed term were consistently stronger predictors of dropping out. We do not interpret this finding as negating previous discussions of dropping out as a long-term, unfolding process, but we do note that in some ways our sample members' behaviors seem to be most tightly linked to their experiences in the very recent past. In the interest of space, we will present the rest of our rationales for including the various independent variables within the results section.

Missing data were treated via multiple imputation, using SAS procedures MI and MIANALYZE (Little & Rubin, 1987; Rubin, 1987; Schafer, 1997). The Markov Chain Monte Carlo (MCMC) method was used, and 20 imputations were generated. Inspection of diagnostic statistics suggested that the relative efficiency of estimates was markedly better with 20 imputations than with five or ten, but that any additional improvements were minimal if more than 20 imputations were used.

For initial descriptive analyses, we use 1,628 cases. These 1,628 represent all NLSY97 sample members born in 1980, except for 63 who were removed from analyses for valid reasons (e.g., had never enrolled in the ninth grade or above by the time of the R1 interview). For the hazards models, we are constrained to those cases for which transcript data are available.[11] With this constraint, we are left with 846 individuals born in 1980. Descriptive statistics for the sample of 1,628 and for the transcript subsample are presented in Appendix A. Appendix A is based on unweighted data. Sampling weights are applied in Tables 1 and 2, as discussed below, because for those descriptive tables we are interested in being able to make statements that should generalize to a national population. Unfortunately, when we get to estimation of hazards models, sampling weights cannot be used. First, the sampling weights provided with NLSY97 data are probably not appropriate for the subsample of 846 cases. Second, PROC PHREG in SAS does not support sampling weights. As presented in this report, we view the unweighted sample analyzed via hazards models as a diverse group comprising individuals from across the United States, but not as a sample that directly reflects the demographic or social composition of United States youth born in 1980.

The transcript subsample (see Appendix A) has a lower proportion of dropouts than does the fuller sample. The most direct reason for this difference is that dropouts, by definition, have interrupted or irregular high school careers. To collect transcripts for dropouts—even just information for the academic terms before a first dropout spell, let alone information from after any subsequent return to school—is difficult. Appendix A also shows that the transcript subsample, as compared with the fuller sample, has somewhat higher proportions of White students, females, and households with two biological parents. And it has slightly higher family incomes, levels of parental education, and ASVAB scores.

[11] See Appendix B for a discussion of transcript data availability, and our data-preparation steps.

Results

Descriptive Graphs and Statistics

Table 1 shows that 20.8% of the individuals in our full 1980 sample had at least one dropout spell sometime before the R3 interview. Before discussing Table 1 (and the other tables) in detail, we first offer Figures 5 through 8 to orient the reader to the data set and the timing of dropout events for those who experienced a dropout spell. Figure 5 shows the distribution of the respondents' ages in months at the time of the R1 interview. They range from 16-years-and-2-months (194 months) to 18-years-and-3-months (219 months). The mode and median are both 16-years-and-10-months (202 months). Thus, while few of these respondents had graduated from high school by the time of the R1 interview, most had experienced multiple semesters of high school and in many cases were old enough to consider legally leaving school if that was their desire. Although we have not included them here, one could also imagine histograms of respondents' ages at the times of the R2 and R3 interviews. For the R3 interview, these ages range from 18-years-and-10-months (226 months) to 20-years-and-3-months (243 months).

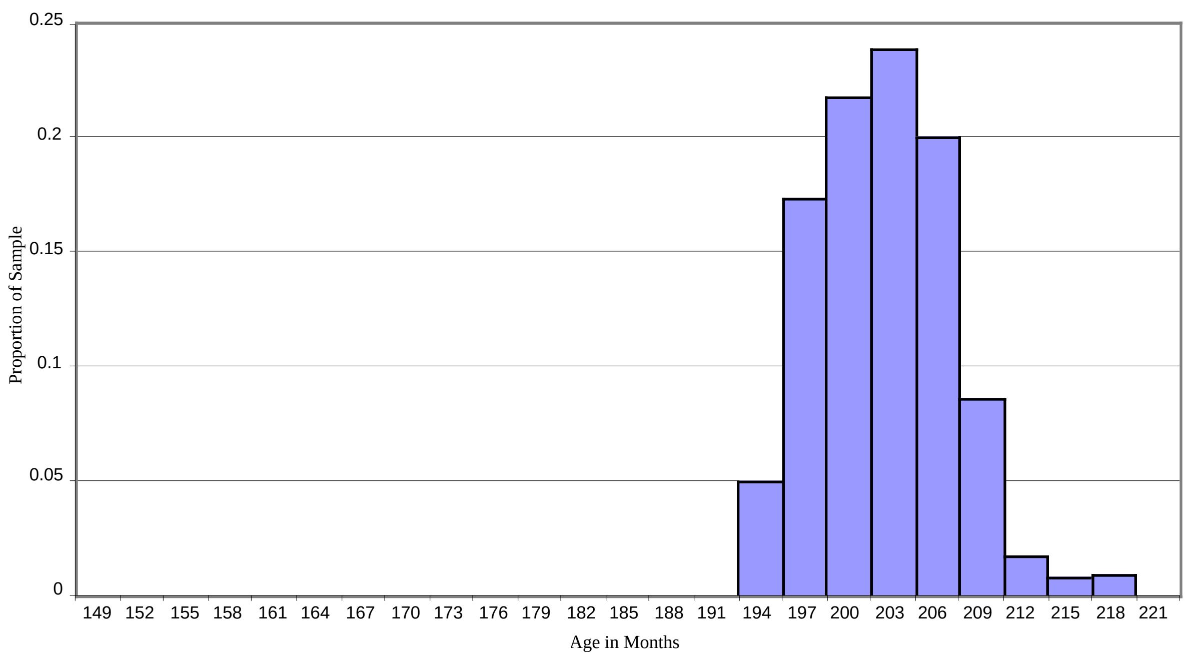

Figure 5. Distribution of age (in months) at time of NLSY97 interview (*N* = 1,628).

Figure 6 shows the distribution of the respondents' ages at the time of their initial entries into ninth grade. These values range from 12-years-and-9-months (153 months—a very young ninth grader) to 17-years-and-3-months (207 months). The median is 14-years-and-8-months (176 months). One way to think about the observed risk period for a typical respondent is to think about someone who began ninth grade in month 176 of his or her life and had his or her R3 interview in month 228 of his or her life. Assuming he or she had neither dropped out nor graduated by month 228, the observed risk period would have been 53 months (228-175). During each of these 53 months, this hypothetical student had some non-negative risk of dropping out, but did not actually drop out. If, on the other hand, he or she had dropped out in month 190, or graduated in month 221, the risk period would have been truncated accordingly.

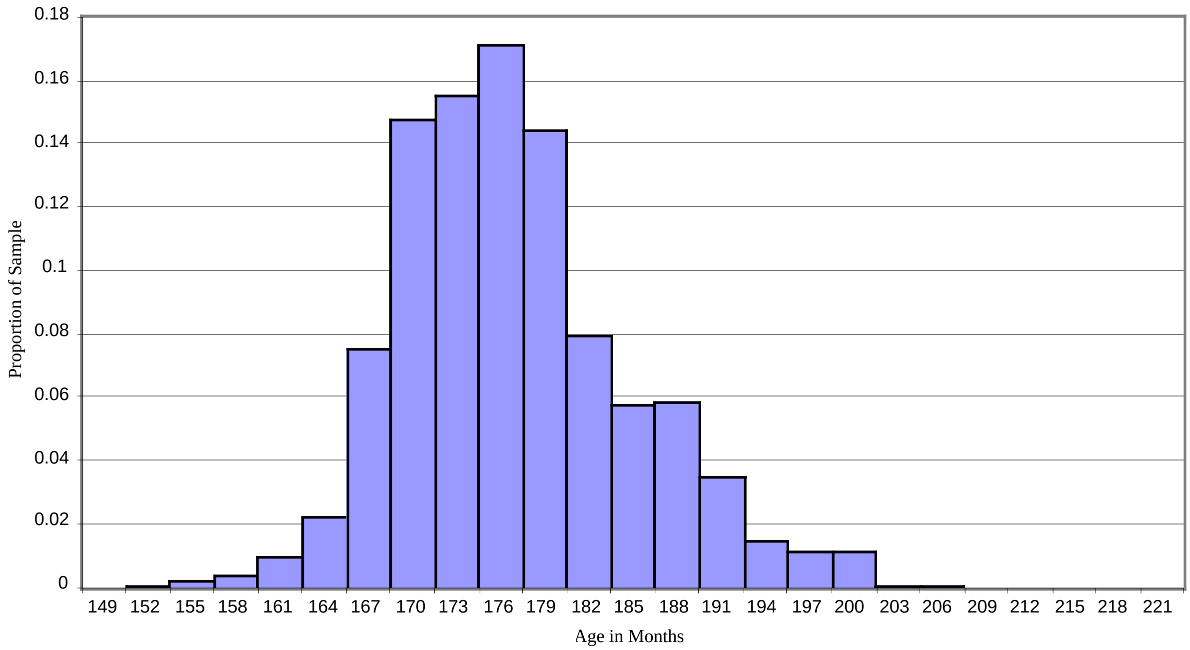

Figure 6. Distribution of age (in months) upon initial entry into ninth grade (*N* = 1,628).

Figure 7 shows the distribution of age at the time of the first valid dropout spell for the 379 individuals who had such a spell. The values range from 164 (a young dropout at 13-years-and-8-months) to 237 (19-years-and-9-months). The median is 206 (17-years-and-2-months). An increase in the incidence of dropping out around the time of the 16th birthday (month 192) is evident in the histogram. Another pronounced increase around the time of the 17th birthday (month 204) is also evident. The sparser concentration of dropout events after approximately month 220 is driven by at least three factors: (a) many of the people who were at relatively high risk for dropping out had already experienced the event by that age and, thus, exited the risk set for first dropout occurrence, (b) many people had graduated from high school by that age and, thus, exited the risk set, and (c) many people had their R3 interviews before that time and, thus, had their observations censored.

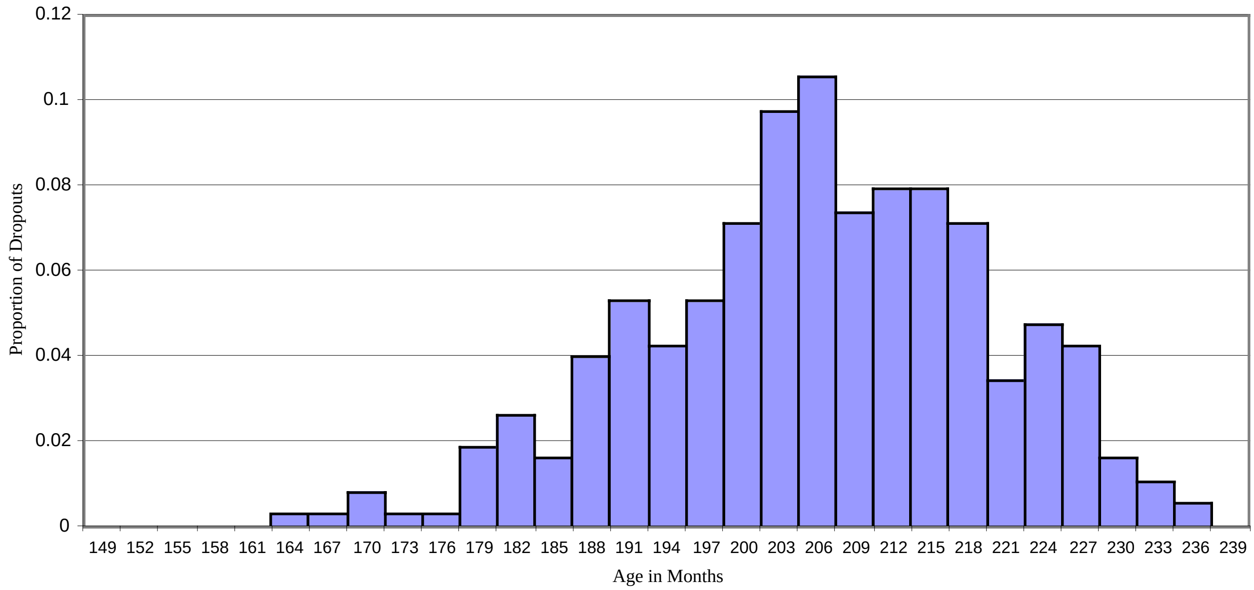

Figure 7. Distribution of age (in months) at time of dropout spell (first spell after entry into ninth grade) for those who did have such a spell (n = 379).

Finally, Figure 8 translates age at dropout event into months after initial entry into ninth grade. This figure illustrates the fact that there were plenty of early dropout spells and plenty of later dropout spells (first spells of dropping out) among the members of this sample. The difficulties of ninth grade transition experienced by many high school students are represented among the individuals who dropped out during the first 9-to-12 months after initial entry into ninth grade. (Even some of those who dropped out 12-to-21 months after initial entry into high school were still struggling to successfully complete ninth grade.) Additionally, though, Figure 8 shows that plenty of students have a first dropout spell after 30, or 40, or even 48 months (4 full years) of high school experience. Thus, the problem of dropping out of high school is not concentrated exclusively in the early years of high school or in the months just before one's classmates would be scheduled to graduate.

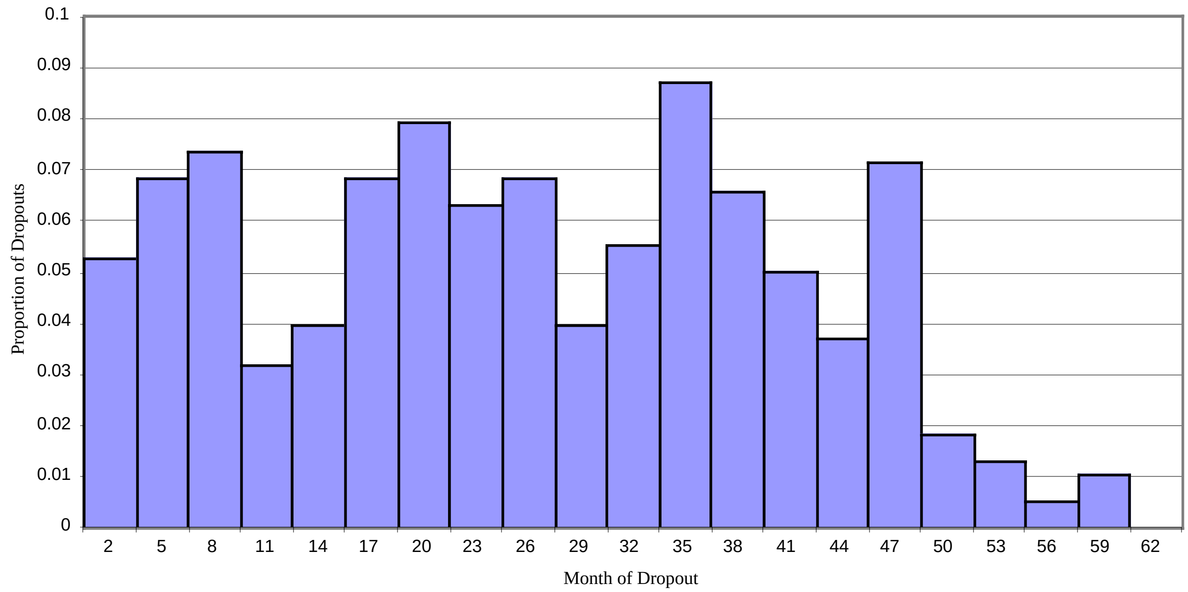

Figure 8. Distribution of month at which dropout event occurred (relative to initial entry into ninth grade) for those who did drop out (n = 379).

Describing further the frequency and location of dropout events in the NLSY97 sample, Table 1 shows that 20.8% (weighted, and presumably generalizable to a national population of individuals born in 1980) experienced a dropout event sometime before the R3 interview. In understanding our dropout measure, it is important to remember that a dropout spell defined as 30 days away from high school for a reason other than vacation does not preclude eventual completion of a high school diploma or a GED.[12]

Table 1 shows percentages experiencing a dropout spell, receiving a high school diploma, and receiving any high school credential by race and ethnicity, gender, eighth-grade grade point average, and residential parents' highest grade completed. Black and Hispanic students were significantly more likely than White students to experience dropping out by R3, and significantly less likely to receive a diploma or any high school credential by R5. Males were somewhat more likely than females to drop out, and less likely than females to receive diplomas or GEDs. Both eighth-grade grades and parental education are related to dropping out and high school completion in the expected directions, and with the magnitude of differences being quite striking. Fully 47.3% of those individuals whose residential parents' highest level of education was less than 12th grade experienced a dropout spell by R3. In contrast, only 4.8% of those whose parents had 16 or more years of formal education dropped out by R3.

[12] Indeed, when Table 1 shows that 80.4% of sample members had attained a traditional high school diploma by the R5 interview period (occurring between November 2001 and May 2002), it is a fact that some of these diploma recipients had experienced one or more spells of dropout before successfully graduating. Having made this note, however, we also stress that our results in the remainder of this report will make clear that even one spell of 30 non-vacation days away from school greatly reduces the odds of eventually receiving a high school diploma or other credential.

Table 1
Percentage With Dropout Event by R3, High School Diploma by R5, and Any High School Credential by R5: Weighted Data for NLSY97 Sample Members Born in 1980 (*N* = 1,628)

	% Dropout event by R3 interview	% H.S. diploma by R5 interview	% Any H.S. credential by R5 interview
Total Sample	20.8	80.4	84.4
Race/Ethnicity			
Black	27.1	70.2	75.9
Hispanic	28.8	72.1	75.8
White	18.1	83.8	87.5
Gender			
Male	22.7	76.0	80.9
Female	18.7	85.2	88.0
Eighth-Grade GPA			
0.0 to 1.0	59.7	34.3	46.7
> 1.0 to 2.0	37.3	69.3	76.9
> 2.0 to 3.0	22.8	77.2	81.2
> 3.0 to 4.0	7.4	93.2	94.4
Parents' Highest Grade Completed			
≤ 11	47.3	57.5	65.8
12	23.2	79.7	83.7
13–15	17.3	83.3	86.6
≥ 16	4.8	93.0	94.9

Table 2 confirms that dropping out as we have defined it truly is an indicator of risk or serious detachment. Those with a dropout event by R3 had only a 27.8% chance of earning a traditional diploma by R5. In contrast, those without a dropout event by R3 had a 94.2% chance of earning a traditional diploma by R5. Note that many of those individuals with dropout spells would ultimately attain GEDs (as revealed by the difference between 27.8% and 45.9% in the second row of Table 2 data). For Black and Hispanic individuals with dropout spells, the probability of eventually earning a high school diploma is lower than the corresponding probability for White individuals with dropout spells. These probabilities are 0.226, 0.265, and 0.291 for Black, Hispanic, and White sample members, respectively.

Table 2
Percentage of Dropouts and Non-Dropouts Attaining High School Diploma or Any Credential by R5: Weighted Data for NLSY97 Sample Members Born in 1980 (*N* = 1,628)

	% H.S. diploma by R5 interview	% Any H.S. credential by R5 interview
Total		
Dropout event by R3?		
No	94.2	94.4
Yes	27.8	45.9
Black		
Dropout event by R3?		
No	87.9	88.2
Yes	22.6	42.9
Hispanic		
Dropout event by R3?		
No	90.5	91.2
Yes	26.5	37.6
White		
Dropout event by R3?		
No	95.9	96.1
Yes	29.1	48.7

Table 2 also gives some indication that Hispanics with dropout spells in their pasts are less likely to use the GED as a route to high school completion than are Blacks or Whites with dropout spells in their pasts. This assertion is based on the proportion of Hispanic dropouts eventually earning “any high school credential” being lower than the corresponding numbers for Black and White dropouts, coupled with the smaller difference between the proportion earning diplomas and the proportion earning “any credential” for Hispanic dropouts, as opposed to Black and White dropouts.

Hazards Models

Having examined some univariate and bivariate descriptive graphs and statistics, we now turn to the estimated hazards models of dropping out. Table 3 displays exponentiated coefficients—that is, multiplicative effects on the hazard ratio—from a series of five models. Model A includes the ascriptive traits of sex and race/ethnicity. Here only the coefficient for Hispanic students is statistically significant, showing an elevated risk of dropping out relative to non-Hispanic Whites.

Model B adds household characteristics and an indicator of urban location. As expected, higher parental education is associated with a reduced risk of dropping out. Living with one’s biological mother only, or one’s biological father only, or a biological parent and a stepparent are all associated with a greater risk of dropping out, relative to living with both biological parents. While these estimates for household composition are significant in this preliminary model, we note that they will lose their significance as various intervening variables are introduced in Models C and E. Finally, living in an urban area is associated with a greater risk of dropping out.

In Model B, Hispanics no longer show an elevated risk of dropping out now that parental education and other factors have been controlled. Also, the lack of significance for the natural log of household income is interesting, especially when coupled with the significance of parental education. The estimates seem to suggest that human capital and parents’ familiarity and comfort with navigating the educational system are more salient in understanding high school persistence than is financial capital.

Model C adds a standardized test score (ASVAB—Mathematics Knowledge) and the respondent’s age at initial ninth-grade enrollment. We interpret the ASVAB score as an indicator of academic achievement or performance. Higher ASVAB scores are associated with significantly lower risk of dropping out, as expected. Age at ninth-grade entry is determined by multiple factors (i.e., a student’s history of failure or retention, state policies about kindergarten entry, parental decisions). According to Model C, adding a full year (12 months) to one’s high school entry age increases the hazard of dropping out by more than 3 times.[13] Consistently, as we examined various model specifications, age at ninth-grade entry was positively and highly significantly associated with the risk of dropping out. Further, as we discuss in the coming paragraphs, the inclusion of this variable proves to be an important control as we isolate the plausible effects of other variables. The difficulties experienced by students who are old-for-grade become apparent in our analyses.

Model D is an attempt to replicate the set of predictors used in Plank’s (2001) research. Here, the time-varying covariates measuring grade point average and coursetaking ratio are introduced for the first time among the five models. It is informative to compare Model D with the findings from the earlier Plank research, keeping in mind that with Model D we utilize more recent data (NLSY97 instead of NELS:88) and change statistical models (using a hazards model with time-varying

[13] The coefficient in the linear model of log-hazards is 0.0999. Multiplying by 12 (months) and exponentiating to calculate the effect on the hazard ratio yields the following: exp(12*0.0999) = 3.32.

covariates instead of a standard logistic regression), but have otherwise included the same set of independent variables (as nearly as the two different data sets will allow).

Table 3
Effects on Hazard Ratio (Based on Cox Nonproportional Hazards Model of Dropping Out) for NLSY97 Sample Members Born in 1980 With Available Transcript Data (n = 846)

Predictor	Model A: Gender and race only	Model B: Adding HH charac-teristics and urban location	Model C: Adding ASVAB and age at ninth-grade entry	Model D: Replication of Plank (2001) specification	Model E: Final model
Female	0.78	0.73*	0.72*	0.90	0.85
Black	1.45	0.95	0.59**	0.62**	0.53**
Hispanic	1.76**	0.86	0.88	0.83	0.88
Asian	0.46	0.40	0.52	0.84	0.66
Other race/ethnicity (non-White)	0.74	0.64	0.75	0.56	0.77
Parents’ highest grade completed		0.83****	0.89***	0.89***	0.89***
ln(household income)		0.95	0.98	0.99	1.00
Biological mother only		1.67**	1.55*		1.39
Biological father only		2.57**	1.38		1.27
One biological parent/One stepparent		2.19***	1.61*		1.53
Other household arrangement		1.66	1.08		1.12
Urban residence		1.78**	1.97***		1.93**
ASVAB—Math Knowledge			0.54****	0.50****	0.65***
GPA (most recent term)				0.53****	0.56****
CTE:Academic ratio (most recent term)				0.17**	0.27
CTE:Academic ratio^2 (most recent term)				5.60**	4.13*
Age (months) at ninth-grade enrollment			1.11****		1.11****
Reduction in -2 log likelihood from model without covariates	10.11	60.42	168.12	138.85	193.34
df	5	12	14	11	17
p	0.0723	< 0.0001	< 0.0001	< 0.0001	< 0.0001

Note. ln = natural log.
*p < .10. **p < .05. ***p < .01. ****p < .001.

Plank's (2001) research had shown, in terms of effects on the log-odds of dropping out, a negative and highly significant coefficient of -4.57 for the first-order coursetaking ratio term; it had shown a positive and highly significant coefficient of 2.97 for the squared term. Together, these two terms generated the U-shaped function described earlier—and a point of inflection where the ratio equaled 0.77. In the present NLSY97 research, we can translate Table 3's effects on hazard ratios back into effects on log-hazards to get the following: The first-order coursetaking ratio term has an estimated coefficient of -1.77.[14] The squared term has an estimated coefficient of 1.72.[15] Again, these two terms generate a U-shaped function. However, the magnitude of each coefficient is less than it had been in the NELS:88 research.

When considering the specification of Model D, we thus find the same general U-shaped pattern that had been reported by Plank (2001), albeit of less pronounced magnitude (less concavity) and with a point of inflection at a slightly lower value (0.51 instead of 0.77). Further data exploration, including examination of an NLSY97 logistic regression (available upon request) suggests to us that the greatest part of the difference between the NELS:88 findings and the results of Model D has to do with changing data sets (as opposed to changing statistical methods). However, it is unclear whether we are detecting historical changes and altered educational processes that occurred across 5 or 6 years, or whether we are simply detecting differences in the methods or precision used to measure various variables in the two studies. Another relatively small part of the difference between the NELS:88 findings and the results of Model D has to do with changing methods (to the more appropriate, more defensible hazards models). The change in methods seems to imply some changes in the strength of estimated effects, thus giving some credence to worries about reverse-causality in the logistic regression results, but—in the balance—this does not seem to be a large source of differing results.

Before we give too much attention to the results of Table 3's Model D, however, let us examine Model E and the importance of keeping age at high school entry in the predictive model. Model E reintroduces household composition variables, urbanicity, and age at high school entry as predictors. Model E fits the data significantly better than Model D (difference in -2 log likelihood of 54.49 with 6 degrees of freedom). What, then, are the substantive similarities and differences between Models D and E?

Both models show Black students having a lower risk of dropping out than do White students—a finding that emerges once socioeconomic status and (especially) standardized test performance are controlled. Both models show higher parental education associated with a reduced risk of dropping out. Both models show higher ASVAB scores, and a higher grade point average in the most recently completed academic term, associated with a reduced risk of dropping out. Model E shows (a) urban residence and (b) each additional month of age at high school entry associated with elevated risks of dropping out, thus highlighting significant risk factors not represented (not modeled) in Model D.

The most noteworthy differences between the two models are in the estimates for the CTE-to-academic-coursetaking ratio. Both Models D and E suggest a U-shaped function, as evidenced by the first-order term's estimated effect of the hazard ratio being less than 1.0 in both models, while the squared term's estimated effect is greater than 1.0 in both models. In Model E, however, the first-order term's coefficient is not significant even at a 0.10 level, and the squared term's coefficient is only marginally significant ($p < 0.10$). Data exploration makes clear that the

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[14] $-1.77 = \ln(0.17)$.

[15] $1.72 = \ln(5.60)$.

differences in the estimates for the coursetaking ratio, between Models D and E, are driven by the exclusion or inclusion of age at high school enrollment—a contingency that will be discussed at length below.

Given these weak results for the coursetaking terms, one must ask whether Model E presents any real evidence of a U-shaped function (consistent with Figure 4). The proper answer to this question seems to be, “yes, but only very weak evidence.” That is, Model E was compared with a model specification with neither a first-order term nor a squared term. This alternative specification is consistent with Figure 3 and a hypothesis of “no effect of coursetaking.” Model E was marginally better than this alternative specification (difference in -2LL of 5.86 with 2 degrees of freedom, $p = 0.0586$).

Also, Model E was compared with a specification with a first-order term but no squared term. This alternative specification is consistent with Figures 1 and 2, and hypotheses of linear effects of coursetaking. Again, Model E was marginally better than the alternative specification (difference in -2LL of 3.81 with 1 degree of freedom, $p = 0.0509$).

Thus, we can tentatively declare Model E our best model for the sample of 846 cases. We cite a fairly mild U-shaped pattern for the effect of the CTE-to-academic ratio on the risk of dropping out, with a point of inflection around 0.46 (where roughly one CTE credit is earned for every two core academic credits).

High School Entry Age as Contingency

If we had ended our analyses with the results in Table 3, we would have declared Model E to be our best model. We would have been able to say that a curvilinear specification of the association between the coursetaking ratio and the risk of dropping out (consistent with Figure 4) was marginally better than specifications of no effect or strictly linear effects of coursetaking (corresponding to Figures 1, 2, and 3). Substantively and statistically, however, the nature and magnitude of Model E’s curvilinear effect is not dramatic in Table 3, and no strong effect of coursetaking on dropping out could have been inferred.

If the empirical evidence had suggested just that fairly simple and modest conclusion, that would have been the end of the story. It would have been our responsibility to report the findings, interpret them, and reconcile them with previous findings and predictions. However, the changing estimates across Table 3’s Models C, D, and E suggested to us that a more complex story involving dropping out, coursetaking, and age at high school entry existed and needed to be explored.

What exactly did it mean that age at ninth-grade enrollment was so highly significant (and stable) in Models C and E? And why were both the first-order and squared terms for coursetaking ratio significant in ways consistent with Figure 4 in Model D (when enrollment age was not controlled), but only marginally significant (as a set, according to an omnibus test) in Model E (when enrollment age was controlled)? In the course of investigating these questions, we confirmed that students who were older upon high school entry dropped out at higher rates. Models C and E reflect this fact, as did additional exploratory analyses (not shown). Additionally, older students are more heavily concentrated than younger students at the medium- and high-levels of the CTE-to-academic ratio (analyses available from the authors).

Clearly, this is not a case of entry age being a *mediating* variable that explains away, or accounts for, the relationship between coursetaking and dropping out. That is, a particular high school coursetaking mix does not *determine* one’s age at high school entry and subsequently, via this mechanism, elevate or reduce the risk of dropping out. To some extent, age at high school entry may cause (or play a determining role in) high school coursetaking. And age at high school entry is clearly associated with the risk of dropping out. Whether we should say that being older than most of one's classmates upon high school entry is (a) a *cause* of dropping out or (b) a *proxy* for various challenges and risk factors is a subtle but important question.

The results displayed in Table 3 and subsequent exploratory analyses led us to reestimate our best model specification separately for two subgroups—those who were less than 15 years old at high school entry, and those who were 15 years of age or older at high school entry. Table 4 presents these results.[16]

Table 4
Effects on Hazard Ratio (Based on Cox Nonproportional Hazards Model of Dropping Out) for Two Subsamples Defined by Age at Initial Ninth-Grade Entry (*n* = 846)

Predictor	Less than 15 years old at initial ninth-grade entry (*n* = 653)	At least 15 years old at initial ninth-grade entry (*n* = 193)
Female	0.89	0.80
Black	0.77	0.36**
Hispanic	0.69	1.08
Parents' highest grade completed	0.88*	0.93
ln(household income)	0.95	1.03
Biological mother only	1.33	1.59
Biological father only	1.90	1.23
One biological parent/One stepparent	1.70	1.81
Other household arrangement	1.04	1.80
Urban residence	1.85	2.07*
ASVAB—Math Knowledge	0.49***	0.80
GPA (most recent term)	0.57**	0.53**
CTE:Academic ratio (most recent term)	0.04*	0.92
CTE:Academic ratio^2 (most recent term)	21.42**	1.69
Age (months) at ninth-grade enrollment	1.01	1.17***
Reduction in -2 log likelihood from model without covariates	74.14	65.23
df	15	15
p	< 0.0001	< 0.0001

Note. ln = natural log.
*p < .05. **p < .01. ***p < .001.

[16] The model specification utilized for each of the two subgroups and summarized in Table 4 is identical to the specification for Model E in Table 3, except that dummy variables for *Asian* and for *other race/ethnicity* are not included. Once the sample was split according to age at high school entry, there was too little representation from these categories to estimate meaningful coefficients. Thus, the excluded reference category for race/ethnicity for Table 4 is all adolescents who were neither Black nor Hispanic.

Estimated coefficients based on the 653 individuals who were less than 15 years old at initial ninth-grade entry are presented in the first column of data in Table 4. Estimates based on the 193 individuals who were 15 or older at ninth-grade entry are presented in the second column. The estimated models for the two subgroups are different in striking and important ways.

For the younger subgroup, age at high school entry is not a significant predictor. While there was variation in age at high school entry for this subgroup, this variation was not systematically associated with dropout likelihood independent of other variables in the model. The effect of ASVAB score, which measures performance on a standardized test, is significant, with higher scores associated with lower risk of dropping out. All three time-varying predictors are significant, these predictors being (a) grade point average in the most recently completed academic period, (b) the first-order term for CTE-to-academic ratio in the most recently completed academic period, and (c) the squared term for CTE-to-academic ratio. A higher grade point average is associated with lower risk of dropping out. The association between coursetaking ratio and the hazard of dropping out is characterized by a pronounced U-shaped function (with a point of inflection at 0.54). In terms of effects on the hazard ratio, the parameters driving this U-shaped pattern are the first-order term that is well below 1.0 (0.04, specifically) and the squared term that is well above 1.0 (21.42, specifically). In terms of effects on the log-hazard, the lower curve in Figure 9 depicts the estimated effect.

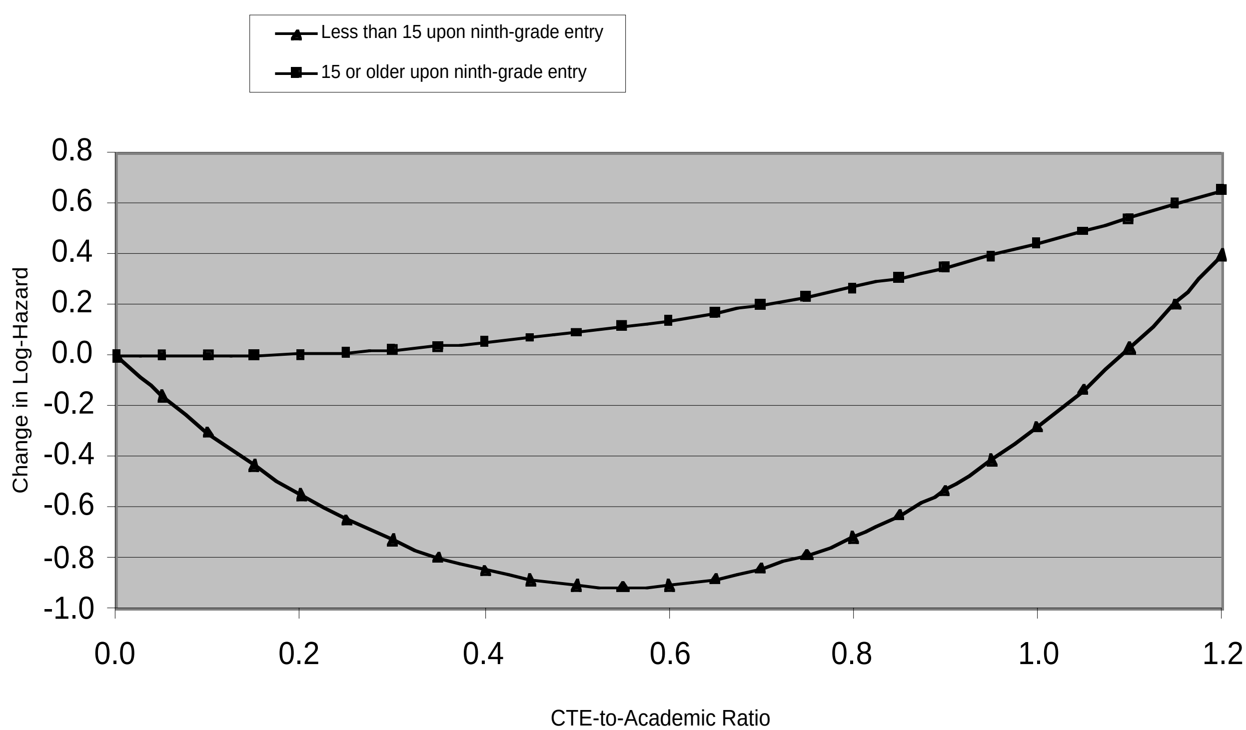

Figure 9. Estimated effects of coursetaking ratio on log-hazard of dropping out for two subsamples defined by age at initial ninth-grade entry.

For the older subgroup (those who were 15 or older at ninth-grade entry), ASVAB score is not a significant predictor of dropping out. Neither are the first-order or squared terms for coursetaking ratio. The effect of the coursetaking ratio on the log-hazard of dropping out for the older subgroup is depicted in Figure 9's upper curve. For the older students, grade point average in the most recent term is once again significant. And age at ninth-grade entry is highly significant (with each additional month of age bringing an increased risk of dropping out).

As we compare and contrast the estimated models for the two subgroups, we reach this general conclusion: For those who are older than is normal upon high school entry, this single factor of age is a strong correlate of dropping out that swamps or obfuscates most other effects. It is not just that the older students as a group drop out at relatively high rates, but also that each additional month of age at high school entry brings an increased risk of dropping out among those who are 15 or older as they enter ninth grade. The fact that ASVAB scores are not a significant predictor of dropping out for the older subsample suggests that weaknesses in academic performance or potential may not be the primary factor leading older students to disengage from school. If academic factors are not the predominant force leading to dropping out among older students, other likely causes include various aspects of the social realm and social stigma. We turn to consideration of these themes in our concluding section.

Discussion and Conclusions

The analyses have led us to conclude that age at the time of initial high school enrollment is an important factor. This story about age is highly relevant to our understanding of the association between coursetaking mix and dropping out. We see students who are older than normal upon high school entry dropping out at higher rates than do students who are normal or even young for grade. We see evidence of a pronounced curvilinear effect of the coursetaking ratio on dropout likelihood for the younger subgroup, but no significant effect of coursetaking on dropping out for the older subgroup.

If we borrow language from dosage research, we might say the following: For students who are of a normal age, or even younger than normal, at the time of high school entry, it appears that some CTE combined with core academic coursetaking is good medicine, but only up to a point. Too much exposure to CTE (concentrating on CTE to the exclusion of adequate academic coursetaking, and moving above the estimated point of inflection) implies increased risk of dropping out. For students who are older than normal upon high school entry, the received dosages of CTE and academic coursetaking do not seem to have detectable effects on dropout likelihood. It seems likely that the constellation of risk factors or challenges encountered by these older students makes them not receptive to any potential effects of coursetaking variation. At the peril of pushing an analogy too far, one can think of one set of patients who are generally healthy, and thus responsive to doses of preventative medicine; one can think of another set of patients whose immune systems are weakened to the point that they are unresponsive to that same medicine.

Let us abandon the dosage language and accompanying metaphors, but consider further what we have—and have not—learned about coursetaking, age, and dropout risk. One thing we have not established definitively is a causal relationship between coursetaking and dropping out. The empirical evidence for the younger subgroup is *consistent* with the claim that a middle-range mix of CTE and academic courses *causes* a reduced risk of dropping out once other factors in our models have been controlled. The use of time-varying covariates for grade point average and coursetaking mix are of some help in bolstering causal inferences. That is, our research design has kept temporal ordering very clear and conceptually sound.

There are, however, unaddressed issues of selection when it comes to curricular experiences. We are in no position to say that if a student with a given grade point average, race, gender, socioeconomic background, and other modeled traits were suddenly transported from a CTE-to-academic ratio of 0.0 to a ratio of 0.4 that his or her risk of dropping out would suddenly drop to the levels suggested by our estimated models. The members of our sample found their individual admixtures of CTE and academic courses through some combination of individual choice, parental or educator guidance, and constraints imposed by their high schools' menus of course offerings. Certainly, the members of our sample were not randomly assigned to their observed levels on the coursetaking ratio independent variable.

Because of these facts, we must be cautious in making any causal inferences. We are simply reporting results of a correlational study (with sophisticated event history methods that do capture elements of time-ordering and nonconstant risk) that are consistent with hypotheses about curvilinear effects of coursetaking on dropout risk.

We began this report by stating that a thorough conceptualization of the high school dropout phenomenon would incorporate an understanding of students' backgrounds and early educational experiences and also their unfolding experiences during high school. We have attempted to be true to this charge. Some of our independent variables capture aspects of family, or ascriptive status, or early achievement outcomes. In the realm of early achievement outcomes, ASVAB score is a proxy for academic competence or performance, and is partly the product of pre-high-school educational experiences. Additionally, the initial value assigned to the time-varying grade point average variable is based on a student's self-reported grades in eighth grade. As such, this level of pre-high-school accomplishment—be it low or high—is carried through the door on the first day of high school as a risk or resilience factor as we have constructed our models. Finally, age at high school entry is a result of student performance, school policies, and family decisions established before the high school career commences. Thus, we have incorporated into our models and explanations descriptions of what the student brings as burdensome baggage or assets on the first day of high school.

Additionally, though, we have modeled accomplishments and exposures that occur during the high school career. In our models, a student's risk of dropping out in any given month is partly a function of the grades he or she received the last time a report card was distributed. Our assumption is that a student receives signals—sometimes deeply felt—about how he or she is faring regarding the official agenda and institutionally valued performance aspects of the school. Also, a student's risk of dropping out is modeled as a function of the coursetaking mix experienced during the most recently completed academic term. If it is true that some students need the contextual and situated learning offered by career and technical education (when it is operating at its best) to find relevance and attachment in their schooling, then our models capture the fact that some students received this exposure, while others did not. For students who were of a normal or young age at the time of high school entry, coursetaking ratios did seem to affect school-leaving decisions.

Specifically, for students who were of a normal or young age upon high school entry, a CTE-to-academic credit ratio of approximately 1-to-2 was estimated to minimize the risk of dropping out once other factors in our model were controlled. A concrete recommendation for schools and educators who are encountering problems with students dropping out would be to ensure that students had the option of arranging their high school schedules in a way that facilitated this 1-to-2 ratio. In a high school where students typically amass 24 Carnegie units over 4 years, such a ratio could be attained if 13 core academic credits were earned, 6.5 CTE credits, and 4.5 other credits (including foreign language, fine arts, or physical education).

Furthermore, beyond a school (or school system) merely allowing such coursetaking combinations, the combinations should be actively encouraged, applauded, or described as high-status endeavors. It is no easy feat to establish particular courses or curricular programs as high status if popular opinion among students, parents, and possibly teachers suggests they are not high status. Nonetheless, we can suggest some possible strategies for actively encouraging and applauding CTE involvement. These might include (a) featuring final projects or products from these courses at school-wide assemblies, (b) offering awards to individuals or groups of students for excellence in their CTE courses, or (c) developing team-teaching arrangements or collaborations between respected science, mathematics, English, or social studies teachers and the teachers of CTE courses.

For older students, however, we are inclined to speculate that the social stigma or awkwardness of a potential role inconsistency troubles them in a way that swamps or overwhelms potential effects of many other aspects of the educational experience—including the CTE-to-academic ratio. Quite likely, to be older than is normal as one enters and proceeds through high school is to be attracted or called to certain behaviors or involvements that are at odds with the life and allegiances of a typical high school student. As we make this speculation, we recall that an older student's standardized test performance was not among the significant predictors of dropping out. We strongly suspect that social roles and feelings of fit and contentment are more relevant to the social psychology of these adolescents than are assessments of one's academic competence.[17]

Indeed, Entwisle, Alexander, and Olson (2004) have reached similar conclusions. In their study of high school dropouts in Baltimore, MD, they found many students who were old-for-grade due to retention earlier in their schooling careers. These students were at elevated risk for dropping out. That these students had been retained and were old-for-grade could be interpreted as indicators of less-than-adequate school performance, but Entwisle and colleagues inferred that retention's power to predict dropping out stemmed primarily from other sources. They reached this conclusion after noting that for their sample test scores and grades, which are also measures of academic performance, lacked predictive power. Entwisle and colleagues suggested that the effects of retention on dropping out emerged because of the pressures students experience when they are off-time in the severely age-graded organization of the secondary school. This organization labels students as "behind," "dumb," or "failures," and adds to the time they must spend in school before graduation. By dropping out, retained and/or old-for-grade students can shed a punishing role and, instead, seek desired status through paid work or other means.

Educators should give attention to trying to help students who are old-for-grade reclaim (or create for the first time) a healthy attachment to school and a goal of high school graduation. Our analyses suggest to us, however, that this will not be accomplished simply through directing such students to a particular set of courses or combination of courses. Most likely, additional efforts will be necessary to help these students feel integrated into the life and activities of the school, believe that degree-completion is both valuable and possible, and guard against too quickly embracing adult roles and involvements that run contrary to the roles and activities required of a high school student.

Despite caveats about weak or nonexistent effects of the CTE-to-academic ratio for students who are old-for-grade, we still stress the strong estimated effects of curricular offerings and

[17] We stand by our speculation about social roles and feelings of fit being more relevant than assessments of academic competence for these older youth. However, we also note the observation of an anonymous reviewer, who stressed that as we note that ASVAB scores are not a significant predictor of dropping out for the older youth, we should not lose sight of the fact that grade point average in the most recent term is significant—a finding that would contradict the interpretation that achievement factors matter little for this group. Instead, one might infer that current or recent achievement is more relevant for these students than is past achievement or ability.

experiences for students who were of a normal or young age upon high school entry. These findings give support to our assertion that curricular offerings and experiences are parts of socially patterned and institutionalized structures leading to engagement for some adolescents and disengagement for others. In making that assertion, we mean the following: Schools as institutions make decisions about what courses will be offered, and what competencies and interests will be nurtured and served within their curricula. Educators, parents, and students make recommendations or choices about what curricular path a given student will follow. Within their courses, students are exposed to a range of knowledge bases and visions of possible futures. Courses differ from one another in what they feature and what they reward. If it is true that students pick up cues about their success and satisfaction partly through their curricular experiences (and we see no reason to suspect otherwise), then it makes sense that the balance of coursetaking from the fairly disparate domains of CTE and core academics would be predictive of a student's attachment to school and, ultimately, the act of dropping out or not.

As we and others push this line of research forward, next steps include incorporating comprehensive understandings of the menu of available offerings at a given school, and understanding a student's choices or assignments within this organizational context. Also, we should attempt to move beyond the simple assertion that "on average, it will be beneficial to have a wide range of curricular opportunities and learning environments so that all students stand a decent chance of finding points of attachment and motivation." More satisfying theories and explanations would incorporate understandings of a given student's set of skills, interests, and learning needs. And then, in turn, the match among these skills, interests, and needs and the opportunities featured within a given school or school system should be assessed and evaluated for its impact. Finally, in seeking an overall assessment of the effects of CTE on opportunity structures and outcomes for youth and young adults, findings about effects on dropping out should be considered in conjunction with findings related to other outcomes including employment, earnings, and postsecondary education.

NLSY97 offers the opportunity to pursue this agenda partially, and other research settings and data sources should be sought as well. We are encouraged to learn that a much larger set of high school transcripts, extending well beyond the youth born in 1980, have now been collected and released (in 2005) as a part of the NLSY97 data. We hope that we (and others) can utilize these data to extend our analyses, and to work with samples that are more fully representative of all United States youth.

APPENDIX A

UNWEIGHTED DESCRIPTIVE STATISTICS FOR NLSY97 SAMPLE MEMBERS BORN IN 1980 AND FOR TRANSCRIPT SUBSAMPLE

Variable	1980 Cohort (*N* = 1,628)	1980 Cohort – transcript subsample (*n* = 846)
Ever dropped 0ut (by R3 interview)	23.3%	13.9%
Female	49.8%	51.1%
Black	27.6%	22.8%
Hispanic	20.4%	18.7%
Asian	2.1%	2.0%
White	48.4%	55.2%
Other race/ethnicity	1.2%	1.3%
ln(household income)	$M = 10.1$, $SD = 2.0$	$M = 10.4$, $SD = 1.7$
Parents' highest grade completed	$M = 13.2$, $SD = 3.0$	$M = 13.6$, $SD = 2.9$
Living w/biological mother only	25.7%	21.5%
Living w/biological father only	3.1%	2.8%
Living w/1 biological parent & 1 stepparent	11.9%	15.1%
Living w/2 biological parents	48.8%	53.5%
Other household arrangement	10.5%	7.1%
Urban location	74.2%	72.3%
Age (in months) at ninth-grade enrollment	$M = 176.9$, $SD = 7.9$	$M = 175.4$, $SD = 6.5$
ASVAB—Math Knowledge (divided by 1,000)	$M = 0.24$, $SD = 1.01$	$M = 0.48$, $SD = 0.85$
Time-dependent grade point average in month 18 (for most recently completed term)		$M = 2.67$, $SD = 0.76$
Time-dependent CTE-to-Academic ratio in month 18 (for most recently completed term)		$M = 0.20$, $SD = 0.28$
Time-dependent CTE-to-Academic ratio^2 in month 18 (for most recently completed term)		$M = 0.12$, $SD = 0.29$

APPENDIX B

USE AND PREPARATION OF NLSY97 HIGH SCHOOL TRANSCRIPT DATA

This appendix describes how we have treated the NLSY97 transcript data. We understand that these data have limitations. However, we have systematically cleaned, recoded, and compared these data with other national data. Ultimately, we believe that it is appropriate to use the NLSY97 transcript data in our analyses.

Data and Coding

Based on communication with staff at the Center for Human Resources Research at The Ohio State University, National Opinion Research Center, and the Bureau of Labor Statistics, we understand that the transcript data are most representative of the 1980 cohort. All of the data presented in this manuscript describe the 1980 birth cohort of the NLSY97 sample. While the total sample of youths born in 1980 is 1,691, transcript data are available for 873 (52%).

Timing of Coursetaking

The transcript data provide information on every term for every school attended by a student. In addition to course titles and grades received for each course, we know the start and stop dates for each of these terms. The timing of these terms is important for our analyses. Therefore, it is important to describe our hand-coding procedures to deal with incomplete dates.

For some transcripts, the dates were incomplete; typically, a *start* month or year, or *stop* month or year, or some combination of months/years was incomplete. For a particular student with missing start and/or stop dates, we utilized available information for the academic schedule of that same school, information available about the type of term (i.e., fall, spring, summer), and information about a student's high school completion date to complete the student's trajectory.

In some cases, we followed general decision rules based on our knowledge of the start and stop months of a typical school system (i.e., the school year generally begins in September).

Credits

In addition to the timing and names of courses, we also know the credits earned for each course. In other analyses (not in the current manuscript), it has been important to document total credits earned, in addition to understanding ratios of credits in one subject area to credits in another. In order to accomplish this, it is important to establish whether a school was awarding Carnegie units for courses, or following some other system, and then to rescale as appropriate. For the present analyses, however, our reliance on the coursetaking ratio makes this part of our data treatment inconsequential. Thus we will not give detail on those data inspection and recoding decisions.

We limit our discussion of course credits to a few relevant procedures. First, in a handful of cases, we corrected obvious data entry errors (e.g., one course bringing 50 credits, while every other course brought 0.5 or 1.0 credits). Secondly, in some cases, we could tell that a course brought a passing grade with no credits. After careful hand inspection, we identified these cases and assigned what we judged to be the appropriate number of credits (based on other information available on that same individual's transcript).

Data Generalizability

We examined whether the transcript subsample differed significantly from the larger 1980 sample (table available upon request). Overall, the transcript subsample matches the whole 1980 cohort quite closely, with a few exceptions. The transcript sample appears to be slightly more advantaged socioeconomically and academically. For example, the transcript sample has fewer minority students, more educated parents, and higher family income. These students are also more likely to be living with both parents.

In terms of academic achievement, the transcript sample is more likely have mostly As and less likely to have mostly Ds than the fuller 1980 sample. (These comparisons were made based upon student self-reported grades, which are distinct from transcript-recorded grades.) They also score higher on the arithmetic-reasoning test administered by the NLSY97, and are less likely to have been suspended. However, the two samples are similar with respect to gender composition, age, household size, residence region, and school type, as well as absences. They are also comparable in terms of CTE program participation, across all types of programs.

We also compared our results on some basic coursetaking patterns to those found in other nationally representative data sets, such as High School and Beyond, National Education Longitudinal Study, and the High School Transcript Study (table available upon request). The NLSY97 1980 cohort represents students attending high school sometime between 1994 and 2000, depending on the year of graduation. Therefore, the data is mostly comparable to the later survey time points shown for the High School Transcript Study. The NLSY97 sample seems to show a slightly lower percentage of students ever taking a CTE course, while the numbers are close for vocational credits, specific labor market courses, general labor market courses, and family and consumer sciences. The NLSY97 1980 cohort sample shows about 22.4% vocational concentrators (students taking three or more courses in a single SLMP area), as compared to the next most recent survey showing 25% of American students as vocational concentrators. However, this survey was done in 1994, and percentages are likely to have changed by the time the NLSY97 1980 birth cohort was finishing high school.

Data Limitations

As mentioned above, the transcript sample is somewhat limited relative to the entire NLSY97 data set. First, we are missing transcripts for about half of the 1980 birth cohort, making a full-scale analysis of the experiences of that cohort problematic. Second, although we carefully inspected each student’s transcript supplemented by other available information about the student or school, it is possible that one could misinterpret a school’s credit system or grading system. Third, there are some incomplete transcripts. Although this is to be expected given student dropout rates and transfers, it still poses some problems for validity. Nonetheless, given the comparisons we have made with the full 1980 cohort and other national data sets, we feel confident that these data can begin to give us an understanding of current patterns of coursetaking and associations with dropping out of high school.

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