High School Dropout and the Role of Career and Technical Education: A Survival Analysis of Surviving High School

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This article uses data from the National Longitudinal Survey of Youth 1997 to investigate high school dropout and its association with the high school curriculum. In particular, it examines how combinations of career and technical education (CTE) and core academic courses influence the likelihood of leaving school. Hazards models indicate a significant curvilinear association between the CTE-to-academic course-taking ratio and the risk of dropping out for youths who were aged 14 and younger when they entered the ninth grade (not old for grade). This finding suggests that a middle-range mix of exposure to CTE and an academic curriculum can strengthen a student's attachment to or motivation while in school. The same association was not found between course taking and the likelihood of dropping out for youths who were aged 15 or older when they entered high school, thus prompting further consideration of the situation of being old for grade in school settings that remain highly age graded in their organization.

The phenomenon of students dropping out of high school has recently gained renewed attention, with researchers and policy makers wanting to know how many students are dropping out, what causes dropout, and what may be done to prevent it (Bridgeland, DiIulio, and Morison 2006; Heckman and LaFontaine 2007; Orfield 2004). Leaving high school before receiving a diploma often represents a culminating event in a long-term process of disengagement from formal education (Alexander, Entwisle, and Kabbani 2001; Finn 1989). Understanding this process requires the consideration of students' traits (some invariant, some malleable) and the social organization of the school, home, and neighborhood.

One important aspect of the school environment is the formal curriculum—the set of courses taken by a student. 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 social connections, boredom, or discouragement. The combination of all courses taken throughout a high school career significantly defines a student's place within the social organization of the school and determines, in part, the paths that a student follows after high school.

One domain of the high school curriculum that has been both lauded and criticized for its potential effects on educational outcomes, including dropping out, is career and technical education (CTE), also known as vocational education. Some have argued that CTE offers a much-needed point of attachment and demonstrates the relevance of schooling for many youths (Advisory Committee 2003). Others have argued that CTE represents a marginalized part of the high school landscape, one in which mixed messages are sent about the value of schooling and a youth's success as a student (Cavanagh 2005). A series of educational reforms in the 1990s emphasized the importance of taking both academic and vocational courses, so that students were prepared for the transition to college and work (Castellano, Stringfield, and Stone 2003).

In this article, we use data from the National Longitudinal Survey of Youth 1997 (NLYS97) to estimate hazards models of the relationship between CTE course taking and high school dropout for a recent cohort of students. Our analyses reveal a curvilinear association between the CTE-to-academic course-taking ratio and the risk of dropping out for youths who were "on time" for grade progression (i.e., younger than age 15 on entering the ninth grade). We interpret this finding as revealing that a middle-range mix of exposure to CTE and the academic curriculum can strengthen a student's attachment to or motivation while in school. We do not find the same significant association between course taking and the likelihood of dropping out for youths who were 15 or older on high school entry, prompting further consideration of the implications of being old for grade in school settings.

BACKGROUND

Research on Dropping Out

Research on dropping out of high school has highlighted a web of sociological, psychological, economic, and institutional factors that contribute to students leaving high school before they receive a diploma (Allensworth 2004; Fine 1991; Orfield 2004). Furthermore, studies have shown that the consequences of dropping out are dramatic and costly—for both individuals and the society. The negative outcomes associated with dropping out include a higher likelihood of unemployment, a greater chance 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; Mishel and Bernstein 1994; National Research Council, NRC, 1993; Rumberger 1987).

Rumberger (2001) reported that despite a long-term upward trend in high school completion in the United States, approximately 5 percent of all high school students drop out of school in any given year.[1] A substantially higher proportion of students leave school for a significant span of time sometime during their educational careers before they receive a high school credential. Klerman and Karoly (1994) estimated that 37 percent of a national sample of young men who were aged 14–21 in 1979 quit high school for at least three months sometime before they completed high school. Rumberger and Lamb (2003) reported that 21 percent of students from the National Education Longitudinal Study of 1988 (NELS:88) cohort dropped out of school at some point after the eighth grade but before they completed high school. In both studies, many of those with spells of dropping out ultimately returned to complete a high school credential. However, as past research has shown and the present analysis reiterates, any time away from high school increases the risk of never obtaining a credential.

Finn (1989) offered two social-psychological perspectives to explain dropping out. Following a frustration–self-esteem model, he 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. Following a participation-identification model, he posited that positive experiences encourage a sense of belonging and thus strengthen attachment to school. Rumberger (2004) drew on both individual and institutional perspectives to understand decisions to quit school. The individual perspective focuses on a student's values, attitudes, and behaviors and considers dropping out of school to be the final stage in a cumulative process of academic and social disengagement from school. The institutional perspective situates individual attitudes and behaviors within the broader settings or contexts in which students live, most notably families, schools, and communities.

As we consider factors that affect dropping out, there are also important questions about the timing of dropout and whether the salience of various risk factors is variable over time. Research has noted the difficulty of the ninth-grade transition for many students and its connection to dropping out (Neild and Farley 2004; Roderick and Camburn 1999). Therefore, it is important to ask whether the effects of various independent variables are constant or nonconstant as the high school career progresses. As one example of such an inquiry, Swanson and Schneider (1999) studied the effects of mobility (both change of residence and change of schools) on educational achievement and social outcomes. They found that the effects of mobility (particularly a change of schools) were nonconstant over time. Specifically, they detected effects that were somewhat negative in the short term but ultimately beneficial in the long term.

As we model the likelihood of dropout, one can imagine several instances in which the effects of independent variables may be nonconstant over time. For example, past studies have noted that there are both academic and social causes of dropping out (Goldschmidt and Wang 1999; Rumberger and Larson 1998). There is reason to ask whether the relative importance of the academic and social realms shifts over time. If students are especially reactive to academic successes and failures early in high school, but more attuned to social attachments later, we may expect the effect of grade point average (GPA) on the likelihood of dropout to be strong and positive in the early months of high school but weaker in later months.

As another example, past research has identified the role incompatibilities that come with being "off-time" or older than one's classmates as a significant strain that can lead to dropping out (Entwisle, Alexander, and Olson 2004; Jimerson, Anderson, and Whipple 2002; Roderick 1994). One can imagine that such strains for those who are old for grade would become especially pronounced as they reach age 17, 18, or 19 when lures toward adult (and nonstudent) roles and identities become especially pronounced. If this were the case, one would expect to find that being old for grade would have a positive association with the risk of dropout at all points in the high school career, but with increasing intensity as one proceeds through high school.

A related issue is whether being old for grade may act as a moderator that affects the strength of association between other independent variables and the likelihood of dropout (Baron and Kenny 1986). For example, students who enter high school old for grade may carry so many risk factors and academic deficiencies that any potential benefits of a particular curricular program are lost on them. Given these possibilities, we examine whether the relationship between course taking and the likelihood of dropout differs according to age at entry into the ninth grade.

CTE

In this article, we explore whether CTE, in combination with academic courses, predicts dropping out. CTE has evolved from what has traditionally been called vocational education. Whether this evolution has been dramatic is open to debate (DeLuca, Plank, and Estacion 2006; 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 15 years, there have been efforts to improve vocational education programs not only to prepare students for jobs, but to increase their educational attainment. Recent federal legislation presents a vision of CTE that involves not only the development of labor market skills, but the integration of CTE and academic subjects, the erasure of the stigma often attached to vocational education, and the provision of pathways to both postsecondary education and employment (Castellano et al. 2003; Lynch 2000).[2]

Formal high school courses that are typically categorized as CTE 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, NCES 1999). Family and consumer sciences courses include home economics, child development, foods and nutrition, and family relations. General labor market preparation courses include basic keyboarding, exploratory industrial arts, college and career planning, and 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, and child care and education. SLMP courses are a combination of classroom-based learning experiences, cooperative education, and other workplace learning.

Although not every U.S. high school offers comprehensive CTE programs, most offer some CTE, and the majority of high school students take at least one CTE course (NCES 2001). In recent years, 90 percent to 96 percent of U.S. high school graduates have taken at least one CTE course during high school (DeLuca et al. 2006; Levesque et al. 2000). The average number of Carnegie units earned in CTE among graduates in 2000 was 3.8, out of an average of 26.2 total credits (NCES 2004).

CTE is not without its critics, and its place within the American high school is not especially secure. Recent federal budget debates, occurring at a time when greater emphasis is being placed on testing and core academic areas, have questioned the effectiveness and merit of CTE (Cavanagh 2005). Some have portrayed CTE as a dumping ground in which unmotivated youths encounter low expectations and outdated training. In past decades, research on tracking has often portrayed vocational education as a domain in which poor and minority youths are disproportionately concentrated, with these students experiencing courses with little rigor and limited learning opportunities (Gamoran and Mare 1989; Oakes 1985; Vanfossen, Jones, and Spade 1987). However, proponents view CTE, when implemented properly, as an important part of the high school environment and a valuable source of attachment, motivation, and learning, especially for non-college-bound students (Arum 1998; Castellano et al. 2003; Rosenbaum 2001).

Part of the disjuncture between the pessimism of the older literature on tracking and the optimism of more recent commentaries on CTE stems from perceptions that a genuine transformation has taken place in the way that occupationally based themes are presented to high school students. The "new" vocational education has been touted as having considerable potential to enhance students' engagement with school and integrate academic content with occupational applications (NRC and Institute of Medicine 2004). In schools that have embraced the "new" vocational education, fairly broad occupational themes are often featured, such as health occupations rather than nursing or industrial production instead of welding. These theme-based settings are intended to offer students considerable autonomy in selecting tasks and methods of learning and in constructing meaning (Advisory Committee 2003; Stone 2000). This approach contrasts with the narrow focus of the older model of vocational education that often attempted to prepare individuals for specific entry-level jobs. We are limited in our ability to discern from the present data how much of the sample members' exposure to CTE can accurately be called "new" vocational education, as opposed to the older model, but we consider these issues again in our concluding section.

CTE and Possible Links to Dropping Out

The question of whether vocational education, or CTE, has a causal connection to dropping out has been posed by researchers periodically for several decades (e.g., Agodini and Deke 2004; Bishop 1988; Catterall and Stern 1986; Combs and Cooley 1968; Grasso and Shea 1979; Mertens, Seitz, and Cox 1982; Perlmutter 1982; Pittman 1991; Rasinski and Pedlow 1998). Despite fairly frequent attempts to address the issue, a clear and consistent answer has not emerged. Reviewing 30 years of studies, Kulik (1998) concluded that participation in vocational programs increases the likelihood that non-college-bound youths will complete high school. Specifically, he estimated that any participation in CTE decreased the dropout rate of such youths by about 6 percent. Despite Kulik's overall conclusion of a positive effect of vocational education on completing high school, some studies have found no such effects (e.g., Agodini and Deke 2004; Pittman 1991).

Another perspective on the relationship between CTE and dropout, drawn from the literature on tracking, suggests a negative relationship. Classic work in the field has highlighted the low quality of the content and teaching in vocational tracks and has demonstrated that the vocational track is often used as a remedial track, serving as a way to remove poor-performing students from classes with their college-bound peers (Oakes 1985; Rosenbaum, 1978). Kang and Bishop (1989) also noted that many students who may be on the verge of dropping out enroll in vocational courses so they can acquire some job-related skills before they leave. Both the channeling and self-selection processes create a situation in which students become increasingly detached from school as a result of unpleasant experiences in these vocational courses.

However, many of these studies were conducted before the federal legislative initiatives in the 1990s that attempted to reform the nature of vocational education by emphasizing an integrated approach to CTE and academic courses. A 2003 report of the Advisory Committee for the National Assessment of Vocational Education suggested that combining academic courses with CTE courses can be a powerful experience for students, keeping them attached to school and motivating them to complete their diplomas. For example, CTE can appeal to different learning styles and interests because the programs directly connect academic skills in the classroom with real-world activities in the workplace. CTE classes can also clarify the value of academic classes by specifying the skills that are needed to succeed in careers of interest, thereby leading students to see a greater value associated with staying in school. Participation in CTE programs may also encourage some students to define their career goals, thus keeping them interested in school (Advisory Committee 2003).

Explained another way, blending CTE with academic work may increase students' engagement, a concept that has been shown to be strongly related to academic achievement and attainment (Connell, Spencer, and Aber 1994; Marks 2000; NRC and Council of Medicine 2004). Past research directs our attention to the ways in which curricular arrangements can affect behavioral, emotional, and cognitive domains of engagement (cf. Fredricks, Blumenfeld, and Paris 2004). The effects of a curriculum can be profound, especially if emotional and cognitive connections are forged for students as they connect their present academic preparation with future goals. In our work, it is important to consider whether any observed associations between students' course taking and the likelihood of dropping out can be explained by arguments about engagement. Our data did not allow us to test important mediating mechanisms involving engagement, but we use the literature on the topic to guide our interpretation of findings.

Models of the Relationship Between CTE and Dropout

To study the relationship between high school course taking and dropping out, we needed an appropriate way to measure a student's curricular experience. In an era in which rigid track definitions (e.g., college preparatory or purely vocational) do not always neatly apply (cf. Lucas 1999), it is useful to examine curricular exposure along a continuum of CTE and academic course taking. For any academic term, 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] This ratio allowed us to summarize a student's location within the curriculum when students were observed to combine CTE and academic courses in many ratios and qualitative patterns.

We offer four competing hypotheses about the relationship between the CTE-to-academic course-taking ratio and the likelihood of dropping out once other relevant factors (prior test scores, high school GPA, gender, race, and socioeconomic status) have been controlled. The first possibility is a positive linear relationship, suggesting that a higher proportion of CTE courses leads to dropout. This possibility follows from some previous research on tracking, which suggested that increased levels of CTE course taking may represent a student being channeled into low-level classes and away from core academic learning opportunities, thus raising the likelihood of the student leaving school. The second possibility is a negative linear relationship between CTE and the likelihood of dropping out, consistent with the expectation that high levels of CTE are beneficial. This possibility suggests that when students have the opportunity to concentrate in CTE, they are more likely to stay in school because more individually relevant and satisfying choices are available to them. The third possibility is no effect—consistent with the idea that the substance of course taking itself has no independent effect on the likelihood of dropping out once other relevant factors have been controlled.

The fourth possibility is a curvilinear relationship by which the likelihood of dropping out initially decreases as the CTE-to-academic ratio increases, but only up to a point. Beyond this point, the likelihood of dropping out increases as the CTE-to-academic ratio increases. Previous work found that a ratio of approximately three CTE courses to every four academic courses was associated with the lowest odds of dropping out of high school (Plank 2001). Ratios either higher or lower than 3 to 4 were associated with an increased risk of dropping out, and this association was especially salient for individuals with poor academic performance.

While this earlier finding is intriguing, there are certain methodological shortcomings 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 (cf. Willett and Singer 1991). When one studies the effects of course taking (and other time-varying independent variables of interest), there is a potential problem of reverse causality (Kang and Bishop 1989). Students generally take more CTE courses in the last two years of high school (Levesque et al. 2000), and therefore any observed association between course taking and CTE may be driven by the fact that only those who persisted to the final years of high school could attain a relatively high (or, at least, middle-range) CTE-to-academic ratio. Our study addressed these issues by using hazards models to account appropriately for the timing of course taking and its relationship to dropout.

METHODS

Sample

We used the NLSY97, which tracks a nationally representative sample of 8,984 youths in the United States who were aged 12 to 16 as of December 31, 1996. Annual interviews collect detailed information about educational, developmental, and labor market experiences. In addition to survey data from the sampled participants, we also used interviews with parents and high school transcripts. We focused on a subsample of the oldest NLSY97 participants—those born in 1980—and used data from Rounds 1–3, extending to Round 5 to establish the date of a high school diploma or receipt of a general equivalency diploma (GED). Round 1 interviews were conducted from February 1997 to May 1998 when the sample members were aged 16 years, 2 months, to 18 years, 3 months. The Round 1 questions asked of the youths and their parents covered past schooling events and statuses as well as current conditions. The Round 3 interviews occurred when the sample members were aged 18 years, 10 months, to 20 years, 3 months.

We measured whether an individual experienced a dropout event between his or her initial entry into the ninth grade and the time of the Round 3 interview. Following the 1980 cohort members until they were 18.83 years to 20.25 years allowed for a comprehensive analysis of their high school careers, dropping out, and completion of degrees without severe problems of right-censored dropout or graduation times (events that occurred after the observation ended).

The initial descriptive analyses were for 1,628 cases, representing all NLSY97 sample members born in 1980, except for 63 who were removed from the analyses for valid reasons (e.g., had never enrolled in the ninth grade or a higher grade by the time of the Round 1 interview). Sampling weights were used in generating descriptive statistics based on the 1,628 cases to generalize to a national population. For the hazards models, we were constrained to 846 individuals for whom transcript data were available (see Appendix B for the availability of data from transcripts and our data-preparation steps). For the estimation of hazards models, sampling weights were not used, as is discussed next.

Modeling Strategy

This article presents estimates from Cox regression models, the most commonly used variant of hazards models (Allison 1995). Hazards models 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 and Singer 1991). 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 various lengths of exposure to risk among the participants in a study are addressed by hazards models in ways that a standard logit model with one record (or observation) per participant cannot address. When time is treated as continuous (as it is in our analyses), what is modeled is the instantaneous risk that an event will happen at Time t, given that it has not occurred before Time t. An intuitive notion of risk will be useful to keep in mind as we assess whether changes in covariates are associated with increases or decreases in a student's risk of dropping out of high school.

The final models presented here are nonproportional hazards with time-varying covariates.[4] The general model can be written as follows:

$$h_i(t) = \lambda_0(t)\exp\{\beta \mathbf{X}_i + \beta \mathbf{X}_i(t)\}. \qquad (1)$$

Equation 1 indicates that the hazard for individual *i* dropping out of school at Time t, given that he or she has not dropped out before t, is the product of two factors: (1) a baseline hazard function $\lambda_0(t)$ that is left unspecified, except that it cannot be negative, and (2) a linear function of a set of fixed and time-varying covariates, which is then exponentiated. For our analyses, the observed risk period began with the first month in which an individual attended the ninth grade and ended when an individual experienced a dropout event for the first time. The period could also end with the receipt of a high school diploma, or right-censoring via the occurrence of the Round 3 interview (or the Round 1 or Round 2 interview if later interviews were not completed). Our unit of analysis was the person-month, with varying start months, length-of-risk period, and methods of leaving the risk set.

Sampling weights were not used in the estimation of the hazards models with our subsample of 846 cases. We followed the recommendations of NLSY97 documentation and technical staff at the Center for Human Resource Research at Ohio State University (2006; J. Zagorsky, personal communication, June 26, 2007). Given our subsample generated by dropping a large number of observations with unavailable transcript data and our application of regression-based techniques, unweighted analyses are recommended. We view the unweighted subsample analyzed via hazards models as a diverse group, comprised of individuals from across the United States, not as a sample that directly reflects the demographic or social composition of U.S. youths born in 1980.[5]

Variables

Dependent Variable The dependent variable in the hazards models indicates the event of being away from school for 30 days or more for a reason other than vacation at some time after initial enrollment in the ninth grade. Information about a spell away from school—and the reason for such a spell—came from the youths' and parents' reports.[6] The dropout event was linked to the month of the high school career in which it occurred.

Ascriptive Traits Prior studies led us to expect that females would be less likely to drop out, but that this effect would attenuate as achievement and other school experiences were introduced into the models (Goldschmidt and Wang 1999; Rumberger 1987). Therefore, we included in our models an indicator for female, with male as the excluded reference category. Indicators for black, Hispanic, Asian, and "other race/ethnicity" were used, with white as the excluded reference category. Past research has shown that dropout rates in the United States are higher for black and Hispanic youths than for white and Asian youths. However, some studies have shown that once family and socioeconomic background are controlled, minority disadvantage in persistence in school is fully accounted for or even reversed (Hauser, Simmons, and Pager 2004). When presenting such a finding, Hauser et al. suggested that other things being equal, minorities would stay in school longer than whites because they lack attractive opportunities outside school.

Family and Residential Context To reflect cultural and financial resources in the home, we included the highest grade completed by a residential parent and the natural log of household income. Household structure was represented by indicators for living with the biological mother only, living with the biological father only, living with one biological parent and one stepparent, and "other" household arrangement, with living with both biological parents the excluded reference category. Prior research led us to expect that children who live with single parents (Krein and Beller 1988; McLanahan 1985) or stepparents (Astone and McLanahan 1991) will drop out at higher rates than will children who live with both biological parents (called "intact" families in much of the literature). Our models were structured to examine whether aspects of academic achievement and course taking account for differences in dropout rates that may be observed between intact and nonintact families. An indicator of living in an urban area, with nonurban areas as the excluded reference category, was included as an important control variable because dropout rates have consistently been shown to be the highest in urban locations (Balfanz and Legters 2004; Hauser et al. 2004).

Proxies for Academic Preparation and Prior Achievement As a proxy for academic preparation and performance, we used the mathematics knowledge subscore from the computer-adaptive form of the Armed Services Vocational Aptitude Battery (ASVAB). This test was administered between summer 1997 and spring 1998 and thus is not an academic performance that was measured before our sample members started high school. Nonetheless, we interpret it as an indicator of academic preparation, heavily determined by pre-high school academic development. Early academic performance was also captured via a self-reported eighth-grade GPA (which was used as the initial value for our time-varying GPA covariate and was replaced by another value only when the first high school term was completed).

We also included age at ninth-grade enrollment, measured in months. For some aspects of our modeling, this variable was treated as continuous. For other purposes, we split it at age 15 (180 months) to distinguish those who were old for grade on entering the ninth grade from those who were not. In most cases, of course, those who were old for grade experienced retention at some point before high school. We used age at enrollment, rather than an indicator of retention, because prior research has shown that being old for grade explains virtually all the association between retention in grade and the risk of dropping out that is not already explained by early academic performance (Roderick 1994).

Time-varying Covariates Characterizing the High School Experience Observed values for some independent variables could change for each month an individual was in the risk set for dropping out.[7] Therefore, our models included the following time-varying covariates: GPA achieved during the most recently completed term, the ratio of CTE credits to academic credits earned during the most recently completed term, and the square of the CTE-to-academic ratio for the most recently completed term. Both a first-order and a squared term were included to allow us to detect a curvilinear association between the course-taking ratio and the risk of dropping out.

Appendix Table A1 presents unweighted descriptive statistics for the dependent and independent variables for the analytic sample of 1,628 individuals and the transcript subsample of 846. The transcript subsample had a lower proportion of dropouts than did the full sample, largely because dropouts have interrupted or irregular high school careers and thus it is sometimes difficult to obtain complete transcripts for the terms they were in school. Appendix Table A1 also shows that the transcript subsample, as compared with the full sample, had somewhat higher proportions of white students, females, and households with two biological parents and slightly higher family incomes, levels of parental education, and ASVAB scores.

RESULTS

A First Look at Dropping Out

Table 1 shows that by the Round 3 interview, 20.8 percent of the individuals in our full analytic sample had at least one dropout spell, defined as 30 days away from high school for a reason other than vacation. Table 1 shows that 80.4 percent of the sample members had attained a traditional diploma by the Round 5 interview period, an estimate that includes recipients of diplomas who had experienced one or more spells of dropout before they graduated. Clearly, though, even one spell away from school greatly reduces the odds of eventually receiving a high school diploma or another credential. Additional analyses (not shown) revealed that those with a dropout event by Round 3 had only a 27.8 percent chance of earning a traditional diploma by Round 5 and a 45.9 percent chance of attaining any high school credential. In contrast, the figures for those without a dropout event by Round 3 were 94.2 percent and 94.4 percent, respectively.

Table 1 also shows attainment outcomes by race and ethnicity, gender, eighth-grade GPA, residential parents' highest grade completed, and age at entry into the ninth grade. Black and Hispanic students were significantly more likely than white students to drop out by Round 3 and significantly less likely to receive a diploma or any high school credential by Round 5. Males were somewhat more likely than females to drop out and less likely to receive diplomas or GEDs. Both eighth-grade grades and parental education were related to dropping out and the completion of high school in the expected directions, with striking differences across levels. Finally, those who were aged 15 or older when they entered the ninth grade dropped out at a much higher rate than did those who were younger than 15 when they entered the ninth grade.

Figure 1 shows the distribution of age at the time of the first dropout spell for the 379 individuals who had such a spell. The values range from 13 years, 8 months, to 19 years, 9 months, and the median is 17 years, 2 months. There is an increase in the incidence of dropping out as the 16th birthday approaches and again as the 17th birthday occurs. The sparser concentration of dropout events after approximately age 18 years, 6 months, is driven by at least three factors: (1) Many of those who were at a relatively high risk of dropping out had already experienced the event by that age and thus exited the risk set for first dropout occurrence, (2) many people had graduated from high school by that age and thus exited the risk set, and (c) some people had their Round 3 interviews soon after that time and thus had their observations censored.

Figure 2 translates age at the dropout event into months after initial entry into the ninth grade and shows that first dropout spells

Table 1. Frequency of High School Dropout, High School Diploma, or Any High School Credential for Members of the NLSY97 Sample Who Were Born in 1980 (weighted, *N* = 1,628)

Variable	Dropout Event by Round 3 Interview	High School Diploma by Round 5 Interview	Any High School Credential by Round 5 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 Grade Point Average			
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
Age at Ninth-Grade Enrollment			
< 15	12.7	88.8	90.9
≥ 15	39.9	60.6	68.9

occurred with considerable frequency both early and late in high school careers. The difficulties of the 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 their initial entry into the ninth grade. For others, dropout spells occurred after 30, 40, or even 48 months of high school, revealing that the problem of dropping out is not concentrated exclusively in the early years of high school.[8]

The wide distribution of the timing of dropout prompts the question of whether different factors are more influential or less influential at different stages of the high school career. The hazards modeling addressed this question.

Results of Hazards Models

Table 2 displays exponentiated coefficients—that is, multiplicative effects on the hazard ratio—from a series of four estimated models. Exponentiated coefficients significantly greater than 1 indicate that a covariate is associated with an increased risk of dropping out, while those significantly less than 1 indicate a reduced risk of dropping out.

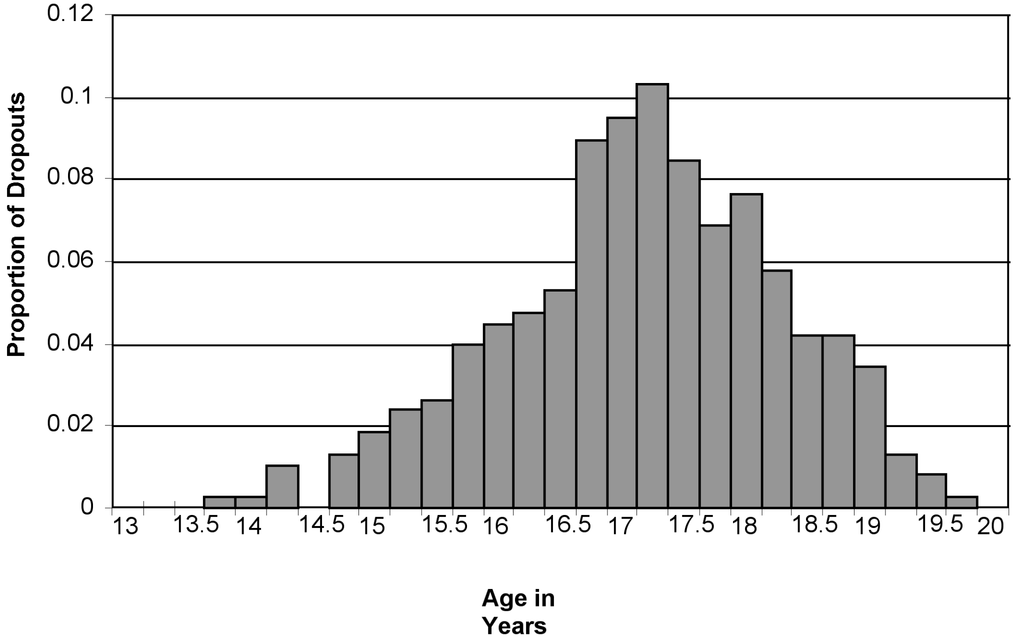

Figure 1. Distribution of Ages at the Time of the Dropout Event (first event after entry into the ninth grade) (*n* = 379)

Model A includes sex and race/ethnicity. Only the coefficient for Hispanic students is statistically significant, showing that a Hispanic student has a dropout risk that is 76 percent higher than that of a non-Hispanic white student (controlling for gender). Coefficients for females and black students are not statistically significant, although they are in the directions that previous research would predict.

Model B adds household characteristics and urban location. As expected, higher parental education is associated with a reduced risk of dropping out. Living with one's biological mother only, with one's biological father only, or with 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 lose their significance as various intervening variables are introduced in Models C and D. It appears that the lower academic performance and delayed entry into high school that are sometimes associated with nonintact family structures account for much of the elevation of dropout rates that were initially estimated for the children living in these families. Living in an urban area is associated with a 78 percent greater risk of dropping out than what is estimated for living in a nonurban area.

In Model B, Hispanic youths no longer show an elevated risk of dropping out after parental education and other factors have been controlled. This finding is consistent with previous findings that much of the observed difference in dropout rates among racial/ethnic groups can be attributed to differences in family and community characteristics (Fernandez, Paulsen, and Hirano-Nakanishi 1989; Hauser et al. 2004). Also, the lack of significance for household income is noteworthy, especially when coupled with the significance of parental education. This finding suggests 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 the ASVAB score and age at entry into the ninth grade. Higher ASVAB scores are associated with a significantly

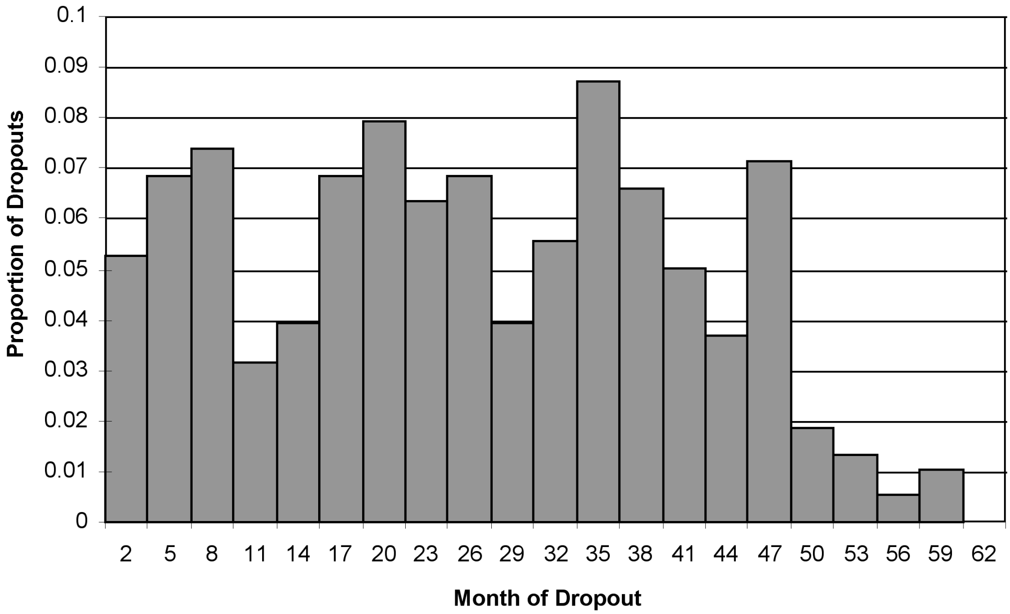

Figure 2. Distribution of the Month in Which the Dropout Occurred (relative to the initial entry into the ninth grade) (*n* = 379)

lower risk of dropping out. Age at entry into the ninth grade significantly predicts dropout, with the interpretation that starting high school a year later increases the risk of dropping out by a factor of more than 3.[9] In this model, black students have a lower risk of dropping out than do white students—a finding that emerges once both socioeconomic status and performance on standardized tests are controlled.

Model D adds time-varying covariates for GPA and the CTE-to-academic course-taking ratio. Higher ASVAB scores and a higher GPA in the most recently completed term are associated with a reduced risk of dropping out. Urban residence and each additional month of age at entry into the ninth grade are associated with an elevated risk of dropping out.

The estimates for the effects of the CTE-to-academic ratio suggest a U-shaped function, as evidenced by the facts that the first-order term's estimated effect on the hazard ratio is less than 1.0 while the squared term's estimated effect is greater than 1.0.[10] These two terms generate a curve with a point of inflection where the course-taking ratio equals 0.46, or where roughly one CTE credit is earned for every two core academic credits. However, in contrast to previous research, the first-order term is not significant and the squared term is only marginally significant ($p < .10$). An exploration of the data makes clear that the differences in the estimates for the course-taking ratio between previous research and the present results are largely driven by the exclusion or inclusion of age at entry into the ninth grade, as we detail later.[11] While the first-order and squared terms for the course-taking ratio are not significant individually, their inclusion as a pair significantly improves the fit of the model. It is for this reason (having conducted omnibus tests of significance) that we cite a slight U-shaped pattern for the effect of the CTE-to-academic ratio on the risk of dropping out.[12]

High School Entry Age as a Contingency

Prior studies and our empirical findings suggest the need to explore further the contingencies that are associated with age at entry into high school. As reflected in Tables 1 and 2, students who were old for grade on entry into high school dropped out at higher rates. Older students are also more heavily concen-

Table 2. Effects on Hazard Ratio (based on the Cox nonproportional hazards model of dropping out) for Members of the NLSY97 Sample Who Were Born in 1980 with Available Transcript Data (n = 846)

Variable	Model A: Gender and Race Only	Model B: With Household Characteristics and Urban Location Added	Model C: With ASVAB and Age at Ninth-grade Entry Added	Model D: Final Model
Female	0.78	0.73+	0.72+	0.85
Black	1.45	0.95	0.59*	0.53*
Hispanic	1.76*	0.86	0.88	0.88
Asian	0.46	0.40	0.52	0.66
Other race/ethnicity (nonwhite)	0.74	0.64	0.75	0.77
Parents' highest grade completed		0.83***	0.89**	0.89**
ln(household income)		0.95	0.98	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***	0.65**
Grade point average (most recent term)				0.56***
CTE-to-academic ratio (most recent term)				0.27
CTE-to-academic ratio^2 (most recent term)				4.13+
Age (months) at ninth-grade entry			1.11***	1.11***
Reduction in -2 log likelihood from model without covariates	10.11	60.42	168.12	193.34
df	5	12	14	17
p	.0723	< .0001	< .0001	< .0001

+$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

trated than are younger students at the medium and high levels of the CTE-to-academic ratio at any given point in the high school career (see Appendix Table A2).

Since age at entry into high school partly determines high school course taking and is associated with the risk of dropping out, we took the initial step of controlling for it before we interpreted the effects of course taking (see Table 2, Model D). However, a further question is whether the association between the course-taking ratio and the likelihood of dropout is fundamentally different for students who enter high school at different ages. To address this question, we reestimated Model D separately for two subgroups—those who were younger than 15 years old at entry into high school (see Table 3, Column 1) and those who were age 15 or older at entry (see Table 3, Column 2).[13]

The estimated models for the two subgroups are different. For the younger subgroup, age at entry into high school is not a significant predictor of dropout. While there was variation in the age at entry into high school for this subgroup, this variation was not systematically associated with the likelihood of dropping out independent of other

Table 3. Effects on Hazard Ratio (based on the Cox nonproportional hazards model of dropping out) for Two Subsamples Defined by Age at Initial Entry to the Ninth Grade (*n* = 846)

Variable	Younger than Age 15 at Initial Entry to the Ninth Grade (*n* = 653)	At least Age 15 at Initial Entry to the Ninth Grade (*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
Grade point average (most recent term)	0.57**	0.53**
CTE-to-academic ratio (most recent term)	0.04*	0.92
CTE-to-academic ratio^2 (most recent term)	21.42**	1.69
Age (in months) at ninth-grade entry	1.01	1.17***
Reduction in -2 log likelihood from the model without covariates	74.14	65.23
df	15	15
p	< .0001	< .0001

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$.

variables in the model. The effect of ASVAB scores is significant, with higher scores associated with a lower risk of dropping out. All three time-varying predictors—GPA, the first-order term for course-taking ratio, and the squared term for course-taking ratio—are significant. A higher GPA is associated with a lower risk of dropping out. The association between the course-taking ratio and the risk of dropping out is characterized by a pronounced U-shaped function (with a point of inflection at 0.54). The lower curve of Figure 3 illustrates how the coefficients for the CTE-to-academic course-taking ratio translate into changes in the log hazard of dropping out for the younger subgroup.

To aid in interpreting this U-shaped pattern for the lower curve, consider two hypothetical students who are alike on all independent variables except the course-taking ratio. Hypothetical Student A took one CTE course for every two academic courses in the most recently completed term, while Student B took no CTE courses. These students, with their CTE-to-academic ratios of 0.5 and 0.0, respectively, differ in their predicted log hazards by a quantity of 0.903 (see Figure 3). By exponentiating the additive effects from the model of log hazards, we can restate this finding: Hypothetical Student A, who struck the middle-range mix of CTE and academic courses, has a risk of dropping out that is only 40.5 percent as great as Student B's.

For the older subgroup (those who were

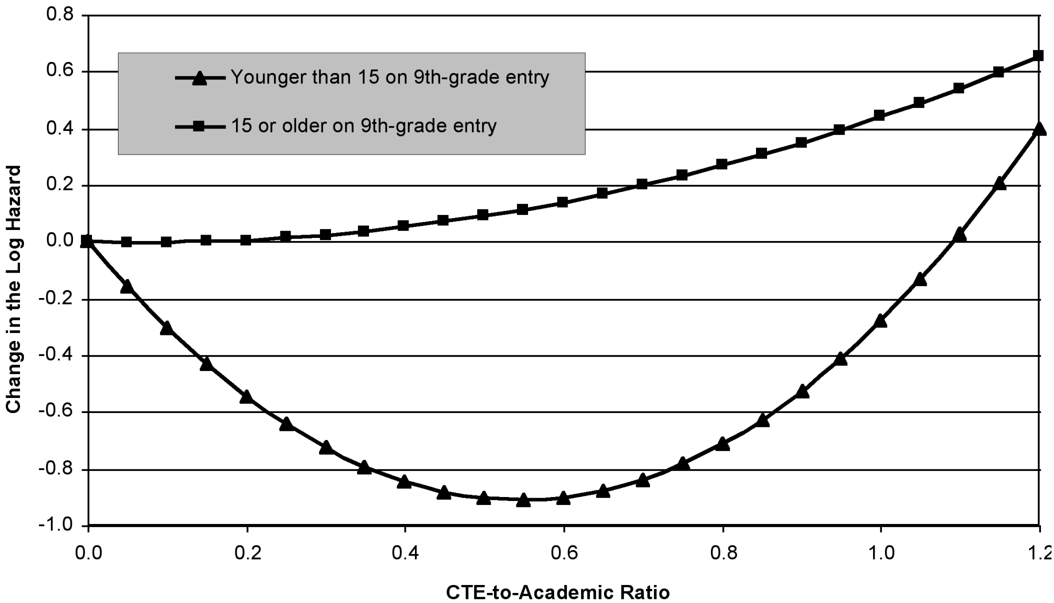

Figure 3. Estimated Effects of the Course-Taking Ratio on the Log Hazard of Dropping Out for Two Subsamples Defined by Age at the Initial Entry into the Ninth Grade

15 or older at entry into the ninth grade), the ASVAB score is not a significant predictor of dropping out, nor are the course-taking coefficients. The effect of the course-taking ratio on the log hazard of dropping out for the older subgroup is depicted in the upper curve of Figure 3. The plotted curve sweeps upward as the course-taking ratio increases, but this is not significant and is therefore statistically indistinguishable from a flat line. For the older students, GPA in the most recently completed term is significant. Finally, age at entry into the ninth grade is significant (with each additional month of age bringing an increased risk of dropping out).

It appears that for those who are old for grade on entry into high school, age is such a strong correlate of dropping out that it swamps most other effects. It is not just that the older students as a group drop out at relatively high rates, but that each additional month that a student is older at entry into high school brings an increased risk of dropping out. The findings that grades but not ASVAB scores are a significant predictor of dropping out for the older subsample suggests that weaknesses in academic performance may not be the only factor that leads older students to disengage from school; other likely causes include various aspects of the social realm and social stigma.

Time as a Contingency

In addition to examining variation by age at entry into the ninth grade, we also explored whether the effects of the independent variables were constant or nonconstant over time. We found only a single significant interaction effect: a negative coefficient for the interaction of age at entry into the ninth grade with time for the subsample of 846 cases. Earlier in this article, we offered a scenario under which increasing effects of age at entry would be expected as the high school career progressed. Instead, the estimated model showed decreasing effects of age at entry as the high school career progressed. The most straightforward explanation for such a finding has to do with the distribution of age at a particular point in time and state laws about the age at which dropping out is legal (generally 16 or 17). Early in high school, younger students are constrained by such laws, while students who are the oldest for their grade often are not; therefore, age makes a difference during this stage of schooling in determining who will decide to leave school. Later in the high school career, as almost all students reach the legal age for leaving school, age plays less of a role in determining which students are most likely to drop out.

DISCUSSION

Our results suggest that for students who are of the modal age or young for grade at the time of high school entry, some CTE, combined with core academic course taking, may decrease the risk of dropout—but only up to a point. A combination of approximately one CTE course for every two core academic courses is associated with the lowest risk of dropping out after other variables in our models are controlled. Being below this point (taking few or no CTE courses) or being above this point (concentrating on CTE to the exclusion of adequate academic preparation) implies an increased risk of dropping out. Our models also revealed significant negative effects of scores on standardized tests and GPA in the most recently completed term on the likelihood of dropping out. The results for course taking, test scores, and grades on report cards jointly support Finn's (1989) model of the frustration that can come with poor performance and the sense of belonging and identification that can come with positive curricular (and extracurricular) experiences.

Although our analyses do not provide direct evidence for these processes, we speculate that some combination of behavioral, emotional, and cognitive engagement is often maximized for students when CTE and core academics are experienced together. To understand why more engagement may be expected for students who combine CTE and academic courses, it is necessary to understand the positive and negative consequences of CTE. On the one hand, CTE may help students more readily see the value of school in preparing them for careers of interest and can encourage students to define their career goals. By connecting school with the transition to adulthood and a career, CTE can clarify the application and value of academic subjects as they pertain to jobs or perhaps the postsecondary education that is needed for a career of interest, thereby keeping youths engaged with school. However, if a student is channeled toward a segregated vocational part of the curriculum, where there are few connections to academically focused teachers and educationally engaged peers, it is easy to see why persistence in school is tenuous.

In contrast to the results for students who entered high school at normal ages or younger, we found that different concentrations of CTE and academic course taking do not have detectable effects on the likelihood that students who are old for grade will drop out. It seems that the constellation of risk factors or challenges that these older students encounter, such as the strains of incompatible roles, diminishes the extent to which these students are receptive to any potential effects of course taking. Quite likely, to be older than is normal as one proceeds through high school is to be attracted to certain behaviors that are at odds with the life of a typical high school student. Since an older student's scores on standardized tests and grades do not completely account for the effect of age on dropping out, we suspect that social compatibility is also relevant for these adolescents, a possibility that was supported by recent research (cf. Stearns et al. 2007).

Roderick (1994) and Entwisle et al. (2004) reached similar conclusions. In their study of high school dropouts in Baltimore, Entwisle and her colleagues found that the lower academic performance of retained students did not account for the students' elevated risk of dropping out. Therefore, they suggested that the effects of retention on dropping out stemmed from social sources as well because of the pressures that students experience when they are off-time in the age-graded organization of the secondary school. This organization labels students as "behind" or "failures" and adds to the time they must spend in school before graduation. By dropping out, old-for-grade students can shed a punishing role and, instead, seek their desired status through paid work or other means.

LIMITATIONS, FUTURE RESEARCH, AND IMPLICATIONS

Although we believe that the study contributes to an understanding of the high school dropout process, there are several limitations that warrant future research. First, while we strongly suspect that our curvilinear finding is partly due to genuine effects of the balance that a student strikes between career preparation and core academics, it is also likely that the U-shaped pattern is partially driven by unmeasured aspects of what is occurring at a deeper pedagogical level in schools where a middle-range mix is available to students. For example, it could be that where we see students pursuing a middle-range combination of academic and CTE courses, they attend schools that are successfully offering integrated programs and broad occupational awareness and where students have considerable autonomy to design their learning experiences. In contrast, it could be that where we see students taking higher concentrations of CTE, these students are in schools that offer programs that still look a lot like the "old" vocational education and all that it implies for low expectations and disengagement. Additional research is needed to understand where and how the principles of "new" vocational education have genuinely been incorporated into U.S. high schools.

Second, while our use of time-varying covariates for GPA and course taking bolsters causal inference, we have not definitively established a causal relationship between course taking and dropping out. It is likely that there are unobserved characteristics of students that both lead them to select courses and determine whether they complete high school. Certainly, the members of our sample were not randomly assigned to their courses but, rather, guided by their or their families' preferences that we have not been able to model. Matches are also nonrandom because schools make organizational decisions about what courses to offer, and to whom, thus constraining students' curricular choices. To understand this process of selection and assignment, research is needed to describe the rigor and breadth of schools' curricular offerings in both the core academic areas and CTE. Such research should first model a student's access to courses across a wide range of curricular areas, including advanced mathematics, Advanced Placement courses, CTE generally, and CTE organized into coherent sequences that build in their depth and specialization. The effects of taking certain combinations of courses conditional on opportunity should then be assessed. Such an endeavor requires high-quality data about schools' curricular offerings, individual students' course taking, and students' enrollment or dropout status measured with precision.

In terms of practical significance, our study signals the importance of two processes. First, the types of courses that students take may be related to their choices to stay in school. Our findings suggest that some students can be retained in school if they take courses that not only have a traditional academic focus, but that give schooling a connection to careers and technical applications of knowledge. Second, as is consistent with a growing body of research, attachment to school varies by students' retention histories and age on entry into high school. This insight suggests that educators should try to help students who are old for grade reclaim or create a healthy attachment to school and the goal of high school graduation. This goal will not be accomplished simply by directing such students to a particular set or combination of courses. Most likely, additional efforts will be necessary to help these students to feel integrated into the life and activities of the school and to believe that completion of a degree is valuable and possible.

NOTES

1. This figure (approximately 5 percent) follows from the event dropout-rate calculation used by the NCES (see Kaufman, Alt, and Chapman 2004). The rate for a given year is the proportion of youths aged 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 a traditional diploma, a GED, or another credential—by the next October. For

discussions of alternative ways to calculate rates of dropout or high school completion, see Balfanz and Legters (2004), Heckman and LaFontaine (2007), Miao and Haney (2004), and Swanson and Chaplin (2003).

2. We refer to the Carl D. Perkins Vocational and Applied Technology Education Amendments of 1990 and 1998 (P.L. 101-392 and P.L. 105-332, also known as Perkins II and III, respectively) and the School-to-Work Opportunities Act of 1994 (P.L. 103-239).

3. CTE 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 SLMP areas; core academics include all courses in mathematics, science, English or language arts (although not foreign languages), and social studies (including history).

4. For the final models in our tables, it is the presence of time-dependent covariates that makes them nonproportional hazards models. 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 parallel. In contrast, in nonproportional models, the time-dependent covariates change at different rates for different individuals, so the ratios of their hazards cannot remain constant. We also explored interactions of nonvarying covariates with time, which is another situation in which nonproportional models are estimated. All models were estimated using SAS PROC PHREG, 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 after their initial entry into the ninth grade.

5. For the hazards modeling, missing data were treated via multiple imputation, using SAS procedures MI and MIANALYZE (Schafer 1997). The Markov Chain Monte Carlo 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 5 or 10, but that any additional improvements were minimal if more than 20 imputations were used.

6. Details of programming and decision rules used in the construction of variables are available on request from the authors. For the majority of identified dropout events, information provided by a 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 Round 1 interview), only the grade within which the event occurred was known. To allow for analyses that maintained the person-month as the unit of analysis, we conducted a random draw to impute in which month within the school year indicated by the parent the event occurred.

7. Operationally, an individual's values on these covariates changed each time an academic term was completed, as indicated by the school transcript. Depending on one's school, these terms might have been quarters (approximately nine weeks in duration), trimesters, semesters, or—rarely—entire academic years.

8. It is also worth noting in Figure 2 that some dropout events occur during what are generally the summer months. For example, Months 11 and 23 would represent July for many of the sample members (specifically, for those who began the ninth grade in September). We allowed "summer month" dropout times for conceptual reasons. A student might have attended school in June 1997, but then not returned to school until January 1998. We did not declare July 1997 to be the student's dropout month *until* we confirmed that the student was not enrolled in either September or October of 1997, but if indeed the student had not enrolled in either September or October, then we thought it was appropriate to declare July the month in which the student stopped attending school (and perhaps the month in which he or she articulated this decision to himself or herself).

9. 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 exp(12*0.0999) = 3.32.

10. The U-shaped function is perhaps eas-

ier to visualize if we translate Table 2's effects on hazard ratios back into effects on log-hazards to get the following: The first-order course-taking ratio term has an estimated coefficient of -1.31 (natural log of 0.27). The squared term has an estimated coefficient of 1.42 (natural log of 4.13).

11. Including age at entry into the ninth grade is clearly important for a properly specified model. We also pursued further analysis to understand differences among a hazards model using NLSY97 data, a logistic regression using NLSY97 data, and a logistic regression using earlier NELS:88 data (cf. Plank 2001). We concluded that differences among models were driven by changing data sets much more than by changing statistical methods. However, it is unclear whether this finding reveals historical changes and altered educational processes that occurred across five or six years or differences in the methods that were used to measure variables in the two studies. Another relatively small part of the difference between findings from NELS:88 and an NLSY97 hazards model has to do with changing methods (to the more defensible hazards model). The change in methods seems to imply small changes in the strength of estimated effects, thus giving some credence to concerns about reverse causality in the logistic regression results, but overall this does not seem to be a large source of different results.

12. The omnibus tests were used to adjudicate among our four competing hypotheses about the relationship between the CTE-to-academic ratio and the likelihood of dropping out. First, Model D was compared with a model that included neither a first-order term nor a squared term, a specification that is consistent with the hypothesis of "no effect" of course taking. This test yielded a difference in -2LL of 5.86 with 2 degrees of freedom, $p = .0586$. Second, Model D was compared with a model with a first-order term but no squared term, a specification that is consistent with the hypotheses of linear effects (whether positive or negative) of course taking. This test yielded a difference in -2LL of 3.81 with 1 degree of freedom, $p = .0509$. Each test suggested that the curvilinear specification is superior to the alternative (though only marginally so).

13. The model specification for each of the two subgroups and summarized in Table 3 is identical to the specification for Model D in Table 2 except that dummy variables for Asian and other race/ethnicity are not included. Once the sample was split according to age at entry into high school, there were too few students in these categories to estimate meaningful coefficients. Thus, the excluded reference category for race/ethnicity for Table 3 is all adolescents who were neither black nor Hispanic.

APPENDIX A

Table A1. Unweighted Descriptive Statistics for Members of the NLSY97 Sample Who Were Born in 1980 and for the Transcript Subsample

Variable	1980 Cohort (N = 1,628)	1980 Cohort – Transcript Subsample (n = 846)
Ever dropped out (by Round 3 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)	Mean = 10.1, *SD* = 2.0	Mean = 10.4, *SD* = 1.7
Parents' highest grade completed	Mean = 13.2, *SD* = 3.0	Mean = 13.6, *SD* = 2.9
Living with biological mother only	25.7%	21.5%
Living with biological father only	3.1%	2.8%
Living with one biological parent and one stepparent	11.9%	15.1%
Living with two biological parents	48.8%	53.5%
Other household arrangement	10.5%	7.1%
Urban location	74.2%	72.3%
Age (in months) at enrollment in the ninth grade	Mean = 176.9, *SD* = 7.9	Mean = 175.4, *SD* = 6.5
ASVAB: Math knowledge (divided by 1,000)	Mean = 0.24, *SD* = 1.01	Mean = 0.48, *SD* = 0.85

Table A2. Descriptive Statistics for CTE-to-Academic Ratio and Grade Point Average During Months 7, 19, 31, and 43 of the High School Career for Two Subsamples Defined by Age at Initial Entry into the Ninth Grade (*n* = 846)

Variable	Month 7	Month 19	Month 31	Month 43
Subsample Younger than Age 15 (*n* = 653)				
Number still in risk set as of month	650	644	635	589
CTE-to-Academic Ratio				
(most recently completed term)				
25th percentile	0.00	0.00	0.00	0.00
Median	0.10	0.05	0.17	0.25
75th percentile	0.25	0.25	0.33	0.67
Grade Point Average				
(most recently completed term)				
25th percentile	2.40	2.25	2.25	2.30
Median	2.93	2.78	2.80	2.85
75th percentile	3.50	3.33	3.33	3.43
Subsample Aged 15 or Older on Entry (*n* = 193)				
Number still in risk set as of month	187	171	149	111
CTE-to-Academic Ratio				
(most recently completed term)				
25th percentile	0.00	0.00	0.00	0.00
Median	0.20	0.20	0.20	0.30
75th percentile	0.33	0.38	0.50	1.00
Grade Point Average				
(most recently completed term)				
25th percentile	2.00	1.98	2.00	2.06
Median	2.50	2.40	2.43	2.64
75th percentile	3.13	3.00	3.00	3.20

APPENDIX B

Use and Preparation of NLSY97 High School Transcript Data

On the basis of communication with staff at the Center for Human Resource Research at Ohio State University, NORC, and the Bureau of Labor Statistics, we understand that the transcript data are most representative of the 1980 cohort. All the data presented in this article describe the 1980 birth cohort of the NLSY97 sample. While the total sample of youths who were born in 1980 was 1,691, transcript data are available for 873 individuals (or 52%).

Continued

APPENDIX B (CONTINUED)

Timing of Course Taking

The transcript data are intended to provide information on every term for each high school attended by a student. In addition to course titles and grades received for each course, we know the start and stop dates for academic terms. For some transcripts, dates were incomplete; typically, a start or stop month or year or some combination of months and years was incomplete. For a student with missing start or stop dates, we used available information for the academic schedule of that same school, information about the type of term (fall or spring), and information about a student's high school completion date to complete the student's trajectory. In some cases, we followed decision rules based on knowledge of the start and stop months of a typical school system (e.g., the school year generally begins in September).

Credits Earned

For most courses, it is clear how many credits were earned. In a few cases, we corrected obvious data-entry errors (e.g., one course earned 50 credits while every other course earned 0.5 or 1.0 credit). In other cases, a course earned a passing grade although no credits were recorded. We identified these cases and assigned what appeared to be the appropriate number of credits on the basis of other information on the same individual's transcript.

Generalizability

Overall, the transcript subsample matched the 1980 cohort closely, with a few exceptions (see Table A1). The transcript subsample was slightly more advantaged socioeconomically and academically; had more educated parents, a higher family income, and more students living with both parents. In terms of academic achievement, the transcript subsample was more likely to have mostly As and less likely to have mostly Ds than the fuller 1980 sample (on the basis of students' self-reported grades). They scored higher on the ASVAB arithmetic-reasoning test and were less likely to have been suspended. However, the two samples were similar with respect to gender composition, age, household size, region of residence, school type, and absences. They were also comparable in terms of participation in various CTE programs (e.g., job shadowing or apprenticeships). We also compared our results on course-taking patterns to those found in other nationally representative data sets, such as NELS:88 and the High School Transcript Study. The results of these comparisons are available on request and confirm that our NLSY97 1980 cohort was similar in its course-taking patterns to other national samples during the mid- and late-1990s.

Limitations

As we mentioned earlier, the transcript subsample was somewhat limited relative to the entire NLSY97 data set. First, we are missing transcripts for about half the 1980 birth cohort, making a full-scale analysis of the experiences of that cohort problematic. Second, despite careful analysis, it is possible that one could misinterpret a school's credit or grading system. Third, there are some incomplete transcripts, which is to be expected, given students' dropout rates and transfers, but 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 begin to give us an understanding of current curricular patterns and their association with dropping out.

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