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**Time to Dropout from College:
A Hazard Model with Endogenous Waiting***

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Abstract

Using data from the 1979 National Longitudinal Survey of Youth (NLSY79), we investigate the college attendance, dropout and graduate behavior of high school graduates. Bivariate duration models, which allow the unobserved determinants of spell durations to be correlated across spells, are developed and used to study the impact of the waiting time from high school graduation until college enrollment on college dropout and graduation rates. We find that delaying college entry after graduating high school significantly increases the chances of college dropout and reduces the probability of attaining a four year degree. Among those who first enroll in four-year institutions, delaying college entry by one year after high school graduation reduces the probability of graduating with a four-year degree by up to 32 percent in models that account for the endogeneity of delaying enrollment. There is also empirical evidence that the negative impact of delayed enrollment on graduation probabilities varies by Armed Forces Qualifying Test (AFQT) score with the largest estimated impact of delaying occurring for those with low AFQT scores.

1. Introduction

A recent story in the New York Times discussed a “small but apparently growing number of high achieving, well-off students [who] are stepping off the fast educational track, at least for a short stroll” (New York Times 2001:A1. A17). The story reported that guidance counselors and college admissions officers along with a flourishing industry of consultants are promoting the notion that “higher education works best for those who wait” (New York Times 2001:A17). Although some individuals may benefit from delaying entry to college is this true for students in general? Before rushing to advise students to take a year off before attending college, we need to know what impact this will have on their chances of graduating.

Delaying entry to college is not a new phenomenon. Among the high school graduating classes of 1972, 1980, and 1982 about one-quarter of those who entered post-secondary education within four years of graduating from high school delayed entry. One-third of those who delayed entry delayed by more than two years. Fourteen years after high school graduation, 68 percent of the class of 1972 had enrolled in some form of post-secondary education and almost one-third had delayed entry (Eagle and Carroll 1988). An analysis of the high school graduating class of 1980 revealed that 53 percent of those who started a bachelor’s degree “on-track” subsequently obtained a degree. In comparison, only 21 percent of those who delayed entry graduated. The effects of delay vary across individuals. For example, when high socioeconomic status students delay

entry, 34 percent eventually graduate whereas only 8 percent of low socioeconomic status students who delayed graduated. These findings led the Department of Education researchers to conclude: "knowing that a decision to delay entry... can mean the chances of getting a bachelor's degree are five times lower than they would be if the student started on track should result in better decisions by high school seniors." (US Department of Education 1989:29).¹

The data from the Department of Education suggests caution before recommending a year off before college. An additional reason for institutions to be concerned about students delaying entry is that there is a growing use of institutional graduation rates as a measure of accountability and a tendency to blame colleges for the failure of students to graduate or to graduate in a timely manner (Adelman 1999).

The college wage premium rose to an unprecedented level in the 1980's (Bound and Johnson, 1989; Murphy and Welch, 1993; Brewer, Eide, and Ehrenberg 1999). College graduates have twice the earnings and two and one-half times the wealth of high school graduates. (Diaz-Gimenez, Quadrini, and Rios-Rull, 1997). Thus, to the extent that delaying college attendance after graduating high school lowers the amount of post-

¹A similar conclusion can be drawn from the recent analysis of the High School and Beyond/Sophomore 1982 cohort. Fully 51 percent of those who did not delay entry to college earned a bachelor's degree while only 20 percent of those who delayed seven to 18 months and ten percent of those who delayed more than 18 months earned a bachelor's degree (Adelman 1999:45).

secondary schooling a high school graduate receives, delay can be costly in terms of reduced future earnings.

This paper investigates the determinants of college completion and dropout and, in particular, the impact of delayed entry on college completion and dropout. It expands upon the existing research tradition by specifying the duration of college attendance until exit as influenced by an endogenous waiting duration until college enrollment (the delay between first college enrollment and high school graduation), family background, personal characteristics, and local labor market conditions. The aim of this paper is to identify the effect of these covariates on college duration, that is, time to graduation and dropout.

To estimate the determinants of the duration of college attendance, while accounting for the effect of the (possibly) endogenous waiting time until enrollment, two bivariate discrete-time hazard models with competing risks are estimated. In the first, we jointly model the duration until college enrollment and the duration of college attendance until exit. For the duration until college enrollment, no distinction is made between those who enroll in a two-year versus four year institutions, since some of those who initially enroll in a two-year institution may ultimately attain a four-year degree. Thus, the standard discrete-time hazard approach is used to model this duration (Kiefer, 1988, Han and Hausman, 1990; Meyer, 1990). In the empirical model we allow college exit to occur for two reasons: dropout and graduation. Thus, the duration of college attendance is

modeled using a discrete-time competing risks approach (see McCall, 1996, for example). To allow for the possible endogeneity of the waiting time until college enrollment, the unobservable determinants of the waiting duration until enrollment are allowed to be correlated with the unobservable determinants of the drop out and graduation risks.

In the second model, we explicitly distinguish between those who first enroll in a two-year institution and those who first enroll in a four-year institution using a competing risks approach. Thus, we model both durations as competing risks. Moreover, when analyzing the enrollment duration we estimate separate competing risks models for those who enter two-year institutions and for those who enter four-year institutions. Again, to account for the possibility of endogeneity of waiting time until enrollment, the unobservable determinants of the risks are allowed to be correlated both within and across the waiting time and college attendance durations.

After a brief (and selective) review of previous research findings in Section 2, Section 3 describes the empirical methods employed in this paper. The 1979 National Longitudinal Survey of Youth data are described in Section 4. Section 5 presents the empirical findings. Even after controlling for potential endogeneity, waiting time until college enrollment is found to be an important determinant of college completion. For example, we find that those who delay enrollment into a four-year institution by one year decrease their probability of graduating with a four year degree by up to 32 percent.

Moreover, we find evidence that suggests that delayed enrollment leads to a larger reduction in the probability of college graduation for those who score lower on the Armed Forces Qualifying Test (AFQT). The final section contains a summary and conclusions.

2. Studies of Educational Attainment

Family background variables such as educational attainment and occupations of parents, family income, and number of siblings are commonly used as control variables in the study of educational attainment. These family background variables, which appear in the educational attainment literature, are primarily intended to capture the financial resources available to students (Light, 1995b). Higher family income is assumed to increase the likelihood of college enrollment and college graduation, or decrease the likelihood of college dropout, other things being equal. The number of siblings also affects educational attainment in the sense that the presence of siblings represents a competing use of family resources. The educational levels and occupations of parents capture not only the effect of family resources but also the positive correlations in educational attainment across generations. These correlations across generations may result from correlations between educational attainment and family income or from the effect of educational levels and occupations of parents on youths' aspirations and the degree of family support or encouragement to successfully complete college.

Empirical studies have found strong positive effects of family background variables on educational attainment. Family socioeconomic status, operationalized by educational levels or occupation of parents, family income, or some combinations of these is found to increase (decrease) the likelihood of college enrollment and college graduation (college dropout) (Manski and Wise, 1983; Manski, 1989; McLanahan, 1985; NCES, 1989; Kane, 1994). These findings demonstrate the significant influence of family backgrounds in determining youths' educational attainment.

Unlike in the study of high school dropout, there is relatively little of empirical study on the effect of local labor market conditions on college enrollment and college dropout. In one of the few studies, Kane (1994) found that unemployment rates were not related to individual enrollment decisions for blacks or whites.

The decision whether or not to attend college is made with imperfect information (see Manski, 1989; Altonji, 1993). Thus, individuals may dropout of college if they subsequently learn after enrolling that the "costs" of schooling are higher than they expected. Also, individuals who do not enroll in college immediately after high school graduation may subsequently enroll if the subsequently learn they are ill-suited to occupations that require only a high school education (see Miller, 1984; McCall, 1990; and Neal, 1999).

In the classic research on college degree attainment, three categories of college students were distinguished (Tinto, 1988, 1993; NCES, 1989): persisters, stopouts, and dropouts. Persisters were defined as students who continued toward their degree goals; stopouts withdrew and subsequently returned; and dropouts withdrew and never returned.²

However, there are several reasons for expanding upon these definitions. First, students may not only stop out and drop out, they may delay entry, enroll part-time, and transfer between institutions (see Adelman, 1999). These behaviors require a more complete set of behavioral definitions. Second, definitions of stopouts and dropouts are directly related to the survey follow-up periods. For example, the National Center for Education Statistics (NCES, 1989) defined dropouts as those who never return to complete bachelor's degree by the last survey year. For the class of 1980, it was by February of 1986. Thus, the classification of a dropout or stopout can depend on the length of follow-up periods. Third, another issue related to dropout is the need to distinguish between dropout from a specific institution and that from the higher education system as a whole. From the perspective of an institution, it can be reasonably argued that all students who leave can be classified as dropouts regardless of their reasons. From the perspective of the higher education system, this may not be the case. That is, a

² See Chapter 2 in Tinto (1993) for more detailed definitions.

student who leaves one institution but enrolls in another institution is an institutional-dropout but not a system-dropout. Consequently, there is no universally accepted definition of dropout or stopout.³

In this paper, the following definition of dropout is used: a “dropout” is a student who left college and did not return to any institution in the higher education system by the end of the survey period (Fall 1990 in the NLSY 79 data). Under this definition, there are two reasons for exit from college: graduation or dropout. The graduation group is defined as those who graduated with a 4-year college degree. Some of them may have experienced stopout periods during their college career.

3. A Competing Risks Model with Endogenous Waiting time

We consider the case where an individual experiences two distinct durations. The first duration is the delay time between high school graduation and college enrollment. The second duration is the duration of college attendance, which may depend on the delay time between high school graduation and enrollment. Since educational duration data in the NLSY are measured in years, a discrete-time hazard approach is taken (see Kiefer, 1988; Meyer, 1990; and Narendranathan and Stewart, 1990 , for example). Moreover, the

³ In case of high school dropout, five different definitions of dropout are used in the various studies. see Kominski (1990).

college attendance duration can end either because the individual drops out of college or because they graduate from college. Thus, for the second duration we take a competing risks approach (see Katz, 1986, Hausman and Han, 1990; Anderson, 1992; Sueyoshi, 1992; and McCall, 1996, for example).

Let T^f be the waiting time between high school graduation and college enrollment. Let T^g be the duration of college attendance until graduation (graduation duration) and let T^d be the duration of college attendance until drop out (drop out duration). Further, let $T^s = \min(T^g, T^d)$.

To incorporate the waiting duration into the statistical model, the survival function conditional on the unobserved variable θ^f and the vector of observed predictor variables \mathbf{z} is assumed to have the following form

$$\begin{aligned} S^f(k^f | \mathbf{z}, \theta^f) &= P(T^f > k^f | \mathbf{z}, \theta^f) \\ &= \exp\left[-\theta^f \sum_{r=1}^{k^f} \exp(\gamma_r^f + (\beta_r^f)' \mathbf{z})\right] \end{aligned} \quad (1)$$

where the parameters γ_r^f are the baseline hazard parameters and the vector β_r^f measures the (possibly time-varying) effects of the regressors on waiting time until college enrollment,

$r=1, 2, 3, \beta$.⁴ Further, it is assumed that θ^f is distributed independently of the vector of predictor variables \mathbf{z} .

In the competing risks model, the joint survivor function for college completion and college dropout, conditional on the two unobserved variables θ^g and θ^d , the vector of predictor variables, \mathbf{x} , and the waiting time until enrollment T^f is assumed to have the following form:

$$S(k^g, k^d | x, \theta^g, \theta^d, T^f) = \exp\left[-\theta^g \sum_{r=1}^{k^g} \exp(\gamma_r^g + (\beta_r^g)'x + \alpha_r^g T^f) - \theta^d \sum_{r=1}^{k^d} \exp(\gamma_r^d + (\beta_r^d)'x + \alpha_r^d T^f)\right]^{(2)}$$

where the parameters γ_r^s are the baseline hazard parameters and the vector β_r^s measures the (possibly time-varying) effects of the regressors, and α_r^s measures the (possibly time-varying) effect of the waiting time until college enrollment, $s = g, d, r=1, 2, 3, \beta$. Further, it is assumed that θ^g and θ^d are distributed independently of the observed predictor variables. The joint distribution of $\theta^f, \theta^g, \theta^d$ is denoted by $G(\theta^f, \theta^g, \theta^d)$. If θ^f is correlated with θ^g and/or θ^d , then T^f will be correlated with θ^g and/or θ^d . However, we will jointly estimate equations (1) and (2) using maximum likelihood estimation to explicitly account

⁴For simplicity of notation, the regressors are assumed to be time-constant. The model is easily extended to the case of time-varying regressors although the notation is cumbersome.

for the possibility of endogeneity. It is assumed that G has a point-mass structure. In particular, we assume that there are N triplets of “location” parameters $(\theta^f, \theta^e, \theta^d)$ in the population where each triplet $(\theta^f, \theta^e, \theta^d)_n$ occurs with proportion p_n :

$$\sum_{n=1}^N p_n = 1$$

Controlling for unobserved heterogeneity is important in models of educational attainment to mitigate potential selection bias (Willis and Rosen, 1979; Cameron and Heckman, 1998). The likelihood function associated with this duration - competing risks (DCR) model is derived in the appendix.

High school graduates attending college may enroll in either two-year or four-year institutions. Some individuals who complete a two-year degree may then continue on to get a four-year degree. In equation (2) above, one predictor variable that included in the specifications will indicate whether the individual first entered a two-year versus a four-year institution. Moreover, we allow for the coefficient associated with this predictor variable to be time-varying in both the college completion and dropout risks.

Alternatively, we model the duration until college enrollment as ending because of two reasons: entry into a two-year institution or entry into a four-year institution. Thus, we take a competing risks approach where $T^f = \min(T^{2y}, T^{4y})$ and T^{2y} and T^{4y}

denote the waiting time until first entry into a two-year and four-year institutions, respectively. In this case equation (1) above is replaced by

$$S(k^{2y}, k^{4y} | z, \theta^{2y}, \theta^{4y}) = \exp[-\theta^{2y} \sum_{r=1}^{k^{2y}} \exp(\gamma_r^{2y} + (\beta_r^{2y})'z) - \sum_{r=1}^{k^{4y}} \exp(\gamma_r^{4y} + (\beta_r^{4y})'z)] \quad (1')$$

where the parameters in (1') have interpretations analogous to those described above.

Now, however, we have a quadruplet of location parameters $(\theta^{2y}, \theta^{4y}, \theta^g, \theta^d)$ with distribution function $G(\theta^{2y}, \theta^{4y}, \theta^g, \theta^d)$. Again, we assume a mass point structure where each of the N quadruplets occurs in the population with proportion p_n :

$$\sum_{n=1}^N p_n = 1.$$

When focusing on those first entering four-year (two-year) institutions, those first entering two-year (four-year) institutions will subsequently be censored in the likelihood function.⁵

4. Data

⁵The likelihood function for the CR2 model can be derived in a manner similar to that for the DCR model (see Appendix B). For the sake of brevity, however, we omit its derivation in this paper.

The data for this study come from the 1979 National Longitudinal Survey of Youth (NLSY79), an ongoing study of 12,686 young individuals who were aged 14 to 21 as of January 1, 1979. The NLSY79 includes information on college attendance, type of college (two-year versus four-year college) as well as personal characteristics such as age, sex, race, number of siblings, Armed Forces Qualifying Test (AFQT) score, and information on the education levels and occupations of parents.

We apply some restrictions to the NLSY79 data set to construct the sample for our analysis. The sample in this study covers only those who were less than eighteen years old as of January 1, 1979 and excludes the military sub-sample. We also drop any observations that contain inconsistent responses over the survey years. Data on average in-state tuition levels for public four-year institutions for 1986-87 was merged to the individual NLSY79 data based on state of residence in 1979. This tuition data is from approximately the midpoint of the observation period.⁶ Although individuals may attend out of state universities or private universities, the in-state tuition level could be thought of as the lower bound on the cost of college enrollment.

Since the accuracy of the schooling information is critical for our analysis, it is essential to have an accurate dating of educational events so that waiting duration to first

⁶Source of state tuition data is State Comparisons of Education Statistics: 1969-70 to 1996-97, National Center for Education Statistics.

college enrollment and college duration are not artifacts of reporting error. To get the time periods for waiting duration and college duration, the following are needed: the year of high school graduation, the year of first college entrance, the year of last college attendance, and the year of college graduation. To identify the year of high school graduation, we used information on high school graduation year and type of diploma. The accuracy of this report is confirmed by inspecting data on highest grade attended, highest grade completed, and current enrollment status. We used all reported schooling information. Observations with marked inconsistencies were eliminated.⁷ Based on the year of high school graduation, first entrance year in college is identified by college related information: college enrollment status, current enrollment status, other grade related information.

The year of college dropout was created by first looking at college enrollment status and highest completed grade in 1990. If a high school graduate was not currently enrolled in college in 1990 and the highest grade completed exceeded 12 but was less than 16 years, we determined the last college enrollment year and designated this as the year of college dropout.⁸ The year of college graduation was created in a similar fashion. For an individual who reported that their highest grade completed was greater than or equal to 16

⁷For inconsistency in NLSY79, see Light (1995a) for further details.

⁸While individuals may decide to return to school in the future, as of 1998 over 97 percent of those who we designate as dropping out from college during the 1979-1990 period had not completed a bachelor's degree.

years, the year in which 16 years of completed schooling is first reported was determined and this year was designated as the year of graduation.⁹ Those who were enrolled in college in 1990 (with less than 16 years of completed education) were treated as right-censored .

After imposing the sample selection criteria described above, the final sample is composed of 4,944 students who are high school graduates. Among them, 2943 individuals have entered college by Fall 1990. The empirical conditional probabilities (hazard) for two-year and four- year enrollment by years since high school graduation are presented in Figure 1. As can be seen from this figure, the majority of those who enter two- or four-year institutions, do so immediately after graduating high school. Among those enrolling immediately after graduating high school, the majority enter four-year institutions while among those who delay enrollment by at least one-year, the majority enter two-year institutions. Additional descriptive statistics and definitions of predictor variables are reported in Table 1.

⁹The exact year of college graduation is reported for some students. This information is used for confirming the created year of college graduation.

5. Results

Before turning to estimates of the impact of enrollment delay on college dropout and completion behavior, some evidence that enrollment delay may impact future wages is presented in Table 2. This table presents the results of log hourly wage regressions for those in our sample who enter college between 1979 and 1990. Wages are from the job held in the week before the 1994 interview. Only those with reported hourly wages in 1994 are included in the regression. Column (1) of the table presents estimates which include controls for gender, race, age, AFQT score, marital status, residence in SMSA, and dummies for 1994 state of residence. In addition, an indicator variable is included which indicates whether the individual delayed college enrollment after graduating high school. Among college entrants, those who delay entry have hourly wages in 1994 that are, on average, 9.2 percent less than those who enter college immediately after high school graduation.¹⁰

To see whether the wage impact of delay arises through reduced educational attainment for delayers as compared to non-delayers, column (2) adds years of completed schooling as a predictor variable. When educational attainment is controlled for in the

¹⁰As can be seen from Figure 1, delayers are more likely to enter two-year institutions than non-delayers. Thus, some of the delay impact on earnings may come from the difference in the type of institution first entered (see Kane and Rouse, 1995). To examine the extent of this impact, a predictor variable indicating whether an individual first entered a two-year as opposed to a four-year institution was added to the regression. The estimated impact of enrollment delay on hourly wages, while reduced slightly in magnitude, remained statistically significant when this variable was included.

regression, the estimated impact of enrollment delay on hourly wages drops to 1.7 percent and is no longer statistically significant. Thus, it appears that the wage impact of enrollment delay arises because delayers attain less education than non-delayers. We investigate the schooling impact of delay in more detail below.

Table 3 presents estimates of the DCR model described by equations (1) and (2) above in the case where the coefficients of all predictor variables are restricted to be time-constant and the unobserved heterogeneity distribution is assumed to have two mass points. As can be seen from the estimates in Table 3, the waiting duration until college enrollment has a significantly negative effect on the graduation hazard rate and a significantly positive effect on the dropout hazard rate. The longer an individual delays college enrollment, the more likely he/she is to drop out and the less likely he/she is to graduate with a four-year degree.

To assess the magnitude of this effect, simulations were performed in which a high school graduate's delay until college enrollment was alternatively set to 0 (enrollment immediately after high school) and 1 (enrollment after delaying one year).¹¹ The college dropout and completion hazards from these simulations are presented in Figures 2 and 3, respectively, when conditioning on entry into a four-year institution and Figures 4 and 5,

¹¹ In these simulations we calculate the probability of graduation for each individual and then average probabilities across individuals.

respectively, when conditioning on entry into a two-year institution. From the hazard estimates in Figures 2 and 3, one can show that the estimated probability of obtaining a four-year degree, conditional on first entering a four-year institution, declines from 0.43 to 0.34 (or by 21 percent) when an individual delays college enrollment by one year after graduating high school. Conditional on first entering a two-year institution the probability of attaining a four-year degree drops from 0.24 to 0.17 (or by 29 percent) when an individual delays college enrollment by one year.

The estimates in Table 3 also show that a higher Armed Forces Qualifying Test (AFQT) score significantly increases the probability of college enrollment and the chances of graduation while significantly reduces the risk of dropout. Female high school graduates have significantly higher college enrollment hazards than males. African American and Hispanic high school graduates are significantly more likely to enroll in college and significantly less likely to drop out than their white counterparts. However, the estimated graduation hazard rates are significantly lower for Hispanics. Others (see Cameron and Heckman (2000) and National Center for Education Statistics(2001)) have also found that once educational achievement is controlled for using test scores like AFQT, minorities are more likely attend college than whites.¹² Kane and Spizman (1994)

¹² This does not mean that the actual enrollment rate of minorities is higher than that of white youths. Since black and Hispanic youths have lower levels of AFQT scores, parental income and parental education, overall minorities are less likely to attend college than white students.

have suggested that a higher rate of college enrollment among non-white high school graduates may be explained by the effects of Affirmative Action.

Some family background characteristics are also related to education behavior. The estimates in Table 2 imply that an increase in father's education significantly increases the enrollment hazard rate and significantly decreases the dropout hazard rate. While an increase in mother's education significantly increases the enrollment hazard. High school graduates with father's who worked in white-collar occupations have both significantly higher college enrollment and graduation hazard rates and significantly lower college dropout hazard rates than those with fathers who did not work in white-collar occupations.

Having more siblings affects college-going behavior by significantly decreasing the enrollment hazard. However, the number of siblings has no statistically significant impact on either the dropout or graduation hazard.

Individuals who have a Graduate Equivalency Diploma (G.E.D.) are less likely to enter college than individuals with a high school diploma. Moreover, among those entering college, those with a G.E.D. have a significantly lower graduation hazard than those with a high school diploma. Thus, those with exam certified high school equivalents have lower educational attainment than those with high school diplomas (See Cameron and Heckman, 1993).

High school graduates who first enter two-year institutions have both significantly higher dropout rates and lower graduation rates than those who first enter four-year institutions. Since graduation and dropout are measured with respect to four-year degrees, this may simply reflect the fact that high school graduates who enter two-year institutions may leave college after attaining a two-year degree.

The state of the labor market has long been thought to affect educational behavior. The estimated impact of an increase in the local unemployment rate on the enrollment hazard was positive, although the impact was only statistically significant at the 10 percent level. An increase in the local unemployment rate was found to have a statistically significant negative impact on the graduation hazard.

In-state public tuition levels were found to impact educational attainment primarily through college dropout behavior. While the estimated impact of increased in-state public tuition levels on the college enrollment rate was negative, the estimated impact was imprecise and not statistically significant at conventional significance levels. However, increased in-state public tuition levels has a significantly positive impact on dropout with some weak evidence that the impact is moderated by family income.

To check the robustness of our estimated impact of delayed entry, Table 4 presents the estimated impact of delaying college enrollment by one year for several alternative model specifications. Rows 1 through 3 of Table 4 present the estimated

impacts based on the DCR model with time-constant coefficients when the unobserved heterogeneity distribution has one, two and three mass points, respectively. Rows 4 through 6 present the estimated impacts based on the DCR model when the coefficient of the duration until enrollment variable is allowed to vary over time according to a third-order polynomial and the unobserved heterogeneity distribution has one, two and three mass points, respectively. Comparing the one mass point estimates to the two and three mass point estimates indicates that the estimated impact of delay does not change substantially when the potential endogeneity of delay is accounted for. Comparing rows 1 through 3 with rows 4 through 6 shows that the estimated impacts of enrollment delay are somewhat larger in models that allow the coefficient of the duration until enrollment variable to be time-varying.

To account for potential selectivity into two-year versus four-year institutions due to the unobserved determinants of the two-year, four-year choice being correlated with the unobservable determinants of completing a four-year degree, Tables 5 reports estimates derived from the CR2 model described by equations (1') and (2) above.¹³ The model estimates in Table 5 are based on the CR2 model where the coefficients of all

¹³The model was estimated twice. In the first estimation, those who first enter four-year institutions are censored in the enrollment duration and in the second estimation, those who first enter two-year institutions are censored in the enrollment duration. In small samples, the two sets of estimates obtained for the coefficients in (1') are not necessarily equal. For our data, the two sets of coefficients estimates for (1') do not qualitatively differ. Thus, Tables 4 and 5 present the coefficient estimates for (1') only in the case where those who enter two-year institutions are censored in the enrollment duration.

predictor variables are restricted to be time-constant and the unobserved heterogeneity distribution is assumed to be characterized by two mass points.

As can be seen in Table 5 an increase in the delay between high school graduation and college enrollment significantly raises the dropout hazard for both those first entering two-year institutions and those first entering four-year institutions. The impact of an increase in enrollment delay on the graduation hazard, while negative both for individuals first entering two-year and for individuals first entering four-year institutions is statistically significant only for those first entering two-year institutions.

To assess the magnitude of the effect of delaying enrollment on the probability of four-year college completion both for those who first enter a two-year institution and for those who first enter a four-year institution, simulations were performed in which an individual's enrollment delay was alternatively set to 0 (enrollment immediately after high school) and 1 (enrollment after delaying one year). The college dropout and completion hazards from these simulations are presented in Figures 6 and 7, respectively, for those who first enter a four-year institution and Figures 8 and 9, respectively, for those who first enter a two-year institution. From these hazard estimates, one can show that the estimated probability of obtaining a four-year degree when the delay until college enrollment increases from 0 to 1 year declines by 27.7 percent and 25.4 percent for those first entering four-year and two-year institutions, respectively.

To check the robustness of our estimated impact of delayed entry, Table 6 presents the estimated impact of delaying college entry by one year for several alternative model specifications. The estimated impacts of delaying enrollment by one year on graduating from a four-year college range from 14.1 to 40.0 percent for individuals first entering two-year institutions and 11.3 to 32.7 percent for individuals first entering four-year institutions with the largest estimated impacts coming from those models which ignore any possible endogeneity of delay.

One result for the other predictor variables that was not evident in the DCR model estimates has to do with the impact of in-state public tuition levels on four-year college completion rates. The results from Table 5 show that an increase in public tuition levels for four-year institutions significantly increases the four-year college dropout rate, but only among high school graduates who enter two-year institutions. Thus, it appears that in states with high four-year public tuition levels, individuals who enter two-year institutions are less likely to transfer to four-year institutions after completing their two-year degree.¹⁴

¹⁴The estimated impact of four-year tuition levels on attaining a four-year degree for those first entering two-year institutions did not change when a control for two-year in-state public tuition levels was included in the estimations. Thus, the estimated impact of four-year in-state tuition levels is not due to its correlation with two-year in-state tuition levels.

Finally, there is some empirical evidence that AFQT scores moderate the impact of enrollment delay on college graduation.¹⁵ Table 7 presents estimates of the impact of delaying college enrollment by one year for individuals in different AFQT percentile score categories when AFQT score - duration of enrollment delay interaction variable is included in the DCR model. As can be seen from the table, the adverse impact of enrollment delay on the probability of graduation from four-year college is concentrated primarily among those in the lower AFQT score categories. For example, among those first entering a four-year institution, the estimated decline in the probability of attaining a four-year degree by delaying enrollment by one year is 7.6 percent for those with AFQT percentile scores in the 75-99 range. The estimated decline in the probability of attaining a four-year degree by delaying enrollment one year increases to 32.9 percent for those with AFQT percentile scores in the 25-49 range and 52.5 percent for those with AFQT percentile scores in the 0-24 range.

6. Summary and Concluding Remarks

The main findings of the paper are: First, the delay between high school graduation and college enrollment is an important determinant of college graduation . The

¹⁵Other possible moderators of the impact of delay that were investigated were family income and gender but only the AFQT score- delay duration interaction achieved statistical significance.

longer a young person takes to enroll in college, the higher the chance is that they do not graduate.

Second, higher ability individuals, as measured by AFQT scores, are more likely to enter college, and, among those entering, more likely to finish. Moreover, delaying enrollment is less costly in terms of reducing the probability of graduating college, for those with higher AFQT scores.

Third, family background, measured by white-collar occupation and education levels of parents, family income, and the number of sibling affect college-going behavior. It is hypothesized that these variables capture the financial resources available to family and, at the same time, the effect of parents on youths' aspirations and the degree of family encouragement.

Fourth, nonwhite high school graduates were found to be more likely than whites to enter college. Specifically, the competing risks estimates suggest that nonwhites are more likely to first enter four-year institutions than are whites.

Fifth, an increase in tuition levels for public four-year institutions appears to reduce the chances that an individual first entering a two-year institution will transfer to a four-year institution and obtain a four-year degree. There was no evidence that family income moderated this impact. Also, tuition levels did not appear to affect the college entry decision or graduation rates of those first entering four-year institutions.

Finally, higher unemployment rates appears to reduce the probability of entering a four-year institution, increase the risk of dropout and decrease the rate of college graduation. These results are consistent with the notion that the unemployment rate reflects financial constraints on college-going behavior.

There are some limitations of the study. First, the NLSY79 does not include detailed information on financial aid which has been found to affect college behavior (Cabera, 1992; Edlin, 1993; Fischer, 1992; McPherson and Schapiro2 1998; DesJardins, Ahlburg and McCall, 2002).¹⁶ Second, measures of employment opportunities rather than the unemployment rate have not been investigated. Third, information on the characteristics of the colleges considered or attended and the GPA attained by individuals while at a particular institution were not available. This latter information may give one indication of the student-institution match. Finally, a limitation of this study was that only one year of average in-state tuition data was used to measure the tuition costs facing an individual. More detailed data on public and private, two-year and four-year institution tuition may give better estimates of the impact of relative tuition rates on college choice and post-secondary educational attainment.

¹⁶ Despite this limitation, Dynarski (1999) was able to use the NLSY to examine the impact of financial aid on college attendance. She constructed a variable for whether or not a respondents father died before they were 18 years of age. She used this variable to proxy for eligibility for Social Security Student Benefits and found that eligibility for the program raised the probability of attendance by about twenty percentage points and that a \$1,000 increase in aid increased the probability of attendance by four percentage points.

One policy implication suggested by the findings of this paper is that high school guidance counselors may wish to caution students against delaying college enrollment, especially students with low test scores. Such a delay may lead to lower post-secondary educational attainment and, in turn, lower future earnings for these students. Colleges may also wish to develop and target programs towards delayed enrollees that will increase their chances of completion.

Appendix

In this appendix we derive the likelihood function for the empirical model described by equations (1) and (2) in the text. For simplicity of notation, we drop from the notation the dependence of functions on the predictor variables z and x and, where appropriate, T^f . Let $P^f(k^f|\theta^f)$ denote the probability of enrolling in college at time k^f conditional on θ^f and $P^{fc}(k^f|\theta^f)$ equal the probability of the spell lasting longer than k^f . Then,

$$P^f(k^f|\theta^f) = S^f(k^f|\theta^f) - S^f(k^f+1|\theta^f), \quad (A1)$$

$$P^{fc}(k^f|\theta^f) = S^f(k^f|\theta^f). \quad (A2)$$

In a manner similar to McCall (1996, p. 679), let $P^g(k^s|\theta^g, \theta^d)$, $P^d(k^s|\theta^g, \theta^d)$ and $P^\infty(k^s|\theta^g, \theta^d)$ be the probability of graduation after k^s years of enrollment; dropping out after k^s years of enrollment; and right censored after k^s years of enrollment, respectively. Thus,

$$P^g(k^s|\theta^g, \theta^d) = S(k^s, k^s|\theta^g, \theta^d) - S(k^s+1, k^s|\theta^g, \theta^d) - .5 [S(k^s, k^s|\theta^g, \theta^d) + S(k^s+1, k^s+1|\theta^g, \theta^d) - S(k^s, k^s+1|\theta^g, \theta^d) - S(k^s+1, k^s|\theta^g, \theta^d)], \quad (A3)$$

$$P^d(k^s|\theta^g, \theta^d) = S(k^s, k^s|\theta^g, \theta^d) - S(k^s, k^s+1|\theta^g, \theta^d) - .5 [S(k^s, k^s|\theta^g, \theta^d) + S(k^s+1, k^s+1|\theta^g, \theta^d) - S(k^s, k^s+1|\theta^g, \theta^d) - S(k^s+1, k^s|\theta^g, \theta^d)], \quad (A4)$$

and

$$P^\infty(k^s|\theta^g, \theta^d) = S(k^s, k^s|\theta^g, \theta^d) \quad (A5)$$

where the term

$$.5 [S(k^s, k^s | \theta^g, \theta^d) + S(k^s + 1, k^s + 1 | \theta^g, \theta^d) - S(k^s, k^s + 1 | \theta^g, \theta^d) - S(k^s + 1, k^s | \theta^g, \theta^d)]$$

is an adjustment for the fact that the data are discrete time.

Let B^w be defined as

$$B^w(k^f, k^s | \theta^f, \theta^g, \theta^d) = P^f(k^f | \theta^f) P^w(k^s | \theta^g, \theta^d), \text{ for } w = g, d, \text{ and } sc,$$

$$B^w(k^f, k^s | \theta^f, \theta^g, \theta^d) = P^f(k^f | \theta^f), \text{ for } w = \hat{c},$$

where k^f denotes the waiting duration to first college enrollment and k^s denotes the duration of college enrollment.

Summing over the N different triplets of location parameters $(\theta^f, \theta^g, \theta^d)$, the unconditional probabilities can be written as follows.

$$B^w(k^f, k^s) = \sum_{n=1}^N p_n B^w(k^f, k^s | \theta^f, \theta^g, \theta^d),$$

where

$$\sum_{n=1}^N p_n = 1.$$

Let $q_i^{\hat{c}}$ be an indicator variable which equals one if individual i did not enroll in any college by the end of survey year; q_i^g is an indicator variable that equals one if this individual graduates, and q_i^d is an indicator variable that equals one if individual i drops out from the higher education system, and $q_i^{\hat{c}}$ is an indicator variable that equals one if individual i enrolled but the enrollment spell is incomplete or right-censored, $i = 1, \dots, M$.

The log-likelihood function is then given by

$$\log L = \sum_{i=1}^M \sum_{w \in W} q_i^w \log(B^w(k_i^f, k_i^s))$$

and $W = \{\hat{c}, d, g, sc\}$.

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Table 1. Sample Means and Standard Deviations
(n=4944)

Variable	Definition	Mean (S.D)
Age	age at the base year (1979)	16.09 (1.32)
Female	equal 1 if sex is female, 0 otherwise.	0.51
Hispanic	equal 1 if Hispanic, 0 otherwise.	0.16
African American	equal 1 if African American, 0 otherwise.	0.27
Education of Father	highest completed grade of father	9.77
Missing Indicator of Father's Education	equal 1 if father's education is missing, 0 otherwise.	0.13
Education of Mother	highest completed grade of mother	10.52
Missing Indicator of Mother's Education	equal 1 if mother's education is missing, 0 otherwise.	0.05
White-Collar Occupation of Mother	equal 1 if mother's occupation is white-collar, 0 otherwise.	0.23
White-Collar Occupation of Father	equal 1 if father's occupation is white-collar, 0 otherwise.	0.23
Family Income	family income at base year (\$1,000)	14.25 (13.46)
Missing of family income	equal 1 if family income is missing, 0 otherwise.	.18
Number of Siblings	number of siblings at base year	3.61 (2.51)
AFQT	percentile score of Armed Forces Qualifying Test	39.11 (26.95)
GED	equals 1 if an individual received an GED, 0 otherwise.	0.12
Public Tuition	In-state residence tuition for 4-year public colleges (\$1986)	1418 (439)
Urban	equal 1 if an individual resides in urban at base year, 0 otherwise.	0.77
SMSA	equal 1 if an individual resides in SMSA at base year, 0 otherwise.	0.68
Region1	equal 1 if an individual resides in northeast at base year, 0 otherwise.	0.18
Region2	equal 1 if an individual resides in north-central at base year, 0 otherwise.	0.27
Region3	equal 1 if an individual resides in south at base year, 0 otherwise.	0.37

Note : ^a conditional upon college students.

Table 2
 Estimated Impact of Delayed Enrollment on Log Wages in 1994

Variable	(1)	(2)
Female	-0.156*** (0.024)	-0.166*** (0.024)
African-American	-0.075** (0.036)	-0.093*** (0.035)
Hispanic	-0.066* (0.039)	-0.054 (0.039)
Years of Education	-	0.054*** (0.007)
Age	0.014 (0.009)	0.018* (0.009)
Reside in SMSA	0.025* (0.014)	0.016 (0.014)
Married	0.069*** (0.025)	0.065*** (0.025)
AFQT(÷100)	0.543*** (0.055)	0.359*** (0.059)
Delayed College Enrollment	-0.092*** (0.027)	-0.017 (0.028)

Notes: Dependent and independent variables measured as of the 1994 interview. Sample includes only those who attended some college by 1990 interview. All log wage regressions estimates include controls for state fixed-effects. Sample size equals 1791.

Table 3
 Waiting Duration -Competing Risks Estimates
 Time-Constant Coefficients, Two Mass-point U.H. Distribution^{1, 2}

Variable	<u>Waiting Duration</u>		<u>College Duration</u>	
	College Enrollment	Dropout	Graduation from 4 year College	
Duration of Delay	---	0.297 *** (0.025)	-0.356 *** (0.084)	
Unemployment Rate	0.015* (0.008)	0.015 (0.012)	-0.048 *** (0.015)	
Education of Father	0.208 ** (0.089)	-0.262 ** (0.118)	-0.185 (0.143)	
Education of Mother	0.298 *** (0.106)	-0.192 (0.143)	0.261 (0.173)	
White-Collar Occupation of Father	0.256 *** (0.055)	-0.237 *** (0.084)	0.234 *** (0.091)	
White-Collar Occupation of Mother	0.048 (0.051)	-0.108 (0.078)	0.070 (0.083)	
Family Income	-0.050 ** (0.057)	0.101 (0.093)	0.055 (0.088)	
Age	-0.096 *** (0.034)	0.132 *** (0.049)	-0.158 ** (0.079)	
Female	0.116 *** (0.043)	-0.088 (0.063)	0.124 (0.076)	
Hispanic	0.481 *** (0.071)	-0.251 ** (0.108)	-0.325 ** (0.145)	
African American	0.405 *** (0.066)	-0.354 *** (0.098)	-0.237 * (0.122)	
AFQT	0.128 *** (0.011)	-0.191 *** (0.018)	0.147 *** (0.023)	
No. of Siblings	-0.254 ** (0.106)	0.070 (0.145)	-0.236 (0.200)	
G.E.D.	-0.553 *** (0.102)	0.209 (0.125)	-2.459 *** (0.633)	
Public Tuition	-0.139 (0.086)	0.521 *** (0.130)	0.102 (0.152)	
Public Tuition × Family Income	0.039 (0.037)	-0.113 * (0.062)	0.014 (0.057)	
First Enroll in 2-Year College	---	0.580 *** (0.069)	-0.902 *** (0.107)	
Log-Likelihood		-11,130.09		
No. of Observations		4944		

Note :

¹ Standard Errors are in parentheses. One, two, or three asterisks indicate significance at the 10, 5, or 1 percent significant level.

² SMSA, Urban, high school cohort and three regional dummies as well as missing value indicators for education levels and occupations of parent are also included in the estimations.

Table 4

Estimated Probability of Attaining 4-year degree for High School Graduates
Duration - Competing Risk model

Model	First Enter 2-year College		First Enter 4-year College	
	Immediate Entry	Delay Entry 1-year	Immediate Entry	Delay Entry 1-year
Time Constant Coefficient				
1. One Mass point U.H. Dist.	0.217	0.159	0.450	0.327
2. Two Mass point U.H. Dist.	0.237	0.167	0.431	0.340
3. Three Mass point U.H. Dist.	0.231	0.174	0.411	0.334
Time-Varying Coefficient				
4. One Mass-point U.H. Dist.	0.260	0.159	0.449	0.313
5. Two Mass-point U.H. Dist.	0.260	0.158	0.454	0.318
6. Three Mass-point U.H. Dist.	0.260	0.159	0.447	0.314

Table 5

Bivariate Competing Risks Estimates
 Time-Constant Coefficients, Two-Mass Point U.H. Distribution ^{1, 2}

Variable	<u>Waiting Duration</u>		<u>2 Year Enrollment</u>		<u>4 Year Enrollment</u>	
	2 Year Enrollment	4 Year Enrollment	Dropout	Graduation	Dropout	Graduation
Duration of Delay	---	---	0.287*** (0.024)	-0.350** (0.171)	0.319*** (0.032)	-0.154 (0.095)
Unemployment Rate	0.006 (0.011)	-0.034** (0.014)	-0.003 (0.016)	-0.029 (0.031)	0.040** (0.019)	-0.056*** (0.017)
Education of Father	-0.067 (0.129)	0.135 (0.152)	-0.226 (0.146)	-0.168 (0.303)	-0.176 (0.195)	-0.148 (0.160)
Education of Mother	0.024 (0.158)	0.626*** (0.177)	-0.297 (0.180)	0.223 (0.364)	-0.275 (0.245)	0.307 (0.197)
White-Collar Occupation of Father	0.071 (0.087)	0.431*** (0.098)	-0.164 (0.101)	0.177 (0.188)	-0.469*** (0.143)	0.265** (0.108)
White-Collar Occupation of Mother	-0.040 (0.078)	0.101 (0.091)	-0.032 (0.094)	0.340* (0.180)	-0.269** (0.129)	0.026 (0.095)
Family Income	-0.064 (0.089)	-0.016 (0.089)	0.079 (0.117)	-0.196 (0.211)	0.154 (0.147)	0.071 (0.095)
Hispanic	0.073 (0.107)	0.728*** (0.145)	-0.360*** (0.136)	-0.246 (0.297)	-0.131 (0.180)	-0.289* (0.169)
African American	-0.082 (0.103)	0.861*** (0.115)	-0.336*** (0.121)	-0.204 (0.258)	-0.537*** (0.168)	-0.084 (0.140)
Age	-0.010 (0.046)	-0.178** (0.069)	0.164*** (0.055)	-0.429*** (0.166)	0.208** (0.090)	0.069 (0.091)
Female	0.063 (0.065)	0.030 (0.076)	-0.098 (0.076)	-0.013 (0.160)	-0.054 (0.104)	0.151* (0.085)
AFQT	-0.028* (0.016)	0.245*** (0.022)	-0.150*** (0.022)	0.129** (0.050)	-0.262*** (0.033)	0.178*** (0.030)
No. of Siblings	-0.191 (0.152)	-0.243 (0.183)	-0.000 (0.178)	0.023 (0.446)	0.186 (0.228)	-0.222 (0.221)
G.E.D.	-0.209 (0.134)	-0.986*** (0.209)	0.086 (.139)	-2.215** (0.957)	0.617*** (0.215)	-3.283*** (1.075)
Public Tuition	-0.161 (0.133)	0.055 (0.149)	0.511*** (0.160)	-0.294 (0.360)	0.291 (0.202)	0.093 (0.167)
Public Tuition × Family Income	0.000 (0.059)	0.064 (0.061)	-0.096 (0.077)	0.199 (0.152)	-0.150 (0.094)	0.009 (0.062)

No. of Observation

4944

Note : see the note in Table 2.

Table 6

Estimated Probability of Attaining 4-year degree for High School Graduates
Duration - Competing Risk model

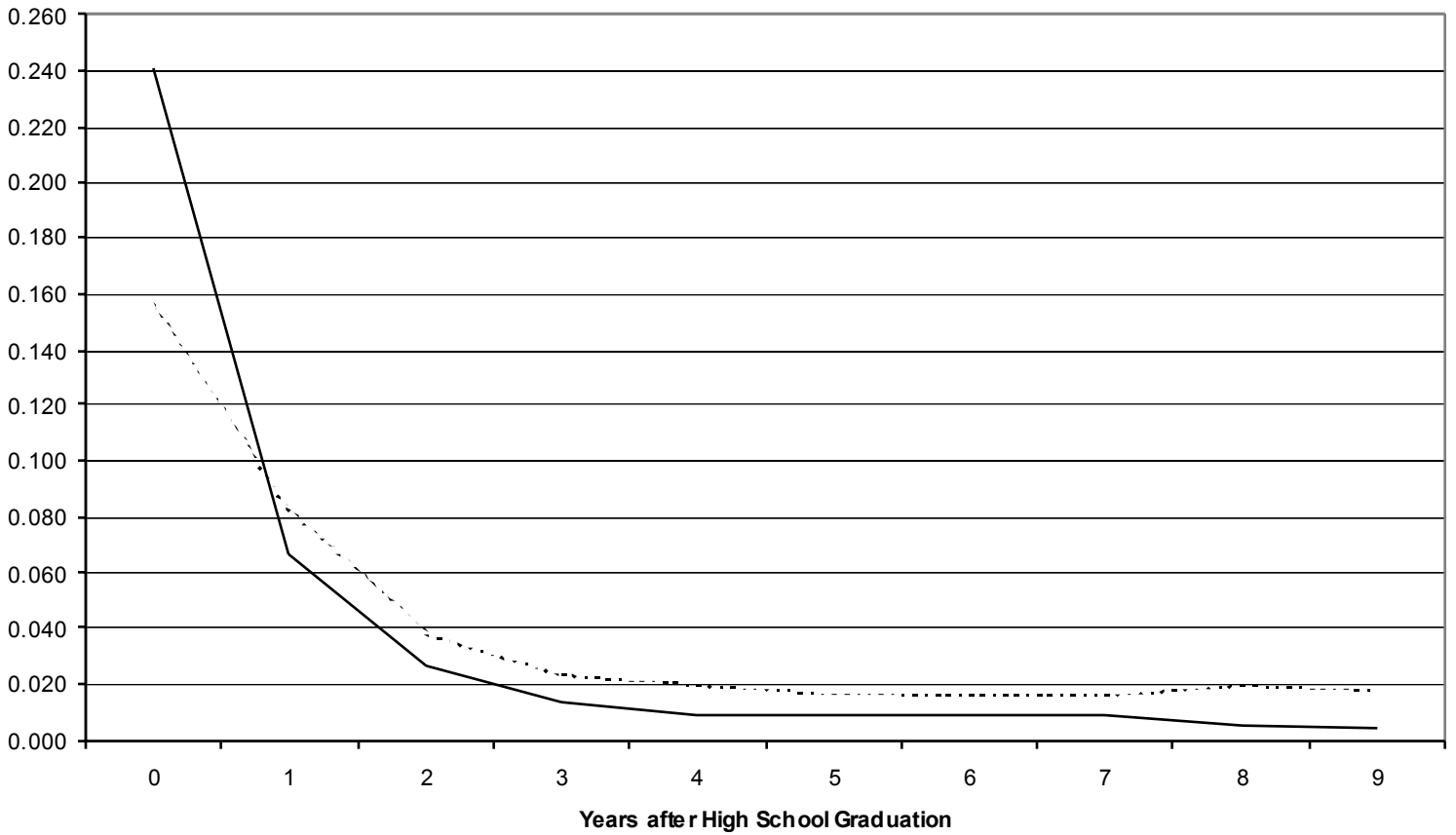
Model	First Enter 2-year College		First Enter 4-year College	
	Immediate Entry	Delay Entry 1-year	Immediate Entry	Delay Entry 1-year
Time Constant Coefficient				
1. One Mass point U.H. Dist.	0.238	0.143	0.447	0.327
2. Two Mass point U.H. Dist.	0.327	0.244	0.343	0.248
3. Three Mass point U.H. Dist.	0.361	0.280	0.301	0.267
Time-Varying Coefficient				
4. One Mass-point U.H. Dist.	0.241	0.146	0.453	0.305
5. Two Mass-point U.H. Dist.	0.342	0.259	0.366	0.258
6. Three Mass-point U.H. Dist.	0.384	0.330	0.434	0.294

Table 7

Estimated Probability of Attaining 4-year degree for High School Graduates by AFQT scores
Duration - Competing Risk, AFQT- Waiting Time interaction model with time-constant coefficients and
Two mass-point U.H. distribution

AFQT Score	First Enter 2-year College		First Enter 4-year College	
	Immediate Entry	Delay Entry 1-year	Immediate Entry	Delay Entry 1-year
0-24	0.203	0.096	0.139	0.066
25-49	0.350	0.212	0.313	0.210
50-74	0.524	0.383	0.559	0.460
75-99	0.668	0.553	0.777	0.718

Figure 1
Four-Year and Two-Year Institution Enrollment Hazards



— Four-Year Institution Entry

..... Two-year Institution Entry

Figure 2
College Dropout Hazard Estimates: First Enter Four-year Institution
Duration-Competing Risks Model with
Time-Constant Coefficients , Two Mass Point Unobserved Heterogeneity Distribution

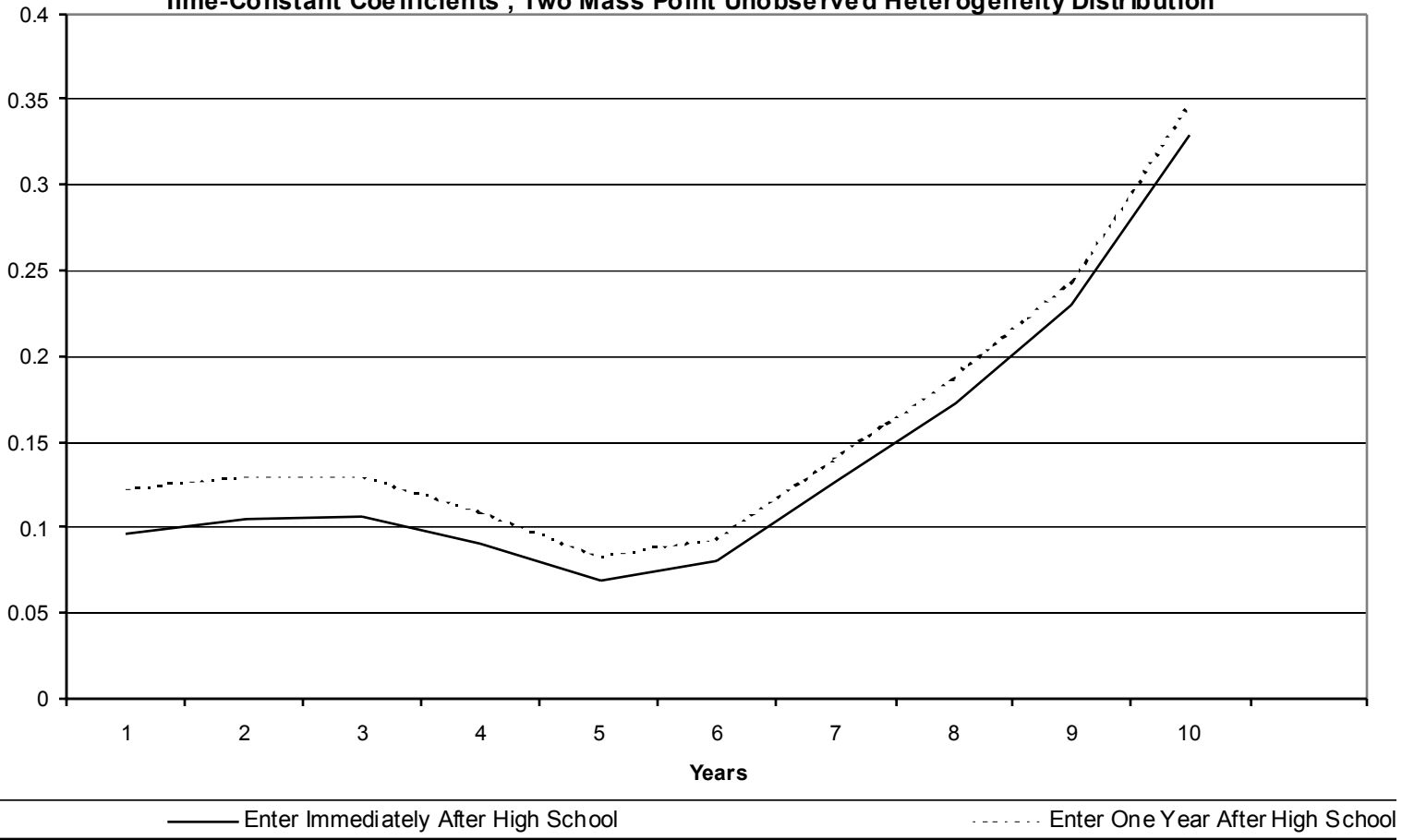
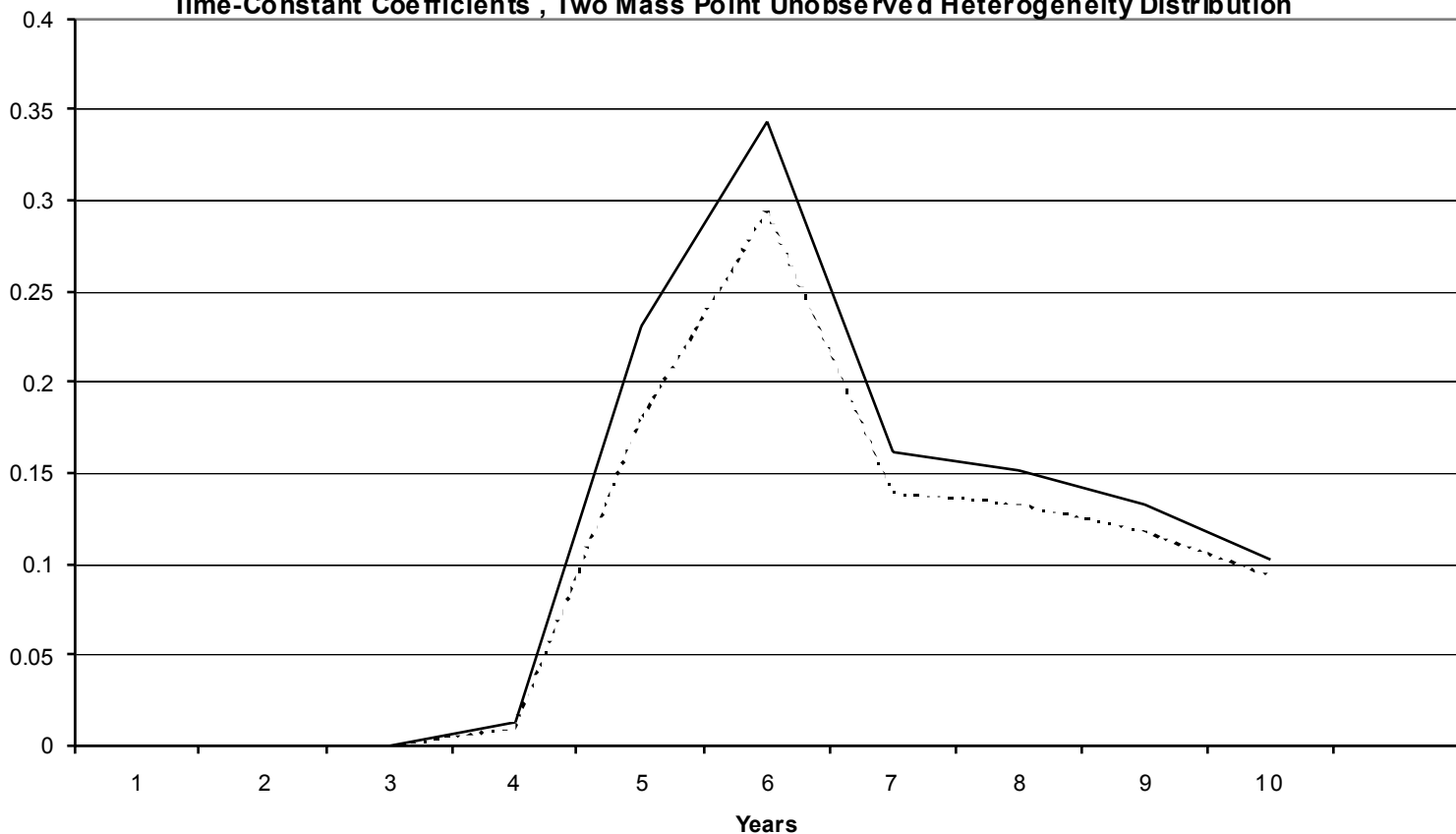


Figure 3
College Graduation Hazard Estimates: First Enter Four-year Institution
Duration-Competing Risk Models with
Time-Constant Coefficients , Two Mass Point Unobserved Heterogeneity Distribution



— Enter Immediately After High School

..... Enter One Year After High School

Figure 4
College Dropout Hazard: First Enter Two-Year Institution
Duration-Competing Risk Models with
Time-Constant Coefficients, Two Mass Point Unobserved Heterogeneity Distribution

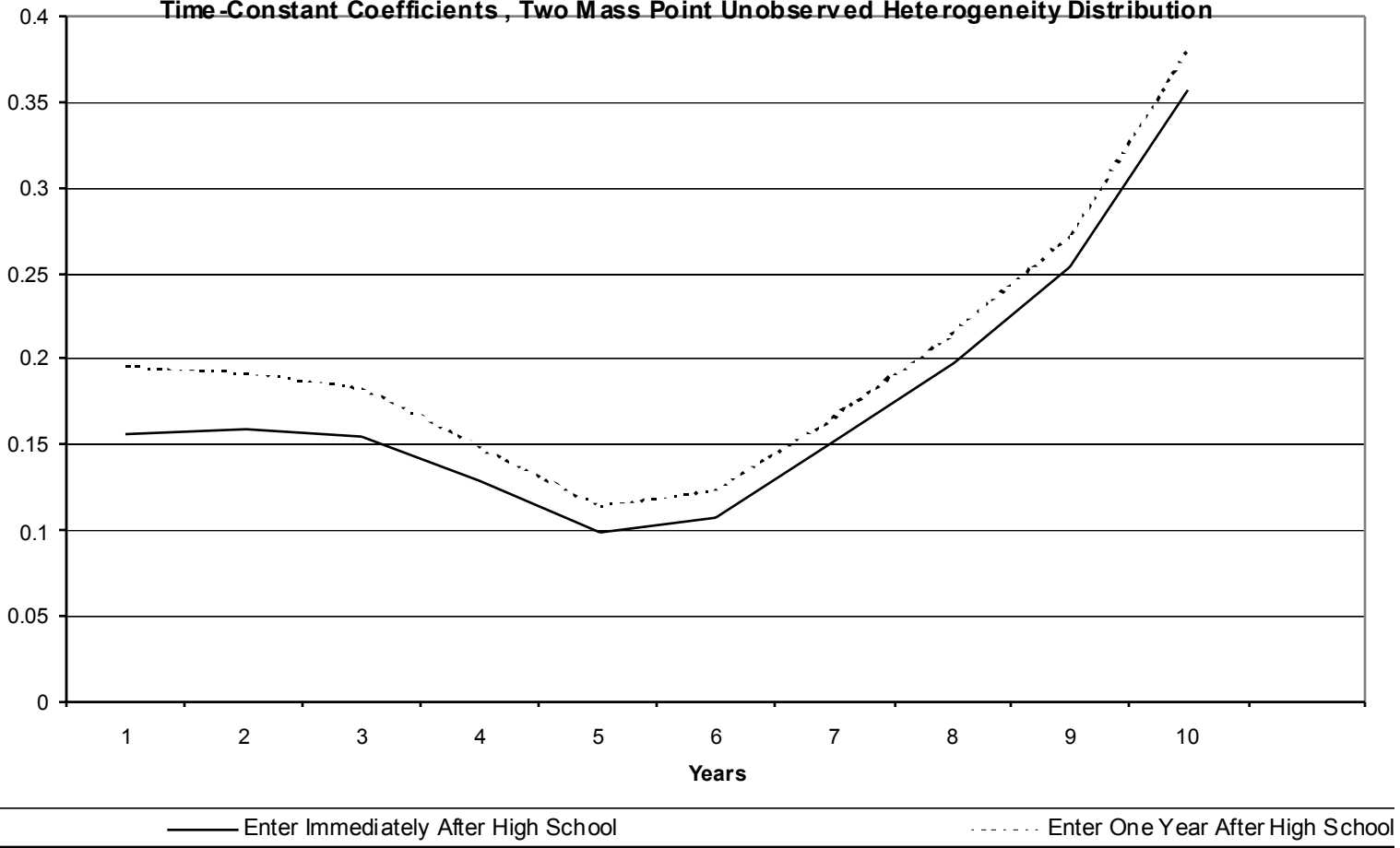
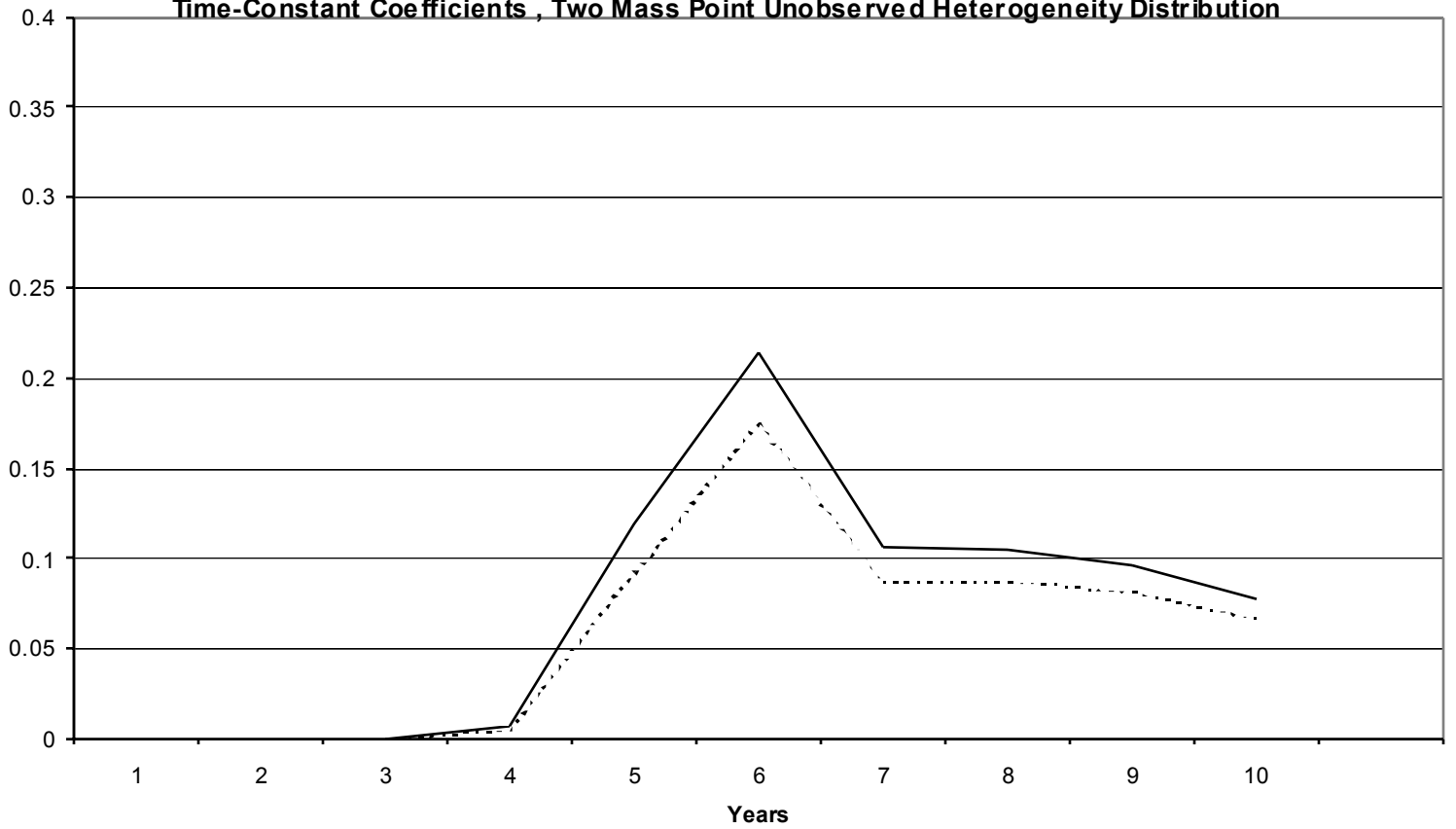


Figure 5
College Graduation Hazard Estimates: First Enter Two-year Institution
Duration-Competing Risk Models with
Time-Constant Coefficients, Two Mass Point Unobserved Heterogeneity Distribution



— Enter Immediately After High School

..... Enter One Year After High School

Figure 6
College Dropout Hazard Estimates: First Enter Four-year Institution
Bivariate Competing Risks Model with
Time-Constant Coefficients , Two Mass Point Unobserved Heterogeneity Distribution

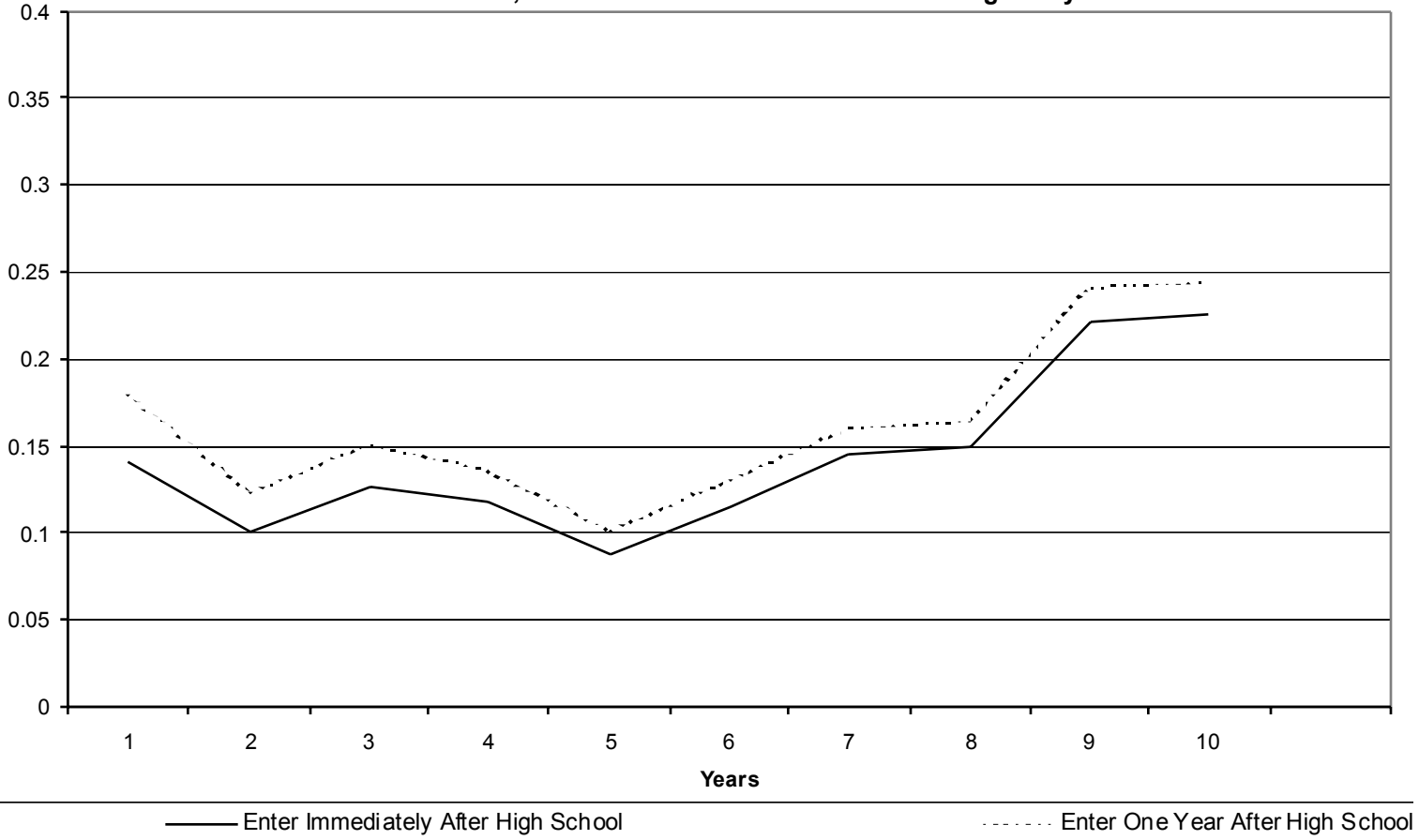


Figure 7
College Graduation Hazard Estimates: First Enter Four-year Institution
Bivariate Competing Risk Models with
Time-Constant Coefficients , Two Mass Point Unobserved Heterogeneity Distribution

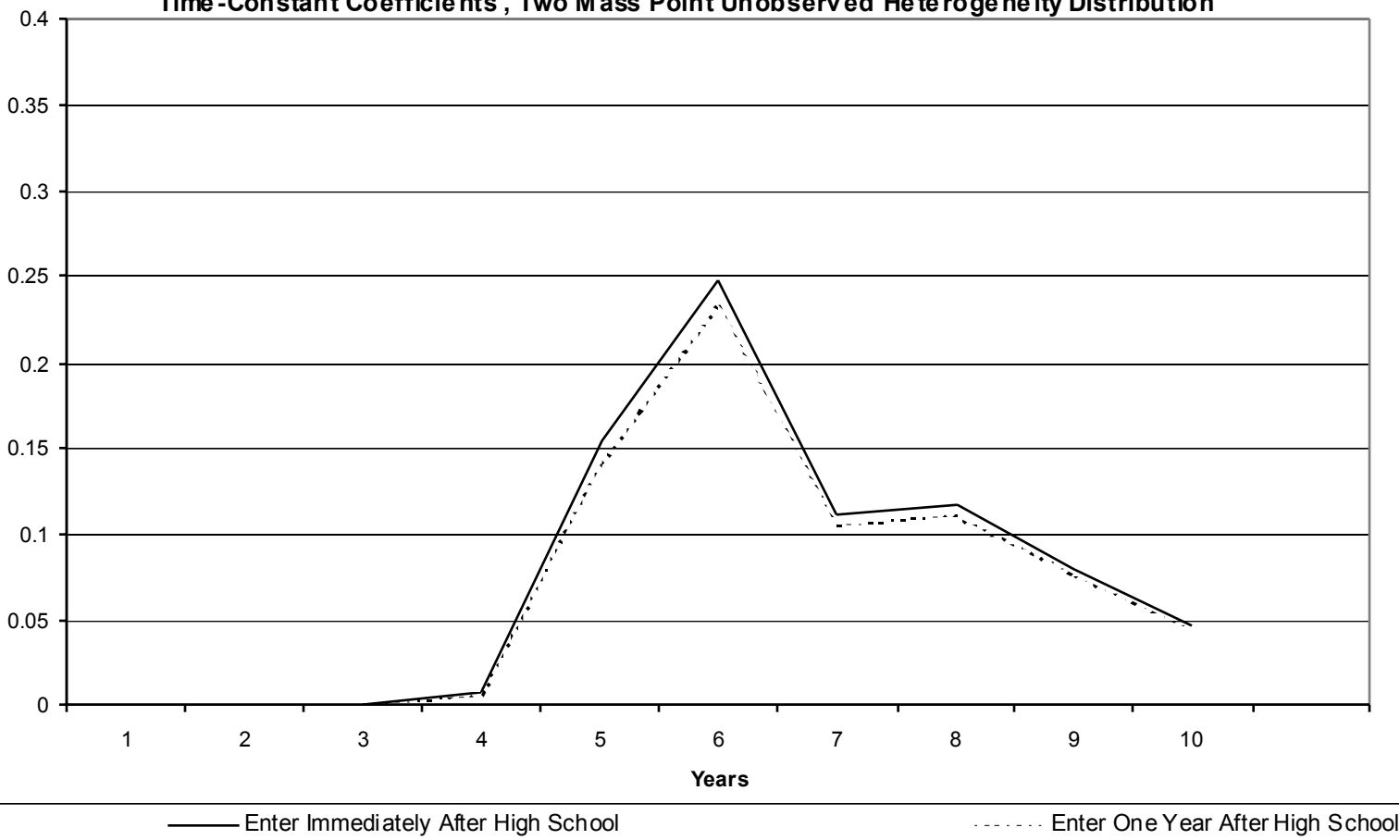


Figure 8
College Dropout Hazard Estimates: First Enter Two-year Institution
Bivariate Competing Risks Model with
Time-Constant Coefficients , Two Mass Point Unobserved Heterogeneity Distribution

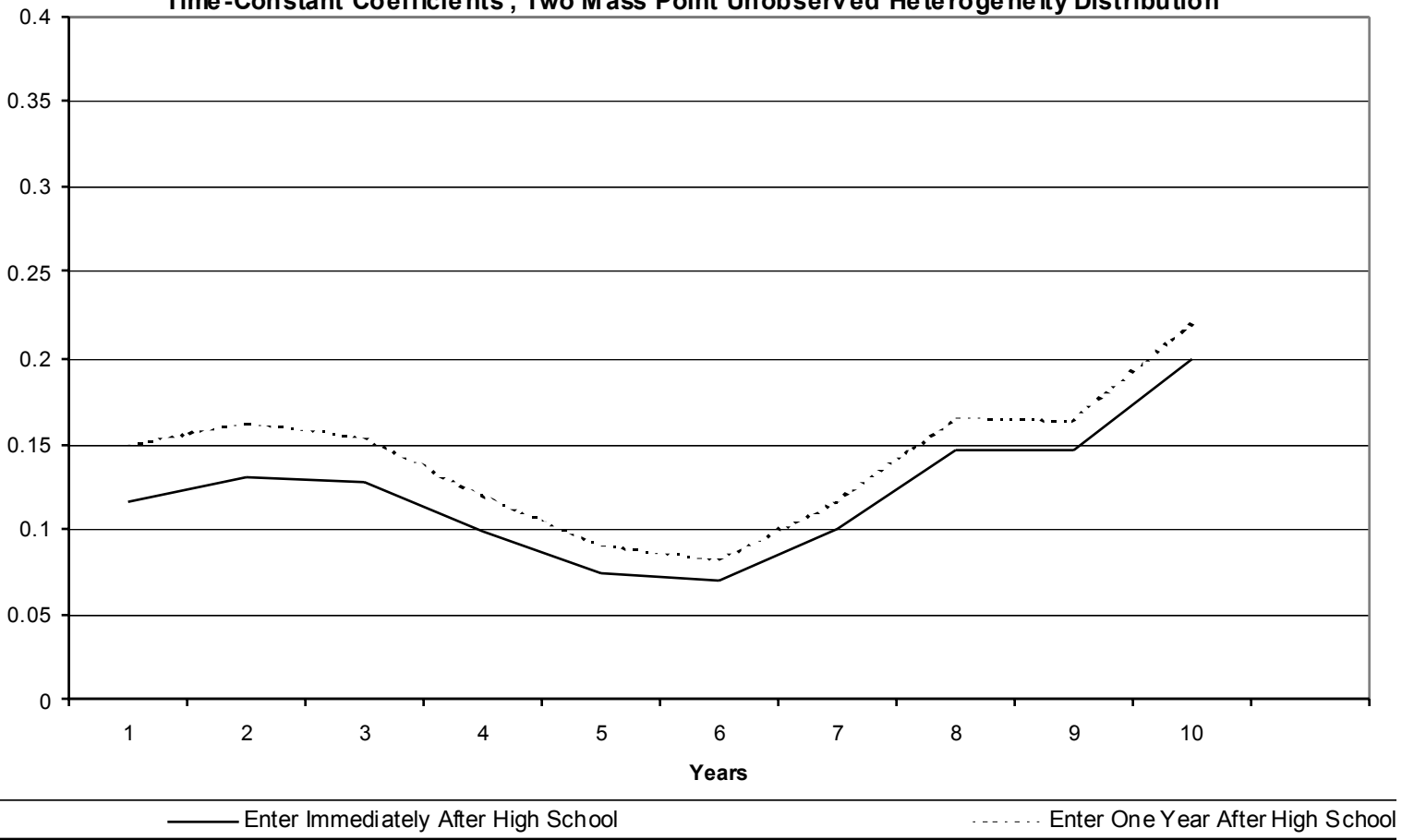


Figure 9
College Graduation Hazard Estimates: First Enter Two-year Institution
Bivariate Competing Risk Models with
Time-Constant Coefficients , Two Mass Point Unobserved Heterogeneity Distribution

