Institute for Research on Poverty
Discussion Paper no. 1391-11

Unequal Pathways through American Universities

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March 2011

This project has been funded by research grants from the Association for Institutional Research and the American Educational Research Association to Sara Goldrick-Rab. An earlier version of this paper was presented at the spring 2008 conference of the Research Committee on Stratification and Mobility (RC28) in Florence, and the 2009 annual meeting of the Sociology of Educational Association (SEA) in Monterey. The authors are grateful for helpful suggestions by James Benson.

Abstract

Student pathways through the American higher education system are complex and entail more than the choice between continuation and dropout. The four-year college system requires students seeking a bachelor's degree to pass through a series of transitions that are marked by the achievement of credit thresholds in each year of study. At those junctures students make critical decisions about their progress: whether to enroll for sufficient credits to ensure timely completion, whether to enroll for fewer credits, or whether to leave school for a limited period of time. This project overcomes the simplistic view of discrete choices between enrollment and nonenrollment and takes a close look at the cumulative nature of the attainment of U.S. students at four-year colleges and the social inequalities arising in this process.

Detailed transcript data from the National Educational Longitudinal Study (NELS-88) and multinomial transition models provide evidence on the shape of and social inequality in four-year college careers. We describe distinct trajectories through college and show that they strongly depend on students' decisions at earlier stages of their college careers. Transitions through college are also found to be strongly related to students' socioeconomic backgrounds. In addition, we show that the penalties incurred from unfavorable earlier choices is greater for disadvantaged students. By fully appreciating the cumulative nature of educational pathways through college we provide an important new view on the complex routes to college completion and trace an important source of the socioeconomic gap in college completion. The relatively rigid structure of the U.S. four-year college system appears to produce strong path-dependent and status dependent cumulative advantages for high-status students.

Introduction

Pathways through the broad and widely differentiated American higher education system are changing. Students are making more choices about which schools to attend and facing more enrollment options than ever before (Goldrick-Rab, 2006; Goldrick-Rab and Pfeffer, 2009; Andrew, 2009; Milesi, 2010). Over 50 percent of today's college students attend more than one institution, and nearly one third take some time off after starting college and later return (Berkner, 2002; Carroll, 1989; McCormick, 2003, Goldrick-Rab, 2006; Goldrick-Rab and Pfeffer, 2009). Thus, the transition from high school to college is now only one of many transitions students make, and as a result postsecondary education can no longer be accurately viewed as a discrete choice between enrollment and non-enrollment, or schooling and non-schooling. Following the initial entry to postsecondary education, students must pass through a series of transitions in order to achieve success in the form of a bachelor's degree. Since degree completion requires more than enrollment, for students seeking a bachelor's degree these transitions occur as they achieve credit thresholds, advancing from freshman to sophomore, sophomore to junior, and junior to senior, progressing toward the degree (Arum and Roksa, 2011). At those junctures students make critical decisions about the pace of their progress: whether to enroll for sufficient credits to ensure timely completion, or to enroll for fewer credits, or whether to leave school for a limited period of time or probably altogether.

Educational transitions research has a long history in the sociological study of education and continues to yield fresh insights into the patterns of educational attainment (Lucas, 2010). Most often, it investigates major transitions from one educational level to the next, such as from secondary enrollment to completion to postsecondary enrollment to completion (Blossfeld and Shavit, 1993). Research that takes a closer look at transitions within these broad educational levels has typically focused on qualitatively different types of schooling – such as vocational and academic schooling on the secondary level (Breen and Jonsson, 2000) or higher- and lower-tier institutions on the postsecondary level (Shavit, Arum, and Gamoran, 2007). A recent contribution by Milesi (2010) has made great progress in applying educational transition models to investigate a more complex picture of educational transitions. She demonstrates that only a minority, and mostly socioeconomically advantaged, of students engage in "traditional trajectories" towards college access and completion. While Milesi provides a complex picture of differently timed trajectories within and across different types of postsecondary institutions, in this paper, we zero in on the detailed sequence of transitions within the higher-tier institution of U.S. education, university. Instead of focusing exclusively on the beginning and end point of college or on summary indicators of a variety of important events throughout college, we closely track the sequential movement of students through each single year of college enrollment in an effort to reveal the cumulative nature of postsecondary attainment. Like most other educational transition research, we also pay detailed attention to the social inequalities that arise in this process. It is essential to recognize that qualitative differences in educational pathways can contribute to social differences in final educational outcomes (Lucas, 2001; Gerber and Cheung, 2008). This contribution focuses on timely progress through college – measured as yearly credit accumulation – as a dimension of social inequality in college careers and bachelor's degree attainment.

Theoretical Background and Hypotheses

To understand the pathways of college students, we employ a student-choice perspective. This perspective recognizes that students do not set out to follow a particular trajectory, but rather make specific choices throughout college that result in an accumulation of transitions, which together make up a trajectory. As Manski and Wise (1983) have observed, students' perception of the costs and benefits associated with attending college may change over time. Manski and Wise posited that these changes occur when a student graduates from high school; we contend that perceptions may continue to change after a student enters college. At each transition point, a student must weigh available college and non-college opportunities and decide to complete the transition, persist but not complete yet, or depart. This study makes these decision points explicit and, most importantly, also investigates how each decision affects subsequent ones as well as ultimate degree attainment. We posit that each of those outcomes may be affected by prior choices. One first contribution of this paper is thus an answer to the question of whether student success in college is path-dependent.

Students' choices are not only shaped by prior educational experiences and outcomes but also directly by their family background. There has recently been a resurgence in efforts to formalize the relationship between family background and educational choices in a rational choice framework (e.g., Breen and Goldthorpe, 1997). While this paper does not necessarily rely on the behavioral assumptions that these models normally make – namely, that students make rational educational decisions based on the cost, utility, and success probability of educational alternatives – it draws the attention to same issue: educational decisions are context-dependent in that students' social backgrounds directly impact their propensity to choose one particular alternative over another. Of course, we already know that there is a significant, persistent gap between the college completion rates of students from disadvantaged backgrounds and those of students from families of high economic and social status[1]. However, when we acknowledge that in the way leading up to degree completion students make a multitude of educational choices, we should also be interested in assessing the impact of socioeconomic background at each of these single decision points.

Our hypothesis is that students from lower socioeconomic backgrounds make less-beneficial choices at each point of their college career than students from more-advantaged backgrounds. In addition, it is also conceivable that the penalties that accrue from poor choices are more severe for disadvantaged students. Once they divert from a more successful pathway to degree completion, they may have more difficulty in returning to this pathway than their more advantaged peers? The empirical test of these inequalities in college pathways and their relation to ultimate degree attainment is the second important aim of this paper.

Our work can also be viewed as an empirical assessment of different concepts of "cumulative advantage" in educational attainment (see DiPrete and Eirich, 2006). We begin by drawing on the most basic notion of cumulative advantage to simply describe how student trajectories diverge over time. We then proceed to a more demanding concept of cumulative advantage as an explanatory mechanism, which implies that current levels of accumulation (here, credit accumulation) directly impact future levels of accumulation. As DiPrete and Eirich (2006) describe, research in sociology of education often lacks a clear definition of the specific type of cumulative advantage process assumed to underlie educational attainment processes. In their terminology, our work ultimately investigates "path- and status-dependent cumulative advantage" (pp. 277–279) by assessing the interaction between status variables and the path-dependent process of attainment.

The early theoretical statement of cumulative advantage processes by Robert K. Merton, which he popularized as the "Matthew Effect," in our view entails an additional conceptual move, namely from the micro-level of individual trajectories to the macro-level context of these trajectories (see also Bask and Bask, 2010). Merton himself considered cumulative advantage processes to occur within and be shaped by a given "opportunity structure" (see Rigney, 2010: p. 19). In educational research, this insight has been most central to work by Kerckhoff that shows how institutional features of the educational system – in his case, educational tracking – produce "cumulative effects of structural deflections" in students' careers (Kerckhoff, 1993; Kerckhoff and Glennie, 1999). Moving beyond organizational features of secondary schools, here we briefly outline why we believe that the institutional structure of the U.S. four-year college system may also foster "structural deflections" that account for cumulative effects in students' careers.

[1] The data used for this study aptly demonstrate this point. Among students who start a four-year college education, 88 percent of those from the highest socioeconomic status (SES) quintile finish a bachelor's degree within eight years from high school graduation, compared to just below half of the students from the lowest SES quintile.

As Breen and Jonsson note, "open systems are those in which early decisions have little influence on later decisions and students' options remain as wide as possible for as long as possible" (2000: p. 760). The same intuition applies to postsecondary transitions: students should, for instance, be able take time off from college and still return with a reasonable chance to graduate. Ideally, we would also want students who fall behind in one year to be able to catch up again at a later point. While widely known for its flexibility in providing second chances via a community college system (Kalogrides and Grodsky, forthcoming), the U.S. higher education system is, in other respects, remarkably rigid. Student progress and ultimately the conferral of a degree are mainly tied to credits based on "seat time" (literally time spent in classroom seats) rather than credits based on learning. Consequently, the intended structure of college careers is very time-focused: Degrees are labeled by the number of years it is supposed to take to earn them. Moreover, credits are often institution- specific, not transferrable across schools or states, and given for some types of learning and not others. Students who take time off often find themselves starting over, essentially penalized for the disruption rather than awarded for work completed. These characteristics, which help colleges preserve status and gain tuition dollars, have led some to call American universities an institution-focusd rather than student-focused system (Goldrick-Rab and Roksa, 2008; Adelman, 2009). Our empirical work assesses the consequences of this described institutional rigidity. Does it matter, and if so, for which students? We are particularly interested in whether it maintains, or even perpetuates, stratification. While in public discourse, college attendance is all about upward mobility, it may be the case that the four-year college system is structured in a way that makes it difficult for students to "get ahead." In as far as it makes it *more* difficult for students who do not start ahead, the system may exacerbate existing inequalities.

Methods

As we just described, for students at a four-year college, the completion of each year of enrollment can be viewed as a crucial transition point on the pathway to degree completion. At each transition (that is, for each year of study), college students face three possible alternatives: completion of a given number of credits that will allow timely graduation, completion of fewer credits, or college exit. The exact outcome categories are defined in the following way: A student is seen to "complete" a transition if she reaches the credit threshold that we identify as adequate progress: 30 credits for the first year, 60 for year two, 90 for year three, and for the fourth year, 120 credits, which is the total number of credits typically required for degree completion. If the student falls below those thresholds but still continues to be enrolled in the following year, she is said to "persist" at this specific transition point. If, instead, she decides to leave college and not return for the following academic year, we classify her as "depart." Those who depart can either take up their college career again in later years or not. While we are not able to track the activities that these students engage in once they depart from college, most of them assumingly enter the labor market or intensify existing work commitments, which have been shown to play an important role even for educational transitions leading into college (Roksa and Velez 2010).

To model the probability of choosing any of these three options we apply multinomial regression models, which have first been introduced to the study of educational transitions by Breen and Jonsson (2000).[2] For the first year of study, the model takes the following form:

$$ln\left(\frac{p_{ik}}{p_{iK}}\right) = \beta_{k0} + \beta_{k1}SES_{ik1} + \sum_{n=3,\ldots,N} \beta_{kn}ACH_{ikn} + \beta_{k2}GPA_{ik2} + \sum_{m=4,\ldots,M} \beta_{km}Z_{ikm} \tag{1}$$

The estimated outcome is equal to the natural logarithm of the expected probability of accomplishing alternative k for individual i, with "complete" serving as the reference category K. The parameter β_{k1} estimates the effect of a continuous socioeconomic background measure (SES) – derived from information on parental education, occupation and household income – on the probability of completing the first year of study. The first summation pertains to a vector of n variables that describe the high school achievement level of student i (ACH_{ikn}). We also include the grade point average (GPA) of the first year of study to control for the fact that academic achievement and transition outcomes are strongly associated.[3] The last summation contains further and extensive controls of individual characteristics (Z_{ikm}), such as basic demographics but also further attributes that have been shown to influence educational success. The main interest lies on the β_{k1} parameter, which tells us about the degree of social inequality in the educational choices of students. We will not further discuss the additional control variables separately but direct the reader to a compact overview of them in the Appendix, Table A.1.

As already mentioned, college attendance consists of a series of educational transitions. For

[2] It might be interesting to note that the multinomial model was originally developed by McFadden (1973) as a "discrete choice model" in which individuals choose from several alternatives to maximize utility. Just as we contended earlier for the case of the rational choice model of educational attainment here, too, there is no need to invoke the behavioral assumptions underlying these formulations.

[3] Although GPA appears as a right-hand variable, the direction of the effect could run both ways: GPA might influence students' decision whether or not to remain enrolled for the next year (which would imply an effect of GPA on the probability of departing). On the other hand, enrolling for a lower number of credits might facilitate achieving a higher GPA. One way or the other, the included college GPA measure controls for achievement differences between students.

each of these transitions – that is, for study years two through four – we therefore separately fit a multinomial logit model for those students still "at risk" for the transition, namely students who enrolled for a second year of study (N = 4,568), for a third year of study (N = 4,374), and for a fourth year of study (N = 4,154).[4] The models are extended in the following way:

$$
\begin{aligned}
ln\left(\frac{p_{ik}}{p_{iK}}\right) &= \beta_{k0} + \beta_{k1} SES_{ik1} + \sum_{n=3,\ldots,N} \beta_{kn} ACH_{ikn} + \sum_{o=N,\ldots,O} \beta_{k2} GPA_{iko} + \sum_{m=O,\ldots,M} \beta_{km} Z_{ikm} \quad (2)\\
&+ \sum_{r=M,\ldots,R} \beta_{kr} PATH_{ikr} \quad (3)
\end{aligned}
$$

These models include grade point averages for each year of study up to the transition point (GPA_{iko}). Most importantly, we also include a vector of prior pathways ($PATH_{ikr}$). Here, the outcomes of prior transitions are entered as dummy variables to assess path-dependence in college careers. At a later point, we also introduce interaction terms between the socioeconomic status of students (SES) and the path-descriptive variables ($PATH$) to examine the proposed social differentials in the extent of path dependence.

Modeling a sequence of student choices while accounting for prior choices is our statistical approach to track the cumulative process of attainment in higher education. The ultimate culminating point, of course, is the attainment of a bachelor's degree. The latter can be modeled in a simple logistic framework with all aforementioned controls included. In those models, the main focus is again on the effects of the socioeconomic indicator and the path-descriptive variables.

Data

Accounting for students' complex postsecondary attendance patterns requires tracking them across their entire college career. This study accomplishes that task by using postsecondary transcript data drawn from the National Education Longitudinal Study of 1988 (NELS:88). The NELS data consist of a national probability sample of 25,000 students first surveyed as eighth graders in 1988 and interviewed again during four follow-ups. The fifth and final wave occurred in 2000, when students were 26 or 27 years old; at that time, 12,144 individuals were interviewed, and requests for the postsecondary transcripts of the 9,602 students who had attended college were submitted

[4]We cannot directly compare odds ratio estimates across these different samples (see Allison, 1999; Mood, 2009) and instead illustrate the estimated effects as changes in predicted probabilities. It should however be noted, that the methodological extension applied at a later stage will allow the direct comparisons of odds ratio estimates (see Mare, 2006: pp. 29-34).

to the relevant institutions. These requests yielded 15,562 transcripts for 8,889 students. Thus, students were followed for eight years after high school graduation, which provides a substantial window within which to measure degree completion.

The sample used in this study comes from the NELS 2000 wave and includes only those students who participated in all follow-up studies[5] and who had a complete transcript record. As a further restriction, we examine only those students who initiated their studies at a four-year institution (N = 4,716), in line with our described focus on bachelor's degree seekers.[6] Since one of our main interests lies in the degree of social inequality in postsecondary education, we should stress that especially the last restriction eliminates many disadvantaged students who gain access to a four-year college only after preceding enrollment in community colleges. In that sense, we are examining social inequalities among a relatively advantaged group of students. From a substantive point, this makes for conservative estimates of social differentials in college careers. From a statistical point, it helps eliminating some of the potential selection bias based on unobserved student characteristics (Grodsky, 2007).

For variables with missing values we apply multiple imputation using the Stata *ice* module (Royston, 2005). Since multiple imputation techniques are known to decrease the variance in regression estimators the regression models presented here are replicated on five imputed datasets and the coefficients and standard errors are averaged according to a rule developed by Rubin (1987). Finally, in order to account for the complex survey design of the NELS data, all analyses are appropriately weighted and standard errors adjusted using Stata's *svy* commands.

Path dependence and social inequality in college trajectories

Description of student pathways

In Figure 1, we provide a description of student pathways through their first four years of study. The modal outcome category – as one should hope – is "complete": 57.5% of all students reach the threshold level of 30 credits after their first year. The percentage of students reaching the yearly credit threshold (60, 90, 120) decreases with later transitions, but still lies at 52.5 percent after year four. Students who fail to meet the credit threshold but continue to be enrolled in the next

[5]The sample is not further limited to students who participated in the first survey since information from the eighth-grade year is not central to the questions studied here.

[6]It is common in this type of research to employ a minimum credit threshold at which students have to be enrolled to be included in the sample (Adelman, 1999; McCormick, 2003). We will not do so, given that such thresholds disproportionately exclude low SES students (see McCormick, 2003: footnote 17), who are of primary interest in this analysis.

year, that is, students who "persist," make up 36.6 percent at the end of freshman year. This figure decreases more sharply across transitions to reach only 27.5 percent for the end of senior year. Finally, a significant percentage of students discontinue their college enrollment at some point. The 5.9 percent of students whom we record as "depart" are not enrolled in any institution in the academic year that directly follows their first year of study. They have left college either in their freshman year or simply did not enroll for the following academic year.

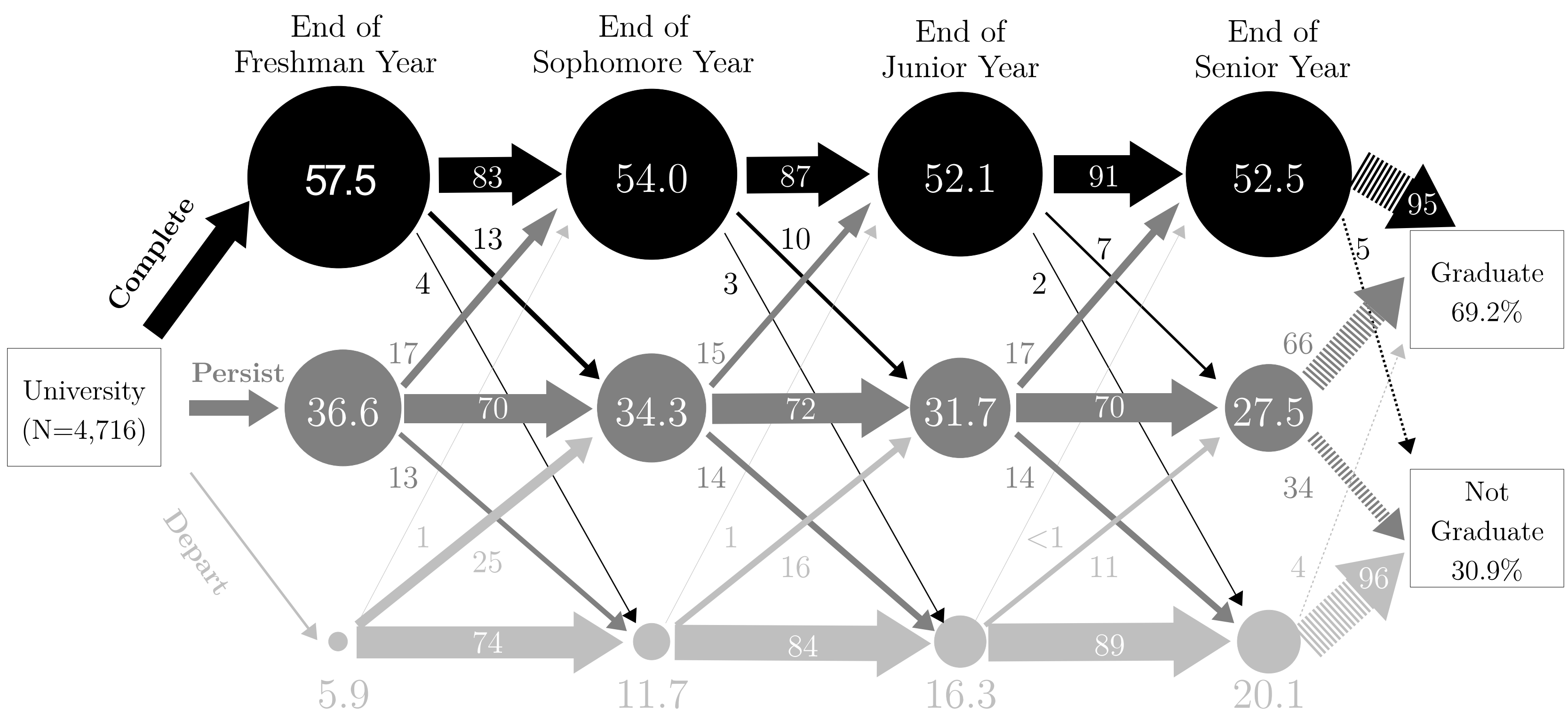
Some return to college at a later point is represented by the arrows between the transitions. While a quarter of them enroll in college again at a later point – 25 percent fall below the credit threshold in the year they pick up their studies again and only 1 percent complete the transition – 74 percent never return. The rate of non-returnees grows across transitions to as much as 89 percent between years three and four. That means the later students discontinue their enrollment, the more probable it is that they never return (although part of this may result from the right-censoring of our data at eight years after high school completion). The pathway of students who "persist" at one transition is fairly stable across the college career. Around 70 percent of those who persist also do so in the following year, 14 percent depart at the next transition point and around 17 percent catch up and complete the next transition. Among those who "complete" a transition, an even higher percentage of students remain in this category: 83 percent who complete freshman year also complete sophomore year. This number grows for later transitions: as much as 91 percent of those who complete junior year also complete senior year.

Conversely, students who "complete" become increasingly less likely with later transitions to fall into outcome categories other than "complete". Among those who successfully complete their senior year, as much as 95 percent also attain their bachelor's degree.[7] Among those who persist at the end of senior year, this proportion is 66 percent. It should be kept in mind that we are allowing for delayed graduation, since we record graduation status up to the maximum point allowed by the data (eight years after high school graduation). So, while the majority of those who persist also graduate, it might be wrong to conclude that all of them simply delay their graduation. As much as one-third (as opposed to 5 percent among the completers) never obtain a bachelor's degree by age 26 or 27. Finally, among the students who have discontinued their enrollment by the end of senior year, 96 percent do not graduate (again, right-censoring might bias this number upwardly).

Overall, the numbers in Figure 1 already suggest a strong degree of path-dependence in college trajectories. Essentially, the most likely outcome of any given transition is the same as the outcome of the preceding transition. This path dependence seems strongest for those who move successfully

[7] About 1 percent of students already graduate after their junior year.

Figure 1: Pathways through university



Note: The size of circles and arrows is proportional to the reported shares in the sample population. Source: NELS (authors's calculations) and timely through college ("completers") and becomes stronger for later transitions. Cumulative advantage is thus an adequate description of these diverging student pathways.

While these findings are certainly interesting, they should not come at complete surprise. One might suspect that good students, that is, those with high achievement in high school and good grades in college, naturally follow advantageous pathways while the remaining students sort themselves into the slow-track (persist) or are destined to stop and drop out (depart). Successful college trajectories might however be more than just the crystallization of student ability. As argued earlier, at each transition they are formed by choices, which might be restricted by earlier choices on the one hand, and student resources, on the other hand. The following multivariate models test this supposition.

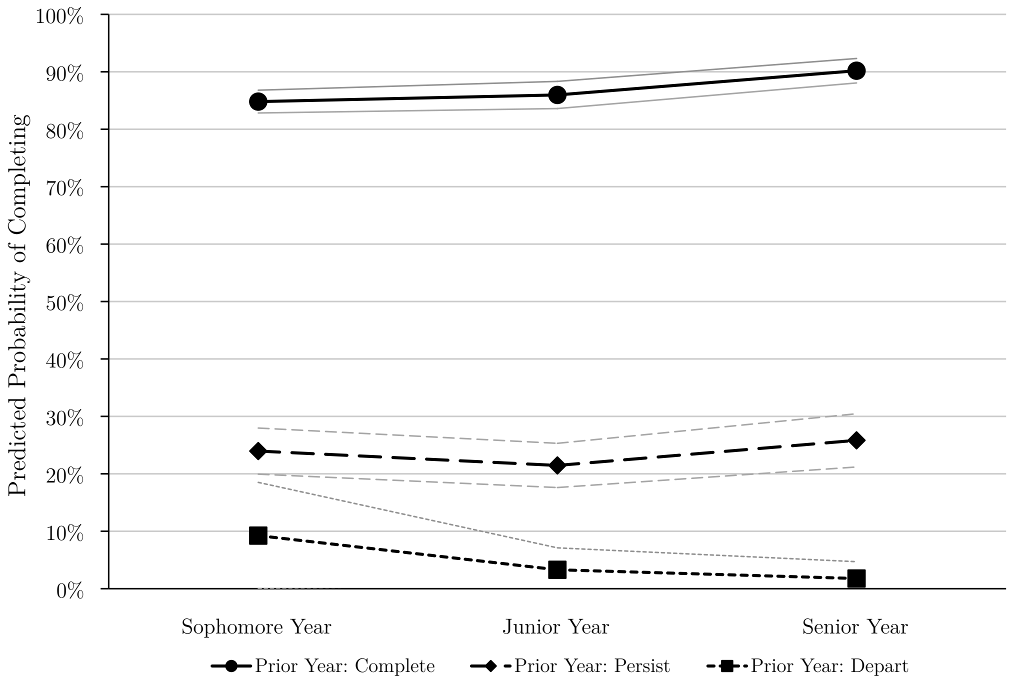
Degree of path dependence in college careers

Are students able to catch up once they have fallen behind? The preceding section has shown that these cases do exist, but also that for the great majority of students the transition status in any year is likely to be the same as in the preceding year. As discussed earlier, we can explain this association with reference to cumulative advantage mechanisms if it persists when taking into account other individual-level factors that shape a student's college career and that potentially confound the associations described above. In short, we need to assess the effects of path-descriptive variables while controlling for the additional student characteristics listed in equation 2.

This section reports the effects of prior transitions estimated in multinomial logit models for transitions outcomes after sophomore year, junior year, and senior year. As usual, the number of coefficients estimated under a multinomial logit model quickly becomes fairly large. For the last transition, the model estimates the impact of 24 variables on three different outcomes. We could thus potentially discuss 48 different coefficients. Since the reader might be interested in learning about the estimates of other substantively interesting variables, we report the full set of coefficients in the Appendix, Table A.2. In line with our theoretical argument, we focus on the path variables and later on the socioeconomic variable and attempt to render these coefficients more intelligible. For reasons mentioned in footnote 4, we display predicted probabilities to do so (Long and Freese, 2006).

Figure 2 reports the estimated effects of transition outcomes from the immediately preceding year of study estimated under the multinomial logit models. The first column shows the probability of completing sophomore year, given different transition outcomes in freshman year and holding a wide range of indicators for students' achievement and other characteristics constant at their mean.

Figure 2: Path-dependence in university transitions
Effects of immediate prior transition outcome on current transition as predicted probabilities (with 95% confidence intervals)



Source: NELS (authors's calculations)

Students who complete their freshman year have a 85 percent predicted probability of also completing their sophomore year, which is more than double the probability of otherwise similar students who do not complete their freshman year (either persist or depart). Likewise, the probability of completing junior year is more than four times higher if a student also completes sophomore year (86 percent) rather than persists (21 percent) or even departs as a sophomore (3 percent). Finally, the probability of completing senior year is particularly meager among students who stop out from college as a senior (2 percent).

Overall, we observe that our assessment of path-dependence in college careers drawn from the descriptive results is corroborated in the multivariate models. Students who complete one transition are most likely to also complete the following transition – independent of other characteristics of these students that we can observe. On the flipside, we also see that students who fall behind once (either by not meeting credit thresholds or by departing from college) are much less likely to catch up again and increasingly so with time passing. This finding is in line with our expectation that the described rigid structure of post-secondary education promotes cumulative advantage and disadvantage. At the very least, however, the findings presented in this section suggest that students on suboptimal college trajectories can be identified early on, namely as early as their first year of enrollment. In this sense, their first year of college attendance reveals crucial information about students that could be taken into account by targeted student retention policies.

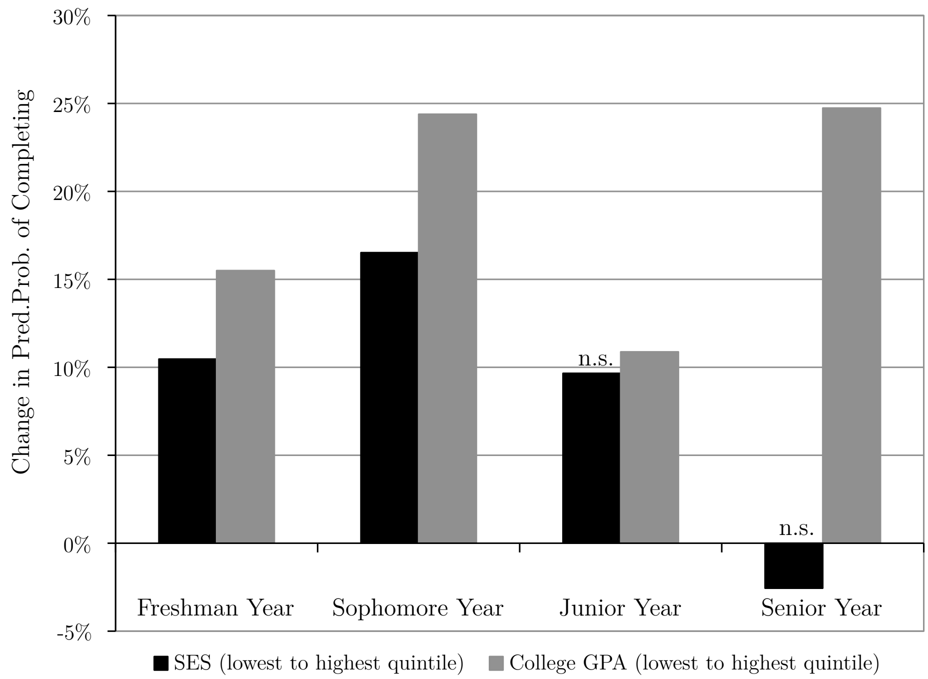
Social inequality in college pathways

We now turn to the question of how college pathways differ by the socioeconomic background of students. Often, researchers juxtapose a student's shown academic achievement to the influence of his family background in an effort to compare the relative forces of achievement and ascription in the attainment process (Blau and Duncan, 1967). In Figure 3, we see that both forces shape student transitions. The college grade point average of the corresponding transition year shows significant positive effects on the probability of completing any given year of college. As expected, the higher a student's demonstrated achievement in a given year, the more likely she is to complete this transition. Comparing the lowest achieving students (bottom GPA quintile) to the highest achieving students (top GPA quintile), we find the probability of completing a given year is higher for the latter group by between 11 to 25 percentage points depending on the year of study.

However, even when achievement differences are taken into account, students' family background still exerts significant independent effects on each transition outcome up to the end of sophomore year. That is, the most-advantaged students in terms of family background (top SES quintile) are 10 to 17 percentage points more likely than the least-advantaged students (bottom SES quintile) to complete freshman and sophomore year, respectively. These "ascriptive" effects are smaller than the achievement effects (on the order of about two-thirds of the size in most years), but considering that we are studying a relative advantaged selection of adults in their early 20s, we consider them of quite considerable size. For the completion of junior year, the effects of family background are only marginally significant when comparing the top and the bottom SES groups but they become substantively and statistically insignificant only for the completion of senior year. Keeping in mind that in these models we also control for earlier pathways, we interpret this again as evidence that the sorting of students into different college pathways along ascriptive characteristics is most important towards the early years of enrollment.

We have not only hypothesized that students' social background affects their choices at each transition step, but in addition also argued for the possibility that the implications of these choices for later transitions, that is, the degree of path-dependence, differ by social background ("path-dependent and status-dependent cumulative advantage," see above). Once disadvantaged students

Figure 3: The relative effects of social background and achievement
Effects of SES and college GPA on transition outcomes as the change in predicted probability
(moving from the lowest quintile to the highest quintile of SES and GPA)



Note: GPA is the grade point average of each respective college year (prior years not included in regressions).
Source: NELS (authors's calculations)

leave the path of continuous and adequate credit accumulation, they might have more difficulty in returning to that path. To test for this possibility, we expand the models estimated so far by an interaction term between the SES variable and the immediately preceding transition outcomes (persist and depart in prior year). Table 1 shows the fit statistics of the base models estimated so far and the differences in model fit that result from introducing the interaction terms. For the sophomore transition, the log likelihood increases by 19.5 points. With a loss of 4 degrees of freedom, this represents a highly significant improvement in model fit. The 38.9 point decrease of the BIC statistic reflects this fact and confirms that there is very strong evidence for the existence of the proposed interaction effects (Raftery, 1995). The model fit improvement for the following transitions, however, is considerably smaller and fails to meet the standard significance levels. Based on these statistics, we conclude that the implications of the choices made in freshman year differ by socioeconomic background while, for later choices, we do not have evidence for social inequality in path-dependence.

In order to confirm that the interaction works in the direction we hypothesized – namely that disadvantaged students are penalized more strongly for "diverting" – Figure 4 displays the predicted

Table 1: Change in model fit from base models to interactive models

	Sophomore Year		Junior Year		Senior Year	
	Base	Difference	Base	Difference	Base	Difference
Log-Likelihood	-2,390.8	19.5***	-2,126.2	4.1	-1,815.5	6.3
Degrees of Freedom	4,498	-4	4,292	-4	4,056	-4
BIC	-3,143.6	-38.9	-3,345.5	-8.2	-3,245.2	-12.7

Notes: Interaction terms between SES and immediately preceding transition outcomes; ***p<.001.
Source: NELS (authors's calculations)

probabilities for departing in sophomore year.[8] Students at the very bottom of the socioeconomic hierarchy (the left-most border of the x-axis), have a probability of 28 percent to depart in their sophomore year if they also departed in their freshman year. This probability is reduced to 17 percent if they persisted in freshman year. If, however, they successfully completed their first year, the probability of departing in the following year of study is reduced to just 8 percent. In short, disadvantaged students' choices in freshman year make a great difference for deciding whether to depart in sophomore year. On the other end of the socioeconomic scale, we observe overall much lower probabilities of departing after sophomore year. More importantly, however, advantaged students' predicted probability of departing is affected to a much lesser degree by their prior transition status. This interaction between social status and the importance of prior pathways is reflected in the narrowing area between the curves shown in Figure 4. The higher a student's socioeconomic status, the less important her choices in freshman year. Or, in yet other words, the "openness" of the system, which we referred to earlier, is realized mainly for advantaged students and largely precluded for disadvantaged students in their early college career. For the latter, rigidity of the college system seems to be the most fitting description.

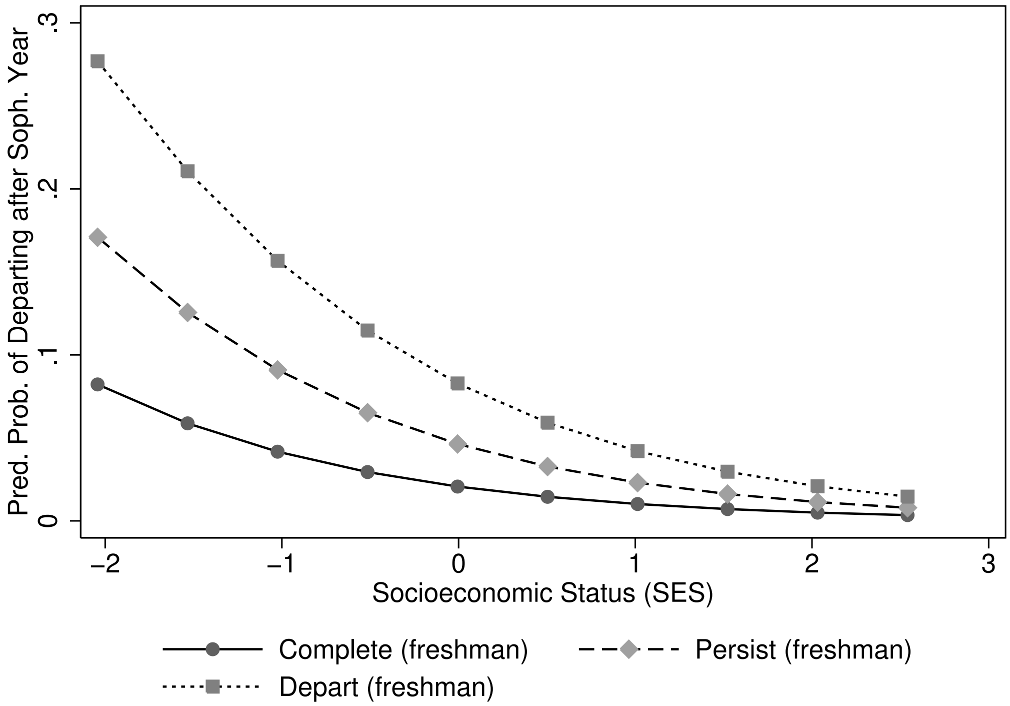
College completion

We have discussed the transition choices of college students across their first four years of study in great detail. Ultimately, of course, we are interested in the final outcome of these choices in terms of degree attainment. If our notion of cumulative advantage in college attainment is adequate, the transition outcomes of each year should translate into different probabilities of attaining a bachelor's degree. We can easily test this empirically by including all path-descriptive variables in a logistic regression model that predicts bachelor's attainment. First of all, it can be stated that a model predicting college graduation is significantly improved in fit when prior college pathways are taken

[8] For reasons of space we do not present the equivalent calculations for the remaining outcomes (complete, persist). The patterns for those outcomes are also less clear-cut than the ones presented, suggesting that the main interaction effects do indeed apply to the "depart" outcome.

Figure 4: Predicted probabilities of departing in sophomore year

Predicted probabilities by prior transition status and socioeconomic background



Note: All other variables at their mean. Source: NELS (authors's calculations)

into account. In our sample, the log-likelihood rises from -976.6 to -828.5, consuming 20 degrees of freedom; a highly significant improvement in model fit.[9] Again, a decrease in the BIC statistic of 296 points strongly reaffirms that a graduation model that includes prior paths is preferable over a model that ignores them – such as the attainment models in the vast majority of sociological studies of higher education. Finally, we ask whether the pathways chosen by students from different social backgrounds contribute to the widely studied social inequalities in college completion. Basically, we want to know how much of the socioeconomic gap in bachelor's attainment can be accounted for by differences in pathways. The empirical answer is based on the comparison of a graduation model that ignores students' pathways with one that includes all path-descriptive variables (see Appendix, Table A.3). A comparison of the strength of the SES effect across these two models reveals that 35.4 percent of the SES effect on degree completion is mediated by path-descriptive variables.[10] In

[9] The model also includes an interaction term between SES and freshman year choices based on the evidence presented above.

[10] The degree of mediation cannot be assessed by comparing odds ratios (see Mood 2009). We therefore again compare the change in predicted probabilities when moving from the lowest to the highest SES quintile (holding all other controls at their mean) between the base model (6.3 percentage points increase in probability of graduation) and the full model including the path-descriptive variables and interactions (4.1 points higher probability of graduation). The substantively same conclusions about the degree of mediation can be reached based on a comparison of marginal effects of the continuous SES measure.

other words, we can account for more than one-third of the socioeconomic gap in bachelor's degree attainment by taking into account the transition choices of students along their college career.

Conclusion

We have provided a detailed look at educational transitions within the postsecondary level. What happens to students between the entry into college and their graduation or non-graduation is of central interest to policymakers as well as scholars of education. We have argued for a cumulative view on postsecondary attainment and to that end gathered evidence for the importance of path dependencies in students' college careers, the independent effects of socioeconomic background on transition outcomes, and social differentials in path dependence. We could confirm the types of cumulative advantage in students' college careers. First, there are clear signs of path dependence in four-year college careers with each transition outcome being most likely to conform to the directly preceding transition outcome. This relationship is not only revealed in our descriptions of pathways but also emerges from the multinomial models that control for a broad range of student characteristics. Path-dependence further seems to increase with later transitions and thus qualifies as a genuine process of cumulative advantage. Second, transition outcomes are clearly affected by students' social background – independent of student achievement. The more advantaged a student in terms of family background, the less likely she is to diverge from the most advantageous pathways. Social inequalities in path dependence, that is, the impact of earlier choices on later ones, were detected for early transitions and the most detrimental student choices. Advantaged students are mostly barred from the consequences of their choices in the first year of study. Finally, we turned to the prediction of bachelor's degree attainment and noted that the attention to the cumulative nature of student attainment significantly improves such attainment model. About one-third of social inequality in degree completion could be explained by the choices students made along their career.

Our description of student pathways towards the completion of a bachelor's degree four-year college and the socio-inequalities in these pathways hopefully serve to motivate further research on the underlying mechanisms that account for these different pathways. Educational policymaking particularly relies on an answer to the question of why different socio-economic groups divert from successful pathways to college completion. We have shown that students depart from college not only in response to lacking achievement. As suggested in other work, the need to work to finance costly four-year college careers might account for the higher incidence of departing college among students from disadvantaged socioeconomic backgrounds (Roksa and Velez, 2010; Benson and Goldrick-Rab, 2011). Similarly, demographic correlates of socioeconomic disadvantage, such as increased family responsibilities (Goldrick-Rab and Sorensen, 2010), might account for some deflections from linear and successful college careers. Missing educational guidance and counseling (Deil-Amen and Rosenbaum, 2003) could be an important institutional factor that helps explain why disadvantaged students make less beneficial decisions in the beginning of college and then suffer disproportionally from those decisions. As it stands, the four-year college system appears to fail to help those who fall behind catch up. Increased flexibility of higher education students may be a necessary response to the increasing complexity in students' college careers. Finding an adequate response becomes all the more pressing as the nation realizes the perils of not only stalling graduation rates but also the perpetuation and exacerbation of existing inequalities among college students.

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A Appendix

Table A.1: Variable Descriptions

Variable	Definition and Coding	Label
Outcomes		
Transition outcome years 1-4	Detailed description in text	trans
Bachelor degree	Dummy variable; 1=Received a bachelor's degree by year 2000	ba
SES and demographics		
Socioeconomic Status	Composite measure of socioeconomic status, derived from parental education, income, occupation as of 1992.	ses
Female	Dummy variable; 1=Yes	female
Black/Hispanic	Dummy variable; 1=Black or Hispanic	nonwhite
High school achievement		
12th grade test score	Continuous measure of percentile score on test of general learned abilities administered to all study participants in 12th grade	nelstest
High school GPA	Dummy variables for quintiles; quintile values are 2.7, 3.07, 3.37, and 3.69; reference category=bottom quintile	hsgpaq
High school curriculum intensity quintiles	Dummy variables for quintiles; assessing the rigor of student's high school curriculum on a 32-point scale; see Adelman (1999); reference category=bottom quintile.	accurhsq
College achievement		
College GPA	Dummy variables for quintiles of student's college grade point average for a given year	gpa
Further controls		
Delay between HS and college	Dummy variable; 1=delayed college entry for at least eight months after high school graduation	dl-hs-year1
College transfer	Dummy variable; 1=changed primary institution (at which most number of credits were earned) between year 1-2, 2-3, 3-4	ch-yearX-Y
Consistent BA aspirations	Dummy variable; 1=student indicated plans to attain a bachelor's degree when surveyed in both 1990 and 1992	consba
Parenthood (1992)	Dummy variable; 1=student had a child by 1992	child
Number of accelerations credits	Continuous measure of the number of credits earned before college entrance through dual enrollment or examination	accelcrd
First institution: selective	Dummy variable; 1=first institution attended is selective or highly selective	year1sel
First institution: public	Dummy variable; 1=first institution attended is public	year1pub
Further controls (for graduation model)		
Consistent rise in college GPA	Dummy variable; 1=student's college GPA consistently increased across the first four years	gpatropos
Consistent decline in college GPA	Dummy variable; 1=student's college GPA consistently decreased across the first four years	gpatroneg

(continued on next page)

Table A.1 *(continued)*

Variable	Definition and Coding	Label
Work-study as part of financial support	Dummy variable; 1= ever used work study as a source of financial support by 1994	workstud
Number of summer credits	Continuous measure of the number of summer credits earned	summcr
Ever part-time	Dummy variable; 1=student was ever enrolled part-time	parttime
Number of college math credits	Continuous measure of the number of college math credits earned	mathcr
WRP Ratio	Continuous measure of the ratio of withdrawn or repeated classes to the total number of classes (negative productivity index)	wrpratio
Ever attended multiple institutions	Dummy variable; 1=student ever attended more than one institution in a given academic year	multinst
Ever taken a remedial class	Dummy variable; 1= student ever took a remedial class	remedial

Source: NELS (authors' calcuations)

Table A.2: Multinomial Regressions (Odds Ratios)

	Outcome: Persist				Outcome: Depart			
	Fresh.	Soph.	Junior	Senior	Fresh.	Soph.	Junior	Senior
ses	0.809∗	0.792∗	0.802∗	1.003	0.465∗∗∗	0.574∗∗	0.659∗	0.736+
	(0.016)	(0.027)	(0.048)	(0.983)	(0.000)	(0.003)	(0.033)	(0.090)
female	0.869	0.773∗	0.948	0.813	0.827	0.583∗	1.114	1.003
	(0.239)	(0.045)	(0.725)	(0.225)	(0.457)	(0.018)	(0.615)	(0.989)
nonwhite	1.303+	0.970	1.009	1.312	0.604	0.826	0.993	0.761
	(0.096)	(0.854)	(0.960)	(0.175)	(0.113)	(0.477)	(0.979)	(0.306)
nelstest	0.983∗∗∗	1.007+	0.997	0.999	1.002	1.004	1.006	0.998
	(0.000)	(0.053)	(0.554)	(0.917)	(0.678)	(0.534)	(0.371)	(0.706)
hsgpaq2	0.733	0.551∗	1.003	1.185	0.960	0.971	0.847	1.010
	(0.153)	(0.012)	(0.992)	(0.620)	(0.919)	(0.938)	(0.609)	(0.978)
hsgpaq3	0.694+	0.466∗∗	0.605+	1.151	0.367+	0.739	0.534	0.842
	(0.099)	(0.007)	(0.054)	(0.648)	(0.079)	(0.371)	(0.159)	(0.666)
hsgpaq4	0.687+	0.570∗	0.706	1.346	0.516	1.010	0.691	1.152
	(0.078)	(0.034)	(0.211)	(0.342)	(0.121)	(0.981)	(0.380)	(0.730)
hsgpaq5	0.521∗	0.432∗∗	0.623	1.273	0.374	0.269+	0.218∗	1.022
	(0.029)	(0.006)	(0.135)	(0.517)	(0.160)	(0.070)	(0.034)	(0.968)
accurhsq2	1.291	0.638	1.386	0.719	0.836	0.351+	0.808	1.034
	(0.558)	(0.340)	(0.600)	(0.701)	(0.791)	(0.078)	(0.739)	(0.974)
accurhsq3	1.185	0.653	1.209	0.575	0.687	0.332+	0.674	0.737
	(0.716)	(0.406)	(0.753)	(0.414)	(0.552)	(0.097)	(0.526)	(0.723)
accurhsq4	0.908	0.543	0.832	0.715	0.527	0.193∗	0.415	0.628
	(0.819)	(0.224)	(0.769)	(0.628)	(0.325)	(0.018)	(0.201)	(0.607)
accurhsq5	0.856	0.483	0.879	0.804	0.256+	0.139∗∗	0.333	0.753
	(0.716)	(0.140)	(0.838)	(0.755)	(0.051)	(0.004)	(0.112)	(0.746)
precredits	0.418∗∗	1.687∗	1.312	0.914	0.230∗	2.070∗	0.503	1.120
	(0.003)	(0.012)	(0.423)	(0.736)	(0.022)	(0.042)	(0.127)	(0.827)
ged	1.514	0.825	0.217	2.037	7.125∗	1.857	0.496	0.379
	(0.568)	(0.813)	(0.118)	(0.367)	(0.042)	(0.492)	(0.507)	(0.463)
gpa1q2	0.925	0.750	0.652+	0.686	0.109∗∗∗	0.279∗∗∗	0.747	0.396∗
	(0.712)	(0.282)	(0.095)	(0.164)	(0.000)	(0.001)	(0.357)	(0.010)
gpa1q3	0.854	0.693	0.769	1.068	0.076∗∗∗	0.140∗∗∗	0.557	0.697
	(0.471)	(0.182)	(0.300)	(0.806)	(0.000)	(0.000)	(0.123)	(0.285)
gpa1q4	0.578∗	0.412∗∗	0.614+	0.943	0.044∗∗∗	0.148∗∗∗	0.494	0.322∗
	(0.031)	(0.004)	(0.080)	(0.866)	(0.000)	(0.000)	(0.115)	(0.020)
gpa1q5	0.516∗	0.472∗	0.608	0.659	0.079∗∗∗	0.053∗∗∗	0.424	0.217∗
	(0.022)	(0.013)	(0.148)	(0.227)	(0.000)	(0.000)	(0.118)	(0.014)
dl-hs-year1	1.682	1.001	1.440	1.331	4.835∗∗	1.502	1.386	1.305
	(0.194)	(0.997)	(0.272)	(0.374)	(0.002)	(0.359)	(0.457)	(0.526)
consba	0.895	0.720+	1.502+	0.801	0.574∗	0.656	0.554+	0.619+
	(0.490)	(0.060)	(0.087)	(0.338)	(0.041)	(0.104)	(0.054)	(0.076)
child	1.729	0.830	5.775∗	0.159+	7.133∗	0.445	3.599	0.657
	(0.437)	(0.795)	(0.033)	(0.078)	(0.049)	(0.428)	(0.244)	(0.676)
accelcrd	0.820∗∗∗	0.885∗∗∗	0.952+	0.965∗	0.870+	0.931+	0.987	0.912∗
	(0.000)	(0.000)	(0.081)	(0.047)	(0.095)	(0.052)	(0.686)	(0.046)
year1sel	0.754+	0.690∗	0.894	0.624∗	0.300∗∗	0.521∗	1.021	0.353∗
	(0.086)	(0.043)	(0.565)	(0.033)	(0.007)	(0.048)	(0.948)	(0.011)
year1pub	2.402∗∗∗	2.200∗∗∗	1.506∗	1.479∗	2.288∗	1.255	1.536	1.341
	(0.000)	(0.000)	(0.033)	(0.042)	(0.014)	(0.321)	(0.103)	(0.247)
trans1pers		18.480∗∗∗	1.654∗	1.306		15.624∗∗∗	1.705+	0.875

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Table A.2 *(continued)*

	Fresh.	Soph.	Junior	Senior	Fresh.	Soph.	Junior	Senior
		(0.000)	(0.012)	(0.207)		(0.000)	(0.066)	(0.615)
trans1dep		41.542∗∗∗	4.086∗	0.980		58.264∗∗∗	10.066∗∗	1.203
		(0.000)	(0.030)	(0.977)		(0.000)	(0.003)	(0.803)
gpa2q2		0.546∗∗	0.675+	0.555∗		0.223∗∗	0.329∗∗	0.763
		(0.006)	(0.098)	(0.038)		(0.001)	(0.006)	(0.395)
gpa2q3		0.406∗∗∗	0.620+	0.635		0.143∗∗∗	0.334∗	0.579
		(0.001)	(0.064)	(0.159)		(0.000)	(0.014)	(0.163)
gpa2q4		0.562∗	0.590+	0.553+		0.259∗∗	0.380∗	0.544
		(0.014)	(0.077)	(0.099)		(0.003)	(0.037)	(0.169)
gpa2q5		0.599∗	0.484+	0.581		0.455+	0.766	0.649
		(0.049)	(0.064)	(0.129)		(0.085)	(0.573)	(0.411)
ch2-year1-2		2.139∗∗∗	2.026∗∗	1.225		2.515∗∗	2.539∗∗	1.812+
		(0.001)	(0.003)	(0.415)		(0.002)	(0.003)	(0.065)
trans2pers			22.964∗∗∗	1.952∗			15.606∗∗∗	1.476
			(0.000)	(0.011)			(0.000)	(0.282)
trans2dep			90.283∗∗∗	7.375∗∗			454.678∗∗∗	8.013∗∗
			(0.000)	(0.004)			(0.000)	(0.007)
gpa3q2			0.636∗	0.833			0.194∗∗∗	0.442∗
			(0.048)	(0.491)			(0.000)	(0.021)
gpa3q3			0.720	0.610+			0.210∗∗∗	0.275∗∗
			(0.149)	(0.054)			(0.000)	(0.002)
gpa3q4			0.733	0.417∗∗			0.104∗∗∗	0.413∗
			(0.293)	(0.005)			(0.000)	(0.034)
gpa3q5			1.247	0.555∗			0.193∗∗	0.936
			(0.491)	(0.047)			(0.002)	(0.866)
ch2-year2-3			1.233	0.974			0.907	0.969
			(0.460)	(0.912)			(0.786)	(0.910)
trans3pers				27.410∗∗∗				23.891∗∗∗
				(0.000)				(0.000)
trans3dep				313.940∗∗∗				937.314∗∗∗
				(0.000)				(0.000)
gpa4q2				0.563+				0.328∗∗
				(0.055)				(0.008)
gpa4q3				0.419∗∗				0.262∗∗
				(0.008)				(0.004)
gpa4q4				0.445∗				0.194∗∗
				(0.012)				(0.002)
gpa4q5				0.590				0.489+
				(0.120)				(0.082)
ch2-year3-4				2.942∗∗				1.681
				(0.002)				(0.177)
constant	3.884∗	0.978	0.311	0.403	1.828	2.974	0.555	0.608
	(0.025)	(0.967)	(0.126)	(0.239)	(0.405)	(0.112)	(0.449)	(0.614)

+ p<.10, * p<.05, ** p<.01, *** p<.001; p-values in parantheses Source: NELS (authors' calcuations)

Table A.3: BA Completion (Odds Ratios)

	Base model		+ Prior Transitions	
sesq2	1.068	(0.750)	0.919	(0.726)
sesq3	2.060∗∗	(0.006)	1.748+	(0.079)
sesq4	1.212	(0.425)	0.912	(0.767)
sesq5	2.560∗∗	(0.002)	2.081	(0.103)
female	1.109	(0.535)	1.180	(0.367)
nonwhite	0.698+	(0.070)	0.614∗	(0.025)
nelstest	0.991+	(0.096)	0.989+	(0.058)
hsgpaq2	0.922	(0.732)	0.854	(0.549)
hsgpaq3	0.943	(0.811)	0.731	(0.256)
hsgpaq4	1.226	(0.435)	1.226	(0.519)
hsgpaq5	1.519	(0.277)	1.313	(0.498)
accurhsq2	1.089	(0.883)	1.005	(0.994)
accurhsq3	1.387	(0.565)	1.296	(0.675)
accurhsq4	1.966	(0.247)	1.744	(0.394)
accurhsq5	1.693	(0.335)	1.618	(0.432)
precredits	1.495	(0.132)	1.624+	(0.099)
ged	0.677	(0.631)	0.425	(0.275)
gpa1q2	2.341∗∗	(0.001)	2.041∗	(0.010)
gpa1q3	2.082∗∗	(0.004)	2.073∗∗	(0.009)
gpa1q4	3.071∗∗∗	(0.001)	2.545∗∗	(0.007)
gpa1q5	4.624∗∗∗	(0.000)	3.849∗∗∗	(0.001)
gpa2q2	1.676∗	(0.020)	1.697∗	(0.028)
gpa2q3	1.220	(0.428)	1.130	(0.643)
gpa2q4	2.391∗∗	(0.004)	2.251∗	(0.017)
gpa2q5	1.800+	(0.071)	1.773	(0.125)
gpa3q2	2.080∗∗	(0.002)	2.007∗∗	(0.008)
gpa3q3	1.627+	(0.065)	1.449	(0.199)
gpa3q4	1.725∗	(0.047)	1.667+	(0.087)
gpa3q5	1.011	(0.975)	1.229	(0.597)
gpa4q2	1.937∗∗	(0.008)	1.711∗	(0.041)
gpa4q3	2.953∗∗∗	(0.000)	2.850∗∗	(0.002)
gpa4q4	2.212∗∗	(0.007)	1.804+	(0.064)
gpa4q5	2.018∗	(0.033)	2.301∗	(0.032)
gpatrneg	0.598	(0.162)	0.677	(0.338)
gpatrpos	1.424	(0.200)	1.467	(0.212)
dl-hs-year1	0.504+	(0.053)	0.418∗	(0.034)
st-ever	0.100∗∗∗	(0.000)	0.184∗∗	(0.001)
ch-lat	1.668	(0.357)	1.383	(0.588)
ch-rev	0.302	(0.169)	0.288	(0.168)
ch-up	4.003	(0.421)	6.475	(0.149)
consba	1.614∗	(0.013)	1.741∗	(0.012)
child	1.264	(0.649)	2.179	(0.282)
accelcrd	1.039	(0.102)	1.015	(0.558)
year1sel	1.434+	(0.097)	1.361	(0.171)
year1pub	0.892	(0.510)	0.951	(0.798)
workstud	0.956	(0.898)	0.958	(0.916)
summcr	1.041∗∗∗	(0.001)	1.034∗∗	(0.006)
parttime	0.289∗∗∗	(0.000)	0.359∗∗∗	(0.000)
mathcr	1.069∗∗∗	(0.000)	1.063∗∗∗	(0.001)
wrpratio	0.000∗∗∗	(0.000)	0.000∗∗∗	(0.000)

(continued on next page)

Table A.3 *(continued)*

	Base model		+ Prior Transitions	
multinst	0.662*	(0.028)	0.663*	(0.036)
remedial	0.717	(0.105)	0.840	(0.430)
trans1pers			0.902	(0.639)
trans1dep			0.617	(0.413)
trans2pers			1.830+	(0.055)
trans2dep			1.149	(0.813)
trans3pers			0.973	(0.929)
trans3dep			0.405	(0.197)
trans4pers			0.338**	(0.001)
trans4dep			0.012***	(0.000)
ses*trans1pers			1.194	(0.394)
ses*trans1dep			1.775	(0.461)
constant	0.768	(0.739)	2.693	(0.264)

+ p<.10, * p<.05, ** p<.01, *** p<.001; p-values in parantheses Source: NELS (authors' calcuations)