The Changing Landscape of Tuition and Enrollment in American Public Higher Education

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The costs of public higher education have risen dramatically in recent years, causing anger among students and concern among policymakers worried about falling college completion rates. In this paper, we explore how public tuition costs affect postsecondary enrollment choices. We examine changes over time in the enrollment decisions of students in states where tuition and fees at public four-year institutions increased rapidly, compared with changes for observationally similar students in states with more modest tuition increases. Using student-level data on twelfth graders in 1992 and 2004 linked to institution-level data, we find a relative decline in the likelihood of attending an in-state public four-year institution among high school graduates from states where public tuition costs increased substantially over this period. Students in states where public tuition increased the most were considerably more likely to enroll in a public two-year college than their counterparts in states that adopted more modest increases. We explore heterogeneity in this pattern of substitution between institutions of varying selectivity and control and for students in policy-relevant socio-demographic subgroups, including those in different parts of the twelfth-grade achievement distribution. Generally, large tuition increases at public four-year colleges have weakened the propensity of high school graduates to enroll in such institutions in their state, and increased their likelihood of enrollment in less prestigious in-state public colleges, out-of-state public institutions, or private universities. These effects are most pronounced among students from families of low socioeconomic status, and nonelite students who perform below the 90th percentile on twelfth-grade math tests.

Keywords: tuition costs, postsecondary enrollment, public universities

The costs of higher education are rising, and rising fast, raising widespread concerns about student debt and a possible higher education "bubble" (see, for example, *The Economist* 2011; Reilly 2011; Surowiecki 2011). Preceding this recent consternation was concern among analysts and policymakers that rising costs would prompt prospective students to forego college

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We thank Sandy Korenman, Marv Mandell, Dahlia Remler, Diane Schanzenbach, and Kevin Stange for helpful comments and conversations. We are also grateful to participants at the Fall 2011 meetings of the Association for Public Policy Analysis and Management (APPAM) in Washington, D.C., and seminars at UMBC, University of Michigan, Baruch, and the Russell Sage Foundation (RSF) conference on higher education effectiveness. Feng Ze Han provided helpful research assistance. All sample sizes are rounded to the nearest ten to comply with IES/NCES restricted-use data reporting standards. Direct correspondence to: Steven W. Hemelt, hemelt@email.unc.edu, University of North Carolina at Chapel Hill, Department of Public Policy, 131 S. Columbia St., Chapel Hill, NC 27599. Dave E. Marcotte, marcotte@american.edu, American University, Department of Public Administration and Policy, School of Public Affairs, 4400 Massachusetts Ave., Washington, D.C. 20016.

and current students to drop out. Recent empirical evidence from studies of enrollment demand and student persistence makes clear that these are well-founded concerns (on enrollment, see Hemelt and Marcotte 2011; on persistence, see Dynarski 2008; Bettinger 2004). Further, as costs increased between 1970 and 1999, the completion rate for those entering college declined by more than 25 percent (Turner 2004).

In this paper we examine a mechanism through which college costs might affect educational attainment and the relatively slow growth in college graduation rates. Shifts in where students enroll may help explain the decline of college completion rates. John Bound, Michael Lovenheim, and Sarah Turner's (2010) examination of factors underlying the decline between the 1970s and early 1990s suggests that a compositional shift toward community college enrollment played a key role. The authors further suggest that institutional rather than student characteristics play the most important role. It is clear that even among four-year colleges, graduation rates vary widely by institution type—from 84 percent at private research universities, to 60 percent at public research universities, to only 37 percent among public institutions that do not award doctorate degrees (Turner 2004).[1] In this paper, we examine whether and how price changes in public higher education have resulted in shifts for some students toward the sorts of public institutions where persistence and other measures of academic support lag, and shifts in enrollment away from state public colleges for other students.

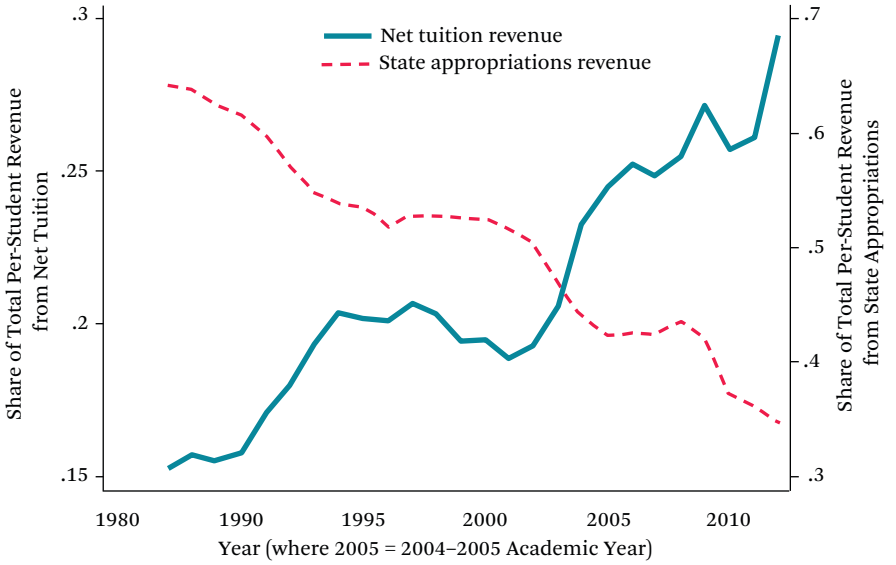
At the core of our analyses are comparisons of postsecondary enrollment decisions of observationally identical students graduating from high school in the same state in different decades. We examine the enrollment decisions of students in states where in-state public tuition prices increased rapidly, compared with observationally identical students in states with more modest tuition price changes. To do this, we pool data on cohorts from the National Education Longitudinal Survey (NELS:88) and the Education Longitudinal Survey (ELS:2002), along with data from the Integrated Postsecondary Education Data System (IPEDS) and the Delta Cost Project on the public postsecondary educational systems in states where students in these surveys completed high school. Of course, states' decisions about financing and the costs of public higher education are surely related to other factors relevant for understanding college attendance and completion. To develop a clearer assessment of the tuition effects themselves, we use a variety of strategies and implement several checks to limit and assess the role of potential confounding changes in state economies and education systems.

BACKGROUND AND LITERATURE REVIEW

Large increases in tuition at state universities have become common (Hemelt and Marcotte 2011). Some of these have been severe enough to spark outrage among students or the public at large, as was the case in California in 2009 (O'Leary 2009; Lewin and Cathcart 2009; Friend 2010). Weak economic conditions and declining general revenue support from state legislatures have put substantial pressure on public college and university administrators and their governing boards to increase tuition (Koshal and Koshal 2000; Rizzo and Ehrenberg 2003; Archibald and Feldman 2011). The results of such pressures are made clear in figure 1. Over the past twenty years, the share of revenue at public four-year colleges accounted for by net tuition (that is, tuition after financial aid is applied) has increased from about 15 percent to nearly 30 percent and the relative contribution of state appropriations has been nearly halved, from about 65 percent to 35 percent.

1. Further, among public four-year institutions, graduation rates vary substantially by selectivity. Using detailed information on students in the 1999 entering cohort at public four-year colleges in Maryland, Virginia, Ohio, and North Carolina, William Bowen, Matthew Chingos, and Michael McPherson report that six-year graduation rates range from 86 percent at the most selective, flagship public institutions, to 51 percent at lower-tier four-year public colleges in these state systems (2009, 193). These disparities remain even after the authors control for differences in the characteristics of incoming students.

Figure 1. Compositional Changes in Revenue at Public Universities



Source: Authors' calculations.

Notes: Sample limited to public four-year institutions appearing between 1987 and 2012 that reported basic enrollment and finance information to the Integrated Postsecondary Education Data System (IPEDS). Revenues accounted for by net tuition and state appropriations are expressed per full-time-equivalent (FTE) student in 2010 dollars (using the Consumer Price Index (CPI)). Net tuition excludes Pell, federal, state, and local grants but includes all tuition paid out of pocket by students and their families or via loans. Total revenue includes the sum of tuition; federal, state, and local appropriations, grants, and contracts; affiliated entities, private gifts, grants, and contracts; investment return; and endowment earnings.

An obvious concern is whether rising costs and shifts in the distribution of the burden of these increases are making higher education less affordable. If so, the recent period of fast-rising tuition may have the effect of limiting educational attainment in the aggregate. Steven Hemelt and Dave Marcotte (2011) update the literature on the relationship between tuition and enrollment, in response to the large tuition increases of the last decade (for a more extensive review, see Leslie and Brinkman 1987; Heller 1997). Among the central findings of that paper was that enrollment was most sensitive to tuition at top-ranked, flagship schools, and research-intensive universities, not at lower-ranked schools within state systems that typically serve students who might be most price sensitive. One explanation for this pattern has to do with compositional shifts in enrollment. As top-ranked, selective public universities become relatively expensive, some prospective and current students may choose private colleges or public colleges out of their home states, even as other students substitute down within their states' public higher education systems into less expensive, but lower-tier public universities. While these enrollment responses to relative price changes are straightforward predictions of consumer theory, no work has been done to test how the decisions of college-bound high school students have changed as the prices of enrollment have shifted dramatically in the last decades.

A clearer sense of how student enrollment decisions are being shaped by price setting policies is important not just to understand implications on aggregate enrollment in public higher education. Public institutions enroll the vast majority of students in American higher education, and relative price changes

could result in substantial shifts across institutions, or enrollment intensity within institutions. Using information on high school graduates from 1972, 1982, and 1992, Bridget Terry Long (2004) finds that the role of college costs has fallen in terms of access to college, but still remains an important determinant of where to enroll conditional on going to college at all, especially for low-income students.

Shifts in where students enroll may play a role in helping us understand why college completion rates have declined, even as enrollment rates have risen. Bound, Lovenheim, and Turner (2010) examine initial enrollment decisions of students from the National Longitudinal Survey 1972 cohort and National Education Longitudinal Study 1988 (NELS:88) cohort, and find important shifts toward community college enrollment. They find that "student observables explain virtually none of the observed cross-cohort shifts in initial school choice" (142). Rather, supply side characteristics play the most important role. We aim to provide insight into how much of these shifts were due to relative price changes.

Our primary aim is to contribute to the understanding of how public college and university tuition policies affect college enrollment decisions, recognizing that students' decisions are embedded in a structure determined by the state in which they reside. That the vast majority of postsecondary enrollment is in public two- and four-year colleges suggests that the primary choice set for many students is the public institutions in their home states (Snyder and Dillow 2011). Further, most private colleges have limited reach, even if their prices are not tied to residency. Much of our understanding of the influence of cost and distance on enrollment decisions comes from variation within cross-sections. We extend this work by pooling cross-sections and embedding the institutions students choose from in a framework determined by where the student lives, public colleges in the same state grouped separately from private colleges and public colleges in other states.

To understand how changes in tuition policy affect college enrollment, we compare enrollment decisions of graduating high school seniors from the NELS:88 and the ELS:2002. These cohorts mainly graduated high school in 1992 and 2004, respectively.[2] The NELS:88 and ELS:2002 cohorts straddle a period of substantial tuition increases, and the data offer rich sets of controls to develop comparisons. We compare the college-going decisions of observationally equivalent students across cohorts in states that see different intertemporal patterns of tuition costs at public colleges and universities.

We estimate effects of relative tuition on enrollment choices using *changes* in enrollment decisions for observationally comparable students within the same state—comparing changes for students in states that have seen large tuition increases over and above changes for students in states with more modest price changes. Our identifying assumption is that states that adopt a sharp increase in tuition are not experiencing changes in other characteristics of their postsecondary institutions that are contemporaneous to tuition increases, nor are they experiencing different trends in the characteristics of students entering postsecondary education. Although we cannot test all possible threats to our identifying assumption, we conduct several relevant falsification and specification tests.

DATA

We combine data from several different sources to create a data set of pooled cross-sections with information on students and how their college-going decisions changed over a bit more than a decade. We use data from the National Education Longitudinal Survey on twelfth-grade students in 1992 and data from the Education Longitudinal Survey to characterize twelfth graders in 2004. These two cohorts of students straddle a period during which the financial landscape changed for many states, driving tuition at public colleges and universities upward. We then merge in data from the Delta Cost Project, the Integrated Postsecondary Education System, and Barron's Profiles of American Colleges on a variety of institutional characteristics, including

2. The NELS:88 and ELS:2002 are described in more detail in the following section.

tuition costs, enrollment, selectivity, and financial endowments. Below, we describe key features of these different data sets.

Institution-Level Data

IPEDS is a collection of interrelated surveys conducted annually by the National Center for Education Statistics (NCES). IPEDS gathers information from every college, university, and technical and vocational institution that participates in federal student financial aid programs (such as Stafford Loans and Pell Grants). Institutions that participate in these programs must report data on enrollments, program completions, graduation rates, faculty and staff, finances, institutional prices, and student financial aid. IPEDS has collected data from institutions since 1986, but reporting standards, variable definitions, and accounting practices have varied over time. The Delta Cost Project is an initiative that seeks to address such intertemporal issues that complicate longitudinal analyses. The Delta Cost Project developed a version of the IPEDS data better suited to longitudinal analyses, especially analyses that incorporate financial data.[3] From the Delta Cost data, we use information on tuition and fees, financial aid, and enrollment.

To group institutions, we use information on level (four-year, two-year or less) and control (public or private) to form sectors of institutions (for example, four-year public). Finally, we use Barron's data to stratify institutions by selectivity.

Student-Level Data

We use student-level data from both the NELS:88, which follows the high school class of 1992, and the ELS:2002, which tracks students finishing high school in 2004. Both of these detailed data sets survey students, schools, parents, teachers, and provide information on family and community life. These surveys include information about students' prior achievement, college plans, and college enrollment decisions. From both surveys, we extract demographic information on twelfth-grade students, including race and ethnicity, educational attainment levels of the students' parents, family income, number of siblings, and math test scores. We extract variables that describe the representative cross-section of twelfth graders in both surveys.

Related to college-going decisions, we use information on whether the student attended college within two years of graduating from high school, whether the student attended an in- or out-of-state college, as well as information about application and acceptance. A student responding to the ELS survey could list up to twenty colleges and universities to which she applied and indicate whether she was accepted; whereas students responding to the NELS could only list up to two schools to which they had applied (and whether they were accepted), as well as a third school which they attended (if different from the other two to which they only applied).

Analytic Sample

We limit our sample in a number of ways. At the student level, we restrict our sample to students who were in twelfth grade in 1992 and 2004, and successfully graduated from high school (that is, received a regular high school diploma). At the institution level, we include all colleges and universities for which the IPEDS reports basic information in both the 1992–1993 and 2004–2005 academic years. Our final sample includes about 23,300 students. When we focus solely on college-going choices conditional on enrollment, the sample drops to about 18,300 students and 2,800 institutions (for more about sample restrictions, see the appendix).

EMPIRICAL APPROACH

To understand how changing tuition policies affect students' decisions about enrollment, we model changes in the likelihood of attending college, as well as the type of college chosen, conditional on attendance. In both cases, we include individual student and family characteristics and policy variables affecting the cost of attendance. In particular, we include

3. For more information on the background and contents of the Delta Cost data, please see http://www.deltacostproject.org (accessed February 23, 2016).

Table 1. Classification of States by Magnitude of Public Tuition Growth

Group	N(States)	Names of States	Mean Change in Public Tuition	
			2010 Dollars	Percentage
Low	12	CO, DC, FL, GA, LA, MS, NV, NY, UT, VA, WV, WY	$1,072	41.2%
Moderate	26	AL, AK, AZ, AR, CA, CT, DE, HI, ID, KS, KY, ME, MA, MI, MT, NE, NM, NC, ND, OK, OR, RI, SD, TN, VT, WA	$2,117	68.0%
High	13	IL, IN, IA, MD, MN, MO, NH, NJ, OH, PA, SC, TX, WI	$3,336	86.8%

Source: Authors' calculations.
Notes: Average changes in tuition costs are calculated using real, enrollment-weighted in-state tuition and fees as reported by public four-year postsecondary institutions in the IPEDS/Delta Cost data.

measures of the cost of attending college in the school year after which a student finishes high school (that is, 1992–1993 and 2004–2005).

Modeling Enrollment

To distinguish between different public tuition and fee policies, we group states into three types based on their patterns of tuition growth at four-year colleges and universities. Specifically, we calculate changes in average, enrollment-weighted real tuition and fee prices (in 2010 dollars) at public four-year colleges and universities by state between the NELS and ELS periods. We then group states according to whether the growth in their real tuition and fee costs was low, moderate, or high. We determine these groupings using the 25th and 75th percentiles of the national distribution of states' average, real enrollment-weighted tuition changes at public four-year institutions. These groups are summarized in table 1. States in the low tuition-growth category include Georgia, New York, and Colorado, where the average change in public tuition costs was small (less than $1,563). The moderate category includes states such as Alabama, Michigan, and California, where real annual tuition and fee costs at public four-year institutions increased between $1,563 and $2,717, or an enrollment-weighted average of about $2,100 over the period. The states in the group with the largest increases between 1992 and 2004 include Illinois, New Jersey, and Texas, where real tuition increases were more than $2,717, with average increases of just over $3,300.

We estimate the effect of moderate and large increases in the costs of public four-year higher education in a student's home state in a difference-in-differences framework. Using the pooled NELS and ELS data, we estimate changes in enrollment decisions over time for students living in states that adopt moderate and large tuition increases between the survey years, over and above the enrollment changes we observe for comparable students in states with more modest changes in the costs of public higher education. Specifically, our difference-in-differences models take the following form:

$$Y_{isc} = \alpha + \theta T_{isc} + \gamma Aid_{isc} + \beta_1 ELS_{isc} + \beta_2 (ELS * Mod)_{isc} + \beta_3 (ELS * Large)_{isc} + \varphi X_{isc} + \delta_s + \varepsilon_{isc} \quad (1)$$

Here, i indexes students, s states, and c denotes whether student i is a member of the NELS:88 or ELS:2002 cohort. Y_{isc} is a binary outcome denoting whether a student attended college within two years of high school graduation; then, conditional on enrollment, Y_{isc} becomes an indicator for whether a student enrolled in a particular type of college (for example, in-state, four-year public institution). T_{isc} is a vector of tuition cost measures: specifically, it includes the enrollment-weighted average real tuition and fees (in 2010 dollars) for four-year public institutions in the student's

home state, in each time period, as well as enrollment-weighted average real tuition and fees at potential substitutes in the student's home state: public two-year colleges and private nonprofit four-year institutions. Aid_{isc} is a vector of controls that measures the enrollment-weighted average, real amount of Pell Grant and institutional grant aid made available to students in a given state, year, and institutional sector (that is, public four-year, public two-year, or private four-year).[4]

We are particularly interested in the effect of large tuition increases on students' decisions, and use distinctions between students living in states that implement large real price changes for four-year colleges to establish treatment groups; changes for students living in states with modest tuition changes serve as a baseline. In model (1), we include state fixed effects (δ_s) to capture state-specific differences in the likelihood of college-going that are persistent over time, and *not* due to large shifts in four-year public tuition prices (that is, difficult-to-measure aspects of higher education culture or support). We then interact dummies indicating groups of states that experienced moderate (Mod_{isc}) or large ($Large_{isc}$) increases in public four-year tuition costs (between 1992 and 2004) with the indicator for the ELS cohort (2004 high school graduates) to identify the difference-in-differences estimate of interest. So, β_3 captures the change in the likelihood of college enrollment between 1992 and 2004 among observationally identical students in states where public four-year institutions adopted large increases in tuition costs, net of changes in the probability of college enrollment experienced by observationally comparable high school graduates in states that saw more modest increases in public four-year tuition costs over the same period. Note that β_2 and β_3 pick up enrollment responses over and above what one would expect from the linear response due to the price change.

It is important to be clear that our definitions of large, moderate, and small tuition changes over this period are arbitrary. Our decision about how to make these distinctions was guided by the goal of transparency—and led to the focus on 75th and 25th percentiles for defining fast and slow tuition-growth states. We settle on this clear way of modeling nonlinear relationships between tuition growth and college enrollment because it establishes obvious comparisons for policy purposes. Our estimates provide insights into the college matriculation behavior of students graduating in states adopting notably different postsecondary tuition policies.

In addition, we control for a range of individual student characteristics (X_{isc}), including race, ethnicity, family makeup, parental education levels, and twelfth-grade math test scores. Finally, we cluster standard errors at the state level in all models to allow for arbitrary correlation of error terms between students within states across cohorts.[5]

We also explore potential heterogeneity in any results for three subgroups: students from families of low socioeconomic status (SES),[6] students whose parents did not attend college, and African American students. Further, we estimate the impact of tuition increases on students of different ability groups. In particular, we compare very high ability students to average and below average ability students. High-performing students are less likely to be affected by tuition increases because they have a larger choice set of colleges and are more likely to receive merit-based aid.

4. These sets of controls help us to isolate the impacts of large changes in public, four-year tuition costs by holding constant changes in attendance costs (and need-based aid available) at competing sectors of institutions in a student's home state.

5. We also weight all models by the survey-specific weights included in the NELS/ELS in order to account for each survey's design and sampling procedure. Unweighted estimates are very similar and are available from authors upon request.

6. The NELS:88 and ELS:2002 surveys contain measures of students' SES. These measures are a function of family income, parental educational attainment, and parental occupation.

Modeling Choices

We conduct the bulk of our analyses via a series of separate difference-in-differences models with different, binary outcomes (attend college, attend an in-state public four-year college). We then extend this intuition to a nested logit model in which we can simultaneously model various outcomes. This setup recognizes college choices are embedded in groups defined by state of residence. The choice sets available to a student vary depending on the public higher education system in her home state, as well as more traditional factors such as distance and likelihood of admission. The most common approach for dealing with a choice model of this type is to assume the individual taste preference is independently and identically distributed, so the probability of a student choosing a particular school can be estimated as a conditional logit. However, a limitation of conditional logit is the need to invoke the independence of irrelevant alternatives (IIA) assumption that the trade-off between any two options will not be affected by the availability of or changes in a third option (Train 2009). This would imply that changes in tuition at a moderately selective four-year public university in a student's home state alters the likelihood a student will attend community college in a way that is proportionate to changes in the likelihood a student attends an out-of-state private liberal arts college or research university. Clearly, this assumption is questionable.

To deal with this, we extend the empirical framework to recognize that any student faced with the decision of choosing among colleges is confronted with cost schedules for different institutions that are a direct function of the state of residence. So, the relative costs of comparable students can look different, solely as a function of state of residence. We group colleges into more homogeneous types (such as selective in-state public four-year colleges or highly selective out-of-state private four-year colleges). This grouping strategy has both conceptual and empirical advantages. Conceptually, grouping accommodates the ways in which students think about their college choices. Grouping has the empirical advantage that it allows us to relax the IIA assumption in an intuitively appealing way: The nested logit approach assumes that changes in costs or attributes of a college within a group has one effect on the likelihood of attending other colleges in the same group, but another effect on the likelihood of attending colleges in a different nest.

We incorporate additional information into the data set we use to estimate the nested logit model. We use Barron's rankings data to group colleges by level, control, and selectivity. We also estimate the likelihood of acceptance (for each college group and student) as a function of math test scores and student-level demographics (that is, gender, race, ethnicity) using information from the ELS and NELS surveys on students' first two college applications (and subsequent admission outcomes). We include the probability of admission (to each group of colleges) as a covariate in our multinomial model (along with enrollment-weighted tuition and fee costs).

RESULTS

To begin understanding these data and changing patterns of postsecondary enrollment, consider the cross-tab of postsecondary enrollment decisions for the high school class of 1992 from the NELS:88 and the class of 2004 from the ELS:2002, presented in table 2. In the top panel, we present mean enrollment decisions for the full NELS and ELS samples of students graduating high school in 1992 and 2004, respectively. In general, differences are small and expected between the groups. The proportion of students enrolling in some form of postsecondary study increased from 74 percent to 80 percent between the two cohorts. This reflects the continued trend toward postsecondary study generally.

In the middle and bottom panels of table 2, we present patterns of enrollment in states that saw, respectively, the slowest and fastest growth in tuition and fees charged at public four-year colleges and universities. Total enrollment increased the most in states with the largest tuition increases. This suggests that these states may have experienced population or economic growth that led to increased demand for higher education, and hence price increases. It may also reflect differences in

Table 2. Postsecondary Enrollment Among High School Graduates

Postsecondary Enrollment	Class of 1992 (NELS:88)	Class of 2004 (ELS:2002)
Full samples		
Enrolled (yes/no)	0.736	0.804
Enrolled in public two-year college	0.243	0.274
Enrolled in public four-year college	0.269	0.326
Enrolled in private college	0.137	0.145
	N=12,090	N=11,220
Students in slow tuition-growth states		
Enrolled (yes/no)	0.758	0.804
Enrolled in public two-year college	0.255	0.253
Enrolled in public four-year college	0.291	0.350
Enrolled in private college	0.143	0.139
	N=2,550	N=2,710
Students in fast tuition-growth states		
Enrolled (yes/no)	0.715	0.811
Enrolled in public two-year college	0.198	0.254
Enrolled in public four-year college	0.284	0.318
Enrolled in private college	0.142	0.173
	N=4,850	N=4,190

Source: Authors' calculations.

Notes: Slow tuition-growth = change in real tuition at public four-years < $1,563; fast tuition-growth = change in real tuition at public four-years > $2,717; college enrollment is captured within two years of high school graduation.

quality between institutions within these states. Importantly, enrollment appears to have shifted toward public two-year and private colleges in states adopting large tuition increases at public four-year colleges, suggesting some substitution.

Table 3 presents select descriptive statistics on all students, and then separately for populations of students in fast and slow tuition-growth states. Differences are minimal between the NELS and ELS samples. Students in the class of 2004 had more highly educated parents than those in the class of 1992, on average. For example, in the NELS:88 sample, 10 percent of students had a mother who completed "some college," whereas the corresponding figure for the ELS:2002 sample is 34 percent. This increase occurred alongside a decrease in the share of mothers who were high school dropouts between 1992 and 2004 and an increase in the percentage earning a college degree. The same trends appear when examining changes in average educational attainment of respondents' fathers between the two survey periods. Such differences are expected.

Comparing the characteristics of students in fast tuition-growth states to those in states that experienced slower growth in tuition at public four-year institutions gives us a sense of how high school graduates and their families have changed over time. Overall, differences in average characteristics are minimal. For both the classes of 1992 and 2004, slow tuition-growth states have slightly higher proportions of minority students (African American, Asian, and Hispanic) than fast tuition-growth states do. More students in states with slow tuition growth (across both high school classes) have mothers who have completed some college. Across periods, we see similar changes in these descriptive statistics for both slow and fast public tuition-growth states.

Table 3. Select Descriptive Statistics on Students

Variable	All Students		Students in Slow Tuition-Growth States		Students in Fast Tuition-Growth States	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Class of 1992 (NELS:88)	N=8,530		N=1,700		N=3,550	
Female	0.50	0.50	0.52	0.50	0.50	0.50
Black	0.11	0.32	0.17	0.37	0.10	0.30
Hispanic	0.09	0.28	0.07	0.25	0.07	0.26
Asian	0.04	0.19	0.03	0.18	0.02	0.15
Other	0.01	0.10	0.01	0.09	0.01	0.07
Math score	49.44	14.10	49.60	13.92	50.17	13.92
Mother's education level						
High school graduate	0.51	0.50	0.48	0.50	0.54	0.50
Some college	0.10	0.30	0.12	0.32	0.08	0.28
College graduate	0.15	0.36	0.16	0.36	0.15	0.36
Postgraduate	0.10	0.30	0.11	0.31	0.10	0.30
Class of 2004 (ELS:2002)	N=11,220		N=2,700		N=4,190	
Female	0.52	0.50	0.52	0.50	0.51	0.50
Black	0.13	0.33	0.19	0.39	0.11	0.31
Hispanic	0.14	0.35	0.12	0.33	0.12	0.33
Asian	0.05	0.21	0.04	0.19	0.03	0.18
Other	0.05	0.22	0.04	0.20	0.04	0.20
Math score	51.54	13.84	51.77	13.45	51.86	13.81
Mother's education level						
High school graduate	0.27	0.44	0.25	0.43	0.30	0.46
Some college	0.34	0.48	0.36	0.48	0.34	0.47
College graduate	0.18	0.39	0.19	0.39	0.19	0.39
Postgraduate	0.09	0.29	0.10	0.31	0.09	0.28

Source: Authors' calculations.

Notes: All means are weighted means, using the survey-specific weights from the NELS (or ELS) as weights to account for each survey's design and sampling procedure. Descriptive statistics are presented for observations with non-missing values. In the regressions that follow, we use indicator variables to control for observations with missing covariate information.

Multivariate Regression Results: Difference-in-Differences

To consider the impacts of large changes in the costs of attending a public four-year college or university, we turn to estimates from equation 1 presented in table 4. Columns 1, 2, and 3 display results from linear probability models of any postsecondary enrollment among all high school graduates in our samples. The remaining columns present models of college attendance at in-state public institutions among those enrolling in college. Across columns 1, 2, and 3, we progress from a model that uses cross-state variation without any indicators for large increases in public four-year tuition costs, to a model with state fixed effects, to our preferred specification that includes both state fixed effects and indicators to capture impacts on enrollment behavior of moderate and large tuition increases.

The differences between the results in columns 1 through 3 make clear the importance of using within-state variation to understand the relationship between tuition and college

Table 4. Impacts of Tuition Increases on Student Enrollment Decisions

	Sample: All Students			Sample: College Enrollees				
	Attend College	Attend College	Attend College	Attend Public College in State	Attend Public College in State	Attend Public College in State	Attend Public Two-Year College in State	Attend Public Four-Year College in State
Independent Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Real four-year public tuition and fees	0.005	0.019***	0.025*	−0.017*	0.001	−0.037*	−0.117***	0.080**
(average cost; per $1,000)	(0.006)	(0.007)	(0.013)	(0.010)	(0.010)	(0.021)	(0.027)	(0.032)
Real two-year public tuition and fees	−0.004	−0.003	−0.005	−0.030**	−0.023	−0.038	−0.092***	0.055*
(average cost; per $1,000)	(0.007)	(0.016)	(0.015)	(0.013)	(0.027)	(0.026)	(0.029)	(0.030)
Real four-year private nonprofit tuition and fees	0.001	0.002	0.003	−0.006	−0.009	−0.011	−0.011	−0.000
(average cost; per $1,000)	(0.002)	(0.006)	(0.006)	(0.004)	(0.009)	(0.008)	(0.010)	(0.009)
2004	0.190***	0.151***	0.163***	0.112***	0.071	0.114	0.120	−0.006
	(0.026)	(0.052)	(0.058)	(0.038)	(0.069)	(0.072)	(0.089)	(0.077)
Moderate four-year public tuition change*2004			−0.037*			0.071**	0.184***	−0.113**
			(0.020)			(0.033)	(0.040)	(0.052)
Large four-year public tuition change*2004			−0.019			0.113**	0.388***	−0.274***
			(0.038)			(0.055)	(0.076)	(0.081)
Include state fixed effects?	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Outcome mean	0.787	0.787	0.787	0.636	0.636	0.636	0.297	0.339
N	23310	23310	23310	18340	18340	18340	18340	18340
R^2	0.140	0.147	0.147	0.060	0.081	0.081	0.151	0.073

Source: Authors' calculations.

Notes: All models include controls for student race, ethnicity, twelfth-grade math test scores, mother's and father's education levels, family makeup, and average Pell Grants and institutional grant aid available to students from four-year publics, two-year publics, and four-year private nonprofits within their home states. Robust standard errors clustered at the state level appear in parentheses.

*$p < .1$; **$p < .05$; ***$p < .01$

attendance: We see no relationship between tuition and enrollment in column 1, but a significant positive relationship between tuition and enrollment growth within states (in column 2). This is consistent with the possibility that postsecondary enrollment demand was increasing in states where tuition was rising the most. Yet column 3 presents evidence that, after conditioning on a direct, linear effect, states with the most rapid increases in public tuition costs between 1992 and 2004 saw (small) decreases in the likelihood of college enrollment. The point estimate for students in states that experienced moderate increases in public four-year tuition is negative and weakly significant, whereas for students in states with the largest increases it is negative and insignificant. Collectively, we interpret these results as suggesting that large increases in public, four-year tuition costs over this period slightly dampened the propensity of students (in those states) to pursue postsecondary education. Yet, relative to the overall increase in college-going likelihood between cohorts (that is, an increase of about 16 percentage points), any such negative effects are quite small.

In the remaining columns in table 4, we present results on the relationship between large public tuition increases and student enrollment at in-state public institutions, conditional on attending college. Among college-going students, changes in the likelihood of attending an in-state public institution between 1992 and 2004 were different in states where tuition costs increased substantially and those with smaller cost increases. Specifically, we estimate a relative increase in the propensity to attend in-state public colleges in states where tuition prices rose drastically compared to states with small real price changes (column 6).[7] Yet the results in columns 7 and 8 illustrate that this relative increase in attendance at in-state public institutions was due to an increased enrollment at public two-year colleges—along with a substitution away from in-state public four-year colleges.

To make these patterns clearer, in figure 2 we graph changes in enrollment probabilities implied by the estimated coefficients from table 4. The three groups of bars depict changes in the probability of enrolling in any in-state public college or university (column 6), any in-state public two-year college (column 7), and any in-state public four-year college or university (column 8). Each bar represents the predicted change in enrollment probability due to an increase in public four-year tuition costs of a particular magnitude.[8] The first panel (three bars) illustrates a moderate decline in the likelihood students enrolled in public postsecondary institutions in states where public tuition grew most slowly. Enrollment in states where tuition growth was larger saw no such decline. This is consistent with the possibility that postsecondary enrollment demand was increasing in states where tuition was rising the most.

The next two panels of figure 2 illustrate that in states where tuition increased the least, students shifted away from enrollment in two-year colleges, and toward enrollment in four-year colleges. Conditional on attending college, the likelihood of attending a two-year public college fell by about 0.12 in these states, while the likelihood of attending a four-year public college or university increased by about 0.08. In states with larger tuition increases, we see no similar increase in the propensity to enroll in public four-year postsecondary education.

Together, these results suggest that states where public higher education costs increased substantially between 1992 and 2004 have strong and relatively inelastic demand for public higher education. Nevertheless, these large increases in public four-year tuition costs appreciably affected college choice, pushing students away from four-year institutions and toward two-year colleges.

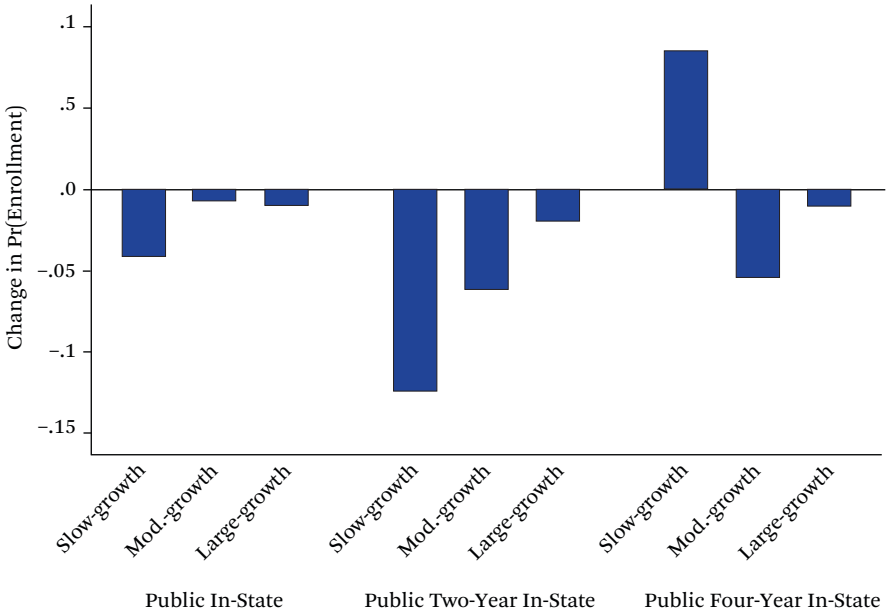
Estimates by Institutional Selectivity

We next consider the relationship between large increases in tuition for public higher ed-

7. Because the preferred models all include state fixed effects, these estimates are net of time-invariant unobserved differences between states.

8. We sum the product of the observed change in real tuition (at the group mean) and the coefficient on the continuous measure of tuition costs plus the coefficient on any relevant group indicator (moderate or large).

Figure 2. Changes in Public Higher Education Choices by Public Four-Year Tuition-Growth Group, 1992–2004



Source: Authors' calculations.

Notes: Sample is limited to college enrollees. Each bar sums the product of the observed change in real tuition (at the group mean) and the coefficient on the continuous measure of tuition costs plus the coefficient on any relevant group indicator (that is, moderate or large).

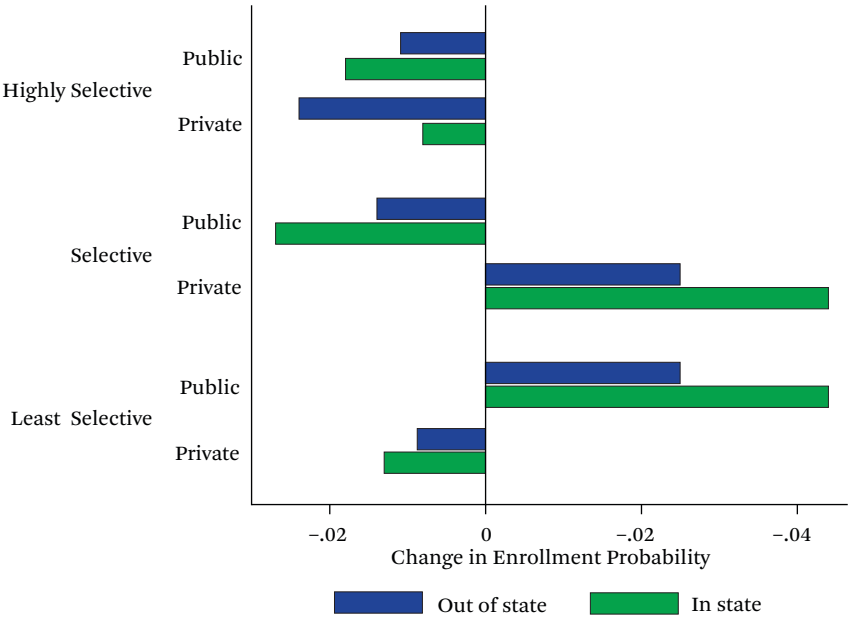
ucation and enrollment at postsecondary institutions with different levels of selectivity. We use Barron's data on the selectivity of colleges and universities to categorize all institutions attended by students in our sample.[9] The Barron's rankings range from less competitive to most competitive and are a function of the percentage of applicants admitted and the average academic preparation and aptitude of admitted students. Those institutions that are not ranked are classified below the less competitive group as noncompetitive.[10] We group the six Barron's categories into three slightly broader categories: highly selective (includes most competitive and highly competitive schools), selective (includes very competitive and competitive schools), and least selective (includes less competitive and noncompetitive schools).

In figure 3, we present results from a series of models in which we estimate the difference-in-differences comparisons of changes in the likelihood of enrolling in various types of postsecondary institutions for students in states where public four-year tuition grew rapidly between 1992 and 2004. Each bar captures the full effect of the mean change in public four-year tuition costs for high-growth states (combining the linear and nonlinear coefficients, as in figure 2). The estimates in figure 3 make it clear that students in states experiencing large increases in public four-year tuition costs over this period are less likely to attend selective (and highly selective) in-state public four-year institutions, but more likely to attend selective private institutions (both in-state and out-of-state). Further, the pattern illustrated here is

9. We are grateful to Ozan Jaquette and Michael Bastedo for sharing these Barron's data.

10. For example, institutions rated as most competitive generally admit less than 33 percent of applicants and have median ACT scores of 29 or higher. Less competitive institutions admit 85 percent (or more) of applicants and have median ACT scores of 21 or lower. Community colleges fall into this category.

Figure 3. Enrollment Changes After Large Public Four-Year Tuition Increases, 1992–2004



Source: Authors' calculations.

Notes: Sample is limited to college enrollees. Bars capture full enrollment effects (linear + non-linear) of large increases in public, four-year tuition costs. See text for definitions of selectivity categories.

suggestive of vertical substitution downward to less and nonselective public institutions (such as community colleges).

Differences by Demographic Subgroups of Students

Although table 4 and figures 2 and 3 provide estimates of average enrollment effects in response to large changes in tuition, we know that student subgroups vary in their price sensitivity (Long 2004). In table 5, we estimate our preferred difference-in-differences specification for three subgroups of particular interest to policymakers: low-SES families,[11] parents did not attend college, and African American. For each subgroup, we estimate our preferred models for the decision about whether to attend college, and then decisions about type of postsecondary institution, conditional on enrollment. The results in table 5 can be compared directly with those in table 4.

For students from low-SES and first-generation college families we find patterns similar to those among all students, only more pronounced. That is, large increases in public higher education tuition have no effect on the likelihood of attending college for these groups, but have larger effects on decisions about where to enroll. These findings suggest that the substitution away from four-year public universities toward two-year colleges, in states where public four-year tuition grew the most, is largely driven by impacts on the initial enrollment decisions of students from families of low socioeconomic status and first-generation college students.

Differences by Student Ability

We next consider whether the relationship between cost and enrollment in public higher education differs for students of varying academic achievement levels. We define ability us-

11. We categorize students from families of low socioeconomic status if the value of the family's SES variable (measured in twelfth grade) is at or below the 25th percentile.

Table 5. Impacts of Tuition Increases on Enrollment by Demographic Subgroups of Students

		Sample: College Enrollees		
	Attend College	Attend Public College in State	Attend Two-Year Public College in State	Attend Four-Year Public College in State
Independent Variables	(1)	(2)	(3)	(4)
Students from low-SES families				
2004	0.125	0.350**	0.421**	−0.070
	(0.108)	(0.145)	(0.164)	(0.110)
Moderate four-year public tuition change*2004	−0.048	0.074	0.161*	−0.087
	(0.054)	(0.085)	(0.088)	(0.069)
Large four-year public tuition change*2004	0.012	0.024	0.325*	−0.301**
	(0.100)	(0.146)	(0.166)	(0.122)
Outcome mean	0.613	0.708	0.425	0.283
N	5630	3450	3450	3450
R^2	0.168	0.069	0.140	0.133
Independent Variables	(5)	(6)	(7)	(8)
Students whose parents did not attend college				
2004	0.163	0.401***	0.289**	0.111
	(0.111)	(0.124)	(0.130)	(0.124)
Moderate four-year public tuition change*2004	0.059	0.215***	0.244***	−0.029
	(0.044)	(0.066)	(0.074)	(0.081)
Large four-year public tuition change*2004	0.133	0.341***	0.446***	−0.105
	(0.081)	(0.118)	(0.135)	(0.133)
Outcome mean	0.663	0.710	0.407	0.303
N	7520	4990	4990	4990
R^2	0.156	0.059	0.143	0.132
Independent Variables	(9)	(10)	(11)	(12)
African American students				
2004	0.242	0.234	0.109	0.125
	(0.205)	(0.222)	(0.274)	(0.258)
Moderate four-year public tuition change*2004	0.029	−0.049	−0.011	−0.038
	(0.067)	(0.088)	(0.082)	(0.115)
Large four-year public tuition change*2004	0.265	−0.162	0.002	−0.164
	(0.160)	(0.220)	(0.218)	(0.288)
Outcome mean	0.742	0.616	0.294	0.323
N	2540	1880	1880	1880
R^2	0.179	0.106	0.165	0.162

Source: Authors' calculations.

Notes: All models include state fixed effects, controls for linear changes in tuition costs at four-year publics, two-year publics, and four-year private nonprofits in students' home states, and controls for student race, ethnicity, twelfth grade math test scores, mother's and father's education levels, family income and makeup, and average Pell Grant and institutional grant aid available to students from four-year publics, two-year publics, and four-year private nonprofits within their home states. Robust standard errors clustered at the state level appear in parentheses.

*$p < .1$; **$p < .05$; ***$p < .01$

ing twelfth-grade math scores and examine distributions of students' math scores by cohort (that is, NELS separately from ELS).[12] We then group students into four different ability groups that we expect to respond differently to changes in costs at four-year public colleges in a state: elite students, in the top 10 percent; high-performing students, in the top 33 percent but not the elite group; average-performing students, between 33 and 67 percent; and low-performing students, in the bottom 33 percent.

In table 6, we provide descriptive statistics for background characteristics of students as well as ranges of SAT scores for the postsecondary institutions students in each ability group report attending. Elite students are likely to score better on entrance exams and report attending colleges with higher-performing peers. As a consequence, these students are likely to gain admission and have the means to attend a wider range of colleges. We expect students in this group to be less affected by tuition at public four-year institutions.

High-performing students are likely to be of the type to gain admission to the most selective public four-year colleges in their home states, but less likely than elite students to qualify for admission to top-tier universities nationally. Low-performing students, on the other hand, are unlikely to qualify for admission to selective public universities in their home states. Rather, these students are more likely to be admissible at less selective or open enrollment institutions, which are also relatively inexpensive. Note that 97 percent of elite students enroll in college within two years of high school graduation, versus 83 percent of average performers and 54 percent of low performers.

In table 6, for each student group we present separate estimates of the impact of large tuition changes at public four-year colleges on the likelihood of attending college and (conditional on attending college) of enrolling in any public in-state college, a public two-year in-state college, and a public four-year in-state college. Several patterns emerge from table 6. Most strikingly, we see different effects of large public tuition increases on the college choices of high-performing and on average-performing students. High performers in states that experienced the largest increases in public four-year tuition costs are substantially less like to attend an in-state public college, especially a four-year institution. Auxiliary regressions for which outcomes measure attendance at in-state, out-of-state, public, and private institutions of particular selectivity levels (based on Barron's data) reveal that high performers exposed to such public tuition increases instead opt for selective private institutions out of state.[13] Average-performing students exposed to the largest public tuition increases were less likely to attend an in-state public four-year institution (relative to their average-performing counterparts in states with more modest tuition increases); but, unlike their higher-performing peers, average performers in these high tuition-growth states were substantially more likely to attend an in-state public two-year college. Complementary regressions on attendance at institutions of varying types and selectivity levels confirm that this effect for average performers is driven by increased attendance at lower-ranked in-state public institutions.

At the extremes of the student ability distribution, we see less evidence of such substitution in college choices. Among elite students, some evidence shows that those in states that adopted large increases in public tuition opted to instead enroll in out-of-state private four-year institutions. Yet, among elite performers, college enrollment (along the extensive margin) grew fastest in states that adopted the largest hikes in public four-year tuition costs between 1992 and 2004. This is not surprising because the demand for higher education among elite students likely is most inelastic. Among low-performing students, exposure to large increases in public four-year tuition costs resulted in an increased likelihood of attending an in-state college. Auxiliary regressions using Barron's selectivity data reveal that, for

12. We use the math score variable from the ELS created specifically to be used in conjunction with the math scores in NELS to examine cross-cohort changes in math performance (NELS-equated).

13. Results from all auxiliary regressions are available from the authors on request.

Table 6. Impacts of Tuition Increases on Enrollment by Student Academic Preparation

Student Subgroup		Independent Variables	Attend College (1)	Attend Public College in State (2)	Attend Two-Year Public College in State (3)	Attend Four-Year Public College in State (4)
Elite students (at or above 90th percentile)						
Characteristics:		2004	0.077	−0.406*	−0.008	−0.399*
Student:			(0.086)	(0.213)	(0.098)	(0.231)
Percent black	2	Moderate public tuition change*2004	0.024	−0.205*	−0.053	−0.153
Percent Hispanic	4		(0.029)	(0.114)	(0.042)	(0.120)
Percent Asian	21	Large public tuition change*2004	0.106**	−0.120	0.107	−0.226
			(0.045)	(0.177)	(0.078)	(0.186)
Percent going to college	97					
College:						
SAT 25th percentile–math	568					
SAT 75th percentile–math	670					
SAT 25th percentile–verbal	550	N	2160	2100	2100	2100
SAT 75th percentile–verbal	655	R^2	0.131	0.182	0.100	0.127
High-performing students (67th–90th percentile)						
Characteristics:		2004	0.049	−0.038	0.129	−0.168
Student:			(0.059)	(0.125)	(0.116)	(0.119)
Percent black	5	Moderate public tuition change*2004	−0.063**	−0.137***	0.017	−0.155***
Percent Hispanic	8		(0.031)	(0.043)	(0.045)	(0.049)
Percent Asian	10	Large public tuition change*2004	−0.109**	−0.226**	0.131	−0.357***
			(0.052)	(0.095)	(0.092)	(0.093)
Percent going to college	93					
College:						
SAT 25th percentile–math	519					
SAT 75th percentile–math	625					
SAT 25th percentile–verbal	509	N	4910	4550	4550	4550
SAT 75th percentile–verbal	615	R^2	0.087	0.134	0.144	0.080

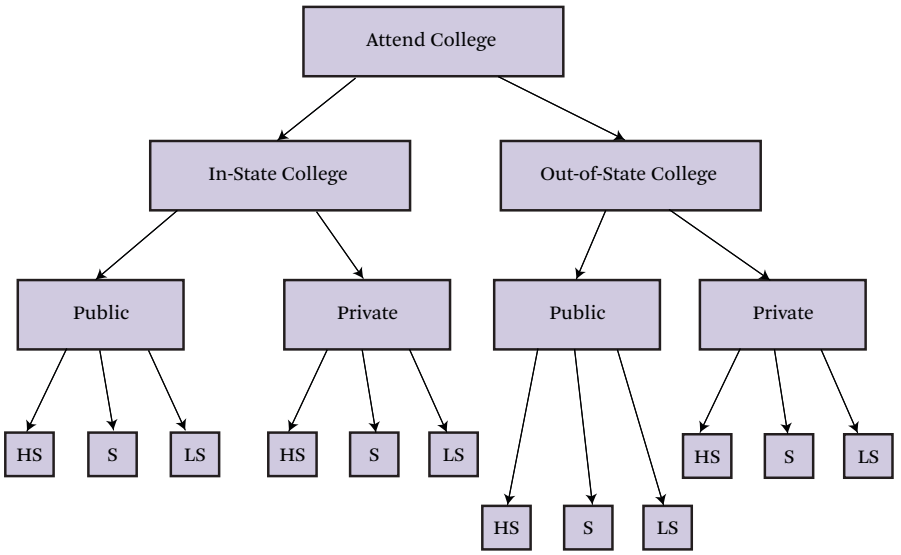
Average-performing students (33rd–67th percentile) Characteristics:		2004	0.228***	0.185*	0.201*	−0.016
Student:			(0.074)	(0.095)	(0.118)	(0.141)
Percent black	9	Moderate public tuition change*2004	−0.009	0.163***	0.274***	−0.111*
Percent Hispanic	12		(0.035)	(0.049)	(0.064)	(0.063)
Percent Asian	8	Large public tuition change*2004	0.018	0.209**	0.475***	−0.266**
			(0.058)	(0.083)	(0.129)	(0.115)
Percent going to college	83					
College:						
SAT 25th percentile–math	486					
SAT 75th percentile–math	595					
SAT 25th percentile–verbal	480	N	7110	5920	5920	5920
SAT 75th percentile–verbal	588	R^2	0.112	0.085	0.144	0.089
Low-performing students (below 33rd percentile) Characteristics:		2004	0.025	0.268	0.300**	−0.032
Student:			(0.080)	(0.166)	(0.141)	(0.131)
Percent black	20	Moderate public tuition change*2004	−0.050	0.173*	0.161*	0.013
Percent Hispanic	19		(0.044)	(0.098)	(0.087)	(0.067)
Percent Asian	6	Large public tuition change*2004	0.029	0.231	0.341**	−0.110
			(0.079)	(0.178)	(0.164)	(0.109)
Percent going to college	61					
College:						
SAT 25th percentile–math	447					
SAT 75th percentile–math	559					
SAT 25th percentile–verbal	446	N	6740	4110	4110	4110
SAT 75th percentile–verbal	557	R^2	0.148	0.076	0.119	0.117

Source: Authors' calculations.

Notes: All models include state fixed effects, controls for linear changes in tuition costs at four-year publics, two-year publics, and four-year private nonprofits in students' home states, controls for student race, ethnicity, twelfth grade math test scores, mother's and father's education levels, family income and makeup, and average Pell Grants and institutional grant aid available to students from four-year publics, two-year publics, and four-year private nonprofits within their home states. Robust standard errors clustered at the state level appear in parentheses.

*$p < .1$; **$p < .05$; ***$p < .01$

Figure 4. Nested Model of College Choice



Source: Authors' compilation.
Notes: HS = highly selective; S = selective; and LS = less selective. All selectivity categorizations are based on Barron's rankings data. See text for detailed discussion of these groupings.

low performers, this increased likelihood is driven by substitution away from moderately selective in-state four-year public institutions toward nonselective ones (such as community colleges).

The different impacts of large increases in public tuition costs across the ability or performance distributions of high school graduates underscore the degree to which shifts in state-level tuition policies affect enrollment decisions of both well-prepared but modestly resourced students as well as more poorly prepared high school graduates.

Nested Logit Results

Rather than modeling enrollment decisions in a series of binary choices, as in tables 4 through 6, we turn next to our nested logit model, which treats the decision among colleges of various types as multinomial. We estimate the effects of tuition and fee price changes at public four-year colleges on a student's decision about whether to attend an in-state public college, or whether to attend a private college or a public college out-of-state and colleges of various selectivity levels. In figure 4, we illustrate the nesting structure into which we group colleges.

In table 7, we summarize the results from the nested logit analysis, presenting parameter estimates for the key policy variables, interacted with cohort, to set up the same difference-in-differences interpretation. The base against which all college choices are compared is enrollment in selective, public institutions in a student's home state. To this base, the estimates compare the likelihood of enrolling in various other types of colleges. The results in table 7 largely conform to the patterns we observe in our series of binary models: students in states adopting relatively large increases in public four-year tuition costs between 1992 and 2004 are more likely to substitute "down" to less selective public colleges, and "out" to selective private and public universities out of state (relative to their counterparts who experienced more modest tuition increases). Relative to the results from our binary models, the nested logit findings emphasize the substitution to out-of-state public and private universi-

Table 7. Nested Logit Results of Impact of Public Tuition Increases on College Choice

Independent Variables	Private, In-State	Private, Out-of-State	Public, In-State	Public, Out-of-state
A. Less/nonselective institutions	(1)	(2)	(3)	(4)
2004	−1.187***	−0.788	−0.843***	−1.158***
	(0.179)	(0.484)	(0.165)	(0.213)
Moderate four-year public tuition change*2004	−0.025	0.037	0.082	0.224
	(0.211)	(0.658)	(0.228)	(0.446)
Large four-year public tuition change*2004	0.181	0.412	0.435	0.741**
	(0.261)	(0.713)	(0.297)	(0.336)
Outcome mean	0.27	0.02	0.33	0.02
B. Selective institutions	(5)	(6)	(7)	(8)
2004	−0.379	−0.641***		−0.476***
	(0.280)	(0.165)		(0.173)
Moderate four-year public tuition change*2004	−0.028	0.257	BASE	0.576**
	(0.368)	(0.318)		(0.286)
Large four-year public tuition change*2004	0.525	1.077***		0.757**
	(0.359)	(0.370)		(0.385)
Outcome mean	0.05	0.03	0.16	0.03
C. Highly selective institutions	(9)	(10)	(11)	(12)
2004	0.724	0.434	−0.202	0.216
	(1.062)	(0.698)	(0.677)	(1.190)
Moderate four-year public tuition change*2004	1.431***	0.760*	0.464	4.371***
	(0.531)	(0.439)	(0.806)	(1.190)
Large four-year public tuition change*2004	2.504***	1.270**	−0.305	20.454***
	(0.824)	(0.502)	(0.691)	(2.011)
Outcome mean	0.01	0.03	0.05	0.01

Source: Authors' calculations.

Notes: N = 119,610; figure 4 depicts the selectivity based nests of postsecondary institutions used in the nested logit model. See text for details about grouping institutions into selectivity categories. The nested logit model includes two alternative-specific covariates: enrollment-weighted, real tuition and fees, and the probability of admission. We model the probability of admission to each selectivity nest of institutions using supplemental data from the NLES:88 and ELS:2002 surveys that capture students' postsecondary application and acceptance outcomes. In auxiliary regressions, we model acceptance as a function of students' math test scores, demographic characteristics, survey (NELS or ELS), and state fixed effects. We then predict admission probabilities for all students for all nests and use this linear prediction as an alternative-specific covariate in the nested logit model. In addition, within the nested logit college-type equations that model attendance, we include the same set of student-level covariates as in all earlier tables. Robust standard errors clustered at the state level appear in parentheses.

*p < .1; **p < .05; ***p < .01

ties that are selective or highly selective in response to large increases in public tuition costs in a student's home state.

VALIDITY AND ROBUSTNESS CHECKS

For both the nested logit and linear probability models, the identifying variation comes from within-state changes in the postsecondary enrollment decisions of students in states that saw rapid growth in public tuition costs between 1992 and 2004, over and above changes for observationally identical students in other states. This difference-in-differences strategy limits many potential threats to internal valid-

ity, but threats remain. Perhaps most important is the possibility that states with the most rapid increases in tuition saw unusual changes in the quality of higher education. If so, then sorting out whether the changes we observe are a price response rather than a behavioral change due to the attributes of a state's colleges is more difficult.

As a first way to assess the importance of this threat, we exploit the fact that some states have tuition reciprocity agreements that permit students in other states to pay their home state's tuition. If students who see larger price changes because of reciprocity agreements exhibit the largest enrollment declines, this provides some assurance that price is the principal motivation for the decline. As a second way to rule out the possibility that enrollment shifts were due to simultaneous changes in institutional quality, we examine changes in other indicators of the quality of public colleges and universities in states with large or small increases in tuition costs.

Tuition Reciprocity Agreements and Student Price Response

The state of Minnesota has reciprocity agreements with three surrounding states: Wisconsin, North Dakota, and South Dakota.[14] Although most reciprocity agreements have substantial conditions or limitations, those between Minnesota and these three states permit a student from the other state to attend its public postsecondary education institutions and pay the same tuition as at a comparable home-state institution (DesJardins 1999; Rayburn 2011).[15] Unlike almost all other reciprocity agreements, Minnesota's arrangements are not limited to students in particular majors. These states are also interesting because they saw quite different rates of tuition growth over the period in which we observe students in both states in our analytic sample: Minnesota's public four-year tuition grew the fastest, placing it in our top category with Wisconsin. Yet students in South Dakota and North Dakota saw more modest increases in public four-year tuition costs that placed those states in our middle group (average increase of between $1,600 and $2,700). Therefore, if price changes affect enrollment decisions, we would expect a relative decrease in the number of students from Minnesota enrolling in Minnesota's best four-year colleges, since they bear the full cost of the larger tuition increase. Because North and South Dakota students did not see the tuition costs of attending Minnesota's colleges rise as much, we should see a smaller enrollment response.

To examine the enrollment decisions of students from Minnesota, South Dakota, and North Dakota in response to these price shifts, we estimate difference-in-differences models similar in intuition to those throughout the paper, which take the following shape:

$$Y_{MN_{isc}} = \alpha + \theta \mathrm{T}_{isc} + \gamma Aid_{isc} + \beta_1 MN_{student_{isc}} + \beta_2 ELS_{isc} + \beta_3 (ELS * MN_{student})_{isc} + \varphi X_{isc} + \varepsilon_{isc} \quad (2)$$

where the outcome is a measure of attendance at a public college in Minnesota for student *i*, from state *s*, in cohort *c*. For this exercise, we limit the sample to students in our NELS-ELS sample whose home state is Minnesota, South Dakota, or North Dakota. We present results from these models in table 8.

As the coefficients on the Minnesota student indicator illustrate, over this time, students from Minnesota were about 32 percentage points more likely to attend a public four-year institution in Minnesota than their counterparts in North Dakota and South Dakota. Yet the relative change in the propensity of Minnesota students to attend Minnesota's four-year colleges declined by about 19 percentage points over observationally identical

14. These are state-specific agreements. For example, Wisconsin and South Dakota do not have a tuition reciprocity agreement.

15. Reciprocity agreements are of two types: tangential and consortium. Tangential agreements involve two states and are agreed on bilaterally for a set period. Consortium agreements are entered into by several states and administered by a common board.

Table 8. Tuition Reciprocity and Student Enrollment Decisions

	Attend MN Public College	Attend MN Four-Year Public College
Independent Variables	(1)	(2)
MN student	0.183	0.317**
	(0.167)	(0.154)
2004	0.653***	0.402***
	(0.087)	(0.077)
MN student*2004	−0.159	−0.192**
	(0.102)	(0.089)
N	450	450
R^2	0.237	0.149

Source: Authors' calculations.
Notes: Models include all student-level covariates reported in tables 3 through 6. Robust standard errors appear in parentheses.
*$p < .1$; **$p < .05$; ***$p < .01$

students in the Dakotas. This relative decline in the likelihood of Minnesota students enrolling in Minnesota's four-year public colleges is consistent with predictions from consumer theory. It also suggests the declining propensity of Minnesota students to attend public colleges in their home state was not driven by a decline in the quality of these schools, given that North and South Dakotans (the reference group) did not show a similar distaste for Minnesota's colleges.

Trends in Higher Education Spending

As another way to test for unmeasured shifts in the quality of four-year public institutions, we examine trends in student services expenditures and research expenditures at public four-year research institutions and at public four-year master's universities. We use these measures to assess contemporaneous changes in the characteristics of colleges and universities in states with rapid public tuition growth.

In figure 5 we present time series of student services and research expenditures per full-time equivalent student (FTE) from 1986 to 2007 at public four-year institutions. Expenditures on student services include costs associated with admissions, registrar activities, and activities whose primary purpose is to contribute to students' emotional and physical well-being and to their intellectual, cultural, and social development outside the context of the formal instructional program (for example, cultural events, student newspapers, intramural athletics, and student organizations). Each panel includes separate time series for states with the fastest and slowest growth in tuition.

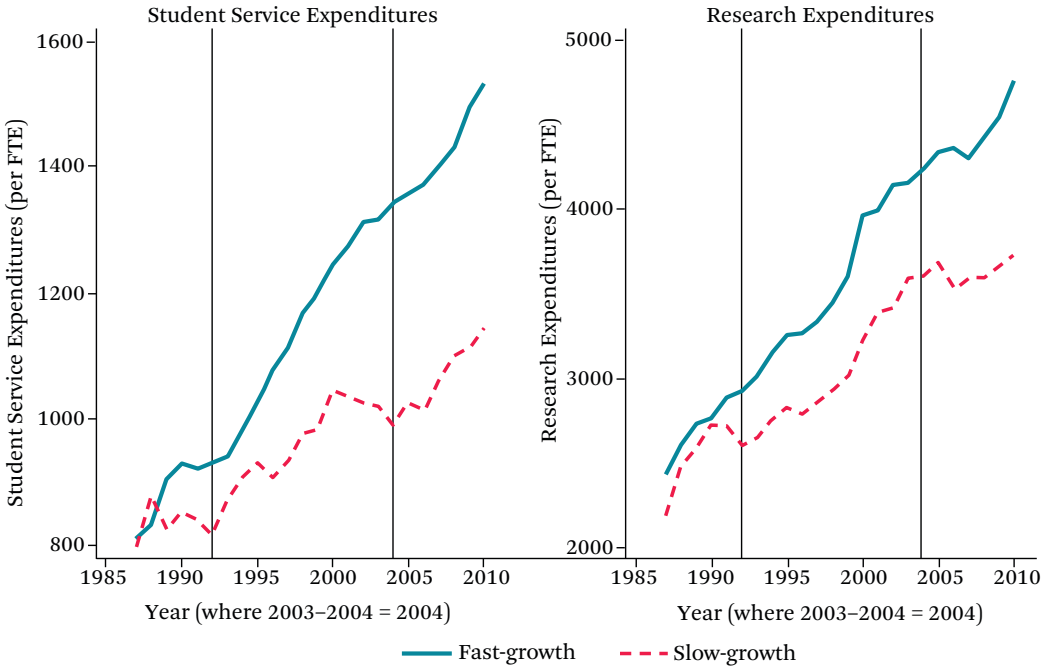
In both panels of figure 5, we see sizeable increases in spending between 1992 and 2004 (the solid vertical lines). Yet, in neither case does any evidence indicate that such expenditures changed differentially across states that adopted large versus small increases in public tuition in ways that would explain our main results. For example, trends in student services expenditures (per FTE) in high tuition-growth states did not decline between 1992 and 2004 while such expenditures rose in low tuition-growth states. These trends do not suggest that changes in other attributes of public institutions in high tuition-growth states dissuaded students from attending.

Changes in Cohort Size and Quality

To assess whether the enrollment shifts we see are potentially a result of relative changes in the quantity or quality of students entering postsecondary education in states where tuition grew fastest, we conduct two tests. First, we examine trends in the stock of high school graduates across our groups of states (as a basic proxy for higher education demand).[16] Second, we consider whether treatment and control states saw different changes in average SAT scores (verbal and math) or eighth grade NAEP math scores during the years that closely match our NELS and ELS cohorts of high school graduates. We calculate standardized changes in these average scores by state and

16. Data on counts of high school graduates by state come from the Common Core of Data (CCD): http://nces.ed.gov/ccd/tables/ESSIN_Task5_f2.asp (accessed February 23, 2016).

Figure 5. Expenditures at Public Four-Year Institutions by Public Four-Year Tuition-Growth Group



Source: Authors' calculations based on data from the Delta Cost Project.
Note: Expenditures are measured in 2010 dollars (using CPI-U).

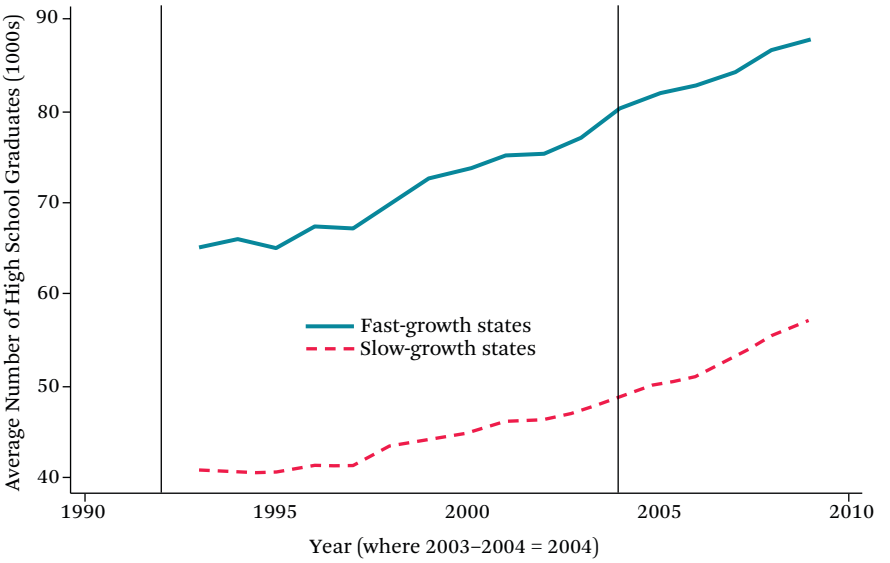
by level of public tuition growth: changes in SAT scores are between 1994 and 2004; and changes in eighth grade NAEP math scores are between 1990 and 2000. Recall that on-time graduation for the NELS cohort was 1992, and for the ELS cohort was 2004.

In figure 6, we present trends in the number of high school graduates across groups of states with different levels of public tuition growth. These trends show no evidence that states adopting large increases in public four-year tuition costs produced differentially rapid or slow growth in the number of public high school graduates, compared to states adopting more modest increases in public four-year tuition costs over the same period. Insofar as stocks of public high school graduates are an adequate proxy for general higher education demand in a state, these trends suggest a similar evolution of demand across both groups of states.

Because demand for higher education (and specifically different types of postsecondary institutions) is a function of both the quantity of potential entrants and the quality of those students in a given year, we use figure 7 to explore differences in test score changes by levels of public tuition growth. It is clear that in states with the largest increases in public postsecondary tuition, NAEP math scores grew significantly faster than in states with more modest increases. Similarly, we see faster growth in SAT math scores, but not verbal, in states where tuition increased the most. The relative increase in the quality of high school students in states with large tuition increases suggests that the relative decline in enrollment growth in the most selective public colleges and universities in these states was not due to declining student quality. If anything, these states saw increases in student quality as measured by NAEP and SAT scores. So, other things equal, one would expect relative growth in demand for the most research-intensive and selective postsecondary institutions in these states.

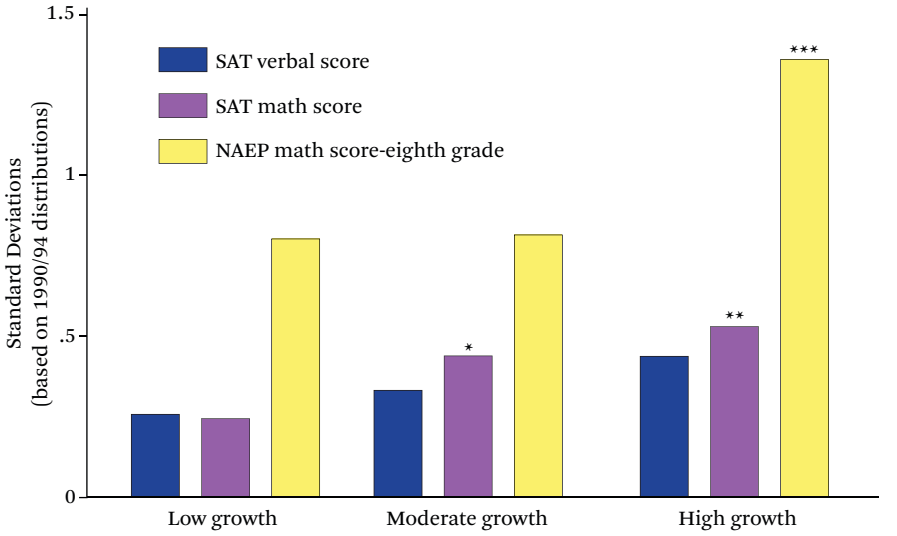
None of these tests is ironclad, but together

Figure 6. High School Graduates by Public Four-Year Tuition-Growth Group



Source: Authors' calculations based on data from the Common Core of Data and the National Center for Education Statistics.

Figure 7. Changes in Average Test Scores Between NELS and ELS by Public Four-Year Tuition-Growth Group



Source: Authors' calculations.
Notes: All changes in scores are standardized off of their earliest distributions: Changes in SAT scores are between 1994 and 2004. Changes in NAEP eighth-grade math scores are between 1990 and 2000. Average changes for moderate and high tuition-growth states are compared with test score changes observed in low-growth states.
N(SAT) = 51; N(NAEP) = 30
*$p < .1$; **$p < .05$; ***$p < .01$

they provide some assurance that the enrollment shifts we observe following large tuition increases were not likely driven by changes in relative cohort size or quality of students entering higher education, shifts in the relative quality of different states' public postsecondary systems themselves, or other particular features of a state.

DISCUSSION AND CONCLUSIONS

The rising costs of college continue to capture media attention and provoke wide-ranging public discussion (Abramson 2011). This has coincided with an integration of the higher education market, stratification of student and institutional quality within that market (Hoxby 2009), and a growing gap between college enrollment and completion rates. In this paper, we attempt to integrate these themes by studying a likely mechanism for at least some of these trends: rising tuition costs of public colleges and universities on student decisions about whether and where to enroll in college. We do so by comparing the early college experiences of observationally identical high school graduates before and after a period during which the financial landscape of most states changed substantially, and tuition at four-year public institutions soared. Because public institutions enroll more than 80 percent of undergraduate students in the United States (Snyder and Dillow 2011, table 2), we also exploit the fact that the state in which a student graduates high school shapes both the college prices she encounters and her choice sets of potential institutions.

Our paper differs from much previous work in that our unit of analysis is not the institution, but the prospective student. We examine the college-going behavior of individual high school graduates as the costs of public higher education increase. We find that the likelihood of attending an in-state public four-year college or university declined between 1992 and 2004 for high school graduates in states where tuition costs increased substantially during the period, compared with students in states where tuition changed more modestly. At the same time, students in states with particularly large increases in public four-year tuition costs were substantially more likely to enroll in less selective public four-year and two-year public institutions in state. These patterns are larger for students from families of low socioeconomic status and nonelite students more generally (those not in the top 10 percent on NELS/ELS math and reading tests).

As state boards and public institutional leaders look to tuition-setting policy as a way to offset declining state appropriations, they need to be aware of the enrollment effects of tuition policies. Although large public college tuition increases do not appear to significantly limit college enrollment overall, they do have an effect on where students enroll. Students in states that implement large increases in public tuition shift enrollment away from public four-year colleges, both toward other alternatives within their state, and to colleges out of state. Given the large and robust literature on the impact of college quality on college completion rates and on employment outcomes (Behrman, Rosenzweig, and Taubman 1996; Black and Smith 2004; Brewer, Eide, and Ehrenberg 1999; Bowen, Chingos, and McPherson 2009; Dale and Krueger 2002, 2011; Hoekstra 2009), these shifts in enrollment choices among college-goers have the potential to limit the stock of college-educated workers in the future, as well as labor market outcomes for individual students.

Our results provide some evidence bearing on the first part of this concern: We find that large increases in the in-state tuition costs of attending a four-year public college or university have weakened the propensity of high school graduates to enroll in such institutions, opting for less prestigious in-state public colleges, out-of-state public institutions, or private colleges. In future work, we plan to explore the implications of these findings on college completion and early labor market outcomes. Nonetheless, the current results make clear that state policies affecting the cost of public higher education help shape where students decide to pursue postsecondary education. Any efforts by policymakers to improve rates of degree completion need to recognize the potential role of composition in shaping aggregate rates of completion.

APPENDIX: DATA AND SAMPLE RESTRICTIONS

ELS:2002

We extract variables from both the student- and institution-level files. From the student-level file, we identify the cross-sectional, nationally representative group of students in twelfth grade in 2004 (that is, from the first follow-up). Within this group, we further restrict to high school graduates.

Using information in the student-level file on the first postsecondary institution attended by college-going high school graduates, we match additional information (by student and order of postsecondary institution attendance) from the student-institution-level file.

```
***** SAMPLE RESTRICTIONS;
** Restriction #1: Keep if 2004
12th-grade cohort member (identified
either in F1 or F2);
keep if G12COHRT > 0 ;
** Restriction #2: Keep only HS
graduates (i.e., regular grads, not
GED completers);
keep if F2F1HSST == 1 | F2F1HSST ==
2   /* Regular high school diploma
by (or before) summer 2004 */;
/* Text from NCES Codebook: "For
example, G12COHRT=1 used with F1QWT
generates estimates for a nationally
representative, cross-sectional
population of the 2004 spring-term
senior class. G12CHORT>0 used with
F2F1WT generates estimates for a
nationally representative panel of
the spring-term senior class,
including F1 nonrespondents." */;
```

NELS:88

We extract variables from both the student- and institution-level files. From the student-level file, we identify the cross-sectional, nationally representative group of students in twelfth grade in 1992. Within this group, we further restrict to high school graduates.

```
  *** sample restrictions;
*** Restriction 1: Keep if 1992 12-
grad cohort member;
*** Restriction 2: Keep only those
earning HS diploma, NOT a GED;
keep if hsstat == 1;
```

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