Geographic Shifts in Higher Education

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Human capital is acknowledged to be a highly productive resource in the "knowledge-based" economy of the late twentieth century. In addition to being a key driver of national economies, it has been recognized as a factor in determining regional fortunes. Discussing New England's economic success in the past quarter century, for example, a recent study issued by this Bank concluded as follows: "The coincidence of the rapid growth in the 1970s of high technology industries and the entry into the labor force of the highly educated baby boomers seems more than pure coincidence. The baby boomers provided the state-of-the-art knowledge, the drive, and the imagination that were necessary to make fledgling companies international competitors" (Browne and Sass 1998). The authors point out that New England institutions' share of college graduates exceeded the region's share of the U.S. population, and that "once exposed to New England's scenic attractions and cultural amenities, many [of the new graduates] wanted to stay," resulting in a high share of college-educated workers in the New England work force.

The New England economy of the late 1990s is even more heavily oriented toward higher education than it was a quarter century ago. Nevertheless, concern is mounting that the supply of highly educated workers has not been adequate to meet the demands of the region's employers. The situation has worsened over the course of the 1990s, as economic recovery has created more job opportunities but the absolute number of bachelor's degrees awarded in New England has fallen, particularly in engineering and computer science (Kodrzycki 1998; Massachusetts Technology Collaborative 1998).

The skill requirements of New England employers, and their ability to draw on local colleges and universities, are not necessarily typical of other parts of the country. Nevertheless, a common complaint of businesses nationwide is that they have not been able to hire as many highly educated workers as they would like to employ, resulting in unfilled

vacancies in professional and technical positions. Regardless of the traditional relationships between employers and nearby universities, many states now are reexamining how their higher educational institutions can play a larger role in the development and growth of "knowledge-based" industries (see, for example, Southern Technology Council 1998).

Colleges and universities have an effect on the availability of labor in their local area in a variety of ways, most notably in educating students who may develop work relationships with local companies and in sponsoring research and development that leads to local job opportunities.[1] This article focuses on what is arguably their largest role: supplying new graduates at the bachelor's degree level.[2] Even though the national rate of growth of college degrees has been fairly steady over much of the past 25 years, their geographic distribution has changed noticeably. In 1972, Florida institutions granted about 22,800 bachelor's degrees, two-thirds of the number graduating from Massachusetts schools and about half the number graduating in Ohio. In 1997, Florida graduated 47,500 students—approximately 7,000 more than in Massachusetts and just 1,000 shy of the total in Ohio.

Colleges and universities have an effect on the availability of labor in their local area in a variety of ways. Arguably their largest role is supplying new graduates at the bachelor's degree level.

Colleges and universities in different locations directly influence their "market share" by setting tuition and other student costs, offering financial aid, and establishing a variety of policies influencing both their selectivity and their quality. However, the geographic distribution of college degrees also reflects decisions made by others. Prior family location decisions determine the number of high school students in each state, and the resources of these families as well as the quality of the primary and secondary schools influence how many of these students are prepared for college. Government policies affect the affordability and accessibility of college, through tuition, fees, and other policies at public institutions. Graduation patterns may also be affected by local economic conditions that alter family finances or the attractiveness of work options for students. The article discusses these influences in greater detail, documents key trends for major states (where possible, back as far as 1972), and demonstrates their relative importance using regression analysis.

The study finds that three factors have served to change the geographic distribution of college degrees since the 1970s. First, states differ widely with respect to demographic trends. Nationally, the number of public high school graduates declined about 13 percent between 1972 and 1997. However, some parts of the Sunbelt have seen increases while the rates of decline in some parts of the Northeast and Midwest have been twice the national average. Second, although greater fractions of high school graduates nationally now enroll in college than was the case in the 1970s, the degree of change in the academic orientation of high school students has been different in different parts of the country. In particular, some states that had very low percentages of high school students taking college entrance examinations in the 1970s now have exam-taking rates that are above the national average. Finally, large and persistent tuition differentials across states have led to shifts in where students attend college. Tuition differences have become more important in light of the substantial increase in the costs of attending college.

The analysis also points to some remaining challenges in understanding the geographic patterns of college degrees. The regressions do much better in explaining patterns for public colleges than private colleges. This is probably because private colleges on the whole draw smaller proportions of their students locally, and because their strategies are more diverse than those of their public counterparts. For the nation as a whole, about two-thirds of all bachelor's degrees are granted by public institutions. However, public colleges continue to have only a minority share in many states in the Northeast, including Massachusetts.

In addition, the interpretation of tuition differentials remains somewhat ambiguous. Undoubtedly, students take tuition into account in deciding whether and where to enroll. However, it is also likely that, to some degree, colleges (or state college systems) offer-

[1] See Beeson and Montgomery (1993), Field et al. (1996), Gibbons (1997), BankBoston Economics Department (1997).

[2] In 1996, bachelor's degrees accounted for 52 percent of all degrees conferred in the United States. The next largest categories were associate (25 percent) and master's (18 percent). See New England Board of Higher Education (1999).

Table 1
Number of Bachelor's Degrees, Top Dozen States and U.S. Total, 1972 to 1997

	Number of Degrees						Percent Change						
	1972	1977	1982	1987	1992	1997	1972–77	1977–82	1982–87	1987–92	1992–97	1972–97	Memo: 1977–97
California	78,669	82,811	84,376	90,003	110,312	105,985	5.3	1.9	6.7	22.6	−3.9	34.7	28.0
New York	78,805	86,844	86,140	86,632	97,056	93,931	10.2	−.8	.6	12.0	−3.2	19.2	8.2
Texas	45,856	51,699	53,562	57,438	64,550	71,412	12.7	3.6	7.2	12.4	10.6	55.7	38.1
Pennsylvania	52,618	53,786	55,487	57,147	64,317	62,449	2.2	3.2	3.0	12.5	−2.9	18.7	16.1
Illinois	45,245	45,204	45,361	47,636	53,615	51,848	−.1	.3	5.0	12.6	−3.3	14.6	14.7
Ohio	46,786	41,147	42,197	43,975	50,747	48,548	−12.1	2.6	4.2	15.4	−4.3	3.8	18.0
Florida	22,817	28,300	28,556	31,430	41,975	47,524	24.0	.9	10.1	33.6	13.2	108.3	67.9
Michigan	37,791	35,941	38,919	38,181	44,965	44,225	−4.9	8.3	−1.9	17.8	−1.6	17.0	23.0
Massachusetts	33,067	37,405	39,916	41,570	45,186	40,420	13.1	6.7	4.1	8.7	−10.5	22.2	8.1
North Carolina	20,776	23,244	24,113	24,919	30,835	34,202	11.9	3.7	3.3	23.7	10.9	64.6	47.1
Virginia	15,733	20,017	22,778	24,010	30,644	30,848	27.2	13.8	5.4	27.6	.7	96.1	54.1
Indiana	24,215	23,794	25,682	26,623	30,938	30,477	−1.7	7.9	3.7	16.2	−1.5	25.9	28.1
12-State Total	502,378	530,192	547,087	569,564	665,140	661,869	5.5	3.2	4.1	16.8	−.5	31.7	24.8
U.S. Total	884,098	916,780	949,748	987,876	1,145,253	1,161,680	3.7	3.6	4.0	15.9	1.4	31.4	26.7

Note: States listed in order of number of bachelor's degrees granted in 1997. U.S. total excludes Service Schools (not allocated to states).
Source: National Center for Education Statistics.

ing low tuition are those that are more willing to accommodate growth.

I. Geographic Patterns of Bachelor's Degrees, 1972 to 1997

In 1997, U.S. institutions awarded almost 1.2 million bachelor's degrees, compared to fewer than 900,000 twenty-five years earlier. The rate of increase over this period has been remarkably steady, except for a surge in the late 1980s and early 1990s (Table 1).[3]

The geographic location of degrees has changed over the past quarter century. To illustrate, Table 1 shows bachelor's degrees awarded in the top 12 states, which collectively accounted for slightly over half of all bachelor's degrees awarded throughout the period and individually accounted for at least 2.6 percent of the total in 1997. Although the list of top states remained similar, individual states showed very disparate rates of growth.[4] The number of bachelor's degrees approximately doubled in Florida and Virginia. North Carolina and Texas also had growth substantially in excess of the 31-percent national figure. Meanwhile, the number of new graduates increased by less than 25 percent in Illinois, Massachusetts, Michigan, New York, Ohio, and Pennsylvania. In the period since 1992, among the top states, only Florida, Virginia, North Carolina, and Texas have experienced any increase in the number of graduates. Massachusetts had the greatest proportional decrease between 1992 and 1997—10.5 percent.

The most pronounced pattern overall has been a steady shift to the Sunbelt: Texas, Florida, North Carolina, and Virginia gained share in almost every five-year period, while Pennsylvania, Illinois, and Ohio tended consistently to lose share. The varying patterns for the remaining states, however, suggest that influences other than broad population shifts may be at work. For example, Massachusetts colleges and universities grew at more than double the national rate from 1972 to 1982, then slowed considerably. Virginia's very modest expansion since 1992 contrasts with much stronger growth in the prior 20 years. California's path has been the most variable of all, showing below-average changes in the 1977–82 and 1992–97 periods but above-average changes in other five-year periods.

In contrast to the geographic shifts in college degrees, changes in the mix between public and

[3] During 1989 to 1993, the increase in bachelor's degrees averaged over 3 percent annually, compared to 0.5 percent annually in the preceding five-year period.

[4] The only changes in the list of top states between 1972 and 1997 were that Virginia moved onto the list and Wisconsin fell off the list.

Table 2
Distribution of Public and Private Bachelor's Degrees, Top Dozen States and U.S. Total, 1992 and 1997

	Public		Private		Percent Change, 1992–97		Share Public	Memo: Public FTE Enrollment Share	
	1992	1997	1992	1997	Public	Private	1997	1976	1996
California	83,368	81,983	26,944	24,002	−1.7	−10.9	77.4	73.0	68.1
New York	41,309	42,620	55,747	51,311	3.2	−8.0	45.4	45.4	43.0
Texas	50,974	55,651	13,576	15,761	9.2	16.1	77.9	80.1	78.5
Pennsylvania	32,363	30,637	31,954	31,812	−5.3	−.4	49.1	51.0	52.6
Illinois	30,962	29,020	22,653	22,828	−6.3	.8	56.0	59.0	52.2
Ohio	33,606	31,744	17,141	16,804	−5.5	−2.0	65.4	70.3	68.9
Florida	27,977	33,187	13,998	14,337	18.6	2.4	69.8	64.2	66.4
Michigan	35,359	33,748	9,606	10,477	−4.6	9.1	76.3	81.1	76.4
Massachusetts	14,593	12,398	30,593	28,022	−15.0	−8.4	30.7	36.2	29.2
North Carolina	21,320	23,462	9,515	10,740	10.0	12.9	68.6	69.1	68.1
Virginia	22,911	22,685	7,733	8,163	−1.0	5.6	73.5	79.3	74.9
Indiana	21,162	20,495	9,776	9,982	−3.2	2.1	67.2	72.6	72.7
12-State Total	415,904	417,630	249,236	244,239	.6	−2.0	63.1	63.5	61.2
U.S. Total	759,481	772,976	385,772	388,704	1.8	.8	66.5	68.4	65.9

Note: States listed in order of number of total bachelor's degrees granted in 1997.
FTE = full time equivalent.
Source: National Center for Education Statistics.

private institutions have been relatively minor. For the nation as a whole in 1997, public colleges granted about two-thirds of all bachelor's degrees, very similar to their share at each 5-year interval going back to 1972. The public-private proportion varies considerably across states, however. Public colleges accounted for less than one-third of all degrees granted in Massachusetts in 1997 and roughly one-half in New York, Pennsylvania, and Illinois (Table 2). In California, Texas, Michigan, and Virginia, their shares were about three-quarters. Unfortunately, a historical breakdown of degrees is not available state by state but enrollment figures indicate that the differences in the public-private mix over time within a state are small, compared to the differences across states.[5] States that had high public enrollment shares in the 1970s also had relatively high shares in the 1990s (last two columns of Table 2).[6]

II. *Explanations for Geographic Shifts*

The geographic distribution of college graduates is the result of decisions made both by students and their families on the one hand and colleges and their financial backers on the other—in other words, the demand and supply sides both play a role. *Individual students'* demand for higher education is influenced by their perceived return to education (which may be inferred by their propensity to take college entrance examinations or, alternatively, gleaned from earnings of existing college graduates), the costs (out-of-pocket expenses plus the opportunity cost of spending time in school), and the financial resources available (both while applying and during the course of their time in college). *Total* demand depends on the number of applicants; therefore demographic fluctuations matter, especially with respect to the size of the age group most likely to attend college. Finally, demand for higher education *in a particular location* reflects geo-

[5] It will become possible to construct fuller historical evidence on public versus private degrees once additional years of the Integrated Postsecondary Education Data System (IPEDS) files are released to the public.

[6] On the whole, enrollments at private colleges rose slightly faster than enrollments at public colleges during this time period. As indicated in Table 2, in California, Illinois, Michigan, Massachusetts, and Virginia, the public share fell between 4½ and 7 points between 1976 and 1996. In the remaining large states, the changes in the share were smaller. Florida had the greatest increase in the share of students enrolled in public institutions, 2.2 percentage points.

graphic variation in these determinants of demand. All else equal, many students prefer to remain in-state to attend college because of factors such as low tuition costs at public institutions and, in all likelihood, relatively good information about nearby institutions, both public and private. Such information may be helpful in developing expectations of the benefits of attending college. Regardless of demand, however, the final pattern depends on *supply-side responses*—how much institutions adjust their capacity for undergraduate education, as well as whether and how they attempt to gain market share or to limit their expansion.

Existing studies have examined college attendance from a variety of perspectives, emphasizing to different extents individual and aggregate demand for a college education, institutional objectives, and federal and state policies. Several of their key findings are useful to bear in mind. First, it is clear that *institutional history matters* in determining current geographic patterns of higher education. Goldin and Katz (1999) note that "almost all of today's noteworthy U.S. universities and colleges were founded before 1900" (p. 38) and that "many of the differences in state support for higher education [as of the early 1900s] persist today" (p. 52). Therefore, rather than explaining why some states have larger concentrations of colleges than others (which Goldin and Katz and various other studies address), this study concentrates on changes over time. Factors potentially influencing college graduation—such as the number of high school students preparing for college—have not moved uniformly across states in recent decades, and these changes may have reinforced or offset fundamental advantages or disadvantages that certain states have compared to others.

In determining current geographic patterns of higher education, history matters, along with the costs of attending college and the responses of institutions to student demand.

Second, *the costs of attending college matter* to prospective applicants. Many researchers have concluded that higher tuition deters college attendance, particularly for low-income students (see Leslie and Brinkman 1988; McPherson and Schapiro 1991; Kane 1995; and references therein). The available literature has not reached consensus, however, on which measures of costs or benefits are most influential in decisions to enroll in and graduate from college. One issue is the difference between "list" tuition and "net" tuition (that is, subtracting out financial aid). Net tuition is the actual cost paid by the student; however, list tuition is more visible and hence perhaps more likely to affect prospective students' decisions about where to apply. Another issue is that *all* students are subsidized as a result of government grants and private charitable contributions to educational institutions; that is, list tuition falls short of college expenditures per student. This "general subsidy" often is larger than financial aid for both public and private institutions (Winston and Yen 1995; Hoxby 1997b). Additionally, the value of a college education ultimately depends not only on the resources expended, but on the return to these expenditures. Some researchers have found that labor market conditions, both during college enrollment and upon graduation, affect college attendance. Finally, it is possible that students have become more aware of the relative costs and benefits of different colleges over time, particularly as they consider a greater array of options. Hoxby (1997b) found that 43 percent of applicants to four-year colleges in 1992 applied to at least one institution that was outside their home state and its adjoining states, almost double the share in 1972.[7]

Finally, existing studies find that *colleges are quite heterogeneous* in the makeup of their student bodies and in the strategies they pursue. Public universities, by their nature, are more committed to expanding access to higher education for in-state residents than are private institutions. Using a sample of individual institutions, Hoxby found that, on average, private colleges drew only 55 percent of their students from in-state, compared to 84 percent for public colleges. In the sample period examined in this study, it seems likely that as the number of in-state high school students applying to college increased, public colleges responded by expanding enrollments. Private colleges that draw from a wide geographic base would be more likely to adjust enrollment to national or re-

[7] In a study of whether students attend in-state or out-of-state institutions, Hoxby (1997a) also investigates non-schooling costs, such as travel and communications. These have fallen over time, thereby contributing to the growing national competition among colleges.

gional rather than local demographic trends, and highly selective private institutions might simply tighten admissions criteria rather than expanding. However, rising numbers of high school graduates in a given state may lead to the establishment or expansion of locally oriented private colleges. Moreover, even within the public sector, individual states might show different degrees of responsiveness to growth in the number of high school graduates. Some states may

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be more committed than others to universal access, by operating a lower-tier college system and a selective state university (or several selective universities). Furthermore, over a short-term horizon, resource constraints may lead public institutions effectively to tighten admissions standards rather than accommodate demographically induced growth in the applicant pool (see Quigley and Rubinfeld 1993).

III. Evidence on Changing Demographics, Secondary School Student Quality, and College Costs

This section presents evidence on key influences on college attendance over the past 25 years, concentrating on the variation among the 12 states that have the largest numbers of college graduates. The following section uses these data and additional indicators to perform regression analyses for all states.

Demographics and Secondary School Quality

For the nation as a whole, the number of students graduating from public high schools started declining in 1978, after the largest baby boom cohorts passed high school age (Table 3). The supply of high school graduates resumed a sustained increase only in 1995. Thus, nationally the number of graduates in 1997 was almost 13 percent lower than in 1972. That the number of bachelor's degrees continued to increase is a reflection of the higher fractions of secondary school graduates who went on to attend colleges and universities.

Table 3 also indicates the number of high school graduates for the top dozen degree-granting states at five-year intervals. Reliable high school figures are available only back to 1971. Most bachelor's programs take four years to complete. However, some students delay or interrupt their college studies or pursue them part-time. Thus, if the average lag is assumed to be five years, the next-to-final column of Table 3, showing percent changes in high school graduation figures for the period 1972 to 1992, is the relevant comparison for the college graduation figures for 1977 to 1997 (last column of Table 1).

On the whole, the geographic shifts in high school graduates are positively correlated with the geographic shifts in college patterns. Only two states of the top dozen had more students graduating from public high schools in 1992 than in 1972: Florida and Texas, and they were in the top third in terms of growth in college degrees. Similarly, New York, Pennsylvania, Ohio, and Massachusetts experienced sharp declines in the size of high school graduating classes and low increases in college graduates. However, in some other states, high school and college trends are less correlated. For example, North Carolina and Virginia had larger increases in college graduates than Texas, and Michigan had a greater increase than other states with similar drops in high school graduates.

One source of discrepancy may be that the high school graduation figures do not include private schools. Although private school enrollments are influenced by the same basic demographic patterns as public school enrollments, the mix of the two could change as a result of social, economic, and legal changes. Comprehensive, reliable annual data on private high school graduates are available only for the period 1989 to 1995. Table 4 presents a summary of this information. Nationally, private high schools accounted for 9.7 percent of total graduates in 1995. Their share is highest in the Northeast and Midwest. Although desegregation arguably caused the large influxes into private schools in the South, as of 1995 Virginia graduates included about 7 percent from private schools and North Carolina only about 5 percent in private schools, not enough to explain why these states experienced such high growth in their college graduate figures. This is confirmed by comparing the 1995 private high school graduation shares with private *enrollment* shares in grades 9 through 12 from the 1970 Census of Population (last column of

Table 3
Public High School Graduates, 1972 to 1997

	Number of Public High School Graduates						Percent Change	
	1972	1977	1982	1987	1992	1997	1972–92	1992–97
California	270,518	266,143	241,343	237,414	244,594	269,294	−9.6	10.1
New York	199,771	212,907	194,605	163,765	134,573	137,600	−32.6	2.2
Texas	153,653	163,574	172,085	168,430	162,270	180,369	5.6	11.2
Pennsylvania	157,415	160,665	143,356	121,219	103,881	109,160	−34.0	5.1
Illinois	128,843	142,040	136,534	116,075	102,742	110,186	−20.3	7.2
Ohio	149,472	156,220	139,899	121,121	104,522	106,924	−30.1	2.3
Florida	78,574	88,137	90,736	82,184	93,674	92,267	19.2	−1.5
Michigan	126,409	135,337	121,030	102,725	87,756	88,000	−30.6	.3
Massachusetts	67,487	75,386	73,414	61,010	50,317	48,933	−25.4	−2.8
North Carolina	70,242	71,146	71,210	65,421	61,157	57,886	−12.9	−5.3
Virginia	62,372	66,738	67,809	65,008	57,338	62,258	−8.1	8.6
Indiana	72,501	76,406	73,984	60,364	56,630	56,569	−21.9	−.1
12-State Total	1,537,257	1,614,699	1,526,005	1,364,736	1,259,454	1,319,446	−18.1	4.8
U.S. Total	2,699,553	2,837,340	2,704,758	2,428,803	2,226,016	2,359,572	−17.5	6.0

Note: States listed in order of number of bachelor's degrees granted in 1997.
Source: National Center for Education Statistics.

Table 4). To the extent graduation and enrollment data are comparable, the figures indicate that the share of graduates from private secondary schools rose only 2.0 points in Virginia and 2.6 points in North Carolina.

Table 4
Private High School Graduates

	Number of Graduates 1995	Private as % of Total 1995	Change in Private Share 1989–95	Memo: Private as Percent of High School Enrollment 1970
California	26,353	9.4	−1.4	7.1
New York	25,489	16.1	1.3	16.7
Texas	8,767	4.9	−.2	4.1
Pennsylvania	18,138	14.8	−.0	16.3
Illinois	14,681	12.2	−.0	14.7
Ohio	12,639	10.4	−1.0	11.8
Florida	10,151	10.2	−1.1	6.7
Michigan	8,805	9.4	−1.2	11.0
Massachusetts	8,561	15.2	.3	16.8
North Carolina	3,144	5.0	1.4	2.4
Virginia	4,463	7.1	1.0	5.1
Indiana	4,055	6.7	.4	7.3
12-State Total	145,246	10.2	−.3	10.8
U.S. Total	245,543	9.7	−.6	9.8

Note: States listed in order of number of bachelor's degrees granted in 1997.
Source: National Center for Education Statistics.

California, Texas, and Florida also had increases from 1970 to 1995.

Perhaps the best measure of how many high school students potentially are interested in attending college is the number taking college entrance examinations. Information on the Scholastic Aptitude Test (SAT) by state is available for the high school classes of 1972 and later. Some universities, especially those in the Midwest, favor the American College Testing Program (ACT); these data are available starting only in 1994.

As expected, even though the total numbers of students graduating from high schools fell over the past 25 years, the numbers taking the SAT rose (Table 5). In Illinois, Ohio, and Michigan, the majority of graduating seniors take the ACT, so trends in SAT-taking may be an unreliable indicator of high school students' interests in attending college in these states. Among the other states, those with very low proportions of high school students taking the SAT in 1972 (Texas and Florida in particular) subsequently had the highest increases. Students graduating from North Carolina in the 1990s also were much more likely to

Table 5
Numbers of Students Taking the SAT by High School Class, 1972 to 1997

	1972	1977	1982	1987	1992	1997	Percent Change 1972–92	Percent Change 1992–97	SAT Takers as Percent of High School Graduates[a] 1972	SAT Takers as Percent of High School Graduates[a] 1997	Percent of High School Graduates Taking the ACT 1997
California	91,619	107,586	102,261	117,198	116,806	134,750	27.5	15.4	30.3	44.7	11
New York	145,723	133,575	139,819	135,724	119,128	123,651	−18.3	3.8	60.2	74.1	16
Texas	51,314	49,528	58,027	75,364	80,174	94,034	56.2	17.3	32.0	50.0	30
Pennsylvania	104,056	91,119	87,039	87,107	81,882	88,125	−21.3	7.6	55.7	68.0	8
Illinois	37,871	25,902	21,820	24,038	17,792	17,078	−53.0	−4.0	25.6	13.5	69
Ohio	46,059	26,366	25,042	30,537	28,194	29,810	−38.8	5.7	27.6	25.0	60
Florida	21,845	35,623	37,879	44,489	48,570	55,085	122.3	13.4	25.0	53.6	36
Michigan	31,529	19,934	14,063	15,538	11,542	11,097	−63.4	−3.9	22.5	11.4	68
Massachusetts	57,382	58,068	56,435	51,707	44,094	45,509	−23.2	3.2	70.6	77.2	6
North Carolina	33,844	35,041	34,507	38,217	36,576	38,468	8.1	5.2	45.9	63.2	11
Virginia	35,958	36,170	36,852	42,125	40,608	43,987	12.9	8.3	53.5	65.6	6
Indiana	39,362	38,297	37,331	35,265	35,802	37,081	−9.0	3.6	50.5	61.0	19
12-State Total	696,562	657,209	651,075	697,309	661,168	718,675	−5.1	8.7	40.4	48.6	n.a.
U.S. Total[b]	1,022,820	979,396	988,270	1,080,426	1,034,131	1,127,021	1.1	9.0	34.0	42.8	36

Note: States listed in order of number of bachelor's degrees granted in 1997.
[a]SAT takers as a percent of high school graduates multiplied by the public share of high school graduates in 1992.
[b]Includes foreign students not allocated to individual states.
Source: College Board, National Center for Education Statistics, American College Testing Program, and author's calculations (see Appendix).

have taken the SAT than those who graduated in the 1970s.

Another relevant indicator may be scores on college entrance examinations. Presumably, higher scores indicate better preparedness for college and should have positive effects on both college acceptance and college completion. Ideally, one would want to examine how many students scored above certain thresholds, but what the College Board provides is the mean score. In any case, this average should be considered in connection with data on the percentages of students taking the exam. All else equal, one would expect average test scores in a state to fall as greater percentages of students take the exam. Table 6 presents state math SAT scores relative to the national average. As much greater fractions of Texas and Florida high school students took the SAT, relative average scores slipped somewhat. However, in North Carolina, the preparedness of applicants appears to have increased over time, since scores improved at the same time that the percentages taking the exam rose.

Table 6
Average Math SAT Scores Relative to the National Average, 1972 to 1997
Percent

	1972	1977	1982	1987	1992	1997
California	101.6	100.0	101.4	101.2	101.4	100.6
New York	102.0	101.6	100.2	98.8	98.2	98.2
Texas	98.6	99.0	97.6	97.0	98.4	98.0
Pennsylvania	99.0	99.8	99.2	98.0	97.2	96.9
Illinois	103.9	106.7	108.7	107.8	110.8	113.1
Ohio	102.0	106.5	106.5	104.0	104.4	104.9
Florida	99.8	97.4	99.6	99.2	98.6	97.7
Michigan	101.6	106.9	108.5	106.4	108.2	110.8
Massachusetts	99.4	99.2	99.4	99.8	99.6	99.4
North Carolina	91.9	91.9	93.7	93.4	95.6	95.5
Virginia	98.4	98.4	99.2	99.6	98.6	97.3
Indiana	97.8	98.0	97.6	97.2	97.2	97.3

Note: States listed in order of number of bachelor's degrees granted in 1997.
Source: College Board.

Table 7
Average Tuition and Fees at Public and Private Collges

	Tuition and Fees (dollars)				Percent Change			Level as Percent of U.S. Average
	1982	1987	1992	1997	1982–87	1987–92	1992–97	1997
Public								
California	230	1,031	1,442	2,720	348.3	39.9	88.6	91
New York	1,031	1,431	2,332	3,802	38.8	63.0	63.0	127
Texas	351	885	1,143	2,028	152.1	29.2	77.4	68
Pennsylvania	1,470	2,496	3,801	4,994	69.8	52.3	31.4	167
Illinois	731	1,708	2,564	3,522	133.7	50.1	37.4	118
Ohio	1,252	1,982	2,839	3,841	58.3	43.2	35.3	129
Florida	605	1,055	1,484	1,789	74.4	40.7	20.6	60
Michigan	1,097	1,877	2,879	3,988	71.1	53.4	38.5	134
Massachusetts	887	1,388	3,705	4,272	56.5	166.9	15.3	143
North Carolina	421	818	1,224	1,641	94.3	49.6	34.1	55
Virginia	822	2,070	3,024	3,968	151.8	46.1	31.2	133
Indiana	1,066	1,627	2,239	3,198	52.6	37.6	42.8	107
U.S. Total	721	1,414	2,117	2,987	96.1	49.7	41.1	100
Private								
California	4,830	8,073	11,767	14,429	67.1	45.8	22.6	112
New York	4,346	7,364	11,088	14,544	69.4	50.6	31.2	113
Texas	2,905	5,510	6,980	9,373	89.7	26.7	34.3	73
Pennsylvania	4,292	7,140	11,040	14,927	66.4	54.6	35.2	116
Illinois	4,091	6,560	9,377	12,376	60.4	42.9	32.0	96
Ohio	3,717	6,176	9,742	12,980	66.2	57.7	33.2	101
Florida	3,427	5,360[a]	8,550	11,112	56.4	59.5	30.0	86
Michigan	3,228	5,093	7,534	9,580	57.8	47.9	27.2	74
Massachusetts	5,060	8,953	13,174	17,188	76.9	47.1	30.5	133
North Carolina	3,282	5,597	8,491	11,651	70.5	51.7	37.2	90
Virginia	3,570	5,724	8,273	11,165	60.3	44.5	35.0	87
Indiana	3,981	6,762	8,566	13,234	69.9	26.7	54.5	103
U.S. Total	3,972	6,658	9,759	12,881	67.6	46.6	32.0	100
Memo: National CPI (1982–84 = 100)	96.5	113.6	140.3	160.5	17.7	23.5	14.4	

Note: States listed in order of number of bachelor's degrees granted in 1997.
[a]The 1987 published figure of $1,367 seems unreasonably low. Therefore this study uses a weighted average of the higher published figures for 1985 and 1988, the closest years available.
Source: National Center for Education Statistics and U.S. Bureau of Labor Statistics.

Much larger increases in scores were observed in Illinois and Michigan, where the ACT came to replace the SAT for all but a small proportion of college-bound students.

Costs of Higher Education

As is well known, college costs have continued to increase rapidly during the 1990s, even as general inflation has subsided. For both public and private institutions, 1997 tuition and fees were triple their levels in 1982, while the overall consumer price index rose only two-thirds (Table 7). However, on average, public education continued to cost only 23 percent as much as private education. (The data in the table refer to average list tuition at four-year schools. The public institution figures refer to in-state rates; tabulated information on out-of-state rates is not available.)

Some of the most rapidly growing public university systems—Texas, Florida, and North Carolina—charge far lower tuition and fees than the national average. In general, the highest charges are in states that show slow growth in the number of graduates. The most significant exception is Virginia, which has

had rapid growth even though its average tuition and fees have been comparable to those in states such as Ohio and Michigan.

The table also indicates some major swings. Average public tuition and fees in Massachusetts went from 98 percent of the national average in 1987 to 175 percent of the national average in 1992 (and recently was at 143 percent). California had a very large increase in the 1990s. In both cases, the increases coincided with severe economic downturns that prompted state governments to reduce spending. By contrast, public college tuition and fees in Florida fell from an already low 75 percent of the national average in 1987 to only 60 percent in 1997.

Average private sector costs also vary across states, but less so than public costs. To a great extent, these costs are correlated within states—for example, Massachusetts has high costs for both public and private colleges while Florida and Texas have low costs in both sectors. However, in some other states, this is not the case. North Carolina's private schools charge seven times the tuition and fees of its public schools; in Michigan, tuition and fees differ by a factor of only 2.4.

As noted above, the actual net cost of education to students depends on financial aid, while the total resources expended on education include government grants and charitable contributions in addition to the tuition and fees paid by students. Table 8 estimates these figures per student at public colleges in 1992 for the major states (the calculations are described in the Appendix). Longer-term historical data for public institutions were not available; nor was comparable information available for the private sector.

Table 8
State-Provided Need-Based Aid and General Subsidy per Student at Public Colleges, 1992
Dollars

	Financial Aid	General Subsidy	Memo: Net Tuition and Fees
California	205	16,474	1,237
New York	1,222	12,989	1,110
Texas	41	9,407	1,102
Pennsylvania	578	9,010	3,223
Illinois	804	14,145	1,760
Ohio	165	8,353	2,674
Florida	90	10,861	1,394
Michigan	238	10,604	2,641
Massachusetts	223	9,717	3,482
North Carolina	13	13,393	1,211
Virginia	30	10,946	2,994
Indiana	238	9,348	2,002
U.S. Total[a]	172	11,126	1,939

[a]Unweighted average of the 50 states and the District of Columbia.
Note: States listed in order of number of bachelor's degrees granted in 1997.
Source: Author's calculations as described in the Appendix.

The overwhelming majority of state government support for public higher education comes in the form of expenditures that benefit all students rather than needy students in particular.

The overwhelming majority of state government support for public higher education comes in the form of expenditures that benefit all students rather than needy students in particular. The general subsidy averaged over $11,000 per student in 1992, the largest share of which came from state governments. By contrast, state-provided need-based financial aid averaged less than $200 per student. Among the top dozen states, only New York contributed average student financial aid in excess of $1,000. Thus, net of state-provided need-based aid, average tuition and fees in New York were about as low as those in Texas, even though list tuition and fees were considerably higher. All the top states provided a general subsidy of at least $8,000 per student. The most generous support was provided in California, Illinois, North Carolina, and New York.

Another way in which states foster college attendance is through two-year (community) colleges. In addition to granting associate degrees, these low-cost institutions may serve to increase access to higher education in general, thereby enabling more students eventually to earn a bachelor's degree at another institution. On the other hand, it is possible that students who attend community colleges are unlikely to have the qualifications or resources to graduate from four-year degrees or that the possibility of earning a two-year degree actually deters some from trying to earn a four-year degree. Thus, the role of community colleges is ambiguous: They could serve

Table 9
Number of Full-Time Equivalent Public Two-Year College Faculty in 1991 per 100 Public High School Graduates in 1992

California	6.6
New York	6.7
Texas	9.3
Pennsylvania	3.7
Illinois	7.5
Ohio	6.3
Florida	7.9
Michigan	5.4
Massachusetts	4.5
North Carolina	11.9
Virginia	1.2
Indiana	4.6
U.S. Average	6.2

Note: States listed in order of number of bachelor's degrees granted in 1997.
Source: National Center for Education Statistics and author's calculations.

either as feeders or substitutes for four-year schools or have no impact at all.

As a measure of each state's community college capacity, Table 9 shows the number of full-time equivalent faculty at public two-year colleges and branches per 100 public high school graduates. Considerable variation exists across the states, and even within regions of the country. North Carolina ranks first among the states shown (and in fact first in the nation), followed by Texas, Florida, and Illinois. The lowest-ranking states are Virginia and Pennsylvania.

IV. Regression Analysis

The regression analysis attempts to explain changes in four-year college degrees for all 50 states and the District of Columbia. Because of changes in data availability over time, two separate groups of regressions were estimated. First, pooled regressions examine changes in the numbers of public plus private bachelor's degrees granted for the periods 1977–82, 1982–87, 1987–92, and 1992–97. The second set of regressions focuses on the 1992–97 period and separately examines changes in bachelor's degrees granted by public and private colleges.

The regressions use the explanatory variables described above and detailed further in the Appendix.[8] College admissions standards are not included in the regressions, for lack of adequate information. The regressions in effect assume that all states raised or lowered admissions standards in tandem. To the extent that colleges in any given state raised (lowered) their standards more than the norm, this will tend to show up as a fitted increase in bachelor's degrees that is higher (lower) than actual.

Pooled Regressions

Table 10 indicates the results from regressions for all the states pooled across the four time periods.[9] As discussed further in connection with the results, all the regressions include dummy variables for time periods; those summarized in the second and fourth columns also include dummies for regions. The inclusion of regional dummies alters the coefficients for the other variables very little. List tuition was measured in log constant 1992 dollars, using two different specifications to account for the blend of public and private colleges by state. The first specification (shown in columns 1 and 2) used a weighted average of public and private tuition and fees, with the weights in each state corresponding to the full-time-equivalent enrollment shares for public and private four-year colleges for an arbitrary base period (fall 1984).[10] In the second specification (columns 3 and 4), public and private tuition and fees entered as separate variables. Public tuition and fees are expressed as log constant 1992 dollars, analogous to the specification used in the first two columns. Average public and private charges are correlated within states. To avoid the problem of multicollinearity, the private tuition and fees variable refers to the percent difference between the actual average list tuition and fees charged at private colleges and the expected charges if private and public tuition within the state followed the "normal" pattern observed across all states.[11] Because of data limitations, this calculation was not performed for 1977; therefore the results in columns 3 and 4 refer to the percent

[8] 1977 tuition (missing from Table 7) was estimated using information on selected colleges in each state.

[9] The total number of observations is less than 204 (4 time periods times 50 states plus the District of Columbia) because 1977 tuition data were unavailable in some cases.

[10] For 1977, owing to lack of data, the variable used is simply the unweighted average of tuition and fees charged at major colleges and universities.

[11] Private tuition in each state was regressed on public tuition, public tuition squared, and a constant. Separate regressions were estimated for 1982, 1987, and 1992. The adjusted R^2 values were .24, .15, and .28, respectively.

Table 10
Regression Analysis for 1977–97 Period
Dependent variable = Percent change in bachelor's degrees granted at public and private colleges in 5-year subintervals, 1977–82, 1982–87, 1987–92, and 1992–97

	Using Weighted Average Tuition		Using Separate Measures for Public and Private Tuition[a]	
	(1) Including Time Period Dummies	(2) Including Time Period and Region Dummies	(3) Including Time Period Dummies	(4) Including Time Period and Region Dummies
Public high school graduates, % change in preceding period	.495*** (.097)	.508*** (.104)	.479*** (.111)	.532*** (.122)
SAT-taking rate, change in preceding period	.470*** (.163)	.463** (.187)	.815*** (.233)	.890*** (.284)
Relative SAT score, change in preceding period	.509 (.343)	.621* (.365)	.814* (.416)	.895** (.452)
Log of weighted average list tuition, beginning of period	−5.06*** (1.29)	−6.61*** (2.31)		
Log of public list tuition, beginning of period			−3.20 (2.12)	−3.94 (2.95)
Percent difference between actual and expected private list tuition			−.024 (.017)	−.023 (.019)
Public share of enrollments, fall 1994			.117*** (.044)	.106* (.060)
Change in unemployment rate	1.20*** (.304)	1.17*** (.303)	1.25*** (.357)	1.37*** (.368)
Constant	32.09*** (9.01)	39.00** (15.13)	21.09 (14.07)	24.97 (17.28)
Adjusted R^2	.459	.471	.462	.464
Root mean square error	7.95	7.86	8.35	8.34
Number of observations	179	179	153	153

[a]1977–82 subinterval omitted.
Standard errors in parentheses.
***Significantly different from zero at 1 percent level.
**Significantly different from zero at 5 percent level.
*Significantly different from zero at 10 percent level.

change in the number of college graduates since 1982. The public college share was entered as a separate variable and was measured using the same full-time-equivalent enrollment numbers used to weight tuition in columns 1 and 2.

In all cases, the regressions account for almost 50 percent of the variation in college graduation shifts across states. According to the estimates, holding all else constant, a given percentage increase in the number of students graduating from high school during a five-year period resulted in about one-half that rate of increase in the number of college graduates in the same state during the subsequent five-year period. Increases in the proportion of high school students taking the SATs and improvements in scores also boosted the number of college graduates with a lag (although the proportion taking the test was a more statistically significant predictor than the average score).

To some extent, increases in the number of students taking the SATs and in their scores reflect changing characteristics of the resident population in each state, which in turn are affected by the health of the local economy and in-migration. A higher proportion of affluent or highly educated families would tend to lead to a greater focus on college preparation on the part of high schools. However, alternative regressions failed to find positive effects from either levels or

changes in personal income per capita or the proportion of residents with a college degree.

Tuition is highly significant statistically. However, numerically the effect is rather small, at least for modest differences in tuition. According to the estimates in columns 1 and 2, 10 percent higher tuition and fees within a state led to only 0.5 to 0.7 percent fewer graduates five years later.[12] Other versions of these regressions investigated whether tuition and fees changes prior to or subsequent to enrollment mattered. These variables were never significant.[13]

The results in the final two columns indicate that the growth in college graduates in a state is related to the mix of public and private institutions and to some extent to the tuition and fees charged at both public and private colleges. The supply of college graduates was higher where the share of public institutions (which charge lower tuition and fees than private institutions and perhaps adjust their capacity more in response to the number of applicants) was higher. The supply of college graduates also was higher where public tuition and fees were low relative to other states and where private tuition and fees were unexpectedly low relative to charges at public institutions. The estimated coefficients for the two tuition variables were greater than their respective standard errors, yet not statistically significant by conventional standards.

The supply of college graduates was higher where the share of public institutions was higher. The supply also was higher where public tuition and fees were low relative to other states and where private tuition and fees were unexpectedly low relative to charges at public institutions.

The regressions indicate that a contemporaneous rise in the rate of unemployment tends to increase college graduation, all else equal. Higher unemployment may add to the difficulties of continuing to finance a college education. However, it also makes dropping out of college a less attractive option, given the scarcity of job opportunities. Additionally, during periods of rising unemployment some job losers may decide to return to college. According to the regressions, these latter effects dominate.

To save space, the table does not report the coefficients for the time dummies (included in all specifications) and the regional dummies (included in the specifications summarized in columns 2 and 4). The purpose of including time dummies is to capture secular shifts in the demand for college as well as any other factors such as business cycles that are national in scope. The estimated coefficients (for the 1982–87, 1987–92, and 1992–97 periods relative to 1977–82) are all positive and significant, consistent with rising college attendance over time. The largest coefficient is for the 1987–92 period, indicating that the nationwide surge in college attendance at that time was not due to changes in the included variables. Instead, it may have reflected a growing perception of high returns to a college degree, as the differential between the earnings of college graduates and non-graduates began to widen considerably in the 1980s, after showing little movement in the 1970s.

The purpose of including regional dummies is to capture the effects of any fixed, omitted factors that are correlated with geographic location. The omitted region is East South Central (defined by the U.S. Bureau of the Census to encompass Mississippi, Alabama, Kentucky, and Tennessee). All the regional coefficients are positive except for the West South Central (Texas, Oklahoma, Louisiana, and Arkansas). The highest coefficients (and the ones that come closest to being statistically significant) are for the two Midwestern regions (East North Central and West North Central). This suggests that omitting high school students' participation in the ACT may lead to biased results for this region.[14] However, the result could also reflect the attractiveness of Midwestern colleges, because of their perceived high quality or their centralized location.

[12] Since the dependent variable is measured as a percentage change and the explanatory variable is the natural logarithm of tuition, a coefficient of 5 implies an elasticity of .05.

[13] In yet another version, the number of each state's tuition compacts with other states was included (see Hoxby 1997a). These bilateral agreements provide for reduced tuition rates for out-of-state students. This variable was insignificant.

[14] For states in which colleges tend to rely on the ACT rather than the SAT, increases in the fraction of high school students taking the SAT may reflect an increased interest in attending *out-of-state* colleges. The coefficients for the SAT variables are larger in the regression that includes the regional dummies.

Regressions for the 1992–97 Period

Table 11 shows the results of separate regressions for public colleges (columns 1 to 5) and private colleges (columns 6 and 7) in the 1992–97 period. For comparison, the last column indicates the results of estimating the combined public plus private regression specification from Table 10 for the 1992 to 1997 period. Each independent variable in the separate regressions enters with the same sign as in the pooled regressions for 1977 to 1997.

The regression presented in column 1 explains the percent change in bachelor's degrees awarded at public colleges using list tuition, as in the pooled regressions. However, the coefficients for most of the variables are now larger than in the pooled regressions for 1972 to 1997, indicating that the structure of decision-making about college attendance has changed over time. The higher coefficients for high school graduation and SAT-taking are consistent with the growing tendency of high school students to attend college.

The regression indicates that 10 percent higher public college tuition and fees in a state in 1992 produced 1.5 percent fewer bachelor's degrees five years later; this is two to three times the estimates in the pooled regressions (though still not large in an absolute sense). This growing sensitivity to cost is consistent with the fact that real tuition has increased over

Table 11
Regression Analysis for 1992 to 1997
Dependent variable = Percent change in bachelor's degrees granted

	Public					Private		Memo: Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public high school graduates, % change, 1987–92	.783*** (.209)	.904*** (.199)	.676*** (.212)	.796*** (.207)	.921*** (.200)	.378 (.543)	.946** (.426)	.427*** (.191)
SAT-taking rate, change 1987–92	1.55*** (.376)	1.59*** (.383)	1.49*** (.368)	1.51*** (.373)	1.57*** (.384)	.823 (1.02)		.211 (.225)
Relative SAT score, change 1987–92	2.55** (1.03)	2.51** (1.05)	2.81*** (1.01)	2.34** (1.03)	2.38** (1.06)	−1.94 (2.82)		.285 (.803)
Log of list tuition, 1992	−14.83*** (4.37)		−12.18*** (4.49)	−13.70*** (4.40)		−21.61* (11.72)	−16.85** (6.75)	−12.08*** (2.75)
Log of net tuition, 1992		−12.98*** (4.20)			−11.78*** (4.39)			
Log of financial aid, 1992			−2.03* (1.11)					
Log of general subsidy, 1992				6.72 (4.95)				
Log of financial aid plus general subsidy, 1992					4.87 (5.18)			
Number of public community college faculty per 100 high school graduates, 1992	−.65* (.37)	−.66* (.38)	−.70* (.37)	−.81** (.39)	−.77* (.40)			
Change in unemployment rate, 1992–97	1.54 (1.14)	1.94* (1.12)	1.26 (1.12)	1.05 (1.18)	1.64 (1.17)	1.06 (2.89)	1.60 (1.73)	.627 (1.09)
Constant	126.26*** (31.48)	112.9*** (30.26)	113.89*** (31.40)	55.38 (60.78)	58.85 (65.00)	207.11*** (101.33)	170.35*** (58.90)	107.76*** (20.98)
Adjusted R^2	.550	.534	.573	.559	.532	.071	.330	.476
Root mean square error	8.33	8.48	8.11	8.25	8.49	21.95	12.91	8.24
Number of observations	51	51	51	51	51	50	46	51

Standard errors in parentheses.
***Significantly different from zero at 1 percent level.
**Significantly different from zero at 5 percent level.
*Significantly different from zero at 10 percent level.

time, as well as with the evidence that high school students are now more likely to apply to out-of-state colleges.

The remaining public college regressions consider alternative measures of cost per student—net tuition (column 2), list tuition and financial aid (column 3), list tuition and the general subsidy (column 4), and net tuition and financial aid plus the general subsidy (column 5). Each of these regressions has an adjusted R^2 between .53 and .57, similar to that in column 1. Thus, none of the alternative cost measures provides clearly better explanatory power than list tuition. In column 3, the adjusted R^2 is relatively high, but financial aid enters with the wrong sign (negative). The general subsidy (in columns 4 and 5) enters positively but its standard error is about as large as the estimated coefficient.

The growing sensitivity to cost is consistent with the increases in tuition and evidence that students are more likely to apply to out-of-state colleges.

A new variable included in the regressions is the number of public community college faculty relative to the number of public high school graduates. The coefficient enters with a negative sign. Thus it appears that greater community college capacity leads to lower growth in bachelor's degrees (though presumably to a greater number of students earning associate degrees).

Alternative versions of the regressions (not shown) included measures of private tuition and the percent change in public tuition. Contrary to expectations, higher private tuition within a state did not lead to substitution of public college enrollment. Nor did changes in public tuition matter, after controlling for its level at enrollment.

Columns 6 and 7 show the regression results for the percent change in bachelor's degrees awarded at private colleges from 1992 to 1997. In column 6, the included variables explain very little of the state-to-state differences in growth rates in bachelor's degrees from private institutions. As hypothesized above, private colleges do not regularly adjust enrollments in response to state-specific demographic shifts. The only variable that is significant is list tuition and fees. The coefficient indicates that 10 percent higher average private tuition would depress the number of degrees by 2.2 percent—about one and one-half times as much as an equal percentage increase in public tuition. However, in 1992, private college tuitions on average were four and one-half times as high as public college tuition. Therefore an equal *dollar* increase at the two types of colleges would have, on average, triple the percentage effect on degrees granted at public colleges.

Column (7) shows somewhat improved results from making several changes. First, four states (Arkansas, Arizona, Nevada, and North Dakota) were dropped.[15] The estimated errors for these states were very large, and making this change alone raised the adjusted R^2 from .07 to .23. Second, regional (rather than state) high school graduate growth rates were used. This reflects the fact that private colleges on average draw substantial proportions of their students from other states. The regression hypothesizes that these out-of-state students come disproportionately from the same region rather than being representative of college applicants nationally. The adjusted R^2 in column (7) is .33, and the growth in high school graduates becomes statistically significant. The other change is the omission of the SAT variables; these are insignificant if measured on a state basis and enter with the wrong sign if measured on a regional basis.

Implications

The regression results can be used to shed light on the question posed at the outset of this study: Why has the geographic distribution of college degrees changed over time? Since many of the determinants enter with a lag, the regressions can also be used to form predictions for the next several years.

Table 12 decomposes the percent change in bachelor's degrees granted in each of the top 12 states during the years 1977 to 1997 into five components: the change in the number of high school graduates, the change in SAT rates and scores, the change in list tuition and fees, all other factors included in the regression (the constant term, time dummies, and the change in unemployment), and the portion not explained by the regression. Table 13 repeats this exercise for bachelor's degrees awarded from public colleges during 1992 to 1997. In each case, the "tuition effect" refers to the estimated impact of having tuition

[15] Wyoming already was omitted in column (6) because it has no private colleges.

Table 12
Factors Contributing to Changes in Bachelor's Degrees Granted in the Top 12 States, 1977 to 1997: Averages for Five-Year Subintervals
Percent

	Actual Change	Predicted Change[a]	Number of High School Graduates	SAT Takers & Scores	Average College Tuition[b]	All Other[c]	Residual (Unexplained)
California	6.8	7.8	−1.2	1.4	.2	7.4	−1.0
New York	2.1	1.9	−4.4	1.0	−2.3	7.5	.3
Texas	8.5	13.8	.7	1.8	3.4	8.0	−5.4
Pennsylvania	3.9	1.1	−4.8	1.0	−2.4	7.2	2.9
Illinois	3.7	3.7	−2.5	−.4	−.9	7.5	−.1
Ohio	4.5	2.9	−4.1	−.1	−.3	7.4	1.6
Florida	14.4	11.8	2.4	2.4	.1	6.9	2.6
Michigan	5.6	3.1	−4.1	−.4	.8	6.8	2.5
Massachusetts	2.3	.2	−3.1	.3	−3.7	6.7	2.1
North Carolina	10.4	7.8	−1.6	1.8	1.3	6.3	2.7
Virginia[d]	11.2	10.6	−2.4	2.5	.7	9.8	.6
Indiana	6.6	5.7	−2.8	.9	.3	7.3	.8

[a]Based on regression in column 1 of Table 10.
[b]Relative to the national average.
[c]Includes the effects of the constant, national average tuition, change in unemployment, and time period dummies.
[d]1982 to 1997.

and fees differ from the national average.[16] Therefore, the effects of rising national tuition are subtracted out in computing the entries in the "all other" column. The regressions used are those shown in the first columns of Tables 10 and 11, respectively.

The highest total growth rate from 1977 to 1997 was in Florida, while the lowest growth rates were in New York and Massachusetts. Table 12 indicates the average five-year growth rates for the four subintervals used to estimate the regression: Florida, 14.4 percent; Massachusetts, 2.3 percent; and New York, 2.1 percent. The predicted college graduate growth rates for these states were all slightly lower than the actual growth rates. Almost one-half of the disparity between Florida's and Massachusetts' growth rates (5.5 out of the 12.1 percentage points) lies in demographics—the faster growth in the numbers of students graduating from high school in Florida than in Massachusetts. The second most important factor, accounting for 3.6 points, lies in these states' persistent differences in college tuition. As indicated above, the regression coefficients indicate that a given percentage difference in tuition is associated with a much smaller difference in college enrollment and graduation. However, when the costs of attending college in different states differ by a large percentage, this can cause significant responses in student demand. In addition, the tuition differentials may also be proxying for differences in college strategies: Florida's lower-cost colleges may have been more willing to expand, while Massachusetts' higher-cost colleges may have been more interested in preserving their selectivity. Third, the relatively sharp increase in SAT participation among Florida's high school graduates (from a low level at the beginning of the period) accounted for another 2.1 points. The "all other" column contributes little to explaining why college graduate growth was so much greater in Florida than in Massachusetts—or, indeed, to cross-state comparisons in general. The entries in this column mostly reflect the increasing national demand for a college education, even in the face of rising costs; the only factor in this column that varies by state is the change in unemployment.

New York's decline in high school graduates was steeper than Massachusetts', while its average college tuition has been lower. Therefore, in comparing New York with Florida, the weights on the individual explanations are somewhat different than in the case of Massachusetts, although the rankings are the same.

For three of the states shown—California, North Carolina, and Virginia—an increasing degree of col-

[16] For the other independent variables, by contrast, the comparison with a zero value has intuitive meaning.

Table 13
Factors Contributing to Changes in Bachelor's Degrees Granted by Public Institutions in the Top 12 States, 1992 to 1997
Percent

	Actual Change	Predicted Change[a]	High School Graduates	SAT Takers & Scores	Public College Tuition[b]	All Other[c]	Residual (Unexplained)
California	−1.7	10.1	2.4	−1.7	5.7	3.7	−11.8
New York	3.2	−4.8	−14.0	5.7	−1.4	4.9	8.0
Texas	9.2	21.1	−2.9	10.5	9.1	4.3	−11.9
Pennsylvania	−5.3	−6.2	−11.2	7.1	−8.7	6.6	.9
Illinois	−6.3	−6.7	−9.0	3.1	−2.8	2.1	.4
Ohio	−5.5	−6.3	−10.7	3.5	−4.4	5.3	.8
Florida	18.6	12.7	10.9	−4.7	5.3	1.2	5.9
Michigan	−4.6	−12.2	−11.4	1.8	−4.6	1.9	7.6
Massachusetts	−15.0	−16.1	−13.7	3.2	−8.3	2.7	1.1
North Carolina	10.1	11.8	−5.1	7.7	8.1	1.2	−1.7
Virginia	−1.0	−1.7	−9.2	6.1	−5.3	6.7	.7
Indiana	−3.2	7.9	−4.8	6.9	−.8	6.7	−11.1

[a]Based on regression in column 1 of Table 11.
[b]Relative to the national average.
[c]Includes the effects of the constant, national average tuition, change in unemployment, and community college capacity.

lege orientation among high school graduates more than offset the negative influence of declining high school numbers after 1977. (The data for Virginia refer to 1982 to 1997, since college tuition data were unavailable for 1977.)

Growth in Texas bachelor's degrees fell considerably short of the regression prediction. It is hard to pinpoint the particular reasons in this case, but various reports point to educational barriers historically for Texas's large, rapidly growing minority population.[17]

In the 1992–97 period, as Table 13 shows, Florida also had the greatest increase in public college graduates (18.6 percent) while Massachusetts had the greatest decrease (15.0 percent). The regression analysis explains this divergence fairly well, although Florida's growth is somewhat underestimated. As in the aggregate regressions for the longer time period, the most important factors were the difference in growth rates for high school graduates and in average tuition. Florida had a large increase in the number of public high school graduates between 1987 and 1992, which tended to raise college enrollments and (eventually) college graduates by 11 points, whereas in Massachusetts the very large decline in high school graduates accounted for a 14-point drop. In the early 1990s, the average tuition and fees at public colleges in Massachusetts was two and one-half times that in Florida. This large disparity accounted for a 14-point difference in the growth in the number of college graduates between 1992 and 1997.

Offsetting these factors, the changing interests and preparation of high school graduates were negative factors for Florida and positive factors for Massachusetts. Between 1987 and 1992, a decreasing proportion of Florida high school students took the SAT and the average SAT score declined relative to the national average. In fact, Florida had the sharpest deterioration in high school student preparedness among all the states in the country in this period. Meanwhile, Massachusetts had an increase in the proportion of high school students taking the SAT and only a very small decrease in SAT scores. These circumstances accounted for an 8-point difference in the rate of growth in college graduates—in Massachusetts' favor.

Among the top 12 states, Texas had the largest positive effect from high school student preparedness in this time period. This served to amplify the positive effect from low tuition and the relatively positive effect (compared to other states) from numbers of high school graduates. However, the 1992–97 regressions continue to overpredict the growth in bachelor's degrees in Texas.

[17] See, for example, the Texas Higher Education Coordinating Board web site at www.thecb.state.tx.us.

In California, the regression estimates a large increase in the number of public college graduates, in contrast to the actual decline. The early 1990s brought sharp cuts in state appropriations for higher education in California. Aside from the increases in tuition and fees (which the regressions take into account), the funding reductions caused large numbers of faculty departures and widespread elimination of course offerings, which in turn contributed to reductions in enrollments and delays in college completion (Breneman 1998).

The regression results suggest that many of the Northeastern and Midwestern states are likely to show more of an increase in new public college graduates through the year 2002 than is the case for the Southern and Western states.

The regression results in Table 11 can also be used to project changes in the number of public college graduates through 2002, given already observed changes at the high school level as well as college tuition and fees in 1997. Such an exercise cannot yield exact figures: Aside from the fact that the regressions fit the past far from perfectly, there is the question of how circumstances may change in the future. Policy changes such as state-specific shifts in admissions criteria and the new federal tuition tax credits enacted as part of the Taxpayer Relief Act of 1997 undoubtedly will have an impact, as will changes in public perceptions of the desirability of obtaining a college degree and of the relative value of particular higher education systems.

Examining nevertheless what the regressions imply for the top 12 states, the most striking conclusion is that many of the Northeastern and Midwestern states are likely to show more of an increase in new public college graduates through the year 2002 *relative to their trends between 1992 and 1997* than is the case for the Southern and Western states. (See Appendix Table 1.) That is, in an absolute sense, states in the South and West generally will continue to show higher rates of growth than states in the Northeast and Midwest. But the disparities will become somewhat smaller as the states that had declines or only small increases in the 1992–97 period show more positive trends from 1997 to 2002.

The analysis shows the sharpest turnaround for Massachusetts; after experiencing a decline in the past several years, the state's public higher education system may now show a modest increase in the number of graduates—all else equal. The most important reasons are that the decline in number of high school graduates has moderated (from −17.5 percent in 1987–92 to only −2.8 percent in 1992–97) and the number of SAT takers has risen. In contrast to most of the other large states, Massachusetts tuition and fees remained constant in real terms between 1992 and 1997, thereby not discouraging college attendance. According to the analysis, other states that are expected to show substantially higher growth in public bachelor's degrees—relative to their recent history—are Ohio, Illinois, New York, Michigan, Virginia, and Pennsylvania. The only state among the top dozen that is expected to show a substantial slowdown, absent offsetting changes, is Indiana, where the number of high school graduates continues to decrease and the measures of high school graduate preparedness used in the regressions show a decline.

V. Conclusions

This study has demonstrated the importance of demographics, high school students' interest in and preparation for college, and college tuition in explaining changes in where students have earned their bachelor's degrees over the past two decades. Although a greater share of college degrees are now earned in Southern and Western states than in the 1970s, this development reflects more than just population shifts. Many of these states graduate a much higher share of college-oriented high school students than previously, and they have kept their college costs low relative to the national average. Looking forward to the next several years, however, public colleges in the Northeast seem likely to show some pickup in the number of graduates, as the pipeline of students coming through high schools is not quite so constricted as it was earlier in the 1990s.

In interpreting geographic shifts in higher education, it is important to bear in mind that the analysis addresses only one part of the larger question of whether the supply of college students in different

locations is "adequate." Ultimately, the answer depends not only on the numbers of graduates (or even the numbers of graduates relative to the population), but on the skill requirements of local employers and their ability to recruit the employees they need. Skill needs and recruitment opportunities can change over time, depending on the nature of economic development. Furthermore, the role of higher education varies from state to state. For some states, expanding higher education opportunities to reach a greater number of residents may be the best way to build up a skilled work force, particularly if some segments of the population are underserved. Other states may focus on attracting more out-of-state students. Still others may lack a large higher education establishment but have other attributes that enable them to attract skilled workers from other locations. Thus, the optimal policy responses to shortages of college-educated workers may differ in different regions and over time.

For some states, expanding higher education opportunities to reach a greater number of residents may be the best way to build up a skilled work force. Other states may focus on attracting more out-of-state students.

For states trying to increase college attendance rates in an effort to augment the supply of educated workers, one implication of the research is the need for coordination of educational policies at the high school and college levels. States that are trying to improve public high schools should also reexamine the capacity and competitiveness of their public college systems. Expanding capacity or lowering charges would entail extra public expenditures, since public college students are subsidized even with current tuition and fees. However, such changes may be consistent with broader economic development goals.

Another key aspect of the findings is that the most important influences on college graduation rates are in place at the time students enroll, if not earlier. In the aggregate, subsequent changes in costs and economic conditions matter relatively little. Thus, states interested in increasing the supply of entry-level, college-trained workers should plan ahead. Barring the possibility of quick increases in the pipeline of college graduates locally, the states' other option is to try to influence where college graduates choose to locate. Evidence on these location and migration decisions will be the subject of follow-on study by the author.

Appendix

by Matthew P. LaPenta

Most of the education data used in this study were taken from tables in the National Center for Education Statistics (NCES), *State Comparisons of Education Statistics* and *Digest of Education Statistics.* These tables were constructed primarily from the Higher Education General Information Survey (HEGIS) and Integrated Postsecondary Education Data System (IPEDS), which are based on information provided by individual institutions. The tables were used instead of the IPEDS and HEGIS data sets because not all years were readily available at the time this article was prepared. As of the date of publication of this article, these data sets are in the process of being transferred from the NCES to the Inter-University Consortium for Political and Social Research (ICPSR). Data for some years are already available online, and the ICPSR is currently in the process of making more readily available online.

IPEDS was the source for bachelor's degrees conferred in 1992 and 1997. For earlier years, the data came from tables in *State Comparisons of Education Statistics.* Individual institutions are reported by the state where they are located, regardless of the location of their parent institution. U.S. service schools are not included. The variables used in the regressions were the five-year percent change in the total number of bachelor's degrees conferred.

The source used for public high school graduates was "Statistics of Public Elementary and Secondary Day Schools," as provided electronically to the author by the NCES. The regressions used the five-year percent change in the number of public high school graduates.

The SAT data were furnished to the author by the College Board. The SAT participation rate is defined as the number of high school graduates who participated in the SAT program during their high school years. Students who participated prior to their senior year were counted only for their senior year; students were counted only once regardless of how many times they took the test. The number of students was divided by the number of public high school graduates in each year; this ratio was then multiplied by the share of public high schools in the overall graduation numbers for 1992. The SAT scores were recen-

Appendix Table 1

Estimated Contributions of Selected Variables to Change in Bachelor's Degrees Granted by Public Institutions in the Top 12 States, Predictions for 1997 to 2002 Relative to 1992 to 1997

Percent

	High School Graduates	SAT Takers & Scores	Public College Tuition[a]	Sum
California	5.5	3.9	−4.3	5.1
New York	15.7	−4.6	−2.2	8.9
Texas	11.6	−7.1	−3.4	1.1
Pennsylvania	15.2	−6.4	1.0	9.9
Illinois	14.6	1.4	.4	16.4
Ohio	12.5	−.5	.6	12.6
Florida	−12.1	14.7	2.3	4.9
Michigan	11.6	4.8	.3	16.7
Massachusetts	11.5	4.4	3.0	18.9
North Carolina	1.0	2.9	.7	4.5
Virginia	15.3	−8.5	1.1	7.9
Indiana	4.8	−18.2	−.2	−13.6

[a]Relative to the national average.

Source: Author's calculations explained in the text.

tered to a consistent scale by the College Board. Students were assigned to states according to where they attended high school. The SAT variables used were the five-year difference in the percentage of participating seniors and the five-year difference in mean math SAT scores relative to the national mean.

The source for tuition and fees in 1987, 1992, and 1997 was *State Comparisons of Education Statistics*. The source for 1982 was *Digest of Education Statistics*. Tuition and fees by state were not available for 1977, so they were estimated for that year using the unweighted average of tuition and fees for the largest schools in each state in 1979, which was the closest available year to 1977, as reported in *Digest of Education Statistics*. Tuition and fees were converted to 1992 dollars using the national CPI.

In some regressions the tuition variable refers to the average for private and public colleges. The weights used are the public and private shares of full-time equivalent enrollment in fall 1984. The source for public and private enrollment is *Digest of Education Statistics*.

Average net tuition and fees at public four-year institutions is measured as average list tuition and fees multiplied by one minus the ratio of state-provided need-based scholarships and grants to the revenue generated by tuition and fees. State-provided need-based scholarships and grants refer to all undergraduates and the revenues from tuition and fees refer to all public higher education programs. To make these data consistent, the revenues from tuition and fees are weighted by the undergraduate share of total enrollment in higher education. To be consistent with the measurement of per student tuition and fees, the ratio should pertain only to four-year undergraduate programs, but the requisite data to make such an adjustment were not available. Also, some states provide financial assistance to students attending private institutions, but it was not possible to separate out these amounts. Finally, no separate information was available on merit aid.

The financial aid variable is equal to the difference between average list tuition and fees and average net tuition and fees. The general subsidy variable attempts to capture the per-student cost of four-year undergraduate education that is funded by government, the private sector, and endowments rather than through tuition and fees. It equals average list tuition and fees for four-year undergraduate institutions multiplied by the ratio of the sum of revenue from tuition and fees, government appropriations, grants and contracts, private gifts, grants and contracts, and endowment income to the revenue from tuition and fees, less average list tuition and fees. Excluded from the calculation of non-tuition revenue are three categories that are largely unconnected with undergraduate education: auxiliary enterprises, hospitals, and "educational activities and other." Nevertheless, some of the non-tuition revenues included in the calculation encompass activities associated primarily with graduate education—notably government grants and contracts. As indicated above, for tuition revenues, it also was impossible to separate out payments associated with four-year undergraduate from other programs.

Because of data limitations, the number of full-time equivalent faculty at public two-year colleges refers to 1991 (not 1992). The source is *Digest of Education Statistics*.

The unemployment rates come from the U.S. Bureau of Labor Statistics. The BLS no longer releases unemployment rates by state for 1977; thus the study uses information published in the 1980 *Handbook of Labor Statistics*.

Finally, Appendix Table 1 presents the estimated contributions of several key variables to the growth in the number of bachelor's degrees granted by public institutions for the period 1997 to 2002. The entries present the difference between these variables' effects in this period and their effects in the prior five-year period. The final column provides the summed effects from the listed variables; it does not encompass any additional national or state factors that may influence the total growth in the number of college degrees granted.

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