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Cohort crowding and nonresident college enrollment☆

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ABSTRACT

This study uses a fixed effects panel data framework to examine the effects of cohort crowding and other variables on nonresident enrollment at four-year public colleges and universities. The results suggest that larger cohorts of resident students crowd out nonresident students at flagship universities, but there is inconsistent evidence of crowd out at non-flagship schools. Additionally, larger cohorts of resident students result in increased nonresident tuition at flagship universities but not at non-flagship schools. When faced with larger cohorts of resident students, flagship universities lower the numbers of nonresident students enrolled and raise the price for nonresidents.

1. Introduction

Nonresident college enrollment is often of considerable interest to policymakers and researchers, and there are a number of potential benefits and costs of educating non-residents. Higher education is becoming increasingly important for both individual welfare and state economies, and policymakers are very interested in increasing the number of educated persons within their states Groen (2011).[1] One potential strategy for states to increase the number of college graduates within their borders is to educate residents of other states since where young people attend college likely affects where they locate after college. Several researchers, however, suggest that the relationship between the production and stock of college graduates in a state is fairly modest due to the post-schooling migration decisions of recent college graduates (Abel & Deitz, in press; Bound, Groen, Kezdi, & Turner, 2004; Groen, 2004; Groen & White, 2004; Hickman, 2009). Public colleges and universities may also benefit from nonresident enrollment through higher tuition revenues, increased student diversity, more talented student-athletes, and enhanced student quality (Rizzo & Ehrenberg, 2004). However, there are also costs to nonresident enrollment. Besides the explicit costs of instruction, an important concern with nonresident enrollment is that educating nonresidents may reduce access to a state's colleges and universities for residents of the state (Hoover & Keller, 2011).[2] Such concerns have led many states (e.g., California, North Carolina, and Pennsylvania) to place official limits on the number or percentage of nonresident students in their public colleges and universities

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[1] Rauch (1993) and Moretti (2004) suggest that the local level of human capital increases wages in the local labor market. Glaeser, Scheinkman, and Shleifer (1995) find that the level of human capital increases population growth in the local area, and Shapiro (2006) suggests that the level of human capital also increases the quality of life in an area.

[2] Others counter that increased nonresident tuition revenue helps institutions fulfill their missions and better serve resident students (Hoover & Keller, 2011).

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(Dill, 2003; Noorbakhsh & Culp, 2002). Furthermore, political pressure often compels public universities to set lower admission standards for resident students than nonresidents (Groen & White, 2004).

The recent economic recession and slow recovery have made nonresident college enrollment an even more important issue. The difficult economic climate has created significant budget problems in many states and higher education has certainly felt the pinch (Bhatt, Rork, & Walker, 2011). With declining state appropriations, many public colleges and universities have considered looking toward nonresident tuition as a possible way to shore up their institution's finances (Abbey & Armour-Garb, 2010; Jaschik, 2009). Nonresidents usually pay tuition rates two to three times that of resident students and many cash-strapped public institutions have recently considered increasing nonresident enrollment, nonresident tuition, or both.[3] Resident tuition rates are sometimes set by statewide higher education governing boards that limit the ability of individual colleges and universities to use resident tuition to make up for budget shortfalls.[4] However, public colleges and universities often have greater flexibility in setting nonresident tuition, though this varies across states depending on the governing structure and policies of the state university system (Bell, Carnahan, & L'Orange, 2011; Calhoun & Kamerschen, 2010).[5] There is also less political resistance to increasing nonresident tuition than resident tuition because nonresidents and their parents are unable to vote in state elections (Jaschik, 2009). However, public institutions recognize that higher nonresident tuition can reduce nonresident enrollment demand and charging a sufficiently high price will actually reduce total revenue from nonresident tuition. Furthermore, the tough economy may make nonresidents more price sensitive and reduce nonresident enrollment demand. Economic difficulties also tend to increase resident enrollment demand at public institutions as young people go to college instead of the labor market, mature students go back to school, and individuals shift from expensive private schools to their cheaper public counterparts. Political pressures to accommodate the increased resident demand further complicate the issues faced by public institutions considering enrolling more nonresidents.

A number of studies have attempted to explain the determinants of nonresident enrollment.[6] Most of these have focused on nonresident enrollment demand with little consideration of nonresident enrollment supply (Zhang, 2007). Tuition and financial aid policies are usually given considerable attention. Given the focus on nonresident enrollment demand, researchers usually expect a higher price to reduce nonresident enrollment. Some studies find that higher tuition and lower financial aid reduce nonresident enrollment (e.g. Curs & Singell, 2002; McHugh & Morgan, 1984; Morgan, 1983; Noorbakhsh & Culp, 2002; Zhang, 2007), but several other studies do not find such an effect (e.g. Adkisson & Peach, 2008; Baryla & Dotterweich, 2001; Dotterweich & Baryla, 2005; Mixon & Hsing, 1994). One explanation offered by Baryla and Dotterweich (2001) and others for the lack of a significant negative effect of nonresident tuition on nonresident enrollment is that tuition levels are a signal of educational quality and the quality effect may offset the price effect. Alternatively, Zhang (2007) suggests that the positive correlation between nonresident enrollment and nonresident tuition in several studies may result from strategic behavior by colleges and universities that experience excess demand for nonresident enrollment. When faced with decreased state funding, such institutions may raise both nonresident tuition and the number of slots available to nonresident students. Other nonresident enrollment explanatory variables that have been investigated by previous studies include institutional quality and selectivity, tuition reciprocity agreements, the student to faculty ratio, NCAA athletic participation, regional amenities such as climate, historically black college or university status, proximity to nonresident students, and income and employment conditions in the local economy.

By neglecting nonresident enrollment supply, most studies either implicitly or explicitly assume that the supply of nonresident enrollment is infinitely elastic. In reality though, many higher education institutions are likely to face important resource and capacity constraints and are reluctant to compromise the quality of education offered in order to expand enrollment. Card and Lemieux (2000) and Bound and Turner (2007) find that larger cohorts of young people have lower rates of college enrollment and degree completion and suggest that supply constraints are likely the underlying cause. Anecdotal evidence abounds about capacity constraints at particular institutions, especially state flagship universities. It certainly seems plausible that supply constraints might affect nonresident enrollment as well. In particular, one might expect supply constrained institutions to reduce the number of nonresidents they enroll.

This study uses a fixed effects panel data framework and instrumental variables to examine the effect of resident cohort size and other variables on nonresident enrollment at four-year public colleges and universities. The results suggest that larger cohorts of resident students crowd out nonresident students at flagship universities,

[3] Summary statistics reported below indicate that the average ratio of nonresident to resident tuition for flagship universities and non-flagship schools in this study is 2.8 and 2.5, respectively. Importantly though, the ratio varies considerably across states with North Carolina having the highest average ratio at 4.9 and New Jersey having the lowest average ratio at 1.6.

[4] Bell et al. (2011) discuss results from a survey on tuition, fees, and financial aid policy administered by the national association of State Higher Education Executive Officers (SHEEO) and completed by state fiscal officers in 45 states. They identify 14 states in which the primary tuition-setting authority belongs to the state legislature or a statewide agency. Authority in other states lies with individual institutions or governing boards for individual systems or local districts.

[5] States also vary in the extent to which they let colleges and universities keep the tuition revenue that they generate. Some allow institutions to keep all tuition revenue, but some states can capture some or all increased revenue from tuition increases (Abbey & Armour-Garb, 2010).

[6] A related literature also seeks to explain the determinants of nonresident tuition (e.g. Greene, 1994; Rizzo & Ehrenberg, 2004).

but there is less consistent evidence of crowd out at non-flagship schools. This suggests that flagship universities often face important resource and capacity constraints and may be unwilling or unable to expand overall enrollment when faced with increased resident demand. Non-flagship schools, however, are less constrained and are generally better able to increase total enrollment to accommodate increased resident demand. This paper also finds that larger cohorts of resident students result in increased nonresident tuition at flagship universities though not at non-flagship schools. When faced with larger cohorts of resident students, flagship universities often reduce their supply of nonresident enrollment and move upward along the nonresident enrollment demand curve.

The remainder of the paper is organized as follows. The next section outlines the theoretical framework for analyzing nonresident enrollment. Section 3 describes the empirical methods used including a description of the data. A fourth section presents the empirical results, and a final section concludes.

2. Conceptual framework

The market for nonresident enrollment can be thought to result from supply and demand (Zhang, 2007). The demand for nonresident enrollment is a function of the price of nonresident enrollment and a number of other factors including the quality of education, other institutional characteristics, attributes of the local area, and conditions in the local labor market. Consistent with the law of demand, nonresident enrollment demand is decreasing in price holding all else constant. Nonresident enrollment demand is increased by educational quality and other institutional and local characteristics that make a college or university more desirable. Students are also concerned about employment prospects both while in school and after school, so nonresident enrollment demand is also increased by a strong local labor market.

The supply of nonresident enrollment is a function of the price of nonresident enrollment, the goals and objectives of higher education institutions, the number of residents in a state meeting a certain academic standard and wishing to enroll in the institution (resident enrollment demand) and the "capacity" of the institution governed by state appropriations and physical and administrative constraints. By the law of supply, the quantity of nonresident enrollment that institutions wish to supply is increasing in price, ceteris paribus Goals and objectives differ across institutions, due in part to differences in missions and the extent of legislative control (Bell et al., 2011). Presumably, most institutions would like to provide a high quality education to a large number of students. Because resources are limited, though, college and university administrators often face tradeoffs between the number of students enrolled and the quality of education (e.g., resources per student) provided and there is likely considerable heterogeneity in institutional preferences between access and quality (Bound & Turner, 2007).

When faced with increased enrollment demand and binding capacity constraints, institutions unwilling to sacrifice quality or unable to increase enrollment must decide how to ration seats among residents and nonresidents. According to Groen and White (2004), public institutions may have an incentive to favor nonresidents over equally qualified residents because nonresidents pay higher tuition and institutions may be able to keep some of the additional tuition revenue that nonresidents generate. Institutions could also try to raise tuition rates and/or admission standards for resident students. However, resident students are more likely than nonresidents to reside in the state after college, and state policymakers have a greater interest in educating residents than nonresidents and are likely to at least partially constrain institutional behavior. Most public institutions have educating state residents as a major part of their mission and a primary goal, and political pressures often require that nonresidents should be "pushed out" of the institution before equally qualified resident students (Jaschik, 2009). As a result, many higher education institutions are likely to decrease the supply of nonresident enrollment when faced with increases in resident enrollment demand. That is, for many institutions an increase in the number of resident students is expected to crowd out nonresident students. Other institutions, however, may be willing and able to increase total enrollment when faced with increased demand by resident students and not reduce nonresident enrollment. The effect of resident enrollment demand on nonresident enrollment, therefore, will depend on the objectives and constraints of the institution.

Public colleges and universities are likely to have some degree of market power in setting their own nonresident tuition, though state policies may limit pricing flexibility in some states (Bell et al., 2011). For many institutions increases in resident enrollment demand may also affect the optimal price charged for nonresidents because nonresident enrollment demand is inversely related to its price. When institutions restrict nonresident enrollment because of resource and capacity constraints, they can also move upward along their nonresident enrollment demand curve and charge a higher price for nonresidents.

3. Empirical methods

This paper estimates a reduced form linear model of nonresident enrollment (*NRE*) in institution *i* in year *t* as function of nonresident tuition (*NRT*), resident enrollment demand (*RE*), the presence of a merit scholarship program in the state (*MER*), state appropriations for higher education per student (*APP*), median household income in the state (*INC*), the unemployment rate in the state (*U*), the college wage premium in the state (*PRE*), the mean SAT score in the state (*SAT*), a regional price measure constructed as the average nonresident tuition rate at competitor four-year public institutions located within four hundred miles of a given institution (*NRTC*),[7] the average household income in neighboring states that share a border (*INCB*), a set of

[7] The regional price measure for flagships excludes non-flagship institutions and vice versa. Following McMillen, Singell, and Waddell (2007), the 400 mile (straight line distance) cutoff for competitor institutions was chosen to approximate a single day car drive.

institution fixed effects meant to capture residual differences in institutions that are time-invariant (δ), and a set of year dummies meant to capture changes over time experienced by all institutions (θ):

$$NRE_{it} = \beta_0 + \beta_1 NRT_{it} + \beta_2 RE_{it} + \beta_3 MER_{it} + \beta_4 APP_{it} + \beta_5 INC_{it} + \beta_6 U_{it} + \beta_7 PRE_{it} + \beta_8 SAT_{it} + \beta_9 NRTC_{it} + \beta_{10} INCB_{it} + \delta_i + \theta_t + \varepsilon_{it}.$$

By the law of demand nonresident tuition is expected to have a negative effect on nonresident enrollment, though previous literature suggests that this is not always the case. Resident enrollment is the main explanatory variable of interest and is expected to have a negative effect on nonresident enrollment. Merit scholarships might increase supply side pressures that would tend to reduce nonresident enrollment, but supply side forces are already captured by resident enrollment. Merit scholarships in a state also may allow some colleges and universities to attract higher quality resident students, and the increased quality of resident students may make institutions more desirable to nonresidents (Rizzo & Ehrenberg, 2004). Increases in state appropriations are thought to increase the quality of higher education and have a positive effect on nonresident enrollment (Bound & Turner, 2007). Increases in household income are likely to lead to better endogenous amenities (e.g. theaters, restaurants, and museums) and better post-schooling labor market opportunities and are expected to increase nonresident enrollment (Adkisson & Peach, 2008). Along similar lines, increases in unemployment in the state are expected to deter nonresident enrollment, and increases in the return to a college degree in the state are expected to increase nonresident enrollment (Baryla & Dotterweich, 2001). SAT scores in the state also capture improvements in the quality of resident students over time. Controlling for resident enrollment, rising student quality is expected to make institutions more desirable to nonresidents (Adkisson & Peach, 2008). Higher nonresident tuition rates at competitors are expected to produce a positive cross-price effect and increase nonresident enrollment (Rizzo & Ehrenberg, 2004). Higher incomes in neighboring states are thought to increase the demand for nonresident enrollment (Zhang, 2007). Institution fixed effects control for time-invariant characteristics such as location and climate. The fixed effects also mean that identification comes from variations over time within institutions.

Both previous literature and the theoretical framework suggest that nonresident tuition is potentially endogenous. States may respond to fluctuations in nonresident enrollment demand by altering nonresident tuition rates. Additionally, observed changes in resident enrollment may be partially due to changes in the supply of enrollment, but the interest in this paper is in the effect that changes in resident enrollment demand have on nonresident enrollment.[8] To account for these concerns, this paper instruments for nonresident tuition and resident enrollment using resident tuition and the number of 18 year olds in the state (measured as of July). Valid instruments should be both relevant and exogenous; in other words the instruments should be significant predictors of the endogenous variables and not be correlated with the dependent variable other than through their effect on the endogenous variables. Resident tuition is expected to have a positive effect on nonresident tuition and a negative effect on resident enrollment, but have no direct effect on nonresident enrollment. The number of 18 year olds in the state is expected to have a positive effect on resident enrollment and a positive effect on nonresident tuition but be otherwise exogenous to changes in nonresident enrollment.

Resident tuition has been previously used as an instrument for nonresident tuition by several studies including Baryla and Dotterweich (2001), Rizzo and Ehrenberg (2004), Dotterweich and Baryla (2005), and Adkisson and Peach (2008). Bell et al. (2011) report that state tuition setting philosophies for resident tuition are generally driven by desires to keep tuition low or moderate and balance budgets, while nonresident tuition is frequently set as a multiple of resident tuition or the full cost of instruction. Resident tuition, therefore, should only affect nonresident enrollment through its effect on resident enrollment and nonresident tuition. Furthermore, the IV approach used here assumes that there is no effect of nonresident enrollment on resident tuition. The approach also requires the population of 18 year olds to be exogenous to nonresident enrollment. This variable is measured as of July preceding the academic year and is unlikely to be directly affected by nonresident enrollment. More generally, the IV approach assumes that state-specific demographic trends driving trends in the number of 18 year olds put supply-side pressure on institutions and affect resident enrollment and nonresident tuition but do not otherwise affect nonresident enrollment.

Data on nonresident and resident enrollment are obtained from the National Center for Education Statistics (NCES) Residence and Migration Survey as part of its Integrated Postsecondary Education Data System (IPEDS). These data are available for every other year between 1986 and 2000 except for 1990 and for every year since 2000. This study uses enrollment data for all first-time freshmen in public four-year colleges and universities for all available years between 1986 and 2007.[9] Data for nonresident and resident tuition also come from the IPEDS, as do institutional addresses used to measure distances between institutions to construct the average tuition at competitor institutions. State appropriations per student also come from IPEDS and are measured at the institution level and with a two-year lag to minimize the potential for endogeneity.

Data on the 18 year old population in a state come from the U.S. Census Bureau. The merit scholarship variable is coded as a binary variable equal to one if the state has a merit scholarship program during the year in question and zero otherwise. The variable was constructed based on merit scholarships programs reported in Heller (2004) and

[8] For example institutional expansion is likely to increase enrollment of both residents and nonresidents.

[9] Results are qualitatively similar using only the even years.

Orsuwan and Heck (2009).[10] Median household income was obtained from Census estimates from the Current Population Survey (CPS); household income in bordering states was computed as a population-weighted average. The state unemployment rate was obtained from the Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics program. The college wage premium was computed from the March CPS as the ratio of the average wage of full-time workers with a bachelor's degree to the average wage of full-time workers with only a high school diploma for workers between the ages of 35 and 54. Mean SAT scores were obtained from various years of the NCES Digest of Education Statistics. Also, all dollars amounts are converted to year 2000 dollars using the BLS Consumer Price Index.

Because the explanatory variables might have differing effects for different types of public institutions, I divide the sample into flagship universities and non-flagship schools.[11] Following Rizzo and Ehrenberg (2004) I define as flagship universities all 84 public universities classified as Research I or II by the Carnegie Foundation in 1994 plus the top public institution in each state that did not have a Research I or II institution.[12] If flagship universities are less willing or less able to expand total enrollment than non-flagships because of greater constraints or differing goals, we might expect resident enrollment demand to have a more negative effect on nonresident enrollment at flagships than non-flagships.

Separate summary statistics for flagship universities and non-flagship schools are provided in Table 1. There are 14 years of data with 92 flagship universities and 529 non-flagship public colleges and universities in the sample. However, the panel is unbalanced because data are missing for some institutions in particular years. From Table 1, we see that flagship universities have both greater resident and nonresident enrollment than non-flagship schools. The percentage of nonresidents is also higher at flagships (21.5) than non-flagships (13.4). Flagships also have higher tuition rates for both residents and nonresidents.

4. Empirical results

This section presents results estimated via 2SLS separately for flagship universities and non-flagship colleges and universities. Because the first-stage results for resident enrollment and nonresident tuition are also of interest, they are presented as well. I begin by discussing the results for flagships and then discuss the results for non-flagships. I also present results for some alternative specifications. Because many variables are measured at the state level, standard errors are clustered by state.

4.1. Flagship universities

The main results for flagship universities are presented in Table 2. The regressions also include a full set of institution and year fixed effects. First-stage results for resident enrollment and nonresident tuition are reported in the first and second columns, respectively. 2SLS results for nonresident enrollment are reported in the third column.

4.1.1. First stage results

According to the results, the population of 18 year olds has a positive effect on resident enrollment with a coefficient of 0.006 that is statistically different from zero at the 1% level of significance. This result suggests that increasing the number of 18 year olds in the state by 1000 increases resident freshmen enrollment in a given flagship university by six students on average. Consistent with the law of demand, increases in resident tuition decrease resident enrollment with a coefficient of −0.094, suggesting that a $100 increase in resident tuition reduces resident freshmen enrollment by 9.4 students. The results also suggest that merit programs significantly increase resident enrollment with a point estimate of 313.1. The positive effect of merit programs on resident enrollment is consistent with a number of previous studies (e.g. Cornwell, Mustard, & Sridhar, 2006; Dynarski, 2000, 2004; Farrell & Kienzl, 2009; Orsuwan & Heck, 2009; Singell, Waddell, & Curs, 2006; Zhang & Ness, 2010). Somewhat surprisingly, state appropriations per student lagged two years are significantly negatively associated with resident enrollment with a coefficient of −0.060. Income in bordering states has a positive effect on resident enrollment with coefficient of 0.021 that is significant at the 10% level of significance. Median household income, the state unemployment rate, and average nonresident tuition at competitor institutions have positive coefficients but are not statistically significant. The college wage premium and mean SAT scores both have negative coefficients but are also not statistically significant.[13]

Results in the second column suggest that the population of 18 year olds in the state also has a positive and statistically significant effect on nonresident tuition at flagship universities with a coefficient of 0.019. This supports the earlier hypothesis that schools respond to pressures from resident enrollment demand by increasing nonresident tuition. The coefficient suggests that an increase in the number of 18 year olds in the state by 1000 results in a $19 increase (in year 2000 dollars) in nonresident tuition. As expected, resident tuition has a positive and highly significant effect on nonresident tuition with a coefficient of 1.471. Thus, when flagship universities raise resident tuition by $1, they raise nonresident tuition by $1.47. The college premium in the state has a negative and significant effect with a coefficient of −582.0; this result suggests that when the state labor market is doing well and the state

[10] I also experimented with separate variables for each state merit program. Doing so does not significantly affect the results for the additional variables in the study.

[11] This is, unfortunately, a somewhat arbitrary division. Within both groups there is undoubtedly a good deal of heterogeneity in both objectives and constraints.

[12] I also include the University of Alabama which anomalously does not fit the above criteria, but is widely considered a flagship university. The results, however, are not affected by excluding the University of Alabama. The full list of flagship public universities (except the University of Alabama) is provided in Table 1 of Rizzo and Ehrenberg (2004).

[13] However, a failure to reject the null does not necessarily mean that these variables have no effect.

Table 1
Summary statistics.

	Flagship universities		Non-flagship schools	
	Mean	St. Dev.	Mean	St. Dev.
Nonresident freshmen enrollment	744	590	155	201
Resident freshmen enrollment	2715	1287	1005	842
State population age 18	123,590	132,232	131,101	116,666
Nonresident tuition	11,530	4322	8296	3076
Resident tuition	4069	1677	3344	1504
Merit scholarship	0.17	0.38	0.19	0.39
State appropriations per student	8108	3122	4938	4971
Median household income	39,783	5607	39,528	5793
Unemployment rate	5.38	1.52	5.36	1.47
College wage premium	1.61	0.21	1.64	0.21
Mean SAT score	1048	79	1037	78
NRT at "Competitor" institutions	11,695	3393	8483	2013
HH income in bordering states	37,600	9885	38,446	8908

Notes: The sample includes 1170 observations for flagship universities and 5986 observations for non-flagship schools.

Table 2
Resident enrollment and nonresident tuition and enrollment in flagship universities.

	First stage: resident freshmen enrollment	First stage: nonresident tuition	Second stage: nonresident freshmen enrollment
Resident freshmen enrollment			−0.242***
			(0.077)
Nonresident tuition			−0.014
			(0.009)
State population age 18	0.006***	0.019***	
	(0.002)	(0.005)	
Resident tuition	−0.094**	1.471***	
	(0.036)	(0.208)	
Merit scholarship	313.130**	354.217	118.615**
	(131.199)	(285.637)	(49.991)
State appropriations	−0.060***	−0.029	−0.020***
	(0.014)	(0.044)	(0.008)
Median household income	0.006	0.050	0.012*
	(0.008)	(0.031)	(0.007)
Unemployment rate	25.264	84.002	−2.087
	(25.060)	(57.623)	(11.779)
College wage premium	−15.005	−582.003**	49.030
	(66.035)	(220.437)	(45.703)
Mean SAT score	−0.582	2.114	0.155
	(1.709)	(5.044)	(0.764)
NRT at "Competitors"	0.049	0.386**	0.021
	(0.034)	(0.154)	(0.020)
HH income in bordering states	0.021*	0.029	0.009
	(0.012)	(0.041)	(0.007)
Institution fixed effects	Y	Y	Y
Year dummies	Y	Y	Y
R^2	0.93	0.95	0.89
Under-identification test LM statistic			6.449
Weak identification test *F* statistic			8.983

Notes: Regressions include 1170 observations. Standard errors are clustered by state.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

would benefit from more college graduates, institutions in the state lower nonresident tuition to incentivize nonresidents to enroll in their state. Flagship universities raise nonresident tuition in response to increased nonresident tuition by competitor institutions with a significant coefficient of 0.386. Merit programs have a positive coefficient but the effect is not quite statistically significant. The same is true for median household income, the unemployment rate, mean SAT scores, and income in bordering states. State appropriations per student have an insignificant negative coefficient.

4.1.2. Second stage results

The 2SLS results for nonresident enrollment are reported in the third column of Table 2. An important concern with instrumental variables is that the second stage estimates may be under-identified or weakly identified if the instruments are not strong predictors of the

endogenous variables. I conduct tests of under-identification and weak identification based on Kleibergen and Paap (2006). The under-identification Lagrange Multiplier (LM) test statistic equals 6.449 with a corresponding *p*-value of 0.011, allowing us to reject the null of under-identification at the 2% level of significance. This allows us to be reasonably confident that the second stage of the 2SLS is identified, i.e. the excluded instruments satisfy the relevance requirement. A related issue is that the model may be weakly identified and cause tests of significance to have incorrect size. To test for weak identification, I estimate a Kleibergen and Paap (2006) *F* statistic. Stock and Yogo (2005) report critical values for maximal IV size for a 5% significance level. The critical value for 10% maximal IV size when there are two endogenous regressors and two excluded instruments is 7.03. The *F* statistic for flagship universities equals 8.983, so we can reject the null of 10% maximal IV size and conclude that the size distortion from 2SLS is not too considerable.

The conceptual framework suggests that increases in resident enrollment demand might crowd out nonresident enrollment at institutions that are unable or unwilling to increase total enrollment. The 2SLS results suggest that this is indeed the case for flagship universities. Resident enrollment has a significantly negative effect on nonresident enrollment with a coefficient of −0.242. The coefficient indicates that an increase in resident enrollment of 100 students reduces nonresident enrollment by roughly 24 students. Thus, resident students crowd out nonresidents, though the effect is less than one for one. At least some flagship universities face significant constraints on resources and capacity and are unable to absorb larger cohorts of resident students without turning away some nonresidents. This suggests that studies that look only at the demand side factors of nonresident enrollment are misguided. Nonresident enrollment at a particular institution is driven not only by the willingness of nonresidents to attend the institution but also by the institution's willingness and ability to enroll nonresident students. Increased enrollment demand by resident students partially crowds out enrollment by nonresidents.

For flagship universities the 2SLS results report that nonresident tuition has a small coefficient of −0.014 for nonresident enrollment that is not statistically significant at conventional levels; the *p*-value equals 0.131. The magnitude of the coefficient suggests that a $1000 increase in nonresident tuition at flagship universities would only decrease nonresident enrollment by 14 students, a fairly small effect given the mean values for nonresident enrollment and nonresident tuition of 744 and 11,530 in Table 1. This also suggests that flagship universities do not appear to be charging prices to nonresidents that maximize total tuition revenue from nonresidents; institutions could increase total revenue by charging higher prices. Given that institutions do not charge higher prices, much of the benefits received from enrolling nonresidents may be non-monetary such as enhanced student quality and increased student diversity.

The merit scholarship variable has a significantly positive effect on nonresident enrollment with a coefficient of 118.6, a result that is somewhat surprising considering that nonresidents are not usually eligible for state merit scholarship programs. This may suggest that merit scholarships make flagship universities more desirable to nonresident students, perhaps because of increased quality of resident students. State appropriations per student have an unexpected negative effect on nonresident enrollment with a coefficient of −0.020. Robustness checks discussed later show that the main results are qualitatively robust to the exclusion of the merit and appropriations variables. Consistent with expectations, increases in median household income attract nonresident students, with a significant coefficient of 0.012. Unemployment has an insignificant negative coefficient, and the college premium, mean SAT scores, nonresident tuition at competitors, and income in bordering states all have insignificant positive coefficients.

4.2. Non-flagship colleges and universities

The results for non-flagship colleges and universities are presented in Table 3. As before, the regressions also include institution and year fixed effects and standard errors are again clustered by state.

4.2.1. First stage results

As with flagship universities, the population of 18 year olds has a positive and statistically significant effect on resident enrollment with a coefficient of 0.007. Resident tuition, however, has an insignificant negative effect on resident enrollment at non-flagship schools. Merit scholarships also increase resident enrollment at non-flagships with a significant coefficient of 141.5. State appropriations per student again have a significantly negative effect on resident enrollment with a coefficient of −0.008. Median household income, the state unemployment rate, and nonresident tuition at competitor institutions all have positive coefficients in the resident enrollment equation but are not statistically significant. The college premium, mean SAT scores, and income in bordering states all have negative but insignificant coefficients.

As seen in the second column of Table 3, the population of 18 year olds in the state has a negative and insignificant coefficient in the nonresident tuition equation for non-flagships. This is in contrast to the positive and significant coefficient for flagship universities. Resident tuition has a positive effect with a significant coefficient of 1.057. The presence of a merit scholarship increases nonresident tuition with a statistically significant coefficient of 359.1. If it is politically difficult for colleges and universities to raise resident tuition in states with merit programs, nonresident tuition may be a way for these institutions to raise revenue if nonresident enrollment is not very responsive to price. Non-flagship schools also significantly increase nonresident tuition in response to nonresident tuition at nearby competitors with a coefficient of 0.573. State appropriations and the unemployment rates both have insignificant positive coefficients. Median household income, the college premium, mean SAT scores, and income in bordering states all have negative coefficients in the nonresident tuition equation but are not statistically significant.

Table 3
Resident enrollment and nonresident tuition and enrollment in non-flagship schools.

	First stage: resident freshmen enrollment	First stage: nonresident tuition	Second stage: nonresident freshmen enrollment
Resident freshmen enrollment			−0.078
			(0.071)
Nonresident tuition			0.003
			(0.004)
State population age 18	0.007***	−0.003	
	(0.001)	(0.003)	
Resident tuition	−0.015	1.057***	
	(0.017)	(0.181)	
Merit scholarship	141.480*	359.142*	17.135
	(73.639)	(207.727)	(20.161)
State appropriations	−0.008***	0.003	−0.002**
	(0.003)	(0.014)	(0.001)
Median household income	0.000	−0.003	0.000
	(0.004)	(0.026)	(0.001)
Unemployment rate	10.866	62.864	−2.922
	(10.407)	(42.561)	(3.635)
College wage premium	−37.796	−186.433	−12.561
	(35.970)	(142.437)	(10.552)
Mean SAT score	−1.312	−0.805	−0.108
	(1.186)	(4.849)	(0.239)
NRT at "Competitors"	0.050	0.573***	0.020
	(0.070)	(0.125)	(0.014)
HH income in bordering states	−0.005	−0.005	0.001
	(0.011)	(0.027)	(0.001)
State fixed effects	Y	Y	Y
Year dummies	Y	Y	Y
R^2	0.90	0.91	0.78
Under-identification test LM statistic			4.028
Weak identification test *F* statistic			9.188

Notes: Regressions include 5986 observations. Standard errors are clustered by state.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

4.2.2. Second stage results

The 2SLS results for nonresident enrollment at non-flagship schools are presented in the third column of Table 3. A Kleibergen and Paap (2006) test of under-identification yields an LM statistic of 4.028 and a corresponding *p*-value of 0.045, allowing us to reject the null of under-identification at the 5% level of significance. The Kleibergen–Paap test for weak identification yields an *F* statistic equal to 9.188, which allows us to reject the null of 10% maximal IV size for a 5% significance level.

The primary variable of interest, resident enrollment, has a negative coefficient of −0.078, but it is relatively small and not statistically significant; the *p*-value equals 0.249. This is in contrast to the significantly negative coefficient for flagship universities of −0.242. Thus, we cannot be reasonably confident that resident students crowd out nonresident students at non-flagship public colleges and universities. The lack of crowding out may suggest that non-flagship schools are generally willing and able to increase total enrollment when faced with increased demand by residents. Many students, however, will not consider non-flagship schools as very good substitutes for flagship universities in the same state.

Among the variables only state appropriations per student has a statistically significant effect, but its negative coefficient of −0.002 is somewhat unexpected. Nonresident tuition has a small positive coefficient that is not statistically significant, suggesting that price has little effect on nonresident enrollment at both flagships and non-flagships. Merit scholarships, median household income, nonresident tuition at competitors, and income in bordering states also have insignificant positive coefficients in the nonresident enrollment equation. The unemployment rate, the college wage premium, and mean SAT scores all have negative but insignificant coefficients for nonresident enrollment. The lack of significance for most of the variables may suggest that after institution fixed effects and year dummies are included there is relatively little systematic variation in nonresident enrollment at non-flagship schools.

4.3. Nonresident enrollment results for alternative specifications

Table 4 reports second stage results for the nonresident enrollment equation for several alternative specifications for both flagships and non-flagships. One important issue is that many studies treat nonresident tuition as exogenous and include it directly in the nonresident enrollment equation. Panel A of Table 4 considers the effects of treating nonresident tuition as exogenous. For flagships the crowd out effect, i.e., the effect of resident enrollment on nonresident enrollment, decreases only slightly to −0.214 and is still significant at the 1% level; the effect of

Table 4
Nonresident enrollment results for alternative specifications.

	Flagship universities	Non-flagship schools
A. Treating NR tuition as exogenous		
Resident freshmen enrollment	−0.214***	−0.078
	(0.074)	(0.069)
Nonresident tuition	−0.001	0.003
	(0.007)	(0.002)
B. Using contemporaneous appropriations		
Resident freshmen enrollment	−0.224***	−0.075
	(0.075)	(0.070)
State appropriations per student	−0.030***	−0.004**
	(0.011)	(0.002)
C. Excluding appropriations		
Resident freshmen enrollment	−0.242***	−0.074
	(0.083)	(0.067)
D. Treating merit as an instrument		
Resident freshmen enrollment	−0.148*	−0.070
	(0.081)	(0.071)
Hansen overidentification test *p*-value	*p* = 0.032	*p* = 0.368
E. Excluding merit		
Resident freshmen enrollment	−0.277***	−0.085
	(0.091)	(0.069)
F. Merit states only		
Resident freshmen enrollment	−0.183***	0.060
	(0.067)	(0.061)
G. Non-merit states only		
Resident freshmen enrollment	−0.316**	−0.171***
	(0.133)	(0.040)
H. NRE limit states only		
Resident freshmen enrollment	−0.204**	−0.136*
	(0.102)	(0.074)
I. Non-NRE limit states only		
Resident freshmen enrollment	−0.558	0.040
	(0.423)	(0.052)
J. Guaranteed admission universities		
Resident freshmen enrollment	−0.294***	N/A
	(0.112)	
K. Non-guaranteed admission universities		
Resident freshmen enrollment	−0.222**	N/A
	(0.113)	

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

nonresident tuition is very small and not statistically significant. Treating nonresident tuition as exogenous does not meaningfully affect the results for non-flagships.

A second issue is that the results for state appropriations in Tables 2 and 3 were somewhat unexpected. Panels B and C of Table 4 consider the effects of exploring alternative specifications for state appropriations. Panel B uses contemporaneous appropriations instead of two-year lagged appropriations and Panel C completely excludes the appropriations variable from all three equations. The main results are robust to both of these alternative specifications.

Another issue is how to treat the merit indicator variable. Panel D treats the merit scholarship indicator variable as a third instrument and excludes it from the nonresident enrollment equation. Adding merit as a third instrument reduces the coefficient for the effect of resident enrollment on nonresident enrollment for flagships to −0.148 and reduces the significance to the 10% level. However, with three instruments and two endogenous regressors we can conduct an overidentification test using Hansen's *J* statistic. The test yields a *p*-value of 0.032, which means we can reject the hypothesis that all of the instruments are valid at the 5% level of significance. A variable is a good instrument if it is correlated with the endogenous explanatory variable(s) but otherwise has no direct effect on the primary outcome variable (nonresident enrollment). Unfortunately, there is no perfect way to discern which instrument(s) is causing us to reject the null that the equation is not overidentified. However, on theoretical grounds one might suspect that the age structure of the population is more likely to be a valid instrument than the presence of a merit program. Doyle (2006) conducts a detailed investigation of why states adopt broad based merit scholarship programs and among other things finds that states with lower levels of educational attainment are more likely to adopt merit programs. Therefore, if merit programs are not randomly assigned, the merit indicator variable could partially capture other effects and should not be used as an instrument. This also suggests caution in interpreting the effects of merit programs as causal. The preferred estimates, therefore, do not use the merit variable as an instrument, but the estimated effect of resident enrollment on nonresident enrollment at flagships is not greatly reduced by doing so. Treating merit as a third instrument does not meaningfully affect the main result for non-flagships. As shown in Panel E, the main results are also qualitatively robust to completely excluding the merit variable from all three equations.

We might also be interested in whether the main results differ for various subsamples. Panels F and G of Table 4 estimate the results separately for states that ever adopted a merit scholarship program (F) and states that never adopted a merit program (G). We might expect differences between the two groups of states. For example, merit programs may impose additional constraints on colleges and universities and affect how they respond to increased resident enrollment demand. Alternatively, the extent to which states have excess capacity to provide higher education to additional students may affect whether they adopt merit programs. For flagships the crowd out effect is negative and significant for both groups of states, but the coefficient for non-merit states of −0.316 is a good bit larger in magnitude than the coefficient of −0.183 for merit states. For non-flagships the coefficient is positive and insignificant for merit states but actually negative and significant for non-merit states with a coefficient of −0.171. This suggests that increased enrollment demand by resident students crowds out nonresident enrollment at non-flagships in non-merit states. All together, these results are consistent with Doyle (2006) and suggest that states with less capacity to absorb additional students in their higher education systems are less likely to adopt broad based state merit aid programs. This further supports the decision to not use merit as an instrument and again suggests that merit effects should be interpreted with caution.

Some states have also adopted official limits on the number or percentage of nonresident students that can enroll in their public colleges and universities, and this could greatly affect the extent to which increased demand by resident students crowd out nonresident students. Official limits might also change over time in response to resident enrollment pressures. Panels H and I split the sample into states that have ever had limits on nonresident enrollment and states that have never (as far as I can tell) had official limits on nonresident enrollment. Unfortunately, it is not perfectly clear which states have ever had limits on nonresident enrollment. I found evidence of some type of limit on nonresident enrollment at some point in time for Arizona, California, Colorado, Florida, Hawaii, Kansas, Michigan, Missouri, New Hampshire, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Virginia, and Washington. However, some states may have limits that are more difficult to identify or *de facto* limits. Furthermore, the exact limits for states which have them often vary considerably over time and within states at a given point in time. The results in Panels H and I, therefore, should be interpreted with considerable caution.

For flagship universities in states with nonresident enrollment (NRE) limits, resident enrollment continues to have a significantly negative effect on nonresident enrollment with a coefficient of −0.204. However, for flagships without NRE limits, the coefficient measuring the extent to which residents crowd out nonresidents is large in magnitude at −0.552, but it is noisily estimated and not statistically significant at conventional levels. For non-flagship schools in states with NRE limits, the crowd out effect is significantly negative with a coefficient of −0.136, suggesting that even non-flagship schools experience constraints on capacity in states adopting limits on nonresident enrollment. For non-flagships in states without NRE limits, however, the effect of resident enrollment on nonresident enrollment has a positive coefficient that is statistically insignificant.

A final issue is that some public institutions of higher education have guaranteed admission policies for resident first time freshmen meeting certain criteria based on high school class rank, high school GPA, and/or SAT/ACT scores.[14] The criteria are sometimes set at the state level such as with California, Florida, and Texas, and sometimes set at the institution level. However, there is a great deal of variation in how these policies are implemented. In Texas, resident high school graduates in the top 10% of their high school class are admitted to any Texas public university of their choice.[15] In California, however, students in the top 4% of their high school class are guaranteed admission to the UC System, but not necessarily the campus of their choice. UC-Berkeley and UCLA are in especially high demand and often have to turn away many students in the top 4%. Similarly, Florida guarantees admission to at least one public university to all students in the top 20% of their high school class, but not necessarily the students' first choice (the University of Florida and Florida State University turn away many of Florida's Talented 20 eligible students). Besides these three states, guaranteed freshmen admission policies exist in at least 21 other flagship institutions including the University of Arizona, Colorado University-Boulder, and the University of Oklahoma. These policies also vary considerably by institution and over time. Furthermore, several other institutions offer implicit guarantees for students exceeding certain admission requirements.

Panels J and K separate flagship universities into those that have ever had a guaranteed admission policy and those that (to my knowledge) have not. The crowd out effect is negative and significant for flagships both with and without admission guarantees, with coefficients of −0.294 and −0.222, respectively. However, corresponding results for non-flagships are not estimated because many non-flagships are virtually open access and it would be very time consuming to collect the required information for all four-year public institutions in the country.

5. Conclusion

Previous studies of nonresident enrollment usually focus on the determinants of nonresident enrollment demand. However, some universities face important supply constraints that are often not considered. This study examines the effect of supply constraints and other determinants on nonresident enrollment. Depending on their goals and objectives, colleges and universities that experience increased enrollment demand from resident students may reduce their supply of nonresident enrollment. If they have some price setting power, schools may also raise the price to nonresident students as their enrollment demand from resident students increases.

Using instrumental variables and institution fixed effects, this paper finds that larger cohorts of resident students do indeed crowd out nonresident students at flagship universities. The results suggest that an increase in resident enrollment of 100 students reduces nonresident enrollment by roughly 24 students at flagship universities. However, the evidence on crowd out at non-flagship schools is weaker and less consistent. This paper also finds that flagship universities raise nonresident tuition in response to larger cohorts of resident students, but non-flagship schools do not. These results are consistent with flagship universities often being unwilling or unable to increase enrollment when faced with increased demand. This paper also supports previous work by Card and Lemieux (2000) and Bound and Turner (2007) suggesting that higher education institutions sometimes face considerable supply constraints and are often unable to expand enrollments to meet rising demand.

The "Great Recession" and the slow recovery that followed likely affected resident enrollment, nonresident enrollment and nonresident tuition at public colleges and universities in complex and important ways. The sluggish economy likely increased resident enrollment demand

[14] Some institutions also have guaranteed transfer admission policies for students at local two-year colleges and even guaranteed admission for nonresidents.

[15] The law was recently modified so that guaranteed admission at UT-Austin is only assured to the top 8%, but students in the top 10% are still guaranteed admission at all other public universities in Texas.

but decreased nonresident enrollment demand. At the same time, some public institutions likely have tried to make up for reduced state appropriations with increased revenue from nonresident tuition. This raises important concerns that declining state appropriations may have reduced access to higher education for both residents and non-residents, especially at state flagship universities. Students denied access to a state's flagship universities are likely to enroll at either non-flagship schools in the state or at flagship universities in other states, both of which have important consequences for states. Over time this may reduce both the quantity and quality of education in a state and have considerable impacts on state employment outcomes and future tax revenue. Students enrolling in other states are less likely to locate in the state after college, which over time will reduce the state's stock of college educated labor. Students enrolling at non-flagship schools may receive a lower quality education, earn lower wages, and contribute less in state tax revenue. Future research should consider the many effects of the recent economic downturn on higher education outcomes, but be mindful that many factors changed simultaneously and disentangling the various effects may be difficult.

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