Price Sensitivity of Demand for Higher Education

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Abstract

In this paper, we estimate the price response of student demand for both in-state and out-of-state students for large, public, 4-year institutions. In addition, we lend consideration to an institution's in-state price growth relative to its state's average in-state price growth and its effect on relative in-state enrollment growth. We find a low elasticity of demand on average, and that out-of-state students exhibit a greater price response than in-state students, consistent with most existing literature. Furthermore, we find that while in-state students may not be all that responsive to changes in price, when contextualizing the change in price and enrollment as relative changes from their state's average tuition change, relatively greater changes in price lead to relatively smaller changes in enrollment. This suggests universities within a state have an incentive to collude on tuition increases.

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I: Introduction

This paper seeks to build upon existing literature on how prospective students react to changes in tuition. Following previous work, we build separate models for in-state enrollees and out-of-state enrollees, as the groups are too different to be pooled into one regression. We theorize that demand for a university education is in line with basic economic theory: quantity demanded will decrease with price. However, our analysis shows price-inelastic demand for university education, with out-of-state students having a relatively stronger sensitivity to price. This result is found by multiple previous studies of public university enrollment (Bradley Curs & Larry Singell Jr., 2002; Steven Helmelt & Dave Marcotte, 2010).

We make two contributions to this literature. First, we use the latest available data, and second, we incorporate measures of in-state competition. We provide new evidence that in-state students respond negatively to increases in tuition that are greater than the average increase of the rest of the schools in a state.

Building upon previous research using updated data is necessary and important because many existing studies were written at a time when the college process was much different. Tuition is rising across the country at unprecedented rates, as tuition for 4-year public institutions was 3.13 times higher in 2017-18 than 1987-88 (College Board, 2017). High school seniors apply to more colleges than ever: the percentage of first-time freshmen applying to 7 or more colleges rose from 10% in 1995, to 17% in 2005, to a peak of 36% in 2015 (National Association For College Admission Counseling, 2017). Information about the quality of professors, dorms, career services, and social life is increasingly available from universities, the Department of Education, and publications and websites such as US News. Universities also increasingly compete for students on a national level (The Economist, 2017). It is our belief that as tuition rises to new highs, the elasticity of demand may change. So, if policy makers were to use these old analyses in setting public policy, they would be assuming the incorrect elasticity of demand and would not create the optimal policy solutions. Secondly, potential students may behave differently pre-financial crisis vs. post-financial crisis in ways unrelated to price, but measurable through other control variables such as SATs. Any analysis used in a policy making context today should incorporate such changes as well.

Using data from the Integrated Postsecondary Education Data System (IPEDS), The National Center for Education Statistics (NCES), and Federal Reserve Economic Database (FRED) we estimate demand for 251 public institutions for the academic years 2009-2016 controlling for price variables, state or national macroeconomic indicators, and various school characteristics. We run three main regressions of interest, with log-log specification[1] controlling for the aforementioned characteristics: list in-state tuition on in-state enrollees, list out-of-state tuition on out-of-state enrollment and the percent change of in-state tuition relative to the state's mean change in in-state tuition on the percent change in in-state enrollees relative to the state's mean change in in-state enrollees. The coefficients we find for these regressions are -0.0522 (not significant), -0.458 (significant at 1% level), and –0.255 (significant at 1% level), respectively.

II: Literature Review

There is a general sentiment in the United States that secondary education is the key to an economically prosperous livelihood. As such, there is extensive research on all topics related to university education, including the effects of increases in tuition. This information is valuable not only to policy makers attempting to make college more accessible, but university administrators

[1] For the first two listed. The third is in percentage points.

attempting to maximize their tuition revenue. The original mission of public state universities was to educate that state's youth, and many economists have attempted to find policies that will ensure an accessible in-state education. In previous attempts to accomplish this, preceding research has focused on the characteristics that determine college choice and how they relate to elasticity of demand.

A paper written by Bradley Curs and Larry D. Singell Jr. at the University of Oregon in 2002 titled, “An analysis of the application and enrollment processes for in-state and out-of-state students at a large public university” served as a primary source of inspiration for our own research. This paper serves as a good foundation for our research as they analyze a very similar question of interest and provide a roadmap for identifying important factors in the application and enrollment decisions. This paper builds upon previous research by further specifying applicants and enrollees by in-state/ out-of-state status. This in-state/ out-of-state enrollment relationship is of particular interest to public universities as it is common for out of state students to pay significantly more than local students, such as at UO where out of state students pay almost 3x the in-state tuition.

This study of individuals uses data from the UO admissions office for Fall-term freshmen recruits from 1995-1996 through 1999-2000 academic years. They use binary probit models, meaning the dependent variable in each is a dummy variable that equals 1 if the person applies and 1 if the person enrolls, respectively. The models include variables for gender, race, academic aptitude, high school factors, and peer income. The authors use expected aid in the application model, and actual aid in the enrollment model. Other financial variables include net price, unsubsidized loans, public competitor price and private competitor price. Competitors are determined by examining the 20 colleges that most frequently receive test scores from UO applicants. Here we note a substantial diversion from our research, as we did not have access to the individual level data for applicants and enrollees at a specific institution. This level of data facilitates a predictive model attempting to understand the factors that influence probability of application and enrollment, whereas we compiled more macro-level data on how price affects the quantity of enrollees.

This study is useful for laying out a variety of models and forcing the question of whether we want to examine individuals or aggregate, and whether it is important to have an application model in addition to the enrollment model. Furthermore, this paper highlights the importance of distinguishing between in-state tuition/ out-of-state tuition and in-state enrollees/ out-of-state enrollees and leads us to expect out-of-state students to be more price inelastic than in-state students. This finding has interesting policy implications when juxtaposed with the assumed mission of public state universities: educating that state's population. This difference in elasticities breeds skepticism of the sustainability of the relationship in which out-of-state students subsidize in-state education through higher tuition.

Curs & Singell (2010) pen another paper together examining pricing strategies in the context of enrollment management. Enrollment management is becoming increasingly important as schools attempt to ensure their own financial sustainability while hoping the best students matriculate. The authors discuss the merits of two policies: "Aim High or Go Low," as the paper is aptly named. Schools can post a very high "sticker" price and provide large discounts to net price in order to attract the best students, or institutions can choose to charge a low sticker price with few discounts. The authors find that in-state students have an inelastic response to net price, and out-of-state students are more responsive. They find that the probability of enrollment decreases with SAT score and High School GPA, implying the more able students want to pursue secondary education at more prestigious institutions. This paper uses an interesting method to calculate price elasticity across different groupings of need and ability by setting up a 3x3 matrix: needy, somewhat needy, non-needy, able, somewhat able, and less able. Again, we hoped to replicate this matrix, but were unable to obtain the individual-level data required for such analysis.

Trisha Bezmen & Craig A. Depken (1998) take a similar approach to us, as they aim to estimate the demand for colleges based on various observable school characteristics. This paper examines applicants as a measure for demand, while we focus on enrollment. This difference reveals the antiquity of the research, as the college decision process has changed dramatically in recent years. High school graduates are applying to many schools, including many they may not actually intend to attend. The paper also highlights the importance of separating public and private universities, as they have different pricing schemes. The authors note that previous research has found both positive and negative coefficients for tuition on enrollment, where positive is often interpreted as a signal for quality and negative demonstrates price sensitivity. They find that the more schools there are in a state, the less demand there is for private colleges and the more there is for publics. Their list of independent variables is very similar to the one we will employ as they have tuition, out-of-state tuition, room & board, income, top 10% of high school class (generally a measure of ability), graduation rate, expenditures per student, student to faculty ratio, number of other in-state schools, and whether it is a Division 1 school. They find in their sample of 226 public schools that the coefficient for in-state tuition on enrollment is negative and out-of-state tuition on enrollment is positive.

Steven Hemelt & Dave Marcotte (2010) analyze "The Impact of Tuition Increases on Enrollment at Public Colleges and Universities" over a 15-year span from 1991-2006. They also use IPEDS data to construct an institution-level panel for all public 4-year colleges and universities. The authors start with a large sample of universities, but create various subgroups based on quality. Hemelt & Marcotte's log-log specification and a number of control variables we had not thought to include such as average income, number of high school graduates, and unemployment rate. They find evidence that enrollment is more price sensitive at the top 120 public universities than less-prestigious institutions. Furthermore, the authors find with significance at the 5% level that enrollment at Research I institutions decreases 0.437% with a 1% increase in out of state tuition, while in-state enrollment decreases by 0.336% at the same institutions. Research I institutions have a larger percentage of out-of-state students than other public schools, which explains some of why the magnitude of response is more significant at these schools. We assume these out-of-state students have alternatives in home state or other states. The authors observe that tuition can vary from school to school across a state, but tuition trends generally remain the same. This is one of the first mentions of pricing relative to other state and/or regional schools, something we are particularly interested in.

Finally Daniel McMillen, Larry Singell, and Glen Waddell (2007) provide evidence that universities in the United States compete on price, and that tuition is in part dictated by geography and quality of competing schools. This paper was one of the few we found discussing regional competition, which is something our paper hopes to address. The US university system has become more competitive and schools must now compete locally, regionally, and nationally for students (C.M. Hoxby 1997). This paper only looks at this through the lens of private institutions, and we have already discussed that publics and privates should be treated individually of one another. While these findings cannot be directly applied to our own research because of this key difference, this relationship is worth noting. An additional insight from this paper is that they highlight the crucial differences between how students respond to changes in the list tuition vs net tuition. They show that students are much more price responsive to changes in the listed price, not to changes in aid. We decide to control for aid and focus on the posted list price for this reason.

III: Data

To analyze the effect of price on student demand, we draw on data from the Integrated Postsecondary Data System (IPEDS), a federally maintained database that contains information on school's pricing and enrollment, our primary variables of interest, as well as institutional characteristics of quality for controls. While IPEDS contains data for all United States postsecondary institutions, we limit our analysis to large (10,000 students and above, 5000 undergraduates and above), public, 4-year, Title IV participating, degree-granting (primarily baccalaureate or above) institutions. Because the central motivation for this paper is to estimate the demand function of students that are attending qualitatively comparable schools to the University of Oregon, it is important to analyze a cross section of schools that face similar price responses from their students. With this in mind, we opt to exclude community colleges and private universities from the sample. Dropping community colleges is motivated by previous work that shows differing elasticities of demand for students of community colleges and public universities (Larry L. Leslie and Paul T. Brinkman, 1987). Removing private universities from the sample is done because of the widely differing pricing strategies that public and private universities follow, with the former charging widely differing rates for in state and out of state students, while the latter charges the same price for all students. After applying these initial restrictions, we are left with a panel data set that includes a cross section of 263 large, public universities for the years 2009-2016.

Additional necessary macroeconomic control data, like the unemployment rates and median household incomes, at both the state level and nationwide, are taken from the St. Louis Federal Reserve Economic Database (FRED). We also require a control for the population of potential college freshman, so we took data on the number of high school graduates by state from the National Center for Education Statistics (NCES).[2]

Once all the data are together, we find it appropriate to all drop observations that have graduation rates below 21% on the basis that these schools are more like community colleges than public universities when judging by the quality of education they provide. Once we have filtered for reasonable quality, we restrict the data even further to drop schools that are deemed qualitatively too far outside the realm of UO, like Thomas Edison State University (a school designed specifically for adults), or Arizona State University-Skysong (ASU's online schooling headquarters).[3] After all the necessary restrictions are placed on the data, we are left with 1906 observations on 251 individual schools. A summary of the descriptive statistics for these observations are contained in Table 1.

[2] The NCES data came in three sections. The 2009-2010 data directly reported the graduating classes and required no adjustments. 2014-2016 data was presented in cohorts and graduation rates, so our high school graduates for those years are the product of those two figures. Lastly, the years 2011-2013 were not reported, and so were linearly imputed.

[3] Two additional schools were excluded from our dataset that are not listed: University of Maryland-University College and Brigham Young University-Idaho

Table 1

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent Variables					
Enrollees	1,856	3,174	1,664	241	10,835
In-State Enrollees	1,131	2,530	1,300	347	10,293
Out-of-State Enrollees	1,131	576	699	0	5,065
Relative %Δ in In State Enrollees	832	0	0.08	-0.32	0.47
Independent Price Variables					
In State Tuition	1,906	6,907	2,635	910	17,688
Out of State Tuition	1,906	18,947	6,402	3,469	45,082
Relative %Δ in In State Tuition	1,656	0	0.04	-0.32	0.37
Controls					
Additional Cost Measures					
In-State Fees	1,906	1,582	1,334	0	11,729
Out-of-State Fees	1,906	1,754	2,048	0	19,899
Room and Board	1,867	9,394	2,091	3,150	19,677
Average Institutional Grant per Freshman	1,872	7,557	7,449	500	46,022
State Characteristics					
State High School Graduates	1,906	116,444	110,965	5,316	405,900
State Median Household Income	1,906	55,082	7,992	33,321	77,216
State Unemployment Rate	1,906	7.4	2.1	3	14
National Characteristics					
National Unemployment Rate	1,906	7.5	1.6	4.9	9.8
National Median Household Income	1,906	55,326	1,860	53,331	59,039
National High School Graduates	1,906	3,080,114	35,432	3,017,102	3,128,022
Institutional Characteristics					
Research Expense	1,906	116,000,000	183,000,000	0	1,010,000,000
Academic Support Expense	1,906	63,600,000	73,700,000	3,394,568	683,000,000
75 Percentile SAT Math	1,659	612	59	470	800
75 Percentile SAT Reading	1,645	592	49	440	750
Graduation Rate	1,905	56	16	22	94
Student Faculty Ratio	1,906	19	3	11	32
# of Public Competitor Schools in State	1,906	9	6	1	24
Total # of Undergraduates	1,906	20,401	8,986	5,437	65,501
Average Professor Salary	1,906	104,992	20,697	64,683	193,097
Acceptance Rate	1,856	68	17	16	100
Applicants	1,856	15,865	12,661	930	97,112

Note: These summary stats are for all observations across all periods.

IV: Methodology

To identify the true relationship between price and student demand, one would ideally want individual level data on the prices of all the schools one applied to, the quality of those schools, the individual's socioeconomic status, academic ability, level of interest in each university and the size of scholarships the individual was offered. Unfortunately, that individual level data is not available to us, so we will be conducting a university level study with a panel of individual universities over time to identify how price affects the number of enrollees at a particular university, with controls for most of the aforementioned variables. In this paper, we model university demand as a function of the posted tuition price, controlling for other aspects of price, macroeconomic pressures, demographics, and university and student quality.

Our decision to focus on the posted tuition price, not the net tuition price post-aid, is because students react stronger to changes in the posted tuition than to changes in aid (Colleen O'brien, 1992). This is believed to occur because information on the posted tuition price is much more easily communicated and available compared to information on expected aid and tuition discounts for merit.

Before we go into the exact model specification, it is important to note that we are using fixed effects estimators for all the following regressions. We do so because we are interested in how price variation over time affects enrollment over time. By taking fixed effects and grouping by university, we remove any variation across universities that is constant over time. To test our hypothesis that using fixed effects is a more appropriate estimator we ran Hausman tests on all our final specifications. Below are the results of these Hausman tests in table 2, and all our basic regressions with RE and FE for comparison in table 3.

Table 2

Hausman Test Results

SPECIFICATIONS	Chi^2	Prob > Chi^2
Pooled Enrollees	175.41	0.000***
In-State Enrollees	180.17	0.000***
Out-of-State Enrollees	142.29	0.000***
Relative %Δ in In-State Enrollees	30.73	0.022**
***FE preferred at 1% Level, **FE preferred at 5% Level		

Table 3

FE vs RE

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		$\ln(\text{In State Tuition}_{t-1})$		$\ln(\text{Out of State Tuition}_{t-1})$		Relative %Δ in In-State Tuition_{t-1}	
FE	ln(Enrollees)	-0.162**	(0.0766)	0.111	(0.0762)		
RE	ln(Enrollees)	-0.0313	(0.0429)	0.0757	(0.0478)		
FE	ln(In State Enrollees)	-0.0522	(0.0600)				
RE	ln(In State Enrollees)	-0.0586	(0.0407)				
FE	ln(Out of State Enrollees)			-0.458***	(0.170)		
RE	ln(Out of State Enrollees)			-0.146	(0.147)		
FE	Relative %Δ in In-State Enrollees					-0.255***	(0.0965)
RE	Relative %Δ in In-State Enrollees					-0.211***	(0.0779)

To begin, we analyze how the total enrollment at a university changes with changes to both in-state and out-of-state price. Our baseline model starts by simply regressing those two price measures, lagged, against total enrollment:

$$\ln(\text{Enrollees}_{it}) = \beta_0 + \beta_1 \ln(\text{In-State Price}_{it-1}) + \beta_2 \ln(\text{Out-of-State Price}_{it-1}) + e_{it} \quad (1.1)$$

The coefficients of interest are β_1 and β_2. We opt to use a log-log specification for our enrollment model so we can directly interpret the beta coefficients as elasticities. For example, a 1% change in the In-State Price leads to a β_1% change in Enrollees, and a 1% change in the Out-of-State Price leads to a β_2% change in Enrollees. Our decision to use a one period lag of price instead of the price in the same period is because people generally don't know exactly what tuition is going to be the year they enroll in a school. The most concrete information, and the information that they are probably using when making their decision, is the tuition level from the year before.

You can assume that we lag all the variables that we discuss in future sections of this paper, unless we explicitly say they are not lagged, for these reasons.

One limitation of equation (1.1) is that while it includes the tuition prices that are being offered to in-state students and out-of-state students, it does not include the prices of other expenses associated with attendance that the students will surely face, as well as the possible deductions to their net price. These include the room and board, fees charged to both in-state and out-of-state students, respectively, and the average institutionally sourced grant aid awarded to incoming freshman. I denote these additional non-tuition price variables as Θ_{it}, which yields:

$$ln(Enrollees_{it}) = \beta_0 + \beta_1 ln(In\text{-}State\ Price_{it-1}) + \beta_2 ln(Out\text{-}of\text{-}State\ Price_{it-1}) + \beta_3 ln(\Theta_{it-1}) + e_{it} \quad (1.2)$$

The next step in building our model, now that the relevant price variables are accounted for, is to include variables that describe the characteristics of the state the universities are situated in. The first set of variables to include in this category are the economic environment the population of potential students in a state are facing. We do this by controlling for the median household income by state in the current period and the unemployment rate by state in the current period.[4] An additional state characteristic that is of significant importance is the number of freshman graduating high school, as these are the pool of potential in-state students. Let's denote these state characteristic variables as Π_{it}, which gives us:

$$ln(Enrollees_{it}) = \beta_0 + \beta_1 ln(In\text{-}State\ Price_{it-1}) + \beta_2 ln(Out\text{-}of\text{-}State\ Price_{it-1}) + \beta_3 ln(\Theta_{it-1}) + \beta_4 ln(\Pi_{it}) + e_{it} \quad (1.3)$$

At this point, the last thing to control for according to our conceptualization of the demand for higher education is information on school quality. We attempt to do this by controlling for a

[4] We choose to not lag the economic control variables because they have perfect information in the current period about their own economic situation.

collection of 9 aspects of school quality. To be consistent with the information that potential students value, we base our set of control variables off the list of variables that contribute to a school's US News ranking, a widely referenced and sometimes respected measure of school quality.

The first aspect of school quality we attempt to control for is university expenditures. To do this we included a 3-year simple moving average of research spending and spending on academic support. The reason for going with the moving average over a single year is because a school's research or culture reputation changes slowly over time, not instantly to any single year variation.

To get an idea of the quality of the students that went to a university, we controlled for the top 75 percentile SAT scores for both math and reading. The objective here is to control for the fact that students are willing to pay more for a higher quality education, and higher quality peers are part of that. To get some indication of the quality of the education being offered, we control for the graduation rate, student faculty ratio, acceptance rate and average professor salary. Lastly, to control for institution size, we include the total number of undergraduates and the total number of applicants in the current period.[5] We denote these 9 institutional characteristic variables as Ψ_{it}, which gives us our final specification:

$$ln(Enrollees_{it}) = \beta_0 + \beta_1 ln(In\text{-}State\ Price_{it-1}) + \beta_2 ln(Out\text{-}of\text{-}State\ Price_{it-1}) + \beta_3 ln(\Theta_{it-1}) + \beta_4 ln(\Pi_{it}) + \beta_5(\Psi_{it-1}) + e_{it} \quad (1.4)$$

[5] We choose to not lag the total number of applicants in the current period because it is a direct input into the current period total enrollees function.

Our final model specification controls for all the relevant price, economic, state characteristic and institution characteristics, and is quite like models found in the existing literature. Unfortunately, a problem remains: the log(in-state) price and log(out-of-state) price are very highly correlated, which introduces issues with collinearity and could thus be biasing our beta estimates. To solve this problem, we construct two separate models that disaggregate in-state enrollees and in-state price from out-of-state enrollees and out-of-state price.

For the in-state model, we drop all variables not specifically applicable to in-state students, like out-of-state tuition and out-of-state fees. Using the same grouping of variables denoting the same categories of variables, our model is

$$ln(In\text{-}State\ Enrollees_{it}) = \beta_0 + \beta_1 ln(In\text{-}State\ Price_{it-1}) + \beta_2 ln(\Theta_{it-1}) + \beta_3 ln(\Pi_{it}) + \beta_4 ln(\Psi_{it-1}) + e_{it} \quad (2.1)$$

For the out of state model, we drop all variables not specifically applicable to out-of-state students, like in-state tuition and in-state fees, and substitute state level variables of the macroeconomic environment for national level measures, since schools compete for out-of-state students on the national level. Using the same grouping of variables denoting the same categories of variables, our model is

$$ln(Out\text{-}of\text{-}State\ Enrollees_{it}) = \beta_0 + \beta_1 ln(Out\text{-}of\text{-}State\ Price_{it-1}) + \beta_2 ln(\Theta_{it-1}) + \beta_3 ln(\Pi_{it}) + \beta_4 ln(\Psi_{it-1}) + e_{it} \quad (3.1)$$

In addition to equations (1.4), (2.1) and (3.1), we also create a model of in-state enrollees that more explicitly addresses competitor price with the Price Growth Deviation from State Mean ($PGDSM_{it}$), a variable that frames a school's % change in price year over year as the difference between their % change in price and the average % change in price for all schools in their state. We relate $PGDSM_{it}$ to the relative change in the school's in-state enrollment growth (Enrollment Growth Deviation from State Mean, $EGDSM_{it}$), with the belief that relatively greater changes in price from their state's average will lead to relatively smaller changes in in-state enrollment from their state's average change. For clarity, these price and enrollment measures are calculated as follows:

$PGDSM_{it}$ = *%Δ In-State Tuition$_{it}$ – Average %Δ In-State Tuition$_{it}$, by(State)*

$EGDSM_{it}$ = *%Δ In-State Enrollment$_{it}$ – Average %Δ In-State Enrollment$_{it}$, by(State)*

We control for all of the same variables as in the in-state model (2.1) and get

$$EGDSM_{it} = \beta_0 + \beta_1 \text{PGDSM}_{it-1} + \beta_2 ln(\Theta_{it-1}) + \beta_3 ln(\Pi_{it}) + \beta_4 ln(\Psi_{it-1}) + e_{it} \qquad (4.1)$$

Our coefficient of interest in this model, β_1, can be interpreted as a 1 percentage point deviation from the state mean % change in in-state price leads to a β_1 percentage point deviation from the state mean % change in in-state enrollment.

V: Results

Pooled Enrollees

The results of our pooled enrollees on both in-state price and out-of-state price are contained in table 4. Starting with the most basic model without any controls and building it up like is described in the methodology section, we find that the beta estimate for in-state price becomes increasingly negative and significant as we add additional controls in. The opposite happens with out-of-state price, which starts as positive and significant, but is slowly muted and shown not to be statistically significantly different from 0. Prior work on analyzing in and out-of-state price on total enrollment has observed this as well and attributed the positive

Table 4

Pooled Enrollees Results

	(1.1)	(1.2)	(1.3)	(1.4)
VARIABLES	ln(Enrollees)	-	-	-
ln(In-State Tuition$_{t-1}$)	0.0371	0.0311	-0.113**	-0.162**
	(0.0451)	(0.0477)	(0.0494)	(0.0766)
ln(Out-of-State Tuition$_{t-1}$)	0.242***	0.108*	0.0813	0.111
	(0.0528)	(0.0586)	(0.0573)	(0.0762)
ln(Room and Board$_{t-1}$)	-	0.167***	0.0455	0.0792
		(0.0451)	(0.0475)	(0.0562)
ln(In State Fees$_{t-1}$)	-	0.0421	-0.0677	-0.0311
		(0.0986)	(0.0963)	(0.107)
ln(Out of State Fees$_{t-1}$)	-	-0.0223	0.0561	3.39e-05
		(0.0989)	(0.0961)	(0.108)
ln(Average Institutional Grant per Freshman$_{t-1}$)		-0.0104	-0.0277**	-0.00258
		(0.0143)	(0.0140)	(0.0151)
ln(State Median Household Income)		-	-0.0206	-0.120**
			(0.0626)	(0.0599)
ln(State Unemployment)	-	-	-0.151***	-0.0313
			(0.0201)	(0.0249)
ln(State High School Graduates$_{t-1}$)		-	0.385***	0.198*
			(0.0790)	(0.108)
ln(3 Year Average Research Expense$_{t-1}$)		-	-	0.0383*
				(0.0197)
ln(3 Year Average Academic Support Expense$_{t-1}$)		-	-	0.0493
				(0.0307)
ln(75 Percentile SAT Math$_{t-1}$)	-	-	-	-0.0131
				(0.157)
ln(75 Percentile SAT Reading$_{t-1}$)	-	-	-	0.00310
				(0.133)
ln(Graduation Rate$_{t-1}$)	-	-	-	0.186***
				(0.0653)
ln(Student Faculty Ratio$_{t-1}$)	-	-	-	0.108**
				(0.0489)
ln(Total # of Undergraduates$_{t-1}$)	-	-	-	0.198***
				(0.0692)
ln(Applicants)	-	-	-	0.233***
				(0.0208)
ln(Average Professor Salary$_{t-1}$)	-	-	-	0.0611
				(0.0571)
ln(Acceptance Rate$_{t-1}$)	-	-	-	0.0846***
				(0.0285)
Constant	5.246***	5.042***	4.220***	-0.382
	(0.250)	(0.301)	(1.257)	(2.017)
Observations	1,598	1,414	1,414	858
R-squared	0.088	0.090	0.149	0.342
Number of unitid	246	228	228	200

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

out-of-state price coefficient to students behaving like price is a perfect signal for school quality. This sentiment is supported when you consider that in-state students probably have the best understanding of the true quality of the institutions in their state, so they don't take price changes as signals for quality changes. On the other hand, out-of-state students are not nearly as close to the out-of-state institutions they're considering, and so they likely have a less solid understanding of the quality, thus forcing them to take price as a signal for quality to help aid the decision.

Despite these results having some theoretical support, we believe that the pooled results are likely to be highly biased due to the high level of correlation between our two variables of interest. With a correlation coefficient between in-state and out-of-state tuition of .7, collinearity is very likely to be biasing our estimates of price's effect on enrollment, so we disaggregate price and enrollment into just in-state and out-of-state to fix for this.

Disaggregated Results

The results for the disaggregated specifications are contained in Tables 5 and 6 below.

Table 5

In-State Results

VARIABLES	(2.1) ln(In-State Enrollees)	- -	- -	- -
ln(In-State Tuition$_{t-1}$)	0.186***	0.102*	-0.0374	-0.0522
	(0.0406)	(0.0532)	(0.0575)	(0.0600)
ln(Room and Board$_{t-1}$)	-	0.0839	-0.0133	0.0212
		(0.0553)	(0.0591)	(0.0631)
ln(In State Fees$_{t-1}$)	-	0.0354*	0.00277	-0.0202
		(0.0203)	(0.0209)	(0.0196)
ln(Average Institutional Grant per Freshman$_{t-1}$)		0.0231	0.00544	0.0172
		(0.0176)	(0.0175)	(0.0169)
ln(State Median Household Income)		-	-0.0422	-0.0609
			(0.0707)	(0.0682)
ln(State Unemployment)	-	-	-0.121***	0.0146
			(0.0233)	(0.0288)
ln(State High School Graduates$_{t-1}$)		-	0.348***	0.293**
			(0.121)	(0.120)
ln(3 Year Average Research Expense$_{t-1}$)		-	-	0.0258
				(0.0223)
ln(3 Year Average Academic Support Expense$_{t-1}$)		-	-	0.0448
				(0.0347)
ln(75 Percentile SAT Math$_{t-1}$)	-	-	-	-0.0924
				(0.177)
ln(75 Percentile SAT Reading$_{t-1}$)	-	-	-	0.00648
				(0.150)
ln(Graduation Rate$_{t-1}$)	-	-	-	0.246***
				(0.0760)
ln(Student Faculty Ratio$_{t-1}$)	-	-	-	0.0716
				(0.0562)
ln(Total # of Undergraduates$_{t-1}$)	-	-	-	0.236***
				(0.0788)
ln(Applicants)	-	-	-	0.205***
				(0.0234)
ln(Average Professor Salary$_{t-1}$)	-	-	-	0.0450
				(0.0667)
ln(Acceptance Rate$_{t-1}$)	-	-	-	0.127***
				(0.0329)
Constant	6.071***	5.587***	4.856***	-1.282
	(0.357)	(0.430)	(1.669)	(2.287)
Observations	1,111	992	992	814
R-squared	0.024	0.038	0.081	0.227
Number of unitid	246	225	225	200

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6

Out-of-State Results

VARIABLES	(3.1) ln(Out-of-State Enrollees)	-	-	-
ln(Out-of-State Tuition$_{t-1}$)	0.656***	0.152	-0.513***	-0.458***
	(0.105)	(0.140)	(0.156)	(0.170)
ln(Room and Board$_{t-1}$)	-	0.757***	0.163	0.235
		(0.143)	(0.155)	(0.177)
ln(Out of State Fees$_{t-1}$)	-	0.0254	-0.0880*	-0.102*
		(0.0525)	(0.0521)	(0.0521)
ln(Average Institutional Grant per Freshman$_{t-1}$)		0.0385	-0.0428	-0.0493
		(0.0446)	(0.0438)	(0.0456)
ln(National Median Household Income)		-	0.336	0.296
			(0.443)	(0.480)
ln(National Unemployment)	-	-	-0.320***	-0.0649
			(0.101)	(0.119)
ln(National High School Graduates$_{t-1}$)		-	-4.549***	-4.844***
			(1.555)	(1.743)
ln(3 Year Average Research Expense$_{t-1}$)		-	-	0.158***
				(0.0594)
ln(3 Year Average Academic Support Expense$_{t-1}$)		-	-	0.0139
				(0.0956)
ln(75 Percentile SAT Math$_{t-1}$)	-	-	-	-0.565
				(0.479)
ln(75 Percentile SAT Reading$_{t-1}$)	-	-	-	0.336
				(0.401)
ln(Graduation Rate$_{t-1}$)	-	-	-	0.0703
				(0.205)
ln(Student Faculty Ratio$_{t-1}$)	-	-	-	0.0960
				(0.149)
ln(Total # of Undergraduates$_{t-1}$)	-	-	-	0.207
				(0.210)
ln(Applicants)	-	-	-	0.353***
				(0.0631)
ln(Average Professor Salary$_{t-1}$)	-	-	-	0.496**
				(0.192)
ln(Acceptance Rate$_{t-1}$)	-	-	-	0.147*
				(0.0886)
Constant	-0.809	-3.296***	75.09***	65.41**
	(1.032)	(1.176)	(23.05)	(26.32)
Observations	1,086	968	968	805
R-squared	0.044	0.086	0.165	0.229
Number of unitid	243	221	221	197

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

When we disaggregate price and enrollment by in-state and out-of-state, the results that we found in (1.1) through (1.4) are essentially reversed for both the in-state and out-of-state price measures. The beta estimate for in-state price goes from positive and significant in the most basic specification to negative and null in the final specification. While different, this is much more in line with previous literature and our own expectation: in-state students are very price inelastic due to their small set of alternatives and go to university no matter what the price is.

The out-of-state results in our disaggregated specification are much more in line with our expectations and previous literature as well. Because out-of-state students face a comparatively wider set of alternatives, one would expect them to at least be more price sensitive than their in-state counterparts. This is exactly what we find. The most basic specification without any other price, economic or quality controls is positive and highly significant, consistent with the pooled model. But as we add in our controls, unlike in the pooled model which fails to find a negative relationship between price and enrollment, the disaggregated model finds that an exogenous 1% increase in tuition will decrease out-of-state enrollment by 0.458% at the 1% significance level.

State-Level Relative Price and Enrollment Growth Results

Lastly, in our model of price competition at the state level, when we regress the relative % changes in in-state price to relative % changes in in-state enrollment we find a negative and statistically significant result that is robust across both the many different specifications and across estimators (FE vs RE). The final result implies that raising tuition by 1 percentage point faster than the average for schools in your state will lead to your enrollment growing by .255 percentage points slower than the average for schools in your state. The results using the FE estimator are contained in table 7.

Table 7

Relative %Δ in In-State Price/Enrollment

	(4.1)	-	-	-
VARIABLES	$EGDSM_{it}$	-	-	-
$PGDSM_{it-1}$	-0.204**	-0.218**	-0.213**	-0.255***
	(0.0910)	(0.0945)	(0.0947)	(0.0965)
ln(Room and Board$_{t-1}$)	-	-0.0654	-0.0277	0.0713
		(0.0687)	(0.0793)	(0.0917)
ln(In State Fees$_{t-1}$)	-	0.00128	0.0123	-0.0193
		(0.0393)	(0.0419)	(0.0478)
ln(Average Institutional Grant per Freshman$_{t-1}$)		-0.0133	-0.00994	-0.0162
		(0.0215)	(0.0217)	(0.0225)
ln(State Median Household Income)		-	0.0256	0.0118
			(0.0869)	(0.0920)
ln(State Unemployment)	-	-	0.0308	0.0634
			(0.0280)	(0.0395)
ln(State High School Graduates$_{t-1}$)	-	-	-0.195	-0.0340
			(0.175)	(0.190)
ln(3 Year Average Research Expense$_{t-1}$)		-	-	-0.0789**
				(0.0333)
ln(3 Year Average Academic Support Expense$_{t-1}$)		-	-	0.0620
				(0.0627)
ln(75 Percentile SAT Math$_{t-1}$)	-	-	-	0.320
				(0.244)
ln(75 Percentile SAT Reading$_{t-1}$)	-	-	-	0.184
				(0.206)
ln(Graduation Rate$_{t-1}$)	-	-	-	0.154
				(0.119)
ln(Student Faculty Ratio$_{t-1}$)	-	-	-	-0.00595
				(0.0911)
ln(Total # of Undergraduates$_{t-1}$)	-	-	-	-0.206
				(0.128)
ln(Applicants)	-	-	-	0.00795
				(0.0350)
ln(Average Professor Salary$_{t-1}$)	-	-	-	0.130
				(0.0966)
ln(Acceptance Rate$_{t-1}$)	-	-	-	-0.177***
				(0.0491)
Constant	-0.000627	0.705	2.109	-3.413
	(0.00299)	(0.558)	(2.206)	(3.384)
Observations	817	732	732	612
R-squared	0.008	0.013	0.017	0.090
Number of unitid	230	208	208	184

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

While these results may seem to contradict the null result found in the in-state model (2.1), it is important we explain the qualitative difference between these results. The reason we believe that these results aren't contradictory is because one is a measure of how students react to changes in price, while the other is how students react to relative changes in price. Because in-state institutions are all raising their prices together, in-state students respond to how an institution's price changes relative to the other schools in the state, not the price change itself. By framing the % price change and % enrollment change as the deviation from the state's mean % change, we successfully incorporate competitor price directly into our explanatory variable and find that the relative price changes, not the price change itself, are what is most salient for in state students.

At this point it is important to note that there are a couple key limitations in our model that may stand in the way of causal inference. Despite controlling for the various aspects of price, macroeconomic pressures, demographics, and university and student quality, we believe that price and enrollment could still be endogenous. This is motivated by two central reasons: The first is that while the marginal cost of adding an additional student is generally far below their average cost due to the high fixed costs universities bear, when a university has reached its capacity, the marginal cost rises far above the average per-student cost. This effects both the number of students that a university will be able to serve as well as the pricing that is needed to fund the costs of adding additional capacity. Furthermore, tuition setting at a University may not be solely a market based process and could be motivated by several other non-market related factors. We fail to include these capacity constraints and non-market factors into our model of demand, therefore these results must be taken as highly correlative, not necessarily causal.

VI: Discussion

We found the null result for the log-log specification of the in-state model and the significant and negative result on the relative change model to be possible signs of anti-competitive behavior from in-state universities. If college is a proven way to maximize one's potential lifetime earnings, there will almost always be an economic argument for it, no matter the cost. And due to the existence of very inexpensive loans, people will always be able to come up with the funds. So, the reality for higher education institutions is there is little to no danger of pricing out students, the only danger is losing students to other universities on the basis of price competition. Because we found that since 2009, in-state students have only been reacting to relative changes in price, not necessarily the change in price itself, this could be evidence that schools have been raising prices in unison, signaling the possibility of an anticompetitive market.

These broader results have interesting policy implications from both the university and state's perspective. A university administrator will look at these results demonstrating relatively inelastic demand for in-state students and propose in-state tuition hikes to increase revenue. According to economic theory they would be correct to do so. While public universities have historically subsidized in-state tuition with high out-of-state tuition, these results suggest that the incentives are currently structured so that the best way to raise revenue with minimal enrollment loss is to raise in-state tuition, not out-of-state tuition.

One responsibility of state policy makers is to ensure access to quality higher education for the state's population, which means making it as financially affordable as possible. And as we've laid out, universities are incentivized to behave in the opposite manner if they want to increase their revenue with minimal enrollment loss. To address these concerns of accessibility considering the contradicting incentives and goals of the university and the state, respectively, state policy makers should consider setting a cap on tuition increases in a given year or incentivize universities to keep in-state tuition low through tax incentives or other means.

VI: Conclusion

In this study, we examine the price sensitivity of student enrollment for large, public, 4-year institutions broken down by in-state and out-of-state and investigate the extent to which state-level price competition plays a role in in-state enrollment. We find that out-of-state enrollment is responsive to price, but is inelastic, and that in-state enrollment is not responsive to exogenous changes in price. However, we do find that in-state enrollment is responsive to the change in price relative to the average change in price for schools in the same state. We think that this combination of elasticities could lead to unfavorable outcomes from the perspective of the state if not properly managed due to how it incentivizes institutions to act and recommend that states consider leveraging some sort of policy instrument that balances out these incentives.

VII: References

Clinedinst, Melissa & Koranteng, Anna-Maria (2017). *State of College Admission*, NACAC.

Curs, Bradley & Singell Jr., Larry (2002). An Analysis of the application and enrollment processes for in-state and out-of-state students at a large public university. Economic of Education Review, 21, 111-124.

Curs, Bradley R., & Singell, Larry D., Jr. (2010). Aim High or Go Low? Pricing Strategies and Enrollment Effects when the Net Price Elasticity Varies with Need and Ability. Journal of Higher Education, 81(4), 515-543. "Growing Competition between Universities Is Changing Student Life."

Dickson, & Pender. (2013). *Do in-state tuition benefits affect the enrollment of non-citizens? Evidence from universities in Texas.* Economics of Education Review, 37(10-125), 126-137.

Gölpek, F. (2012). *Price of higher education and individual demand.* Procedia - Social and Behavioral Sciences, 41(C), 349-356.

Hoxby, C. M. *The Changing Market Structure of US Higher Education.* Mimeo, Harvard University, 1997a.

Hübner, M. (2012). *Do tuition fees affect enrollment behavior? Evidence from a 'natural experiment' in Germany.* Economics of Education Review, 31(6), 949-960.

Leslie, L. L., & Brinkman, P. T. (1987). *Student price response in higher education.* Journal of Higher Education, 58, 181-204.

Ma, Jennifer, Sandy Baum, Matea Pender, and Meredith Welch (2017), *Trends in College Pricing 2017*, New York: The College Board.

Martin, R. E. (2000). *Enrollment management as a portfolio investment problem.* College and University, 76(1), 25.

McMillen, D., Singell, L., & Waddell, G. (2007). *Spatial Competition and the Price of College.* Economic Inquiry, 45(4), 817-833.

O'Brien, P. M. (1992). Enrollment in higher education: *The role of information about College costs and financial aid.* Unpublished qualifying paper, Harvard University.

Steven W. Hemelt, & Dave E. Marcotte. (2011). *The Impact of Tuition Increases on Enrollment at Public Colleges and Universities.* Educational Evaluation and Policy Analysis, 33, 425-437.

The Economist, The Economist Newspaper, 23 Feb. 2017, www.economist.com/britain /2017/02/23/growing-competition-between-universities-is-changing-student-life.

Trisha Bezmen, & Craig A. Depken. (1998). *School Characteristics and the Demand for College.* Economics of Education Review, 17, 205-210.