College Markups Over Time and Across Students*

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Abstract

I estimate the drivers of rising college prices in the United States using a structural model of college price competition and detailed student-level data. Prices at non-selective colleges are largely driven by costs, but rising prices at selective colleges are driven by growing markups. Effective marginal costs also vary systematically across different types of students, and discounts for low-income students primarily reflect lower effective marginal costs, not smaller markups. Finally, the results suggest a shift over time in the preferences of elite colleges away from more traditional measures of merit, like test scores, in favor of other characteristics, particularly race.

Keywords: Higher education, College pricing, Markups

JEL Codes: I22, I23, L11

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1 Introduction

High and rising college prices in the United States have attracted the attention of students, parents, policymakers, and researchers. Between 2008 and 2020, sticker prices rose by an inflation-adjusted 61 percent, and transaction prices—sticker price minus institutional discounts—rose 39 percent over the same period (see Table 3).[1] This represents a continuation of a decades-long trend in the price of college outpacing inflation (de Brey et al., 2022). Rising college prices have raised concerns about the affordability of college for low- and middle-income students, the public cost of financial aid programs, and the consequences of growing student debt.

Many explanations for rising prices have focused on drivers of college costs. One explanation known as Baumol's cost disease says that increased productivity in other sectors puts upward pressure on the wages of skilled workers, and that labor-intensive industries, like education, that cannot easily substitute for workers or automate their tasks will see their costs rise (Baumol and Bowen, 1965). Other explanations have highlighted the role of reduced state appropriations for public colleges (Kane et al., 2005). Still others have pointed to the proliferation of administrators and other non-faculty staff as well as lavish on-campus amenities (Zywicki and Koopman, 2017; Jacob et al., 2018). However, I find that price increases at elite colleges mostly reflect rising markups, not costs.[2] What's more, aggregate statistics mask significant heterogeneity in pricing behavior as well as changes in pricing over time.

The notion of a college's "effective marginal cost" was first introduced by Epple et al. (2006) to account for important differences between colleges and more typical firms. Like a typical firm, colleges incur direct monetary costs for enrolling and educating a student, such as salaries for professors and other support staff and the cost of facilities. But colleges' costs also reflect factors that aren't present for firms in most industries. For example, when students are both customers *and* inputs into the production process, a characteristic Rothschild and White (1995) refer to as customers-as-inputs, then the effective marginal cost of enrolling a student will also reflect her productivity as an input, which would explain why colleges offer lower prices to high-achieving students. A college's effective marginal cost of enrolling a student should also reflect the expected net present value of her future donations. Furthermore, effective marginal costs might reflect preferences of legislators and donors who, implicitly or explicitly, subsidize some types of students over others. Thus, effective marginal costs reflect a combination of direct monetary costs (including opportunity costs), productivity of the student on campus, expected future donations, and any preferences colleges may have over student characteristics.[3]

I identify effective marginal costs and markups at colleges in the United States between 2008

[1] Dollar amounts were adjusted for inflation using the CPI-U.

[2] This is consistent with the findings of Cai and Heathcote (2022) who argue that greater income inequality has raised the willingness to pay for college among high-income households, thereby driving up the price of college.

[3] These preferences may come from donors, but they could come from other sources as well like the personal preferences of college leaders or an explicit institutional mission to educate certain types of students.

and 2020 using a structural model of college price competition and detailed student-level data on prices and student characteristics. The data come from the National Postsecondary Student Aid Study, a nationally representative survey of college students with high-quality data on prices and financial aid. Motivated by the model of college price competition in Fillmore (2023), I show that we can identify effective marginal costs and markups under much weaker assumptions than are necessary to identify the full model. The identification argument is intuitive—a student's markup is simply the difference between the price her college actually charged her and the lowest price it charged her identical classmates because, in equilibrium, the lowest price a college charges to a particular student type will be equal to its effective marginal cost for that type. Averaging over all colleges, I find that rising markups, not effective marginal costs, are the primary driver of rising prices, although this differs substantially across types of colleges. Effective marginal costs primarily drove price growth at two-year and less selective four-year colleges, while markups primarily drove price growth at more selective colleges. At one extreme, effective marginal costs at two-year colleges rose by $993 between 2008 and 2020, which accounted for 70 percent of all price growth during those years. At the other extreme, effective marginal costs fell by over $2,000 at very selective public colleges and by over $9,000 at very selective private colleges even as their transaction prices rose by 46 percent and 21 percent, respectively, due to a near doubling of their markups.

What's more, relative to public two-year colleges, the higher prices charged at four-year colleges stem mostly from larger markups rather than effective marginal costs (see Table 5). At public four-year colleges, effective marginal costs tend to be similar to, or lower than, those at two-year colleges. And by 2020, effective marginal costs at very selective public colleges were nearly $3,500 lower than at two-year colleges. Despite having similar or lower costs, transaction prices at four-year public colleges greatly exceed those at two year colleges due to significantly higher markups. The picture is similar, but a bit more varied for private four-year colleges. Among less selective private colleges, their effective marginal costs exceed those of two-year colleges by several thousand dollars, meaning that the higher prices at these colleges stem from both higher costs and markups. But very selective private colleges have had lower effective marginal costs than two-year colleges since 2016. Regardless of selectivity though, higher markups explain a majority of the higher prices private colleges charge relative to public two-year colleges.

Effective marginal costs also vary systematically across different types of students. If a college exhibits a lower effective marginal cost for a particular characteristic, then the college is willing to forgo revenue in order to enroll a student with that characteristic. If find that effective marginal costs are uncorrelated with student characteristics at two-year colleges but they differ by income, race, and test scores at four-year colleges. Effective marginal costs rise with income, which means colleges are willing to forego revenue to enroll lower-income students. Looking across college types, the premium they are willing to pay for lower-income students has either remained stable or declined over time. Perhaps surprisingly, larger effective marginal costs, not

markups, account for the higher prices that wealthy students pay. The same is true for race—racial minorities at elite colleges pay lower prices because they have smaller effective marginal costs, not smaller markups. Between 2008 and 2020, the premium colleges were willing to pay for racial minorities grew substantially. In 2008, public colleges were willing to forgo about $3,000 to enroll a Black or Hispanic student relative to a similar white student. By 2020, that premium had grown to $5,000 for Hispanic students and nearly $10,000 for Black students. At very selective private colleges, the trend is even starker—the premium they were willing to pay for Black and Hispanic students grew from about $6,000 in 2008 to nearly $20,000 in 2020. Finally, effective marginal costs tend to decline with test scores and high school GPA, meaning that colleges value higher ability students. However, by 2020 very selective colleges no longer valued test scores at all. Very selective private colleges appear to have shifted weight away from test scores in favor of high school GPA, but their public counterparts appear to have stopped valuing test scores without putting any additional weight on high school GPA. Taken together, these findings suggest a shift in the revealed preferences of elite, four-year colleges away from more traditional measures of merit in favor of other student characteristics, particularly race.

2 Data

My data come from the 2008, 2012, 2016, and 2020 waves of the National Postsecondary Student Aid Study (NPSAS) (National Center for Education Statistics, 2008–2020). NPSAS is a large, nationally representative survey of higher education students that is conducted roughly every four years. Each survey collects information on student demographics, academic preparation (e.g., test scores, high school GPA, etc.), college major, and the college the student is attending. But the primary focus of the survey is on financial aid, so NPSAS collects very detailed measures of the costs of college and students' financial aid packages. Much of this information is drawn from administrative records, rather than being self-reported by students, which enhances its reliability. For all students I observe a self reported measure of parent income, while for the large majority of students who apply for federal aid, I also observe a high quality measure of parent income drawn from the student's Free Application for Federal Student Aid (FAFSA). The NPSAS data allow me to observe a student's sticker price and calculate her transaction price by subtracting any institutional grants (i.e., discounts) she received.

The NPSAS data vary in size across years, ranging from 50,060 in 2008 to 25,150 in 2016 (see Table 1). Because NPSAS samples so many students, I am able to estimate effective marginal costs separately by college type based on whether the college is public or private and its selectivity. Table 2 reports summary statistics by college type for parent adjusted gross income, ACT score, high school GPA, and race. Students at private and more selective public colleges tend to have higher incomes, higher ACT scores and higher high school GPAs. More selective colleges enroll fewer Black and Hispanic students except that very selective colleges

enroll slightly more Hispanic students than moderately selective colleges.

Table 1: Sample Counts by Year and Type of College

	Sample counts			
	2008	2012	2016	2020
All	50,060	33,410	25,150	31,020
Very selective				
Public	6,090	3,330	2,790	2,490
Private	4,580	2,540	2,640	2,780
Moderately selective				
Public	13,490	7,320	8,170	8,830
Private	7,530	3,030	4,320	3,640
Not selective				
Public	5,020	2,870	2,110	3,630
Private	1,720	1,260	920	1,100
Two-year				
Public	11,650	13,060	4,190	8,550

Each cell reports the number of observations in the sample for that year and college type rounded to the nearest 10. No sample weights were used.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008, 2012, 2016, and 2020.

3 Model and identification of effective marginal costs

I model each student as an auction, where colleges submit offers, or "bids," to attract the student (Fillmore, 2023). A student invites a college to participate in her auction by submitting an application in the fall. The college chooses to participate by admitting the student and making a take-it-or-leave-it offer in the spring. Student i evaluates her offer from college j using the utility function $u_{ij} = v_{ij} - p_{ij}$, where v_{ij} represents her valuation, in dollars, of attending the college and p_{ij} is the transaction price college j offers her. The student's valuation, v_{ij}, depends on college j's characteristics as well as how the student values those characteristics. I normalize the utility of a student's outside option, attending no college, to be zero. Thus, the higher student i's valuation for college j, v_{ij}, the higher price college j can charge and still attract her. Of course, multiple colleges will typically be bidding on a student, and this competitive pressure will impose some discipline on college j's ability to raise price.

Colleges compete for students on price, and a college "wins" the auction—the student enrolls—if it makes the best offer, as judged by the student. Student i selects the college which offers her the most utility, which may not necessarily be the college which offers her the lowest price. Colleges care about maximizing both the quality of their students as well as tuition revenue. College j's payoff from enrolling student i is $\pi_{ij} = p_{ij} - c_{ij}$, where $c_{ij} = z_j + \omega(X_i) + \gamma I_{ij}$ represents college j's effective marginal cost, in dollars, of enrolling the student. I_{ij} is a dummy

Table 2: Summary Statistics by Type of College

	Income		ACT score		High school GPA		Race		
	Mean	SD	Mean	SD	Mean	SD	White	Black	Hispanic
All	$ 72,696	$ 84,626	22.2	5.1	3.50	0.56	61.5%	11.8%	14.9%
Very selective									
Public	$ 91,588	$ 98,180	24.9	4.7	3.71	0.44	60.9%	7.4%	12.7%
Private	$113,504	$122,572	27.1	4.9	3.79	0.39	63.1%	7.7%	10.9%
Moderately selective									
Public	$ 76,739	$ 82,183	22.4	4.4	3.55	0.51	65.8%	11.0%	12.3%
Private	$ 86,086	$ 93,312	22.8	4.5	3.59	0.51	70.2%	10.4%	10.0%
Not selective									
Public	$ 55,599	$ 63,356	20.3	4.3	3.40	0.57	58.8%	13.2%	19.3%
Private	$ 65,571	$ 84,126	20.8	4.6	3.40	0.59	58.9%	14.3%	17.4%
Two-year									
Public	$ 47,480	$ 52,095	19.2	4.3	3.26	0.62	54.0%	15.4%	20.1%

Each cell represents the value for students attending that college type pooled across all years of the data. Dollar amounts are converted to constant 2016 dollars. No sample weights were used.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008, 2012, 2016, and 2020.

equal to one if college j is a public college and i is from out of state. The vector X_i denotes characteristics of student i that are observed to both the college and the econometrician, while z_j is a college fixed effect that is observed to the college only.[4] c_{ij}, which may be positive or negative, represents college j's effective marginal cost of enrolling i. If the college were to drop its price all the way to c_{ij}, it would receive a payoff of zero, so c_{ij} is the college's willingness to receive for enrolling student i.[5]

In this model, colleges may have market power for two reasons: 1) if the college knows it faces few competitors for a given student, then it can afford to bid less aggressively and offer a higher price, and 2) if the college learns that v_{ij} is relatively high, then it has some room to extract surplus from the student by offering a higher price. College j knows z_j and learns v_{ij} and X_i, and by extension c_{ij}, during the application process, but it does not know the v's or c's of the other colleges bidding on the student. [6]

After learning c_{ij} and v_{ij}, college j makes a take-it-or-leave-it price offer, p_{ij}, to student i to

[4]The college fixed effect z_j captures aspects of college j's effect marginal cost that are specific to j but do not vary across students, such as per-student costs of instruction or student services as well as the opportunity cost of diverting resources from, say, research into instruction.

[5]Empirically, effective marginal cost (c_{ij}) turns out to be positive for most students at most colleges, although in more recent years effective marginal costs at very selective colleges have turned negative, implying these colleges are willing to offer discounts in excess of sticker price.

[6]It is simplest to assume that, conditional on student covariates X, learning that student i has applied to j does not provide j with additional information about its likely competitors. However, the identification and estimation of effective marginal costs and markups does not depend on this assumption.

maximize its expected markup (payoff) $\pi_{ij}\,\mathbb{P}[j \text{ wins}] = (p_{ij} - c_{ij})\,\mathbb{P}[u_{ij} \geq u_{i\ell}\ \forall \ell \neq j | X_i]$.[7] Up to this point, we have been thinking about the college's decision in terms of price offers. However, if we recast the college's problem, we can express the model as a first price auction in utility bids. Define $s_{ij} \equiv u_{ij} + \pi_{ij} = v_{ij} - c_{ij}$ to be the total surplus from matching student i with college j. I assume that $s_{ij} \sim F_{S|X,j}$ with support $[0, \overline{S}]$ and density strictly positive over the support.[8] Then $\pi_{ij} = p_{ij} - c_{ij} = (v_{ij} - c_{ij}) - (v_{ij} - p_{ij})$, and the college's objective can be rewritten as

$$\max_{u_{ij}} \quad \{s_{ij} - u_{ij})\}\,\mathbb{P}[u_{ij} \geq u_{i\ell}\ \forall \ell \neq j | X_i] \tag{1}$$

In essence, college j offers student i a portion (u_{ij}) of the match surplus (s_{ij}), and student i accepts j's offer if it is the highest utility offer she receives. Mathematically, this is equivalent to a first-price auction in utility bids. In Fillmore (2023) I show how to identify and estimate the model, which requires making assumptions about the information structure (e.g., independent private values) and rules of the auction (e.g., first-price, sealed bid auction). But if we confine ourselves to estimating effective marginal costs and markups, we can avoid estimating the full model and greatly relax many of these assumptions. Under a wide variety of settings—symmetric and asymmetric bidders, independent and affiliated privates values, etc.—an equilibrium boundary condition emerges that says a bidder with the lowest possible valuation will bid his value. In this case, the boundary condition implies that a college facing a match surplus of zero will offer zero utility. It essentially amounts to a rationality constraint—the student would never accept negative utility and, with zero surplus to split, the college would never offer positive utility. In other words, when match surplus is zero the college's price offer will equal its effective marginal cost, so we can identify the effective marginal cost to college j of enrolling student i, c_{ij}, by looking at the lowest price j ever charged to students with the same covariates as i. We then calculate the markup as the difference between i's observed price and her effective marginal cost. The following lemma, adapted from Fillmore (2023), formalizes the identification argument.

Lemma 3.1. *The distribution of winning college markups $G_{\pi|X}$ is identified from $G_{p|X,j}$, the distribution of winning transaction prices conditional on student characteristics X and the identity of the college j.*

Proof. Recall that college j's markup from enrolling student i is $\pi_{ij} = p_{ij} - c_{ij}$. Define the function $y(X, j) \equiv \inf\{\text{supp}(G_{p|X,j})\}$ to be the greatest lower bound of the support of transaction prices, conditional on student covariates and the identity of the college. It remains to show that $y(X, j)$ exists and is equal to college j's effective marginal cost c_{ij} when $X = X_i$. c_{ij} is a lower bound of $\text{supp}(G_{p|X,j})$, so $y(X, j)$ must exist,[9] but is it equal to c_{ij}? Suppose, by way of

[7] A negative transaction price can arise if $c_{ij} < 0$. In practice, this would look like an institutional grant that exceeds tuition and fees. The remainder can be used to pay for room and board, books, etc.

[8] These are standard assumptions in the empirical auctions literature and are necessary to guarantee the existence of a Nash equilibrium.

[9] The college would never be willing to charge a student less than c_{ij} because it would receive a negative payoff.

contradiction, that it is not so that $c_{ij} < y(X, j)$. Recall that the college charges a markup in the interval $[0, s_{ij}]$ and a zero markup when $s_{ij} = 0$. Since, by assumption, the density $f_{S|X} > 0$ everywhere, including at 0, and the equilibrium bid function is continuous, a positive mass of winning transaction prices will lie in the interval $[c_{ij}, y(X, j)]$. But this means that $y(X, j)$ was not a lower bound after all. Thus, $y(X, j) = c_{ij}$ and $G_{\pi|X,j}(\pi) = G_{p|X,j}(p - y(X, j))$. Integrating over j yields the distribution $G_{\pi|X}$. □

Intuitively, college j will charge a zero markup to a student with match surplus equal to zero. And since the density of match surpluses is positive over the entire support, we will be able to find such a zero-markup student, asymptotically, for any combination of covariates (X_i). We then calculate markups by comparing the prices charged to all other students at college j with covariates X_i to the price paid by this zero-markup student.

4 Empirical strategy

As explained in Section 3, we can nonparametrically identify effective marginal costs by looking at the lowest price a college ever charges a particular type of student. Unfortunately, although the effective marginal cost is nonparametrically identified, the identification proof does not immediately suggest a feasible estimator. Therefore, I adopt a parametric assumption about the quantile function of prices and assume that the left tail of the quantile function follows the parametric form

$$Q_p(\tau|X, j) = \alpha_0(X, j) + \alpha_1(X, j) \cdot \tau + \alpha_2(X, j) \cdot \tau^2, \tag{2}$$

where $Q_p(\tau|X, j)$ is the τ-th quantile of transaction prices for a student at college j with covariates X. $\alpha_0(X, j)$, $\alpha_1(X, j)$, and $\alpha_2(X, j)$ are all parameters to be estimated and can vary with student characteristics X and the identify of the college. The parameter $\alpha_0(X, j)$ represents the left boundary of the support of the distribution—conditional on X and j—and thus the effective marginal cost to college j of enrolling a student with characteristics X. Our goal is to estimate α_0 for each student in the data.

We can think about the parametric assumption in (2) in two ways. The first is to treat it as an assumption about the precise functional form of the quantile function. The second is to treat this assumption as a polynomial approximation of the left tail of the quantile function. Whichever perspective we take, in order to estimate $\alpha_0(X, j)$, I estimate the following quantile regression specification at multiple quantiles

$$Q_p(\tau|X, j) = X\gamma^{(\tau)} + a_j^{(\tau)} \qquad \tau = .1, .2, \ldots, .5 \tag{3}$$

where the $a_j^{(\tau)}$ are college fixed effects.[10] For each student, I obtain the fitted values from (3),

[10]The vector X_i includes parent income, ACT score, high school GPA, age, year in school (freshman, sophomore, etc.), gender, race, and whether the student is in-state. These variables were all interacted with a dummy for

$\widehat{q}_i^{(\tau)} = X_i\widehat{\gamma}^{(\tau)} + \widehat{a}_j^{(\tau)}$. Then, separately for each student, I fit the curve in (2) by regressing the fitted values $\widehat{q}_i^{(\tau)}$ on a quadratic in τ, giving me an estimate $\widehat{\alpha}_{0i}$ of effective marginal cost for each student in the sample (see Figure 1 for a graphical illustration).[11] Each student's estimated markup is simply the difference between her observed transaction price and her estimated effective marginal cost $\widehat{\alpha}_{0i}$. I compute standard errors using blocked bootstrap resampling. I block by college type—private or public interacted with selectivity—and resample colleges with replacement 500 times.

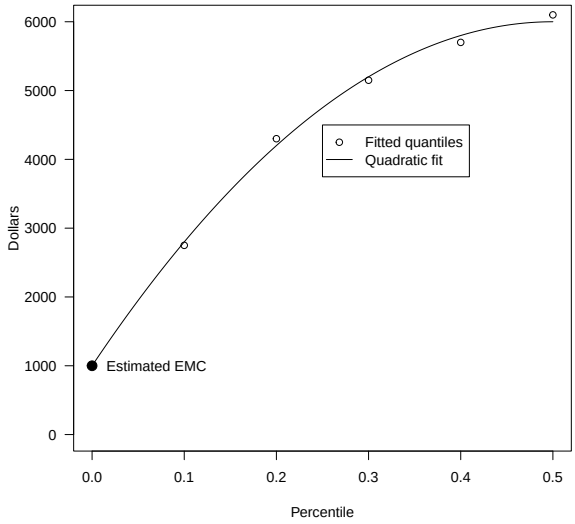


Figure 1: Estimating Effective Marginal Costs Using Quantiles of Transaction Price

5 Results

5.1 Effective marginal costs and markups across colleges

Table 3 reports average effective marginal costs and markups by year and college type. Looking at all colleges together, average markups are more than twice average effective marginal costs. Effective marginal costs have not grown over time while markups have grown by 61 percent. But these averages mask a great deal of heterogeneity across different types of colleges. Generally speaking, private colleges have higher effective marginal costs than public colleges. Aside from that, there is not a clear relationship between effective marginal costs and selectivity. Rather, more selective colleges tend to charge larger markups, which is why they tend to be more

whether the student was classified as dependent or independent. I also included linear and quadratic terms for the number of full-time-equivalent months enrolled.

[11] To be more precise, I estimate the effective marginal cost for student i at the college j she is attending.

expensive than their less selective peers. In more recent years, effect marginal costs at very selective colleges have turned negative. As mentioned above, negative effective marginal costs are possible because they incorporate more than just the direct costs of enrolling the student. Indeed, we would expect negative costs to emerge more often at colleges that are less reliant on tuition as a source of revenue.

Table 4 calculates the growth in costs, markups, and prices between 2008 and 2020. Across all colleges, transaction prices rose by $3,361, entirely due to growing markups. Indeed, effective marginal costs fell slightly. But as before, there is a lot of heterogeneity across types of colleges. At two-year colleges, transaction prices rose by $1,415, 70 percent of which can be explained by rising effective marginal costs. At non-selective private colleges, transaction prices actually fell by $3,232 due to a reduction in both effective marginal costs and markups. Non-selective public colleges saw little change in costs, markups, or prices over this period. Moderately selective private colleges saw little price growth due to lower costs largely offsetting higher markups. At moderately selective public colleges, prices rose by $3,468, with 71 percent of that rise due to higher effective marginal costs. At very selective public colleges, transaction prices rose by $3,777 due to a $2,061 reduction in effective marginal costs being offset by a $5,838 rise in markups. Finally, at very selective private colleges prices rose by $4,774 because, even though costs fell by $9,133, markups rose by $13,907.

Table 5 reports effective marginal costs and markups relative to those at two-year colleges in each year. Notably, effective marginal costs at four-year public colleges are similar to, or smaller than, those at two-year colleges. Thus, the higher prices at four-year public colleges come predominantly from higher markups, not costs. This may seem counterintuitive, but recall that we're talking about effective marginal costs, not just monetary costs. Four-year colleges may build more expensive facilities and employ more expensive faculty, but they are also wealthier and less reliant on tuition revenue. This creates an income effect which increases the amount a more selective college is willing to pay to attract a student, thereby lowering its willingness to receive. I find that these effects roughly cancel out at public colleges so that effective marginal costs at public colleges do not differ much by selectivity (with the exception of very selective public colleges in 2020), while markups rise with selectivity. In contrast, both effect marginal costs and markups at private colleges are higher and tend to rise with selectivity. The exception is very selective private colleges, where effective marginal costs have fallen considerably below those at two-year colleges in recent years even as markups have doubled and now exceed those at two-year colleges by tens of thousands of dollars.

5.2 Effective marginal costs and markups across students

Effective marginal costs and markups also vary systematically across different types of students. To summarize how they correlate with different student characteristics, I project each of them

Table 3: Estimated Effective Marginal Costs and Markups

		Mean across all students			
		EMC	Markup	Transaction price	Sticker price
All	2008	$2,547 (208)	$5,969 (214)	$8,516 (202)	$10,903 (250)
	2012	$2,741 (239)	$6,522 (229)	$9,263 (228)	$12,098 (265)
	2016	$2,982 (274)	$8,089 (293)	$11,071 (249)	$15,251 (350)
	2020	$2,259 (354)	$9,618 (443)	$11,877 (346)	$17,533 (470)
Very Selective					
Public	2008	$1,155 (678)	$7,093 (873)	$8,248 (553)	$9,490 (620)
	2012	$3,354 (902)	$7,021 (641)	$10,374 (761)	$11,547 (737)
	2016	$2,170 (1,388)	$10,432 (1,273)	$12,602 (1,007)	$15,041 (1,108)
	2020	-$907 (1,253)	$12,931 (1,928)	$12,024 (944)	$15,332 (1,246)
Private	2008	$6,492 (1,046)	$16,609 (775)	$23,101 (1,222)	$33,021 (1,493)
	2012	$3,003 (1,712)	$21,241 (1,422)	$24,244 (1,618)	$37,047 (1,889)
	2016	-$1,108 (1,547)	$26,682 (1,395)	$25,574 (1,577)	$42,525 (2,066)
	2020	-$2,641 (1,958)	$30,516 (1,771)	$27,875 (1,334)	$48,505 (1,127)
Moderately Selective					
Public	2008	$636 (373)	$6,142 (409)	$6,778 (266)	$7,900 (283)
	2012	$2,167 (387)	$6,381 (412)	$8,547 (278)	$9,889 (333)
	2016	$2,291 (442)	$7,589 (465)	$9,880 (267)	$11,684 (341)
	2020	$3,089 (550)	$7,157 (442)	$10,246 (480)	$12,701 (523)
Private	2008	$8,095 (571)	$9,854 (352)	$17,948 (559)	$25,991 (716)
	2012	$7,614 (802)	$10,313 (637)	$17,927 (464)	$27,538 (602)
	2016	$8,913 (767)	$10,858 (531)	$19,771 (819)	$32,994 (1,305)
	2020	$7,197 (875)	$11,127 (907)	$18,324 (748)	$34,239 (846)
Not Selective					
Public	2008	$1,673 (629)	$3,933 (587)	$5,606 (293)	$6,289 (321)
	2012	$1,786 (455)	$3,909 (436)	$5,695 (390)	$6,255 (429)
	2016	$1,725 (659)	$4,099 (598)	$5,824 (539)	$6,544 (611)
	2020	$1,877 (516)	$3,818 (442)	$5,695 (421)	$6,633 (509)
Private	2008	$8,223 (1,653)	$8,878 (1,032)	$17,101 (1,327)	$21,516 (1,242)
	2012	$3,467 (1,510)	$15,074 (1,361)	$18,541 (1,271)	$27,668 (1,521)
	2016	$6,300 (1,484)	$8,074 (1,130)	$14,375 (1,141)	$19,701 (1,637)
	2020	$7,002 (831)	$6,867 (744)	$13,869 (644)	$23,417 (1,290)
Two-year					
Public	2008	$1,537 (143)	$994 (108)	$2,531 (78)	$2,700 (75)
	2012	$1,691 (169)	$1,060 (113)	$2,751 (101)	$2,974 (84)
	2016	$2,554 (199)	$1,251 (161)	$3,805 (133)	$3,996 (131)
	2020	$2,530 (179)	$1,416 (136)	$3,946 (136)	$4,149 (138)

Each cell reports the mean of the column variable across students attending that college type in that year (bootstrapped standard errors are in parentheses). By construction, the mean transaction price must equal the mean EMC plus the mean markup. Dollar amounts are converted to constant 2016 dollars. Sample weights were used (NPSAS variable WTA000).

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008, 2012, 2016, and 2020.

Table 4: Decomposing the Growth in Transaction Prices

	Growth from 2008 to 2020			
	EMC	Markup	Transaction price	Sticker price
All	-$288 (419)	$3,649 (500)	$3,361 (399)	$6,631 (527)
	-8.6%	**108.6%**	**100.0%**	
Very Selective				
Public	-$2,061 (1,451)	$5,838 (2,098)	$3,777 (1,080)	$5,841 (1,373)
	-54.6%	**154.6%**	**100.0%**	
Private	-$9,133 (2,255)	$13,907 (1,978)	$4,774 (1,826)	$15,484 (1,881)
	-191.3%	**291.3%**	**100.0%**	
Moderately Selective				
Public	$2,453 (670)	$1,015 (608)	$3,468 (562)	$4,801 (608)
	70.7%	**29.3%**	**100.0%**	
Private	-$898 (1,024)	$1,274 (979)	$376 (915)	$8,248 (1,107)
	-238.9%	**338.9%**	**100.0%**	
Not Selective				
Public	$203 (823)	-$115 (765)	$89 (511)	$344 (603)
	228.8%	**-128.8%**	**100.0%**	
Private	-$1,221 (1,856)	-$2,011 (1,297)	-$3,232 (1,440)	$1,901 (1,789)
	37.8%	**62.2%**	**100.0%**	
Two-year				
Public	$993 (218)	$422 (174)	$1,415 (151)	$1,449 (152)
	70.2%	**29.8%**	**100.0%**	

The dollar amounts report the growth in the column variable between 2008 and 2020 (bootstrapped standard errors are reported in parentheses). For effective marginal cost (EMC) and markup, the change as a percent of the change in transaction price is also reported. By construction, the change in transaction price must equal the change in EMC plus the change in markup. Dollar amounts are converted to constant 2016 dollars. Sample weights were used (NPSAS variable WTA000).

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008 and 2020.

Table 5: Effective Marginal Costs, Markups, and Prices Relative to Two-Year Colleges

		Relative to public two-year colleges			
		EMC	Markup	Transaction price	Sticker price
Very Selective					
Public	2008	-$383	$6,099	$5,716	$6,791
	2012	$1,663	$5,961	$7,624	$8,573
	2016	-$384	$9,181	$8,797	$11,044
	2020	-$3,437	$11,515	$8,078	$11,183
Private	2008	$4,955	$15,615	$20,570	$30,322
	2012	$1,313	$20,181	$21,494	$34,074
	2016	-$3,663	$25,431	$21,769	$38,529
	2020	-$5,171	$29,100	$23,929	$44,356
Moderately Selective					
Public	2008	-$901	$5,148	$4,247	$5,200
	2012	$476	$5,321	$5,797	$6,916
	2016	-$263	$6,338	$6,075	$7,688
	2020	$559	$5,741	$6,299	$8,552
Private	2008	$6,558	$8,860	$15,417	$23,291
	2012	$5,923	$9,253	$15,176	$24,564
	2016	$6,358	$9,607	$15,966	$28,998
	2020	$4,667	$9,711	$14,378	$30,090
Not Selective					
Public	2008	$136	$2,939	$3,075	$3,590
	2012	$95	$2,849	$2,944	$3,281
	2016	-$829	$2,848	$2,019	$2,548
	2020	-$653	$2,402	$1,749	$2,485
Private	2008	$6,686	$7,884	$14,569	$18,816
	2012	$1,776	$14,014	$15,790	$24,694
	2016	$3,746	$6,824	$10,570	$15,705
	2020	$4,472	$5,451	$9,923	$19,269

Each cell reports the mean of the column variable across students attending that college type in that year minus the mean for public two-year colleges. By construction, the mean transaction price must equal the mean EMC plus the mean markup. Dollar amounts are converted to constant 2016 dollars. Sample weights were used (NPSAS variable WTA000).

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008, 2012, 2016, and 2020.

onto student characteristics X_i and college fixed effects

$$price_i = X_i \cdot \beta^{(p)} + \gamma^{(p)}_{j(i)} + \epsilon_i \tag{4}$$

$$emc_i = X_i \cdot \beta^{(e)} + \gamma^{(e)}_{j(i)} + \eta_i \tag{5}$$

$$markup_i = X_i \cdot \beta^{(m)} + \gamma^{(m)}_{j(i)} + \nu_i \tag{6}$$

where X_i represents student characteristics like test scores, income, or race, and the $\gamma_{j(i)}$ represent college fixed effects with $j(i)$ denoting the college student i is attending.[12] I run the regressions in (5)–(6) separately by type of college. Figures 2–6 plot the coefficients corresponding to income, test scores, high school GPA, and race.[13]

Figure 2 plots the coefficients corresponding to parent income. These coefficients quantify the degree to which effective marginal costs and markups correlate with income among students at the same college. At two year colleges, effective marginal costs and markups are essentially unrelated to income. Not so at more selective colleges where prices tend to rise with income. Perhaps surprisingly, I find that this is almost entirely driven by higher effective marginal costs, not higher markups. In 2008 for example, effective marginal costs at highly selective private colleges rose by \$5 for every \$100 in income while markups did not rise at all. Why might effective marginal costs be higher for higher income students, even holding other characteristics like test scores fixed? One plausible explanation is that colleges prefer to enroll lower income students, whether because of an institutional mission to provide access to education, because university leaders themselves prefer to enroll low-income students, or because donors want to see the university enroll such students.

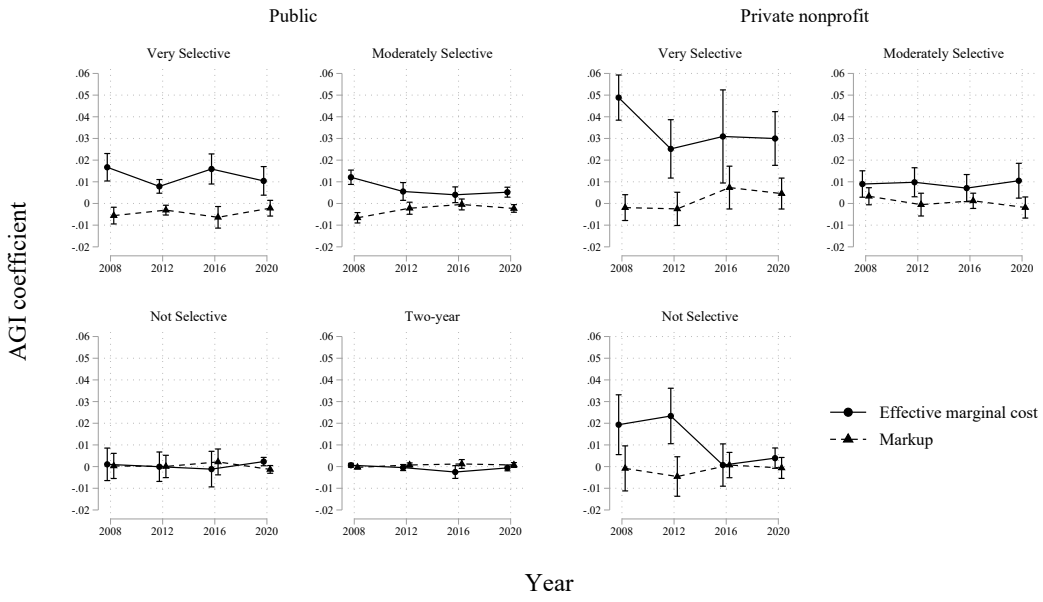
Figure 3 plots the coefficients corresponding to test scores.[14] Just as with income, effective marginal costs and markups are unrelated to test scores at two year colleges. At more selective four-year colleges in 2008, transaction prices tended to decrease with test scores, due to lower effective marginal costs. In 2008, all types of four-year colleges were willing to pay roughly \$2,000 for a one standard deviation increase in test scores. Two-year colleges stand out as the one type of college that was not.[15] Markups, on the other hand, tended to rise somewhat with test scores, though not enough to offset the decline in effective marginal costs. In other words, more selective colleges in 2008 valued higher scoring students and were willing to pay to attract them, which sounds like the most obvious finding in the world to someone even vaguely familiar

[12] When projecting effective marginal costs and markups onto student characteristics, I restrict the sample to dependent students. The vector of student characteristics includes parent income, test scores, high school GPA, age, gender, race, in-state status, and undergraduate level (e.g., Freshman, Sophomore, etc.).

[13] Since equations (4)–(6) are all linear projections and $price_{ij} = emc_{ij} + markup_{ij}$ by construction, then $\widehat{\beta}^p = \widehat{\beta}^e + \widehat{\beta}^m$.

[14] NPSAS converts SAT scores (ranging from 400–1600) to the ACT scale (ranging from 1–36) for students without ACT scores. I then standardize ACT scores to have a standard deviation of one.

[15] This finding will not be surprising to those who are familiar with higher education in the United States. Two-year public colleges generally do not offer academic scholarships or other forms of merit aid.



This figure plots the estimated coefficient from regressing EMC and markup on AGI for dependent students, separately by year and college type. The regression includes income, ACT scores, high school GPA, age, gender, race, in-state status, undergraduate level, and college fixed effects as covariates. The bars plot plus or minus 1.96 standard error bands based on bootstrap resampling. ACT scores and high school GPA are standardized. No sample weights were used.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008, 2012, 2016, and 2020.

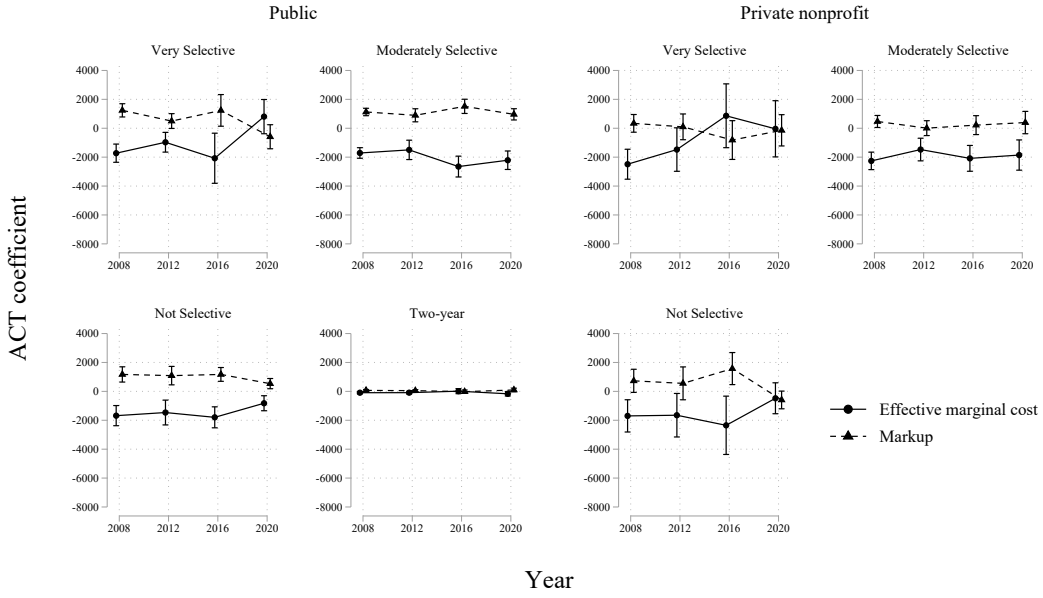
Figure 2: OLS Coefficients on Parent Adjusted Gross Income

with higher education. Curiously, this pattern has disappeared at very selective colleges in more recent years. By 2016, very selective private colleges were no longer willing to pay for higher scoring students, and, by 2020, very selective public colleges had followed suit. Many of these elite schools officially stopped requiring test scores for admission during the Covid pandemic. But in practice, they had already stopped valuing these scores years earlier.

Perhaps very selective colleges did not stop valuing student ability, but merely shifted their focus away from test scores and toward other measures of ability like high school GPA. Figure 4 provides some evidence for this hypothesis in the case of very selective private colleges. Figure 4 plots the OLS coefficients for high school GPA.[16] Generally speaking, colleges are willing to pay less for high school GPA than for test scores. For example, in 2008 very selective private colleges were willing to pay roughly $2,500 for a standard deviation in ACT scores but only about $1,000 for a standard deviation in high school GPA. But between 2008 and 2020, private very selective colleges appear to have placed more weight on high school GPA over time so that, by 2020, they were willing to pay about $2,500 for a one standard deviation in GPA and nothing for ACT scores. In contrast, very selective public colleges do not appear to have placed more weight on high school GPA over time.

Finally, figures 5 and 6 plot the coefficients on Black and Hispanic dummy variables. The omitted racial category is white, so these coefficients reflect the difference between Black/Hispanic

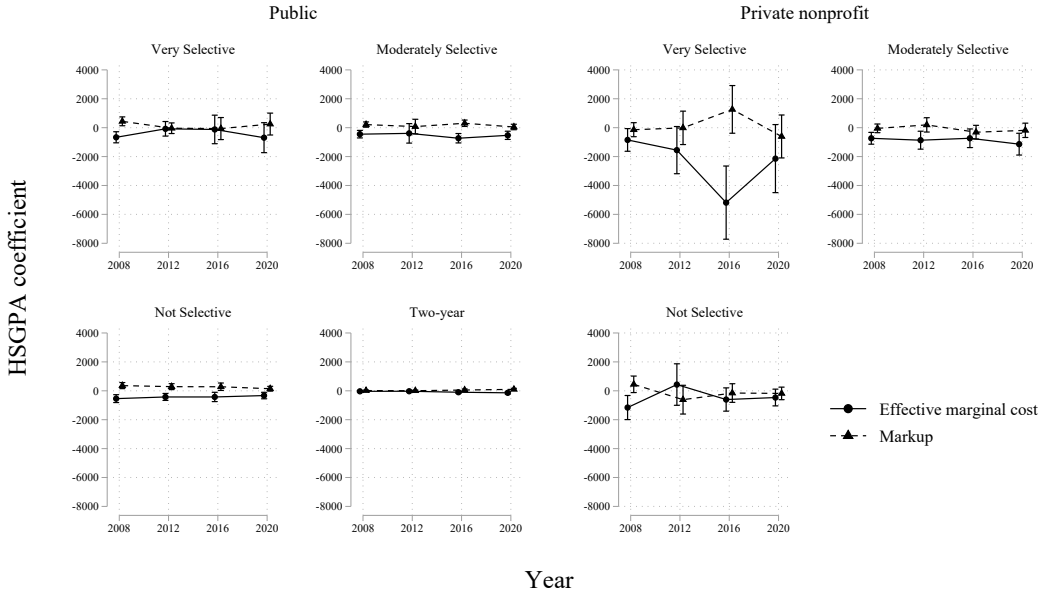
[16]High school GPA is standardized to have a standard deviation of one.



This figure plots the estimated coefficient from regressing EMC and markup on ACT for dependent students, separately by year and college type. The regression includes income, ACT scores, high school GPA, age, gender, race, in-state status, undergraduate level, and college fixed effects as covariates. The bars plot plus or minus 1.96 standard error bands based on bootstrap resampling. ACT scores and high school GPA are standardized. No sample weights were used.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008, 2012, 2016, and 2020.

Figure 3: OLS Coefficients on ACT Exam Score

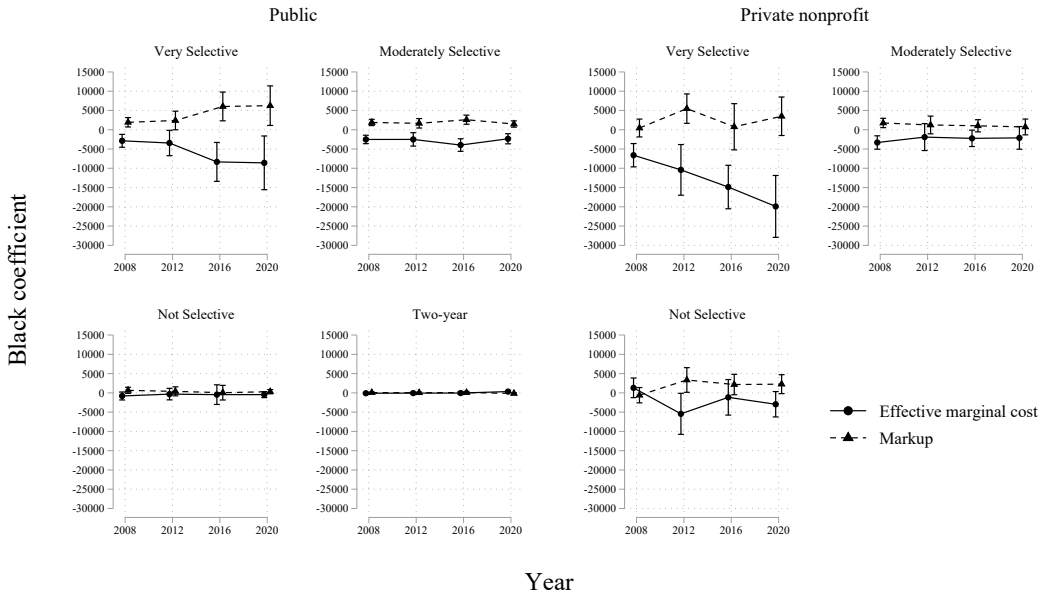


This figure plots the estimated coefficient from regressing EMC and markup on HSGPA for dependent students, separately by year and college type. The regression includes income, ACT scores, high school GPA, age, gender, race, in-state status, undergraduate level, and college fixed effects as covariates. The bars plot plus or minus 1.96 standard error bands based on bootstrap resampling. ACT scores and high school GPA are standardized. No sample weights were used.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008, 2012, 2016, and 2020.

Figure 4: OLS Coefficients on High School GPA

costs and markups and those of white students enrolled at the same college.[17] Relative to their white classmates with similar characteristics, effective marginal costs are much lower for Black and Hispanic students at more selective four-year colleges. At very selective public colleges in 2020, effective marginal costs were nearly $10,000 lower for Black students than white students; at very selective private colleges the difference was over $20,000. That is, very selective private colleges were willing to enroll a Black student for $20,000 less than a similar white student. Meanwhile, markups for Black students were, if anything, a bit higher than for white students. The same pattern emerges for Hispanic students—by 2020 effective marginal costs were roughly $5,000 lower at very selective public colleges and nearly $20,000 lower at very selective private colleges. Between 2008 and 2020 colleges' preferences for enrolling Black and Hispanic students appear to have grown substantially at very selective colleges. At moderately selective four-year colleges, preferences for Black and Hispanic students are less pronounced, with no trend over time. And at non-selective four-year and two-year colleges, preferences for Black and Hispanic students disappear.

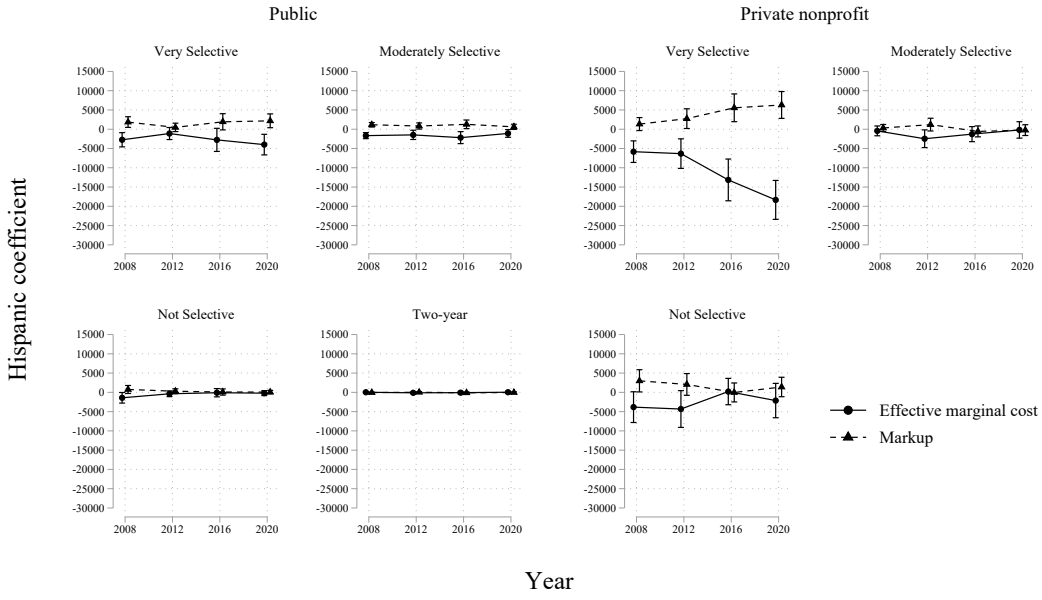


This figure plots the estimated coefficient from regressing EMC and markup on Black for dependent students, separately by year and college type. The regression includes income, ACT scores, high school GPA, age, gender, race, in-state status, undergraduate level, and college fixed effects as covariates. The bars plot plus or minus 1.96 standard error bands based on bootstrap resampling. ACT scores and high school GPA are standardized. No sample weights were used.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008, 2012, 2016, and 2020.

Figure 5: OLS Coefficients on Black Dummy Variable (relative to white)

[17]The other racial categories include Asian and "Other."



This figure plots the estimated coefficient from regressing EMC and markup on Hispanic for dependent students, separately by year and college type. The regression includes income, ACT scores, high school GPA, age, gender, race, in-state status, undergraduate level, and college fixed effects as covariates. The bars plot plus or minus 1.96 standard error bands based on bootstrap resampling. ACT scores and high school GPA are standardized. No sample weights were used.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Postsecondary Student Aid Study, 2008, 2012, 2016, and 2020.

Figure 6: OLS Coefficients on Hispanic Dummy Variable (relative to white)

6 Conclusion

I identify effective marginal costs and markups at colleges in the United States between 2008 and 2020 using a structural model of college price competition and detailed student-level data on prices and student characteristics. The identification argument is intuitive—i's markup is identified from the difference between the price j actually charged i and the lowest price j charged i's identical classmates. Averaging over all colleges, I find that rising prices are driven mostly by rising markups, not effective marginal costs, although this masks substantial heterogeneity across different types of colleges. Effective marginal costs were the primary driver of price growth at two-year and less selective four-year colleges, while markups were the primary driver of price growth at more selective colleges.

Effective marginal costs also vary systematically across different types of students. Although effective marginal costs are uncorrelated with student characteristics at two-year colleges, they differ by income, test scores, and race at four-year colleges. Perhaps surprisingly, larger effective marginal costs, not markups, are the main driver of the higher prices that wealthy students pay. The same is true for race—racial minorities pay lower prices because they have lower effective marginal costs, not smaller markups. Moreover, very selective colleges' preference for enrolling Black and Hispanic students grew substantially between 2008 and 2020. Finally, effective marginal costs tend to decline with test scores, although by 2020 this relationship

had curiously disappeared at very selective colleges. Very selective private colleges appear to have placed less weight on test scores and more on high school GPA over time. Their public counterparts also placed less weight on test scores over time, but without placing a greater weight on GPA. The results on race and test scores suggest a shift over time in the revealed preferences of elite four-year colleges away from more traditional measures of merit, like test scores, in favor of other student characteristics, particularly race.

References

W J Baumol and W G Bowen. On the Performing Arts: The Anatomy of Their Economic Problems. *The American Economic Review*, 55(1/2):495–502, 1965.

Zhifeng Cai and Jonathan Heathcote. College Tuition and Income Inequality. *American Economic Review*, 112(1):81–121, jan 2022.

Cristobal de Brey, Anlan Zhang, and Sarah Duffy. Digest of Education Statistics, Table 310.10. Technical report, National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, DC, 2022. (accessed November 15, 2023).

Dennis Epple, Richard Romano, and Holger Sieg. Admission, Tuition, and Financial Aid Policies in the Market for Higher Education. *Econometrica*, 74(4):885–928, 2006.

Ian Fillmore. Price Discrimination and Public Policy in the US College Market. *Review of Economic Studies*, 90(3):1228–1264, 2023.

Brian Jacob, Brian McCall, and Kevin Stange. College as country club: Do colleges cater to students' preferences for consumption? *Journal of Labor Economics*, 36(2):309–348, 2018.

Thomas J Kane, Peter R Orszag, Emil Apostolov, Robert P Inman, and Andrew Reschovsky. Higher Education Appropriations and Public Universities: Role of Medicaid and the Business Cycle [with Comments]. *Brookings-Wharton Papers on Urban Affairs,*, pages 99–146, 2005.

National Center for Education Statistics. National Postsecondary Student Aid Study (NPSAS). U.S. Department of Education, Institute of Education Sciences, 2008–2020. URL `https://nces.ed.gov/surveys/npsas/`.

Michael Rothschild and Lawrence J White. The Analytics of the Pricing of Higher Education and Other Services in Which the Customers Are Inputs. *Journal of Political Economy*, 103 (3):573–586, 1995.

Todd J. Zywicki and Christopher Koopman. The Changing of the Guard: The Political Economy of Administrative Bloat in American Higher Education (March 23, 2017). *George Mason Law & Economics Research Paper No. 17-12*, 2017.

Online Appendices

Online Appendix A Data

I include students who satisfy the following sample restrictions:

- An undergraduate student
- Enrolled at least five full-time-equivalent months (*i.e.* one semester)
- 30 years old or younger
- Attending a college in one of the 50 states plus Washington DC
- Attending only one college in the school year
- Attending either a public or private not-for-profit college
- Enrolled in a degree program
- Not on an athletic scholarship
- Not receiving a tuition waiver due to parent's employment

Prices were adjusted for the number of full-time equivalent months the student was enrolled. We also adjust dollar amounts for inflation using the CPI-U (current dollars are adjusted to constant 2016 dollars). In the 2019–2020 wave, NPSAS allowed for a third gender category, "Genderqueer, gender nonconforming, or a different identity," so we include an additional dummy for this category in that year.