Forthcoming in *Journal of Labor Economics*

College as Country Club: Do Colleges Cater to Students' Preferences for Consumption?[*]

Brian Jacob
University of Michigan and NBER

Brian McCall
University of Michigan

Kevin Stange
University of Michigan and NBER

December 11, 2015

Abstract

This paper investigates whether demand-side market pressure explains colleges' decisions to provide consumption amenities to their students. Using a discrete choice model of college demand, we find that most students appear to value consumption amenities such as operating spending on student activities, sports, and dormitories, while the taste for academic quality is confined to high-achieving students. Heterogeneity in student preferences creates variation in demand pressure across institutions, which we estimate can account for eleven percent of the total variation in the ratio of amenity to academic spending across four-year colleges in the U.S.

Keywords: College choice; Consumption value; Higher education market; Discrete choice.

[*] We would like to thank Jon Bartik, Michael Gelman, Jonathan Hershaff, Max Kapustin, Geoff Perrin, Nathan Schwartz, Elias Walsh, and Tamara Wilder for their research assistance. We would also like to recognize the valuable comments and suggestions provided by various seminar and conference participants. We also thank Bridget Terry Long and Ozan Jaquette for sharing institutional data and for helpful comments. Jacob can be contacted at bajacob@umich.edu; McCall can be contacted at bpmccall@umich.edu; Stange can be contacted at kstange@umich.edu. All errors are our own.

I. Introduction

In line with the human capital framework developed by Becker (1964), economists typically model education as an investment wherein individuals forgo current labor market earnings and incur direct costs in return for higher future wages. While this framework does not rule out that education may also provide immediate consumption, such consumption aspects have received little attention in the literature.[1] Recently, however, there has been much popular criticism of the recreation that often accompanies investment in higher education (Wotapka, 2012) and an accumulation of evidence on limited student learning (Arum and Roksa, 2011), minimal study effort (Babcock and Marks, 2011), and poor graduation rates (Bound, Lovenhiem, and Turner, 2010) on American college campuses.

Absent from much of this discussion is a recognition of the substantial heterogeneity in amenity provision across institutions.[2] In 2007, for example, the roughly 1,300 four-year public and private non-profit postsecondary institutions in the United States spent an average of $0.51 on consumption amenities for every dollar spent on academics. This ratio varied tremendously, from $0.26 at the 10^{th} percentile to $0.80 at the 90^{th}. Thus different institutions make very different choices about the level of consumption amenities to offer their students. While there are several systematic patterns to this heterogeneity – for instance, public institutions spend relatively less on consumption amenities – the sources of these patterns have not been previously explored. This paper is the first to assess whether the resource allocation of higher education

[1] Exceptions include Schultz (1963) and Oreopoulos and Salvanes (2011). Some related literature describes the effect of education on subsequent household production as a "consumption aspect" of education in the sense that it increases the efficiency of future consumption (see Michaels 1973). These benefits of education would not count as consumption value in our framework as they accrue post-schooling.

[2] Throughout this paper, we use operating expenditure on instruction + academic support and student services + auxiliary as measures of the academic and consumption amenities offered by institutions, respectively. While not obvious ex-ante that these spending measures are good proxies for academic and consumption amenities, we present several pieces of evidence to support this interpretation.

institutions is driven by student demand, as market pressure may compel some colleges to cater to students' desires for consumption amenities.

To investigate this, we estimate the demand consequences of each institution's spending decisions and examine whether colleges' provision of consumption amenities correlates with this demand-side pressure. We estimate a discrete choice model of student demand in which student preferences for different college attributes (e.g., academic quality, net price, consumption amenities) are inferred from observed college choices. Using these estimates, we calculate institution-specific demand elasticities, and explore how these elasticities relate to college spending patterns.[3]

We find that many students do appear to value college consumption amenities, though there is significant preference heterogeneity across students. Higher-achieving students have a greater willingness-to-pay for academic quality than average and wealthier students are much more willing to pay for consumption amenities. This demand pattern holds after accounting for several shortcomings in much of the prior work on college choice, including fixed unobserved differences between schools, price discounting, and unobserved choice set variability created by selective admissions.

Preference heterogeneity causes different colleges to face very different market incentives depending on the characteristics of students on their enrollment margin. More selective schools have a much greater incentive to improve academic quality since this is the dimension most valued by their marginal students. Less selective (but expensive) schools, by

[3] This approach is in the spirit of the standard differentiated product demand models used to study product demand (e.g. Berry, Levinsohn, Pakes, 1995), residential choice (e.g. Bayer, Ferreira, McMillan, 2007), and school choice (e.g. Hastings, Kane, and Staiger, 2009). Since we do not model the broader decision of whether to enroll in a four-year institution (vs. a 2-year institution or non-enrollment) our results are most applicable to moderately selective institutions and their students, who would rarely choose one of these outside options (about three quarters of institutions included in our analysis).

comparison, have a greater incentive to focus on consumption amenities. The elasticities implied by our demand model can account for 11 percent of the total variation in the ratio of amenity to instructional spending between colleges, and including them on top of key observable characteristics (sector, state, size, selectivity) increases the explained variation by 17 percent. While the development and estimation of a full general equilibrium model of postsecondary supply and demand is beyond the scope of this paper, our estimates suggest that higher education institutions do respond to the demand pressure they face along this important non-price dimension.

Our results contribute to two related literatures. First, our analysis speaks to the small but growing literature that examines higher education institutions from the perspective of a market (Rothschild and White 1993, 1995; Epple, Romano and Sieg, 2006; Hoxby 1997, 2009). Our analysis is in the spirit of Hoxby (1997), who shows that changes in the level of competition in the U.S. higher education market explain changes in tuition and quality. However, her analysis – along with most of the literature – focuses on academic quality and cost, while we examine another dimension on which colleges compete. Second, our demand model expands the range of college characteristics examined in the college choice literature, demonstrating that consumption amenities are an empirically important factor determining the sorting of students to colleges and thus deserve more attention.

Our findings also shed light on the functioning of the postsecondary market. Unlike in the K-12 sector, quality assurance in higher education operates largely through market pressure – the fear of losing students should compel colleges to provide high levels of academic quality. Our findings suggest this accountability mechanism is more complex since demand-side market pressure may compel investment in consumption amenities rather than academic quality at many

institutions. A parallel dynamic occurs in the hospital market, where patient amenities are a much stronger driver of hospital demand than clinical quality (Goldman and Romley, 2008, Goldman, Vaiana, Romley, 2010).

This study does not inform whether this investment in consumption amenities is good or bad for students and taxpayers. Prior work on this question is mixed, finding that spending on student services is associated with positive student outcomes (Webber and Ehrenberg, 2010), while intercollegiate athletics might lower student achievement (Lindo, Swensen, Waddell, 2012).[4] Furthermore, extracurricular and social activities could also foster the acquisition of non-academic skills that are valued in the labor market. In this paper, we investigate the college choices of students and spending decisions of institutions as related to consumption amenities, leaving an assessment of the longer-term consequences for future work.

The remainder of the paper proceeds as follows. The next section reviews prior work on the higher education market and on the consumption value of education. Section III introduces our empirical strategy and elaborates on the identification challenges. Our data is discussed in Section IV, along with a detailed discussion of the validity of our measures of consumption amenities. The estimates of our demand model are presented in Section V. Section VI develops a framework for understanding how demand-side pressure faced by colleges may influence their spending priorities and examines this empirically using the estimated model of student demand. Section VII concludes.

II. Prior literature

Despite the vast literature on the returns to education and college choice, there has been relatively little analysis of the market for higher education. In the seminal model of the higher

[4] There is also a vast literature that finds substantial returns to academic quality (Black and Smith, 2004; Hoekstra 2009), though none of these studies have attempted to separate the returns to academic quality from the returns to consumption amenities, though these college attributes are positively correlated.

education market, Rothschild and White (1993, 1995) find that complementarities between students' academic aptitude and colleges' academic resources generates vertical differentiation and efficient sorting of students to colleges. Hoxby (1997, 2009) shows how several important changes in the postsecondary market structure have affected college price and quality. She demonstrates that the declining cost of air travel and telecommunications along with the rise of standardized college admissions testing have made the undergraduate market more geographically dispersed and competitive. G has increased the tuition, subsidies and prices of colleges on average and led to greater between-college variation in tuition, subsidies and student quality. Epple, Romano and Sieg (2006) develop an equilibrium model of the market for higher education that also generates substantial between college heterogeneity in resources and student outcomes. While this existing literature demonstrates that colleges do respond to market incentives, it has primarily focused on price, geographic location, and academic aspects of colleges. The role of consumption amenities as a competitive dimension in the market has not been previously investigated.

We also contribute to the voluminous literature on college choice. Since the seminal work of Manski and Wise (1983), many empirical models of college choice have focused on estimating the importance of price, academic quality and distance. For example, Long (2004) finds that the role of college costs and distance has become less important over time while proxies for college academic quality such as instructional expenditures per student became more important over time.[5] Only a few studies have explored consumption aspects of college quantitatively. Pope and Pope (2009) find that football and basketball success increases the quantity of applications received and the number of students sending SAT scores. Since the

[5] Other papers that estimate the willingness to pay for academic quality include McDuff (2007), Monks and Ehrenberg (1999) and Griffith and Rask (2007).

additional applications come from both high and low SAT scoring students, colleges are able to increase both the number and quality of incoming students following sports success. Alter and Reback (2014) find that changes in both academic and quality-of-life reputations listed in two popular college guidebooks affect the number of applicants received and the quality and geographic diversity of incoming students.

Another literature attempts to quantify the consumption (and other non-pecuniary) value of education. This approach compares observed schooling to the financially optimal amount or type, concluding that schooling itself must contribute directly to utility if individuals consume a level or type of schooling that is not financially optimal (Lazear, 1977; Schaafsma, 1976; Kodde and Ritzen, 1984; Oosterbeek and Ophem, 2000; Arcidiacono, 2004). Unfortunately, these approaches are not able to separate an individual's preference for a particular type of work from consumption value during schooling. The choice to attend college or pursue a specific major implies a particular career path, which influences not only monetary rewards, but also working conditions and other job attributes that affect utility. In this way, these studies differ substantially from this paper in focus and approach.[6]

III. Empirical Strategy for Estimating Demand

Our objective is to estimate student willingness to pay for various attributes of college in order to calculate the demand elasticities that individual colleges face. We estimate a discrete choice model of college choice, building on the approach taken by Manski and Wise (1983) and Long (2004). We extend the prior work by focusing on preference heterogeneity and by accounting for three sources of bias often ignored: fixed unobserved differences between schools, individual-specific price discounting, and selective admissions.

[6] Our approach is more closely related to Jacob and Lefgren (2007), who find that wealthy parents want teachers that increase both achievement and student satisfaction. This latter aspect could be considered "consumption value" in our framework.

A. Basic Setup

Individuals choose from J total colleges, each with a variety of different attributes. Individuals receive indirect utility from attending college j that is a function of the academic quality (A_j) and consumption amenities (C_j,) of the institution, the distance from their home (D_{ij}, a proxy for the non-monetary commuting costs), and consumption of all other goods ($Y_i - T_{ij}$) where Y_i is income and T_{ij} is the price of college j to individual i:

$$U_{ij} = \alpha_{1i}(Y_i - T_{ij}) + \alpha_{2i}A_j + \alpha_{3i}C_j + \alpha_{4i}D_{ij} + \varepsilon_{ij} \qquad (1)$$

ε_{ij} is an unobserved individual-specific taste preference for school j. Individuals compare the potential utility received from attending each college and choose to attend the college that maximizes their utility. We assume the random components in equation (1) are independent and identically distributed across individuals and choices with the extreme value distribution, so that the probability that individual i is observed choosing college j is given by the simple conditional logit formula. We are interested in estimating the parameters a_{1i}, a_{2i}, a_{3i}, and a_{4i}. In a cross-sectional sample, these parameters are identified by differences in the enrollment shares across institutions and subgroups that are related to the variables of interest. If students value instructional expenditure, for example, then schools with more spending on instruction should have a greater share of all postsecondary students than schools with less spending. Coefficients on attributes that vary across students within schools will additionally be identified by within-school variation. To permit reasonable substitution patterns, we allow preference parameters to vary with student gender, ability (as measured by 12th grade test scores) and socioeconomic status.[7]

[7] With homogeneous preferences, the relative choice probabilities for any two alternatives will not depend on any other alternatives (independence from irrelevant alternatives) and cross-elasticities will exhibit proportional substitution, which is unrealistic if students tend to substitute between colleges with similar characteristics.

B. Identification Issues

If observed college characteristics are related to unobserved determinants of demand at specific institutions, then estimates may suffer from omitted variable bias. Much of the existing college-choice literature does not address this fundamental identification concern.[8] We address three main sources of bias.

First, to eliminate time-invariant unobserved college characteristics that influence demand, we combine multiple cohorts and include institution fixed effects for the 1,235 colleges in our analysis sample.[9] The identifying assumption is that changes in college attributes are uncorrelated with changes in unobserved demand factors for individual colleges. For instance, if colleges that increase spending on consumption amenities also strengthen other favorable attributes (e.g., desirable alumni network), or do so in anticipation of demand surges, then our estimates will overstate the causal effect of amenities on colleges' ability to attract students. Furthermore, our demand model necessarily requires that factors besides tuition and the two spending categories must also vary for the institutional budget constraint to be satisfied. For institutions with the same change in tuition and instructional spending to have different changes in amenity spending, other revenue sources (state appropriations, endowment and alumni donations, revenue derived from auxiliary enterprises) or non-included spending categories (public service, research) must also vary. These other forms of heterogeneity may bias our demand model estimates if they too directly impact enrollment decisions. However, we argue that these factors may be much less salient than those we explicitly include.[10]

[8] Structural equilibrium models of the college market (Epple, Romano, and Sieg, 2006) potentially address this issue, but at a cost of stronger assumptions.

[9] To our knowledge, the only other papers to take this fixed effects approach to college choice are Avery, Glickman, Hoxby, and Metrick (2005) and Griffith and Rask (2007). We estimate this model through an iterative procedure in the spirit of Berry (1994) and Guimarães and Portugal (2009).

[10] In addition, short-run constraints on physical capital may create adjustment frictions which will lead us to understate preferences for certain college characteristics. Furthermore, if the market responds to a demand for

Second, our preferred specifications use estimated net price rather than college sticker price to account for price discounting, which varies across students, schools, and time and likely influences enrollment. To implement this, we estimate a model with the net price ratio (sticker price minus all grants over sticker price) as the dependent variable using the 1996 and 2004 National Postsecondary Student Aid Study. The model was estimated separately for six groups (defined by race X sector X in-state) separately by year and with many interactions, so it is quite flexible. Estimates were used to predict net price for all student-school pairs in our analysis sample. Appendix C and accompanying tables provide more detail on these models. Our estimates are robust to a variety of plausible net price specifications.[11]

Third, we address bias resulting from selective admissions, which prevents some people from attending certain schools even if they desire to do so. Selective admissions creates a specific form of omitted variable bias by miss-specifying students' choice sets (i.e., we do not observe the actual set of schools that a student could feasibly attend). The consequence is that estimates will cofound school selectivity with student preferences, causing us to overstate (understate) student WTP for attributes of less (more) selective schools. Previous researchers have addressed this issue in a number of ways, though each approach has important limitations. For example, controlling for characteristics that determine choice set variation (e.g., Long, 2004) makes it impossible to separately identify admissions constraints from preference heterogeneity. On the other hand, estimating a model of choice set determination explicitly (Arcidiacono, 2005) is not feasible in our setting both because our choice set is only partially observed and our

college amenities with the creation of new amenity-rich schools, then the inclusion of fixed effects will also cause us to understate the value students place on amenities. In practice, the entry and exit of colleges seems unlikely to be important in our analysis since we observe few openings or closings of "regular" four-year colleges.

[11] Our preferred model includes quadratics of standardized test scores, SES, and SAT percentile of the institution, the pair-wise interactions between these three variables, the ratio of institutional grant aid to tuition, the ratio of state grant aid to tuition, spending on amenities and academics, and interactions between these four institutional characteristics and student test scores and SES. Institutional and state grant aid interactions account for need- and merit-based aid programs that vary across states and institutions and over time.

estimation strategy includes institution fixed effects.[12]

Our approach is to integrate out over the possible choice sets (Conlon and Mortimer, 2010; Desposato, 2005) using a computationally feasible approximation provided by a weighted conditional logit model where weights are equal to the likelihood that a given alternative is contained in an individual's choice set. The intuition is that the unconditional probability of enrolling in college *j* (which we observe) is the product of the probability of attending conditional on being accepted and the probability of being accepted. For the large number of nonselective institutions where the probability of admissions is near one, the probability of enrollment is simply that estimated by the standard conditional logit. For schools to which the student has little chance of being admitted, the weight will be very low, which means the probability of enrollment is also low.

A key benefit of this approach is that it allows preferences for a given school to be high while the empirical likelihood of observing a student at this school is low. The key challenge to this approach is to obtain credible estimates of the probability of admissions for each student x college pair. To do so, we use information on applications and admissions for our student sample and employ an extremely flexible model that includes dozens of student and school characteristics (and their interactions) that influence a college's admissions decision. The identifying assumption is that, conditional on the rich student and school characteristics included, there are no unobservable factors that are simultaneously correlated with the likelihood of admissions and enrollment. Appendix C and accompanying tables provide more detail on the method and these models. Our estimates are robust to a variety of plausible admissions model specifications.

[12] Specifying the choice set ex-ante is problematic since some excluded alternatives may be chosen. Conditioning on the set of schools accepted to (Arcidiacono, 2004) loses all information contained in students' application decisions, which may bias preference estimates if attributes vary in importance between the application and enrollment stages.

Lastly, in some specifications we also control for other time-varying characteristics associated with each college (e.g. state unemployment rate and the size of high school class) and for binary indicators of whether the college is located in the same state and/or region in which the student attended high school. These latter variables control for hard-to-observe factors such as family connections that will influence a student's college choice beyond the distance and cost variables that we already have in the model.

C. Interpretation Issues

Interpreting demand responses as preferences requires several assumptions. First, this interpretation assumes that students are informed about college characteristics. If information is incomplete, we might misinterpret a lack of demand for an attribute with a lack of information about the attribute. In particular we worry that measures of academic quality, such as spending on instruction, academic support, or faculty-student ratios, may be less visible to potential students than consumption amenities. Thus we may under-estimate students' valuation of academic relative to amenity attributes, though we may still correctly quantify the demand responses to changes in spending on academics and amenities specifically. Second, the estimated coefficients are necessarily scaled by the transformation of spending into attributes that students actually care about. So if one spending measure is a better proxy for the latent attribute than the other, coefficients on the spending categories are not strictly comparable.

Third, variables we interpret as "consumption" may actually measure some things that provide labor market returns, and thus be properly categorized as "investment." For example, Webber and Ehrenberg (2010) find evidence that student service expenditures are positively associated with graduation rates. Moreover, it is entirely possible that certain attributes have aspects of both consumption and investment. Regardless of the interpretation, our estimates

should still accurately reflect the effect of these spending categories on students' college choice.

IV. Data, Sample and Measures

We combine student-level data from two nationally representative cohorts of high school seniors with college-level data on nearly all four-year colleges in the U.S.[13]

A. Student-Level Data

We combine nationally representative samples of the high school classes of 1992 (National Educational Longitudinal Study, NELS) and 2004 (Educational Longitudinal Survey, ELS), which follow students from high school into college. We limit our sample to individuals who graduated from high school and attended a four-year institution within two years of expected high school graduation. According to our calculations from the 1996/01 Beginning Postsecondary Students Longitudinal Study, this represents more than two-thirds of all BA-seeking beginning postsecondary students. We also restrict our analysis to students who attended a college in our sample, and were not missing key covariates (test scores, race, gender, family SES, college choice, etc.).

We assign out-of-state tuition levels to individuals residing in all states other than the one in which the institution is located, so we do not take into account tuition reciprocity agreements between neighboring states. Tuition does not vary by in-state status for private institutions. As a proxy for the distance between a student's home and a college, we calculate the distance between the centroid of the zip code in which the student's high school is located and the centroid of the zip code in which each institution is located.

[13] We exclude students attending two-year colleges from our analysis primarily because these students are very heterogeneous in their collegiate intensions and aspirations. We focus on students that all share the same basic goal of attaining at least a four-year degree who can arguably be combined into the same demand model. For additional detail on data sources and sample construction, see Appendix A.

B. College-Level Data

We combine data from a number of different sources to construct an unbalanced panel of nearly all four-year postsecondary institutions for 1992 and 2004.[14] We use expenditures on instruction and academic support per FTE (from IPEDS Finance survey) as a measure of the institution's academic quality, which include expenses for all forms of instruction (i.e., academic, occupational, vocational, adult basic education and extension sessions, credit and non-credit) as well as spending on libraries, museums, galleries, etc. Following the prior literature, in most specifications we also use the average SAT score of students in the college as a second measure of academic quality. We obtained the average SAT percentile score (or ACT equivalent) of the incoming student body for 1992 from Cass Barron's *Profiles of American Colleges* (1992). For 2004, we used the average of the 25th and 75th SAT percentile, which we obtained from IPEDS. We categorize institutions by Barron's selectivity categories, obtained from the National Center for Educational Statistics.

C. Measuring Consumption Amenities

Our measure of consumption amenities is current spending on student services and auxiliary enterprises, also derived from the IPEDS Finance survey. Expenditure-based measures have the benefit of availability and consistency across colleges and over time, while also capturing many different dimensions of consumption amenities. We conducted a variety of analyses to validate this expenditure-based measure. We describe the key results below, and refer the interested reader to Appendix B for a more complete discussion.

[14] We limit our sample to public and non-profit private undergraduate four-year schools, excluding all two-year (or less) schools, all for-profit schools, schools offering professional degrees only, all specialized colleges (divinity, art, etc.) and very small colleges. These small schools are arguably not in many students' consideration set. We also drop colleges with missing or zero expenditure or price data, along with colleges missing institutional grant aid information. For additional detail on data sources and sample construction, see Appendix A.

Table 1 shows how price and expenditures vary across institution types and over time for our sample colleges. Private institutions, more selective institutions, and doctoral institutions have higher tuition and fees compared with their peers and also spend considerable more per student on instruction and academic support. For example, the most selective private universities spend roughly $19,400 more on instruction compared with the least selective public colleges. While private and more selective institutions also spend more on amenities (column (3)), institutions that grant graduate degrees actually spend less per student (conditional on sector and selectivity). Column (4) quantifies the relative importance of academic vs. amenity spending across school types. Private and bachelors colleges devote relatively more spending to amenities than others and there is a stark negative relationship between selectivity and relative amenity spending. For example, the ratio of amenity to academic spending in the least selective private schools is roughly 0.10 higher than in the most selective privates. The most selective public institutions also spend relatively less on amenities compared with less selective publics, though the pattern is less striking. In column (5), we see that private colleges at all selectivity levels experienced substantially faster growth in amenity spending than public colleges. While the estimates are not particularly precise, it appears that privates in the middle to bottom of the selectivity continuum saw the largest gains in amenity relative to academic spending (column 6).

Spending on student services and auxiliary enterprises include a wide variety of budget objects. Student services includes spending on admissions, registrar, student records, student activities, cultural events, student newspapers, intramural athletics, and student organizations. Auxiliary expenditures include operating expenditures for activities that are revenue-generating, such as residence halls, food services, student health services, intercollegiate athletics, college unions and college stores. None of these categories includes interest payments or other capital

expenses nor do they include amenities provided by the private sector.[15] Discussions with representatives at the National Association of College and University Business Officers (NACUBO) and our examination of operating budgets from a handful of institutions suggested that expenses associated with athletics, student residence halls, student dining and student activities constitute a large portion of auxiliary spending. The largest categories within student services are typically expenses associated with the admissions office, the financial aid office, and the Dean of Students' Office, which administers student activities and student life initiatives. Quantitative information collaborates this. Financial data on intercollegiate athletics in 1992 suggests that it is almost always included in student services or auxiliary and represents roughly 10% of expenditures in both these budget categories (including institutions with no intercollegiate sports programs). We also find that the percent of undergraduates living on campus and the number of intercollegiate sports offered are both significantly related to amenity spending and the change in fraction of students living on campus between 1992 and 2004 is a strong predictor of the change in spending on auxiliary and student service. Finally, spending in these two categories is correlated with several qualitative measures of campus quality of life included in the Princeton Review guidebooks. There is a positive and statistically significant association between campus quality of life rating, student happiness designation, and campus beauty designation from Princeton Review and an institution's expenditures on auxiliary and student services. Collectively this evidence suggests that variation in these two spending

[15] We view our spending measures as picking up not just the subsidy provided by the college for these activities (paid for out of tuition and fees) but rather a broader measure of the amount of consumption amenities available to students at campus (some of which is paid for by colleges and some of which is paid for by the students). For this reason, we do not subtract off the revenue generated by auxiliary activities to isolate the auxiliary subsidy (if any), as this would understate the amenity level available on campus.

categories captures many factors – athletics, student housing, recreation – that influences students' quality of life and arguably represent consumption amenities.[16]

D. Summary Statistics

Table 2 presents summary statistics of the college data, separately by sector for 1992 and 2004. Real tuition costs and spending on academics and amenities increased considerably during the 1990s, though there are differences across sectors. Public institutions saw a greater proportionate increase in tuition prices, while private institutions saw larger relative increases in spending. Although spending increased in both categories, the average ratio of amenity to academic spending remained constant over this period.

Many of these measures are highly positively correlated. In 2004, log per-student spending on instruction/academic support is correlated 0.62 with student services/auxiliary spending. Tuition, expenditures and SAT percentile are all correlated at 0.49 or higher with each other. Schools that have high SAT-scoring students tend to spend more on both academics and amenities and also charge higher tuition. Because changes in college attributes within institution over time (as opposed to levels) will identify the preference parameters in our model, it is useful to also consider the correlation of changes. These correlations are substantially smaller than the correlations in levels, which suggests we will have independent variation to identify preferences for multiple attributes.

Table 3 presents summary statistics for our analysis sample. The middle panel presents statistics on the colleges attended by our sample. Over our analysis period, the real cost (including tuition, fees, room & board) increased by more than forty percent, from $14,802 in

[16] Since our preferred demand model includes institution fixed effects, any changes in the composition of student services or auxiliary spending towards uses that are more academic over time would complicate the consumption amenity interpretation of our results. Unfortunately, there is no systematic way to assess changes in spending within the broad categories of student services and auxiliary enterprises.

1992 to $20,859 in 2004, while the average distance traveled to college increased from 196 to 220 miles. Schools attended by our sample increased spending on academics 18 percent over the period and spending on consumption amenities by roughly 8 percent.

Each of these surveys asked high school seniors what factors they viewed as most important in selecting a college, including courses, academic reputation, low cost, availability of financial aid, athletics and social life. We first standardize each item using the 1972 mean and standard deviation (students reported importance on a 4-point scale), and then calculate a simple average of two items for each composite: academics (courses and reputation), costs (low cost, financial aid), and social amenities (athletics, social life).[17]

V. Estimates of Demand Model

A. Main Estimates

Table 4 presents estimates (odds ratios and standard errors) of the choice model pooling the 1992 and 2004 cohorts and imposing homogeneity in student preferences.[18] In order to help interpret magnitudes, the bottom panel of the table reports measures of "willingness-to-pay" (WTP) for each college attribute. WTP is given by the (negative) ratio of the estimated coefficient on that attribute to the estimated coefficient on log(total cost).

Column (1) does not include college fixed effects and demonstrates patterns found in much of the previous literature. Cost and distance are major predictors of where students choose to enroll, as is spending on academics, spending on consumption amenities, and peer quality. Controlling for selective admissions and the actual price faced by each student in column (2)

[17] This normalization reflects our use of the 1972 cohort in earlier analysis. The normalization base does not impact our results.

[18] To provide a direct comparison with previous work, we also replicated and extended the analysis of Long (2004) by including various measures of college consumption amenities into her conditional logit specifications. Many of these consumption amenities are significant predictors of student choice above and beyond the academic measures she studied and their inclusion diminishes the estimated importance of instructional expenditure. These results are available from authors upon request.

increases the estimated willingness-to-pay for both measures of academic quality and slightly reduces the importance of consumption amenities.

Specification (3) includes college fixed effects to control for unobserved desirable aspects of colleges, changing the results in several meaningful ways. First, the importance of cost increases noticeably, suggesting that expensive colleges also possess unobservable qualities that are attractive to students. Second, the estimated importance of other college attributes declines; consumption amenities become less important (but remain statistically significant) and the coefficient on instructional spending actually becomes negative. Column (4) controls for other regional and geographic characteristics that may be correlated with college amenities. Indicators for whether a college is in the student's home state and region are strong predictors of student choice, but inclusion of these controls does not qualitatively change the estimated importance of other college amenities.[19] In this final specification, we estimate that students are willing to pay roughly 0.14 percent more to attend a school that spends 1 percent more on consumption amenities and 0.7 percent more to attend a school whose mean SAT score is 1 percentage point higher on the national distribution. In order to attend a top quartile school (in terms of mean SAT measure) instead of a bottom quartile school, a student would be willing to pay 32 percent more (i.e., .007 x (79-34) = .315).[20]

The results presented above suggest that, on average, students value institutions' spending on consumption attributes and the academic ability of their peers, but do not value

[19] Since this final specification absorbs average within-institution price differences between in-state and out-of-state students, the estimated importance of cost also diminishes.

[20] We also estimated specifications that included controls for the cost of living in each college's city to absorb variation in spending due to higher prices which may not reflect differences in real amenities. To address multicolinearity concerns, we also estimated specifications that exclude average SAT score. Neither of these specifications altered our estimates and instructional expenditure remains insignificant throughout. When four spending categories (instruction, academic support, student services, and auxiliary spending) are entered separately, the point estimates on student services and auxiliary are both individually positive, though the one on auxiliary spending is larger. Coefficients on instruction and academic support spending are both negative. These results are available from the authors upon request.

spending on instruction. However, preferences are likely to differ between students and this preference heterogeneity will impact the elasticities faced by colleges.

Table 5 reports estimates for models that include interactions between student characteristics (sex, ability and family income) and the five college attributes (odds ratios are difficult to interpret with many interactions, so raw coefficients are presented). Regardless of whether fixed effects are excluded, preference heterogeneity is considerable. Wealthier students are substantially less sensitive to price and distance and higher achieving students are less sensitive to distance. Male students are more price sensitive than female students. High-ability students have a much greater preference for academic quality, both in the form of instructional spending and mean SAT. Recall that these models account for the predicted probability of acceptance that incorporate the 12^{th} grade test scores along with other measures of academic aptitude so this finding is not simply an indication of the greater likelihood of acceptance to elite institutions among such students. Interestingly, differences in valuation for consumption amenities by student ability and income is less pronounced, though higher income students have a greater preference for consumption amenities.

Figure 1 summarizes the variation in predicted WTP across our sample, plotting the distribution of WTP for each college attribute separately by SES and student achievement. There is substantial heterogeneity in students' willingness to pay for all college characteristics. The WTP for consumption amenities is positive for most members of the sample, though much higher for wealthier students. There is also substantial variation in preference for academic quality; high achieving students tend to derive greater value from high academic quality. In fact, the distribution of estimated preferences for instructional spending does not overlap between students in the top and lowest test score terciles. Appendix D presents additional descriptive

information on WTP for models with and without fixed effects and for subgroups. Our estimates suggest that students with the greatest willingness-to-pay for consumption amenities are low-ability, high-income students and that academic spending only has a positive WTP for high-ability students. These broad patterns hold regardless of the inclusion of fixed effects.[21]

B. Robustness of Main Model

In Table 6, we explore the robustness of our demand model to various sources of bias and misspecification. One concern is that instructional spending is an imperfect (or not salient) measure of the resources institutions devote to academic quality. Column (2) uses the log of number of full-time faculty per FTE student as our measure of academic resources, which is also common in the literature (e.g. Bound, Lovenheim, and Turner, 2010). This model produces results that are qualitatively identical (and for some coefficients, quantitatively similar) to that using instructional and academic support. Given that four-year colleges are quite heterogeneous, a second concern is that marginal spending at different types of institutions may be used for very different purposes. Column (3) lets the marginal effect of the two spending categories differ by the highest level of degree offered. We find no significant differences between institutions offering different degrees, though estimates are not very precise. Furthermore, estimates of the heterogeneity across individuals are not impacted nor is model fit improved much by this added flexibility. Column (4) controls for sector-specific time trends, which accounts for any unobserved changes in preferences for private vs. public colleges that coincide with differences in spending trends. This specification has the additional feature of eliminating any bias arising from changes in accounting standards (and thus reported spending) that affected private and

[21] We also estimated a random coefficients model (Train 2009), without college fixed effects. This analysis suggests that preference for consumption amenities is fairly broad-based across all students, while taste for academic quality exhibits substantial heterogeneity across the population. Furthermore, our observed characteristics (male, math score, and SES) do a good job characterizing this heterogeneity, as indicated by the reduced residual coefficient variation when these observables are included. These results are available from the authors.

public colleges differently.

Appendix D reports results for a host of alternative specifications, including controlling for the mix of undergraduate major fields, the fraction of students that have financial need, and using either student services spending or auxiliary spending in isolation as the amenity measure. We also considered various ancillary models for financial aid and admissions, including a parsimonious specification which includes some institutional and student characteristics, but omits several institutional characteristics (including spending on amenities and academic) and interactions with student characteristics. These parsimonious models are quite similar to our preferred model (with very flexible financial aid and admissions controls). Adding additional richness and flexibility in these ancillary models (beyond some basic heterogeneity) does not materially impact predicted aid, admissions, or our choice model estimates. This gives us confidence that the remaining sources of unobservable heterogeneity in aid or admission are unlikely to cause substantial bias to our demand model.[22]

The decision to condition our sample on students that attend four-year colleges could bias our estimated preferences because it excludes responses from students entering the four-year market when college attributes change. This may be particularly problematic for the least selective public institutions, which compete most directly with two-year institutions and non-enrollment. From Table 1 we know that the least selective public institutions have lower levels of both categories of spending, so extrapolating our preference estimates to low levels of spending should be done cautiously. More generally, our model permits preferences for college attributes to vary linearly with ability, SES, and gender, so extrapolations far from the median student and

[22] To account for the possibility that admissions officers partially know students' propensity to attend and incorporate this into admissions decisions, we also estimate an admissions model that includes students' self-reported "preferences" for campus social life and academics directly and interacted with amenity and academic spending. These additions have little impact on predicted admissions or our estimated choice model and thus we omit them from our main specification.

institution characteristics could be problematic, putting aside bias arising from sample selection.

C. Students' Stated Preferences for Consumption Amenities

Further evidence that the observed enrollment response to spending on student services and auxiliary enterprises reflects the importance of consumption considerations is presented in Table 7. The model includes interactions between our five college attributes and the three self-reported student "preference" measures described earlier. If spending on student services and auxiliary was capturing consumption amenities, we would expect students who report that a school's social life is important to be more responsive to this attribute. Similarly, if academic spending were a good proxy for academic quality, students who report academics to be very important to them should be more responsive to spending on instruction.

Indeed, we find exactly these patterns. These estimates account for selective admissions and financial aid so these patterns do not simply reflect differences in acceptance or financial aid generosity at schools with different characteristics between students citing "social" vs. "academic" factors. The model also includes interactions with the three observable characteristics examined earlier (male, math score, and SES), so the stronger preference that high achieving students have for colleges that spend more on instruction is held constant. Students seeking a college with a strong social life respond favorably to spending on amenities but negatively to spending on academics. Students choosing colleges based on academics are attracted to colleges that spend more on instruction, but are unresponsive to spending on amenities.

We also found that spending on consumption amenities appears to be less important in areas that have locational amenities that act as substitutes (e.g. vibrant urban life or access to beaches as measured by the "quality of life" developed in Albouy, 2012) and more important for

students planning to live at home or at campuses where more students live on-campus.[23] These results and the evidence in IV.C suggest that the spending measures we examine serve as adequate proxies for consumption amenities and academic quality.

VI. Implications of Demand Pressure for the Postsecondary Market

A. Model of College Expenditures by Type

To illustrate how demand pressure may influence institutions' spending decisions, we sketch a simple model of college resource allocation. The model is described more fully in Appendix E. For simplicity we assume that there are two (non-price) college attributes, academic quality *A* and consumption amenities *C*, and colleges have a price equal to *T*. We assume that colleges choose tuition, academic quality, and consumption amenities to maximize net revenues $\pi_j = N_j\left(T_j, A_j, C_j\right) \times \left\{T_j - r_j(A_j, C_j)\right\}$ where N_j is institution-specific total enrollment and $r_j(A_j, C_j)$ is the per-student cost function which we assume to be additively separable for the two amenities and reflects that colleges have different technologies (costs) in producing academic quality and consumption amenities. The population of students is characterized by their income level (I), as well as their preferences for academic quality (α), college consumption amenities (γ), and income (β).

We find that the optimal ratio between consumption and academic spending is given by:

$$\ln\left(\frac{C^*}{A^*}\right) = \ln \xi_C - \ln \xi_A + \ln r_A - \ln r_C \,. \qquad (2)$$

where ξ_A and ξ_C are elasticities of enrollment with respect to price, academic quality and consumption amenities respectively. Thus, the optimal ratio between consumption amenities and academic quality will depend positively on the enrollment elasticity with respect to consumption

[23] These results are reported in Appendix D, though some estimates are imprecise.

and negatively on the enrollment elasticity with respect to academic quality. [24]

Rather than specify ex-ante which institutions have enrollment that is more or less sensitive to consumption amenities or academic quality, we instead use estimates of ξ_C and ξ_A from our discrete choice demand model. Variation in demand elasticities across institutions comes from variation in preferences across students combined with differences across institutions in the underlying distribution of students who are on their enrollment margin. If preferences differ between groups of students (e.g. high SES vs. low SES), an institution's total enrollment elasticity is a weighted average of group-specific elasticities with weights proportional to each group's prevalence in the population and initial enrollment likelihood at that institution.

Thus, institutions operating in a market with many amenity-sensitive students or with a large share of their enrollment coming from such students will experience large overall demand shifts in response to changes in their amenity offerings. This insight motivates our focus on preference heterogeneity as a source of heterogeneity in the demand pressure institutions face. Appendix E provides a more formal derivation of this result. With these elasticities in hand, our approach is essentially to estimate a version of equation (2) above including many observable college characteristics to control for the possible correlation between elasticities and $(\ln r_A - \ln r_C)$.

B. Do Colleges Respond to Demand Pressure?

To characterize the demand-side pressure faced by postsecondary institutions we conduct

[24] The purpose of this theoretical analysis is to illustrate how the demand model links to institutional incentives for making different types of spending. Institutions almost certainly have different objectives, including differing desires to enroll students from different subgroups which they implement via recruitment, admissions, and financial aid, in addition to changes in tuition and spending. We abstract from these differences in objectives. However, we will make spending type comparisons between institutions that share similar characteristics (public, size, selectivity, total spending) in order to control for differences in institutional objectives that vary with these observed characteristics.

a series of simulations to determine the elasticity of college j's enrollment with respect to changes in various attributes, holding all else equal. For each individual college we alter a single characteristic, holding constant all other characteristics at the college as well as all characteristics at other colleges, and record how the entire pattern of enrollment across all colleges changes. These marginal responses are expected to vary across colleges due to variation in the preferences of their marginal students and differences in the proximity of colleges with similar attributes (i.e., competitors). For instance, colleges whose marginal students are wealthy but with low academic aptitude will see particularly large enrollment responses to changes in consumption amenities spending, though the opposite is true for colleges attracting many high-achieving, low-income students.

Figure 2 plots the distribution of predicted own total enrollment elasticities with respect to each of the four college characteristics, using estimates from our main model (Table 5, specification 2). Consider first the distribution of price elasticties shown in the top-left panel. The entire distribution of elasticities falls to the left of zero, indicating that all schools experience a downward sloping demand curve (i.e., a negative enrollment response to higher tuition). Overall demand is price-elastic: a 1% increase in price is associated with a 1.6% decrease in total enrollment. One caveat is that this analysis may understate the responsiveness of enrollment at some colleges because we have not included enrollment from students entering the four-year market when college attributes change. This underestimation is likely to be particularly problematic for tuition changes (rather than spending changes) at less selective public universities.[25] We return to this issue below.

[25] Prior work has found that proximity and (to a lesser extent) price influences the two-year vs. four-year and overall enrollment decision (Rouse, 1995, Long 2004), but sector response to institutional spending is very modest (Stange, 2012, Smith and Stange, 2015). Consequently, simulated elasticities are potentially understated for changes in

The panel in the top-right corner shows that all colleges have a positive total enrollment response to marginal increases in consumption amenities spending. While most colleges are estimated to have a positive total enrollment response to marginal improvements in average SAT score, the response is negative for some institutions. Consistent with the results presented in Table 4, the vast majority of colleges appear to have a negative total enrollment response to increases in academic spending.

Figure 3 plots the distribution of implied own-elasticities for enrollment of high SES (above the 75th percentile, solid line) and of high achieving (above the 75th percentile of math test score, dashed line) students. The total enrollment elasticity (bold line) is included for reference. High achieving students are particularly responsive to improvements in academic quality, both in the form of average SAT and instructional spending. In fact, high achieving students are the only subgroup that responds positively to academic spending. On the other hand, marginal increases in consumption amenities spending will have a greater impact on colleges' enrollment of high SES students. Most institutions can increase total or high SES enrollment by increasing consumption amenities, though the response of high-achieving students is smaller. The implication is that most colleges face a trade-off: increases in academic spending will attract high achieving students, but may deter enrollment from a broader student body. Increases in amenities spending, however, will attract all types of students (though disproportionately lower-achieving and high income students).[26]

We validated this finding by demonstrating that changes in the actual share of high SES first-time freshman enrollment is related to model-predicted enrollment changes in a period

tuition, but are probably not too far off for changes in spending. The bottom two selectivity categories in our sample, which would be most subject to this concern, represent approximately 28% of institutions and 24% of students.

[26] This same pattern is apparent in models that do not include fixed effects, use faculty-student ratio as the measure of academic quality, or let the marginal effect of spending differ by type of institution. These are reported in Appendix D.

outside of our sample timeframe. For private, non-profit institutions from 2008 to 2012, we regressed the actual share of high SES first-time freshman on interactions between elasticities for high SES enrollment and lagged institutional characteristics, controlling for institution and year fixed effects. We found that changes in amenity spending had a stronger positive impact on the enrollment of high-income students at schools where our model predicts these students to be particularly responsive to amenity spending. [27]

Figure 4 depicts how demand-side pressure varies with institutional selectivity at baseline. Though the own-price elasticity is similar across institutions with very different levels of selectivity, there are clear differences in responsiveness to other characteristics. The demand response to academic quality is more positive at more selective schools. Students on the margin of attending more selective schools tend to place greater value on academic quality and thus changes in academic quality have a greater impact on overall enrollment. For consumption amenities spending is less clear. Very low selectivity schools experience a slightly greater enrollment response to an increase in amenities spending than moderately more selective schools, but responsiveness then increases with selectivity at higher levels of selectivity. Furthermore, institutions of very different selectivity face relatively similar incentives for attracting the most high-achieving students, but very different incentives when trying to attract students overall.[28] Figure 4 also demonstrates that there is substantial variation in demand response to consumption amenities even among institutions with similar levels of selectivity.

[27] Results are reported in Appendix D. Since 2008 private non-profit institutions report the number of students in certain income groups for first-time freshman who have applied for federal financial aid. This allowed us to calculate the enrollment share for different income groups at these colleges annually (assuming that FAFSA non-applicants are in the highest income group).

[28] As shown in Appendix D, this result is qualitatively very similar with or without college fixed effects, but does depend strongly on the inclusion of preference heterogeneity. Without it, the response to all characteristics appears to be similar across institutions and student groups. This pattern can be quantitatively and even directionally incorrect since some colleges may face negative enrollment responses when they increase academic quality, while other colleges may see a positive response overall or for certain subgroups. Heterogeneity in institution-specific demand pressure is masked without allowing for individual preference heterogeneity.

Do colleges that face greater pressure to provide consumption amenities respond accordingly? Figure 5 plots the ratio of consumption amenities spending to academic spending from 1992 to 2007 for four groups of colleges, categorized by their enrollment elasticity with respect to these two categories of spending. Colleges that face the highest demand elasticity for consumption amenities and the lowest elasticity for academic spending (solid line) provide the highest level of spending on the latter, relative to the former. These schools spend nearly $.80 on consumption amenities for every dollar spent on academics. In contrast, colleges that face the greatest pressure to spend resources on academics only spend $0.45 on consumption amenities for every dollar spent on academics. These ratios have not changed appreciably over time at the group level. Note that this cross-institutional variation is not used to estimate the parameters of our student demand model since our preferred specifications include college fixed effects, which control for any time-invariant characteristics of colleges.

To explore the correlates of spending patterns across institutions more systematically, Table 8 presents OLS estimates of the cross-sectional relationship between the ratio of consumption amenities spending to instructional spending in 2004 and various institutional characteristics. Column (1) shows the relationship for several key observable characteristics, which are likely to both proxy for institutions' technologies (costs) in producing academic quality and consumption amenities and to reflect differences in preference-induced demand pressure. Public and larger institutions spend proportionately less on consumption amenities (relative to academics). More selective institutions also spend relatively more on academics. There is little evidence of a "wealth" effect; conditional on the other covariates, the spending ratio is uncorrelated with an institution's overall level of log spending. We also include state fixed effects to capture any state-specific market characteristics that may correlate with spending

priorities. These five characteristics can explain 20% of the variation in the spending ratio, with the "public" dummy alone explaining 10%.

Column (2) correlates spending priorities with institutions' estimated enrollment elasticities (which are standardized to have a mean of zero and standard deviation of one). A one standard deviation increase in the consumption amenity (academic) spending elasticity is associated with a $0.10 increase ($0.08 decrease) in the spending ratio. By themselves, these elasticities can explain 11% of the variation in the spending ratio. Controlling for institutional sector, selectivity, size, total spending, and state fixed effects reduces the magnitude of these effects but changes the qualitative finding very little (column (3)). In fact, including the elasticities on top of the key observable institutional characteristics increases the explained variation in spending ratio seventeen percent. It is important to note that this figure actually understates the total contribution of the demand elasticities to spending patterns since some of the variation "explained" by observable characteristics such as sector and state could be operating through demand pressure.[29] These broad findings are quite robust to alternative specifications of the demand model (columns 4 to 6).[30]

This evidence suggests that the demand elasticities we estimate do characterize important features of the higher education market above and beyond observable college characteristics. Importantly, colleges seem to respond to these market pressures when choosing the optimal mix of consumption and academic attributes to offer their students.

VII. Conclusions

[29] Furthermore, measurement error in our estimates of the two spending elasticities will also tend to bias estimates in Table 8 downwards. For instance, elasticities may be understated for the least selective public universities which draw students from the two-year sector or non-enrollment when they become more attractive. To the extent that this measurement error is classical once observed characteristics (public, total spending, average selectivity) are included, this will tend to bias the estimates in Table 8 towards zero.

[30] The elasticity with respect to number of FT faculty per student is not a good predictor of the spending ratio, but specification (5) demonstrates that the consumption amenities elasticity is still a good predictor of spending patterns even when FT faculty per student is used to construct a measure of elasticity with respect to academic resources.

In this paper we find that students do appear to value college consumption amenities, as revealed by their college choices. Importantly, there is significant preference heterogeneity across students; wealthy students are willing to pay more for consumption amenities while high-achieving students have a greater willingness-to-pay for academic quality. This finding is robust to a number of alternative specifications for demand and controls for several important sources of bias.

The existence of significant preference heterogeneity has important implications for the postsecondary market, since it results in different colleges facing very different incentives depending on their current student body and those they are trying to attract. More selective schools have a greater incentive to improve academic quality since this is the dimension most valued by its marginal students. Less selective schools (particularly privates), by comparison, have a greater incentive to focus on consumption amenities, since this is what their marginal students value. These demand pressures appear to have real consequences, as the colleges facing greater pressure to spend on consumption amenities are much more likely to do so. We estimate that a one standard deviation increase in colleges' enrollment elasticity is associated with a $0.10 increase in ratio of amenity to academic spending. Student preferences do appear to alter how educational resources are spent. This preference-induced demand pressure explains 11% the variation in spending priorities across four-year institutions.

More generally, our results suggest that colleges compete for students on many dimensions – price, distance, consumption amenities, academics – and that different students respond differently to these attributes because preferences are so heterogeneous. The importance of market pressure to the behavior of higher education institutions has not been thoroughly examined and the slim prior literature on the topic has focused exclusively on the role of

academic quality and cost, ignoring other dimensions on which colleges compete. One implication of our analysis is that for many institutions, demand-side market pressure may not compel investment in academic quality, but rather in consumption amenities. This is an important result given that quality assurance is primarily provided by demand-side pressure: the fear of losing students is believed to compel colleges to provide high levels of academic quality. However, our findings do not speak to the normative issue of whether the provision of consumption amenities is good or bad for students and taxpayers and prior work is mixed on this question (Webber and Ehrenberg, 2010; Lindo, Swensen, Waddell, 2012).

This discussion highlights four broad areas for future work. First, it would be natural to extend this analysis to understand the objectives of colleges by comparing their actions to the demand-side incentives they face. Our findings suggest that colleges respond to competitive demand pressures as expected, but a complete theoretical and empirical analysis of the supply side is beyond the scope of this paper. Previous work in this area has focused on colleges' admissions and financial aid decisions, but has not modeled colleges' provision of consumption amenities. Second, our analysis has focused on students that enroll in public and non-profit four-year colleges shortly after high school. Students attending community and for-profit colleges may have quite different preferences for college attributes, which colleges may consider. Future work should aim to better understand the college choice process of these students as well. Third, our analysis could be extended to understand how differences in preferences influence how students engage with college and persist. Variation in preferences for consumption and academics between students is one possible explanation for differences in college completion that has not been explored. Lastly, our analysis does not speak to the welfare consequences of the strong link between consumption and educational investment. Perhaps extracurricular and social

activities foster the acquisition of non-academic skills or make academic skills less costly to obtain. Given the substantial amount of public investment in higher education – some of which funds consumption amenities – it is natural to ask whether this investment is sound. We leave these questions for future researchers to answer.

References

Albouy, David, 2012. “Are Big Cities Bad Places to Live? Estimating Quality of Life across Metropolitan Areas.” University of Michigan. Mimeo.

Alter, Molly and Randal Reback. (2014). “True for Your School? How Changing Reputations Alter Demand for Selective U.S. Colleges.” *Educational Evaluation and Policy Analysis*, Vol. 36 No. 3 346-370.

Arcidiacono, Peter (2004). ”Ability sorting and the returns to college major.”*Journal of Econometrics* 121, 343-375.

Arcidiacono, Peter (2005). "Affirmative Action in Higher Education: How Do Admission and Financial Aid Rules Affect Future Earnings?" *Econometrica*, 73(5): 1477-1524.

Arum, Richard and Josipa Roksa (2011). *Academically Adrift: Limited Learning on College Campuses.* University of Chicago Press: Chicago, IL.

Avery, Chris, Mark Glickman, Caroline Hoxby, and Andrew Metrick (2005). “A Revealed Preference Ranking of U.S. Colleges and Universities.” NBER WP 10803.

Babcock, Philip and Minday Marks (forthcoming) The Falling Time Cost of College: Evidence from Half a Century of Time Use Data , *Review of Economics and Statistics*.

Bayer, Patrick, Fernando Ferreira, and Robert McMillan (2007). “A Unified Framework for Measuring Preferences for Schools and Neighborhoods.” *Journal of Political Economy*, August.

Becker, Gary (1964). *Human Capital*. New York: Columbia University Press.

Berry, Steven T. (1994). "Estimating Discrete-Choice Models of Product Differentiation," *RAND Journal of Economics*, 25(2): 242-262.

Berry, Steven, James Levinsohn, and Ariel Pakes (1995). "Automobile Prices in Market Equilibrium," *Econometrica*, 63(4), pages 841-90, July.

Black, Dan, and Jeff Smith (2004). "How Robust Is the Evidence on the Effects of College Quality? Evidence from Matching," *Journal of Econometrics*, 121, 99–124.

Bound, John, Michael Lovenheim, and Sarah E. Turner (2010) "Why Have College Completion Rates Declined? An Analysis of Changing Student Preparation and Collegiate Resources." *American Economic Journal: Applied Economics*, 2(3): 1-31.

Brand, Jennie, and Yu Xie (2010). "Who benefits Most From College? Evidence for Negative Selection in Heterogeneous Economic Returns to Higher Education." *American Sociological Review*

Conlon, Christopher T. and Julie Holland Mortimer (2010). "Demand Estimation Under Incomplete Product Availability." NBER Working Paper No. 14315,September 2008, Revised May 2010.

Desposato, Scott (2005). "A Model of Unordered Multiple Choice with Unobserved Choice Set Selection" University of California San Diego, mimeo.

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

Goldman, Dana and John Romley (2008). “Hospitals as Hotels: The Role of Patient Amenities in Hospital Demand.” NBER Working Paper 14619.

Goldman, Dana, Mary Vaiana, and John Romley (2010). “The Emerging Importance of Patient Amenities in Hospital Care.” *New England Journal of Medicine* 363: 2185-2187.

Guimaraes, Paulo and Pedro Portugal (2009). "A Simple Feasible Alternative Procedure to Estimate Models with High-Dimensional Fixed Effects," IZA Discussion Paper 3935.

Griffith, Amanda and Kevin Rask (2007). “The influence of the US News and World Report collegiate rankings on the matriculation decision of high-ability students: 1995-2004. *Economics of Education Review*, 26: 244-255.

Hastings, Justine S., Thomas J. Kane, and Doug O. Staiger, 2009. “Heterogeneous Preferences and the Efficacy of Public School Choice.” Mimeo.

Hoekstra, Mark (2009). “The Effect of Attending the Flagship State University: A Regression Discontinuity Approach.” *The Review of Economics and Statistics*, 91(4): 717–724.

Hoxby, Caroline (1997). “How the Changing Market Structure of U.S. Higher Education Explains College Tuition.” NBER Working Paper 6323.

Hoxby, Caroline (2009). “The Changing Selectivity of American Colleges. “*Journal of Economic Perspectives*. 23(4): 95-118.

Jacob, Brian and Lars Lefgren (2007). "What Do Parents Value in Education? An Empirical Investigation of Parents' Revealed Preferences for Teachers," *The Quarterly Journal of Economics*, 122(4): 1603-1637.

Jacob, Brian, Brian McCall, and Kevin Stange (2013). “Conditional Logit Estimation with Unobserved Choice Sets.” Mimeo, University of Michigan.

Jaquette, O. and E. Parra. 2014. "Using IPEDS for Panel Analysis: Core Concepts, Data Challenges, and Empirical Applications," in Higher Education: Handbook of Theory and Research (Volume 29).

Kodde, D.A. and J.M.M. Ritzen (1984), ”Integrating consumption and investment motives in a neoclassical model of demand for education”, *Kyklos* 37(4), 598-605.

Lazear, Edward (1977). “Education: consumption or production?” *Journal of Political Economy* 85(3).

Lindo, Jason M., Isaac D. Swensen, and Glen R. Waddell. 2012. "Are Big-Time Sports a Threat to Student Achievement?" *American Economic Journal: Applied Economics*, 4(4): 254-74.

Long, Bridget Terry (2004). “How have college decisions changed over time? An application of the conditional logistic choice model.” *Journal of Econometrics* 121:271-296.

Manski, Charles F. and David A. Wise (1983). *College choice in America*. Cambridge, MA: Harvard University Press, 1983.

McDuff, DeForest (2007). “Quality, tuition, and applications to in-state public colleges.” *Economics of Education Review*. Vol. 26: 433-449.

Michaels,R.T, (1973). “Education in nonmarket production,” *Journal of Political Economy*, Vol. 80.

Monks, James and Ronald G. Ehrenberg (1999). “The Impact of *U.S News & World Report* College Rankings On Admission Outcomes and Pricing Decisions at Selective Private Institutions.” NBER Working Paper No. 7227 July 1999

Oreopoulos, Philip and Kjell Salvanes (2011). “How large are returns to schooling? Hint: Money isn’t everything.” *Journal of Economic Perspectives* 25(1): 159-184.

Oosterbeek, H. and H.V. Ophem (2000), ”Schooling choices: Preferences, discount rates, and rates of return”, *Empirical Economics* 25, 15-34.

Pope, Devin G. and Jaren C. Pope (2009). “The Impact of College Sports Success on the Quantity and Quality of Student Applications.” *Southern Economic Journal* 75(3): 750-780.

Rothschild, Michael, and Lawrence J. White (1993). “The University in the Marketplace: Some Insights and Some Puzzles.” In *Studies of Supply and Demand in Higher Education*, ed. Charles Clotfelter, 11–37. Chicago: University of Chicago Press.

Rothschild, Michael, and Lawrence J. White (1995). “The Analytics of the Pricing of Higher Education and Other Services in Which the Customers Are Inputs.” *The Journal of Political Economy*, 10(3): 573–86

Rouse, Cecilia. (1995). “Democratization or Diversion? The Effect of Community Colleges on Educational Attainment,” *Journal of Business & Economic Statistics*. Vol. 13, No. 2, p. 217-224

Schaafsma, J. (1976). “The consumption and investment aspects of the demand for education”, *Journal of Human Resources* 11(2), 233-42.

Schultz, T. (1963) *The Economic Value of Education*. New York: Columbia Univ. Press.

Stange, K. (2012). Ability Sorting and the Importance of College Quality to Student Achievement: Evidence from Community Colleges. *Education Finance and Policy*, Vol. 7 (1) (Winter 2012)

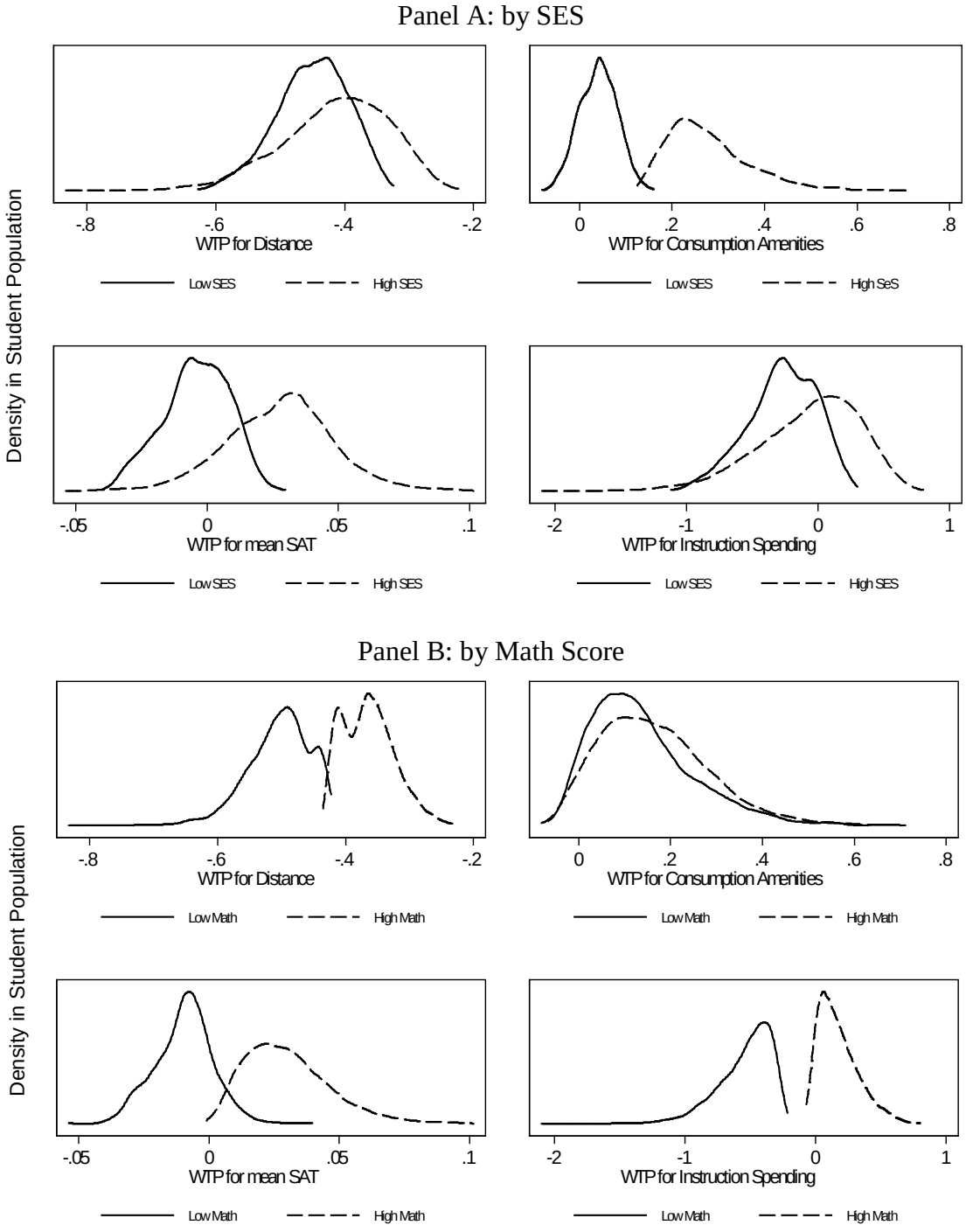
Smith, J. and K. Stange. (2015) A New Measure of College Quality to Study the Effects of College Sector and Peers on Degree Attainment. *Education Finance and Policy*, forthcoming.

Train, Kenneth E. (2003). *Discrete Choice Methods with Simulation*. New York: Cambridge University Press.

Webber, Douglas A. and Ronald G. Ehrenberg (2010). "Do expenditures other than instructional expenditures affect graduation and persistence rates in American higher education?," *Economics of Education Review*, 29(6): 947-958.

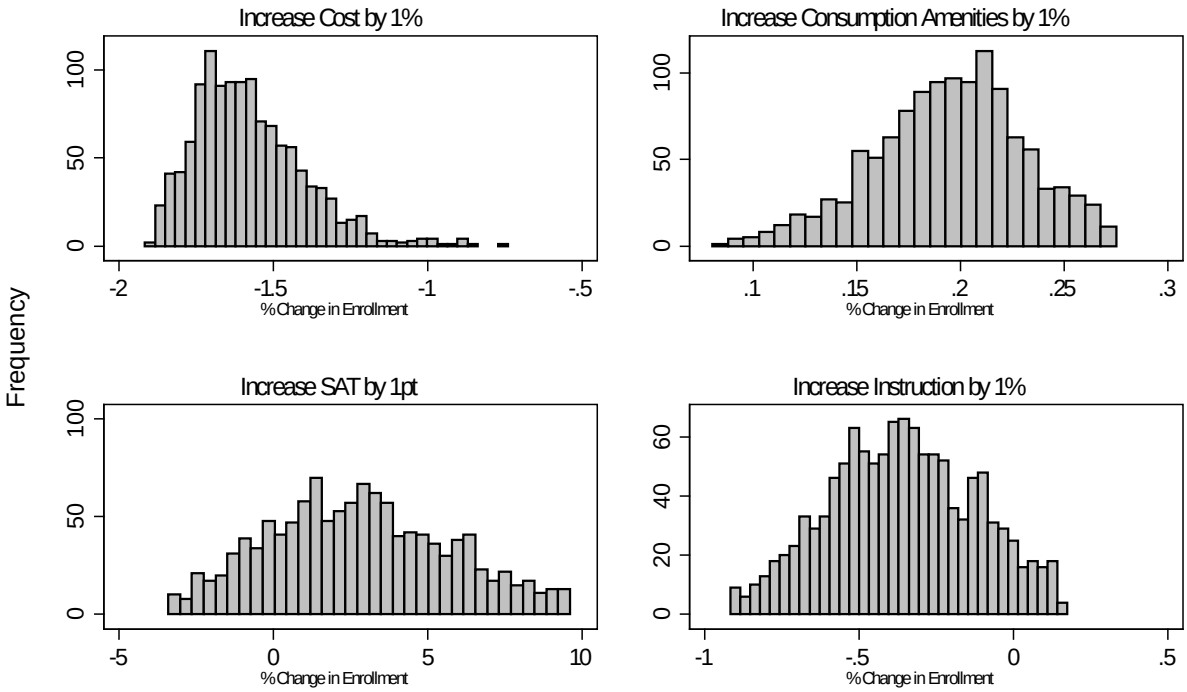
Wotapka, Dawn. (2012). “Resort Living Comes to Campus.” *Wall Street Journal*, December 6, 2012.

Figure 1: Distribution of Willingness-to-Pay for College Attribute



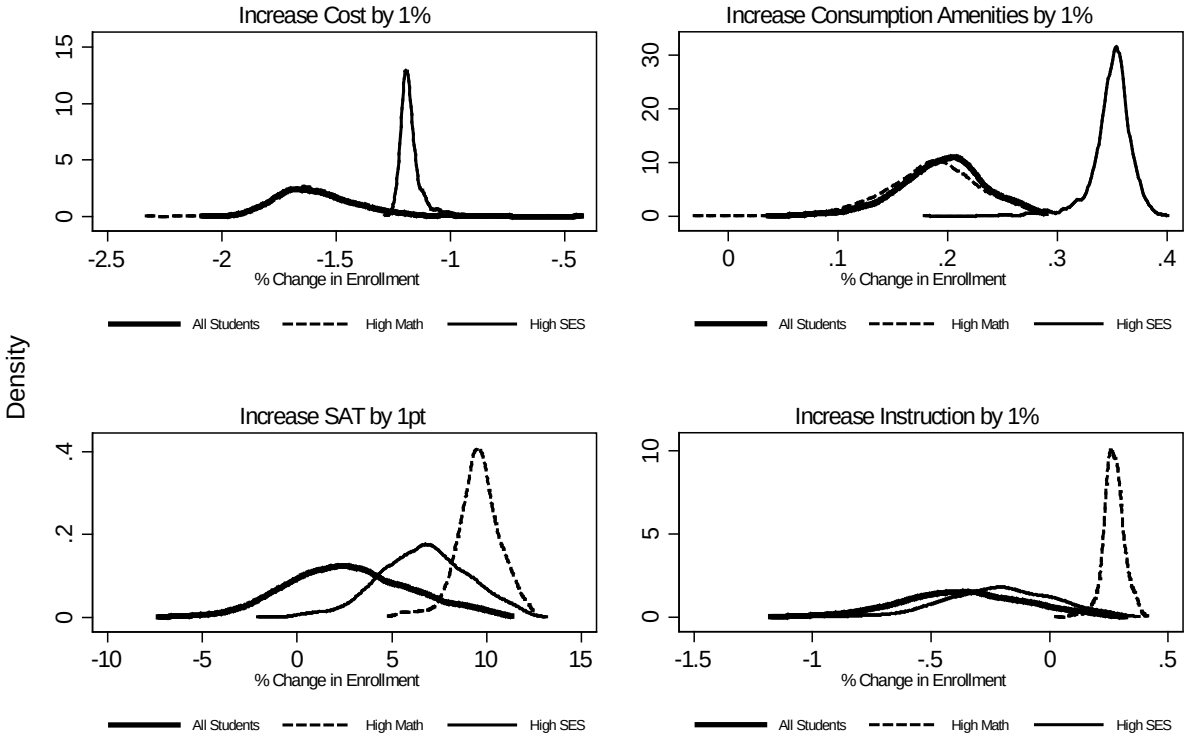
Notes: Notes: WTP for spending and distance can be interpreted as the percent increase in cost students are willing to pay to attend a college with a 1% increase in spending or 1% further away. Estimates come from the model in Table 5 (Specification 2) which includes interactions between college characteristics and male, math score, and SES. In each panel, high and low groups represent the top and bottom third by SES or math score, with middle third omitted.

Figure 2: Distribution of Percent Change in Enrollment Share
In response to change in own characteristic



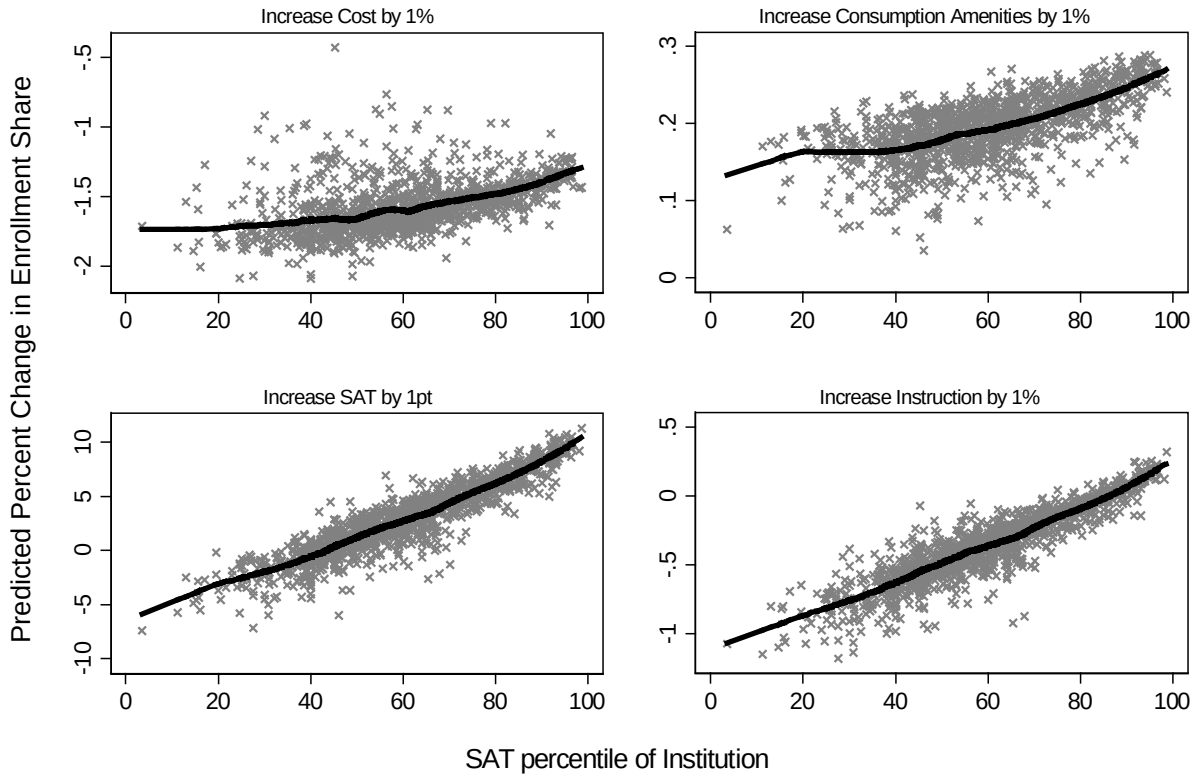
Notes: Each graph plots the distribution of the percent change in total enrollment at each individual college if this college were to change a single characteristic. Enrollment response is simulated using the estimates from the model Table 5 (Specification 2), which includes interactions between college characteristics and male, math score, and SES. Top and bottom 1% of observations are trimmed.

Figure 3: Distribution of Change in Enrollment Share for High Math and SES Students In response to change in own characteristic



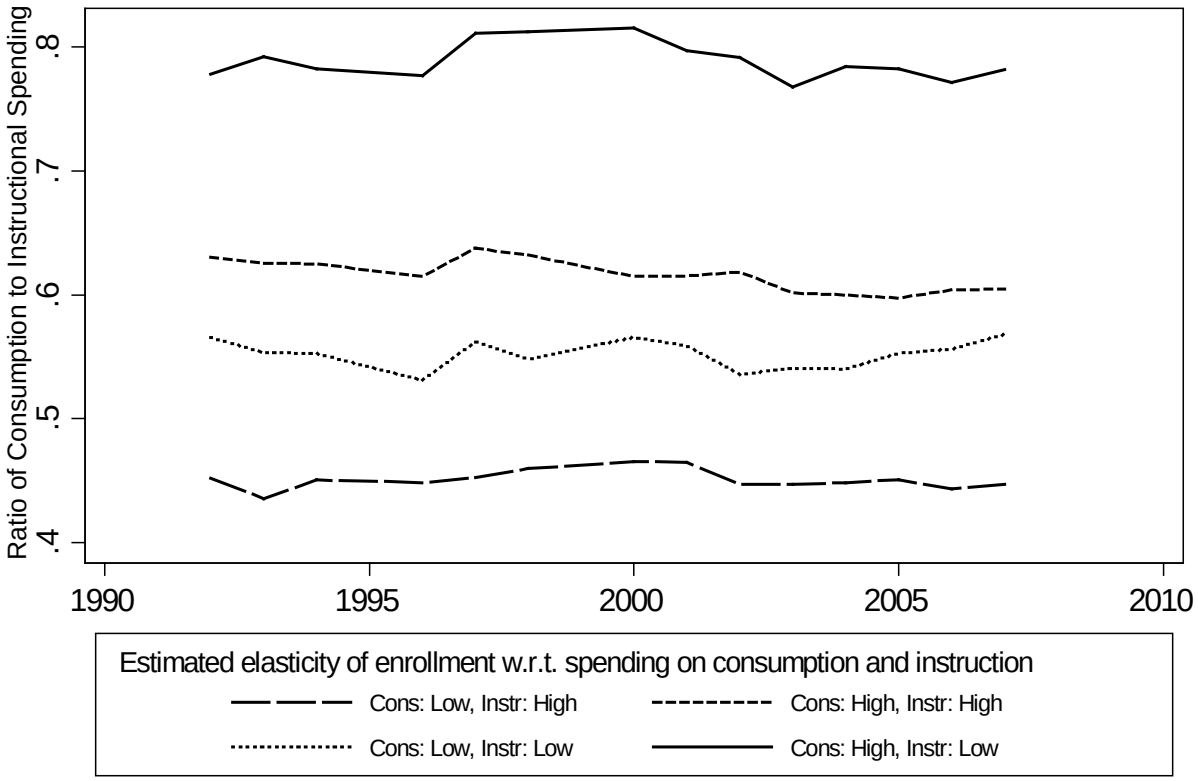
Notes: Each graph plots the distribution of the percent change in enrollment (all students, high math students, high SES students) at each individual college if this college were to change a single characteristic. Enrollment response is simulated using the estimates from the model in Table 5 (Specification 2) which includes college fixed effects and interactions between college characteristics and male, math score, and SES.

Figure 4: Total Enrollment Response to Change in Own College Characteristic by Institution Average Student SAT



Notes: Each point represents a separate simulation where the characteristic of a single college is changed in isolation. Enrollment response is simulated using the estimated choice model in Table 5 (Specification 2) which includes interactions between college and student characteristics. Graph includes lowess smoothed prediction line using a bandwidth of 0.20.

Figure 5: Trends in Spending Priority, by Estimated Elasticity to Spending Type



Notes: Enrollment elasticity to spending by type is simulated using the estimated choice model in Table 5 (Specification 2) which includes college fixed effects and interactions between college characteristics and male, math score, and SES. Colleges were divided into terciles for each of the spending elasticities, but only four of the nine resulting groups are displayed for clarity of presentation. Spending ratios are calculated at the college-level and then averaged across colleges in each group

Table 1 - Expenditures across Institution Type, 1992 and 2004

	1992				Change from 1992 - 2004	
	Tuition and Fees	Academic Spending per Student (Instruction + Academic Support)	Amenity Spending per Student (Auxiliary + Student Service)	Ratio: Amenity Spending / Academic Spending	Log Change in Amenity Spending	Log Change in the Amenity/Academic Ratio
	(1)	(2)	(3)	(4)	(5)	(6)
PhD Granting Institution	928.9*	3664.4**	-319.0	-0.219**	-0.0208	-0.0149
	(382.9)	(447.1)	(212.6)	(0.0230)	(0.0319)	(0.0357)
MA Granting Institution	389.0	628.7*	-703.3**	-0.133**	-0.0335	-0.0249
	(277.6)	(274.2)	(176.4)	(0.0214)	(0.0293)	(0.0325)
Private * Barron's Selectivity Group 1 (Most selective)	21965.4**	19425.3**	8212.5**	0.0890+	0.162+	-0.0867
	(510.4)	(2065.5)	(782.1)	(0.0530)	(0.0892)	(0.106)
Private * Barron's Selectivity Group 2	18367.6**	9563.6**	4820.9**	0.115**	0.196*	-0.0189
	(1937.3)	(1781.8)	(510.3)	(0.0371)	(0.0971)	(0.0952)
Private * Barron's Selectivity Group 3	14683.2**	4269.3**	3236.6**	0.194**	0.187**	0.0739
	(582.6)	(636.0)	(273.0)	(0.0349)	(0.0690)	(0.0679)
Private * Barron's Selectivity Group 4	11616.8**	1679.2**	1968.9**	0.204**	0.184**	0.0817
	(326.6)	(401.9)	(224.2)	(0.0299)	(0.0688)	(0.0652)
Private * Barron's Selectivity Group 5	9246.0**	1244.9*	1162.2**	0.190**	0.250**	0.129
	(369.6)	(625.3)	(243.5)	(0.0452)	(0.0822)	(0.0860)
Private * Barron's Selectivity Group 6 (Least selective)	5223.5**	-432.2	104.0	0.188*	0.570*	0.0300
	(674.7)	(582.3)	(466.5)	(0.0754)	(0.225)	(0.126)
Public * Barron's Selectivity Group 1 (Most selective)	229.6	15808.9**	6578.7*	-0.00814	-0.0354	-0.0510
	(1163.4)	(4636.2)	(2633.7)	(0.113)	(0.131)	(0.130)
Public * Barron's Selectivity Group 2	1304.0**	5301.9**	2280.3**	0.0309	0.0288	-0.0121
Public * Barron's Selectivity Group 3	745.7*	3338.4**	1699.8**	0.0583+	-0.00494	0.0532
	(289.8)	(635.8)	(278.0)	(0.0354)	(0.0829)	(0.0826)
Public * Barron's Selectivity Group 4	562.2**	954.1*	1026.0**	0.0893**	0.000213	0.0398
	(196.5)	(377.4)	(219.6)	(0.0290)	(0.0690)	(0.0660)
Public * Barron's Selectivity Group 5	426.5*	1108.6**	434.8*	0.00182	0.0305	0.0783
	(206.7)	(385.2)	(209.3)	(0.0298)	(0.0704)	(0.0708)
Constant	2390.6**	4464.7**	3063.7**	0.579**	0.112+	-0.0519
	(292.0)	(407.2)	(232.4)	(0.0305)	(0.0667)	(0.0660)
Number of observations	1362	1362	1362	1362	1362	1362
R-squared	0.839	0.541	0.464	0.231	0.095	0.009

Notes: Public unselective institutions (Barron's Selectivity Group 6) is the reference category. Standard errors in parentheses. + p<0.10, * p<0.05, ** p<0.01. Sample: Regular 4-year institutions with good parent/child relationship that were in the sample in 1992 and 2004.Observations weighted by the enrollment of first-time, full-time undergraduates in the year.

Table 2. College Summary Statistics

	1992		2004		Within-institution change, 1992 to 2004	
mean (std. dev.)	public	private	public	private	public	private
In-State Tuition	3,609	16,013	5,490	22,377	2,138	7,131
	(1,438)	(5,817)	(2,155)	(7,031)	(1,319)	(3,024)
Out-of-State Tuition	9,389	16,018	13,929	22,377	5,100	7,123
	(3,148)	(5,809)	(4,466)	(7,031)	(2,643)	(3,037)
Room and Board	5,398	6,229	7,140	7,646	1,615	1,397
	(1,642)	(1,881)	(1,475)	(1,928)	(1,310)	(1,613)
Freshmen Fall Enrollment	1,476	527	1,837	593	397	103
	(1,077)	(520)	(1,473)	(556)	(643)	(263)
Full-Time Equivalent Enrollment	9,524	2,850	11,086	3,464	1,838	741
	(7,844)	(3,481)	(9,161)	(4,016)	(2,482)	(1,233)
Instructional and Academic Support $ per FTE	7,599	9,455	8,395	12,209	1,043	3,572
	(3,204)	(7,056)	(3,673)	(10,442)	(1,529)	(4,681)
Student Services and Auxiliary Enterprises $ per FTE	3,413	5,713	3,602	6,462	381	1,139
	(1,628)	(2,938)	(2,146)	(3,506)	(1,534)	(1,957)
Median or mean SAT Ptile	59.51	68.82	52.58	62.00	-7.14	-4.66
	(15.36)	(17.37)	(16.11)	(18.58)	(10.74)	(9.37)
Highest degree offered is BA	0.13	0.38	0.10	0.26		
	(0.34)	(0.49)	(0.30)	(0.44)		
Highest degree offered is MA	0.46	0.42	0.42	0.44		
	(0.50)	(0.49)	(0.49)	(0.50)		
Highest degree offered is PhD	0.41	0.20	0.48	0.29		
	(0.49)	(0.40)	(0.50)	(0.46)		
Number of Schools	445	520	466	616	393	419

Notes: All spending variables are deflated by the CPI-U and are in 2009 dollars. Sample includes non-specialized public and non-profit private four-year university and colleges attended by members of micro sample. Final two columns restricted to institutitons that appear in both 1992 and 2004 samples.

Table 3: Student and Student-College Characteristics

	1992		2004	
Number of students in analysis sample	4,037		5,644	
Number of chosen alternatives	4,037		5,644	
Number of non-chosen alternatives	3,891,668		6,101,164	
Background Characteristics of Analysis Sample	Mean	SD	Mean	SD
Male	0.47	0.50	0.45	0.50
Standardized math score	0.62	0.83	0.65	0.82
Standardized SES	0.41	0.97	0.48	0.98
Standardized composite measure of importance of various college characteristics in analysis sample*				
Academics (courses, reputation)	0.27	0.74	0.33	0.69
Cost (low costs, availability of financial aid)	-0.14	0.65	-0.02	0.67
Social Life (athletics, social life)	-0.03	0.83	0.18	0.87
Characteristics of institution student attended				
Cost (Tuition + Fees + Room and Board)	14,802	8,649	20,859	10,648
Distance from institution to home (miles)	196	385	220	483
School Mean SAT (percentile)	67.54	17.26	62.07	17.17
Spending on academics/fte ($2009)	9,996	6,909	11,838	9,108
Spending on amenities /fte ($2009)	4,664	2,706	5,040	3,304
Log(enrollment)	7.10	0.97	7.35	0.95
Predicted probability of admission	0.73	0.16	0.82	0.17
Predicted net price	11,597	6,783	15,347	7,731
In state	0.74	0.44	0.73	0.44
In region	0.82	0.39	0.82	0.38
Characteristics of institutions not attended				
Cost (Tuition + Fees + Room and Board)	18,716	6,972	26,045	8,446
Distance from institution to home (miles)	955	708	1,002	779
School Mean SAT (percentile)	64.53	17.10	57.94	18.15
Spending on academics/fte ($2009)	8,598	5,687	10,565	8,446
Spending on amenities /fte ($2009)	4,652	2,679	5,231	3,312
Log(enrollment)	6.46	0.92	6.58	0.94
Predicted probability of admission	0.68	0.20	0.80	0.22
Predicted net price	13,428	5,445	17,447	6,750
In state	0.03	0.18	0.03	0.18
In region	0.12	0.33	0.13	0.33

Notes: *Simple item average, standardized with 1972 mean and s.d.

Table 4: Estimates of the Predictors of College Choice, No Preference Heterogeneity (Odds Ratios Reported)

	Dept Variable: College Chosen by High School Graduates in 1992 and 2004			
	(1)	(2)	(3)	(4)
Log (Tuition, Fees, Room & Board)	0.137 ***	0.195 ***	0.046 ***	0.389 ***
	(0.0039)	(0.0054)	(0.0018)	(0.0145)
Log (Distance)	0.327 ***	0.324 ***	0.315 ***	0.484 ***
	(0.0020)	(0.0020)	(0.0019)	(0.0042)
Log (Spending on Consumption Amenities/FTE)	2.032 ***	1.592 ***	1.402 ***	1.137 ***
	(0.0536)	(0.0417)	(0.0374)	(0.0294)
Log (Spending on Academics/FTE)	1.158 ***	1.484 ***	0.873 ***	0.880 ***
	(0.0375)	(0.0510)	(0.0306)	(0.0292)
School Mean SAT (percentile)	1.013 ***	1.018 ***	1.011 ***	1.006 ***
	(0.0009)	(0.0009)	(0.0009)	(0.0009)
Institution state unemployment rate				0.948 ***
				(0.0138)
Log(high school grads in institution state)				0.997
				(0.0209)
College located in the student's home state				8.269 ***
				(0.3642)
College located in the student's census region				2.061 ***
				(0.0910)
Log (Lagged first time freshman enrollment)	Yes	Yes	No	No
Accounting for Probability of Admissions	No	Yes	Yes	Yes
Log (Predicted net price) used as cost measure	No	Yes	Yes	Yes
College Fixed Effects	No	No	Yes	Yes
Willingness-to-Pay (s.e.)				
Log (Distance)	-0.563	-0.689	-0.376	-0.768
	(0.0097)	(0.0140)	(0.0052)	(0.0318)
Log (Spending on Consumption Amenities/FTE)	0.357	0.284	0.110	0.136
	(0.0137)	(0.0168)	(0.0086)	(0.0275)
Log (Spending on Academics/FTE)	0.074	0.241	-0.044	-0.136
	(0.0161)	(0.0200)	(0.0110)	(0.0365)
School Mean SAT (percentile)	0.007	0.011	0.004	0.007
	(0.0004)	(0.0005)	(0.0003)	(0.0009)

Notes: Odds ratios are reported with robust standard errors in parentheses. All specifications have 10,002,513 observations. Spending on consumption amenities includes student services and auxilary enterprises (primarily food service, sports, and dorms). Academic spending includes both instruction and academic support services. Selective admissions is accounded for by weighing each observation in the conditional logit model by the predicted probability that each student would be admitted to the school in the given year. See text. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Estimates of the Predictors of College Choice, Heterogeneity by Observable Student Characteristics

	Dept Variable: College Chosen by High School Graduates in 1992 and 2004			
	(1)		(2)	
	Est.	(S.E.)	Est.	(S.E.)
Log (Tuition, Fees, Room & Board)	-1.086 ***	(0.0543)	-1.790 ***	(0.0624)
X male	-0.182 ***	(0.0646)	-0.194 ***	(0.0727)
X math score (standardized)	0.016	(0.0448)	-0.020	(0.0503)
X SES (standardized)	0.385 ***	(0.0379)	0.425 ***	(0.0423)
Log (Distance)	-0.787 ***	(0.0128)	-0.892 ***	(0.0125)
X male	0.012	(0.0137)	0.007	(0.0138)
X math score (standardized)	0.095 ***	(0.0093)	0.112 ***	(0.0092)
X SES (standardized)	0.174 ***	(0.0078)	0.176 ***	(0.0078)
Log (Amenity Spending/FTE)	0.327 ***	(0.0413)	0.196 ***	(0.0415)
X male	-0.024	(0.0507)	-0.041	(0.0548)
X math score (standardized)	0.006	(0.0339)	-0.042	(0.0358)
X SES (standardized)	0.120 ***	(0.0281)	0.132 ***	(0.0293)
Log (Academic Spending/FTE)	-0.292 ***	(0.0548)	-0.794 ***	(0.0601)
X male	0.085	(0.0627)	0.094	(0.0686)
X math score (standardized)	0.510 ***	(0.0426)	0.631 ***	(0.0472)
X SES (standardized)	0.032	(0.0363)	0.050	(0.0394)
School Mean SAT (percentile)	-0.002	(0.0013)	-0.009 ***	(0.0014)
X male	-0.005 ***	(0.0018)	-0.005 ***	(0.0020)
X math score (standardized)	0.025 ***	(0.0012)	0.030 ***	(0.0013)
X SES (standardized)	0.010 ***	(0.0010)	0.011 ***	(0.0011)
Log (Lagged first time freshman enrollment)	Yes		No	
Accounting for Probability of Admissions	Yes		Yes	
Log (Predicted net price) used as cost measure	Yes		Yes	
College Fixed Effects	No		Yes	
Unemployment rate, log(HS grads), In-state, In-region	Yes		Yes	

Notes: Coefficients are reported with robust standard errors in parentheses. Both specifications have 10,002,513 observations.Spending on consumption amenities includes student services and auxilary enterprises (primarily food service, sports, and dorms). Academic spending includes both instruction and academic support services. Selective admissions is accounded for by weighing each observation in the conditional logit model by the predicted probability that each student would be admitted to the school in the given year. Predicted net price is from auxilliary model estimated with other data. See text. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Robustness of Main Model

	Main model (1)		FT faculty as academic resource measure (2)		Spending effects vary by institution level (3)		Sector time trend (4)	
	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)
Log (Tuition, Fees, Room & Board)	-1.790 ***	(0.0624)	-1.836 ***	(0.0617)	-1.794 ***	(0.0624)	-1.848 ***	(0.0633)
X male	-0.194 ***	(0.0727)	-0.150 **	(0.0707)	-0.195 ***	(0.0726)	-0.197 ***	(0.0725)
X math score (standardized)	-0.020	(0.0503)	0.092 *	(0.0495)	-0.020	(0.0503)	-0.021	(0.0501)
X SES (standardized)	0.425 ***	(0.0423)	0.425 ***	(0.0412)	0.425 ***	(0.0423)	0.425 ***	(0.0422)
Log (Distance)	-0.892 ***	(0.0125)	-0.878 ***	(0.0123)	-0.892 ***	(0.0125)	-0.892 ***	(0.0125)
X male	0.007	(0.0138)	0.004	(0.0135)	0.007	(0.0138)	0.007	(0.0138)
X math score (standardized)	0.112 ***	(0.0092)	0.096 ***	(0.0090)	0.112 ***	(0.0092)	0.112 ***	(0.0092)
X SES (standardized)	0.176 ***	(0.0078)	0.176 ***	(0.0077)	0.176 ***	(0.0078)	0.175 ***	(0.0078)
Log (Amenity Spending/FTE)	0.196 ***	(0.0415)	0.074 *	(0.0431)	0.324 ***	(0.0733)	0.223 ***	(0.0421)
X male	-0.041	(0.0548)	0.020	(0.0583)	-0.042	(0.0550)	-0.043	(0.0550)
X math score (standardized)	-0.042	(0.0358)	0.082 **	(0.0377)	-0.038	(0.0366)	-0.040	(0.0358)
X SES (standardized)	0.132 ***	(0.0293)	0.101 ***	(0.0312)	0.135 ***	(0.0297)	0.137 ***	(0.0293)
X Masters-level institution					-0.034	(0.0780)		
X PhD-level institution					-0.200	(0.0799)		
Log (Academic Spending/FTE)	-0.794 ***	(0.0601)	-0.609 ***	(0.0840)	-0.904 ***	(0.0889)	-0.525 ***	(0.0601)
X male	0.094	(0.0686)	-0.156	(0.1051)	0.095	(0.0685)	0.097	(0.0684)
X math score (standardized)	0.631 ***	(0.0472)	0.220 ***	(0.0686)	0.627 ***	(0.0475)	0.635 ***	(0.0472)
X SES (standardized)	0.050	(0.0394)	0.170 ***	(0.0595)	0.049	(0.0394)	0.050	(0.0393)
X Masters-level institution					0.011	(0.0735)		
X PhD-level institution					0.170	(0.0752)		
School Mean SAT (percentile)	-0.009 ***	(0.0014)	-0.013 ***	(0.0013)	-0.009 ***	(0.0014)	-0.009 ***	(0.0014)
X male	-0.005 ***	(0.0020)	-0.004 **	(0.0019)	-0.005 ***	(0.0020)	-0.005 ***	(0.0020)
X math score (standardized)	0.030 ***	(0.0013)	0.036 ***	(0.0012)	0.030 ***	(0.0013)	0.030 ***	(0.0013)
X SES (standardized)	0.011 ***	(0.0011)	0.012 ***	(0.0010)	0.011 ***	(0.0011)	0.011 ***	(0.0011)
Public X 2004							0.289 ***	(0.0345)

Notes: Coefficients are reported with robust standard errors in parentheses. Spending on consumption amenities includes student services and auxilary enterprises (primarily food service and dorms). Academic spending includes both instruction and academic support services. All specifications have 10,002,513 observations and include college fixed effects, state unemployment rate, log(high school graduates in state), and dummies for in-state and in-region. Selective admissions is accounded for by weighing each observation in the conditional logit model by the predicted probability that each student would be admitted to the school in the given year. Predicted net price is from auxilliary model estimated with other data. See text. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Conditional Logit Estimates of the Predictors of College Choice, Heterogene

Independent Variables	(1) Est.		(S.E.)
Log (Tuition, Fees, Room & Board)	-4.023	***	(0.0916)
X social life important (standardized)	0.039		(0.0474)
X expenses important (standardized)	-0.544	***	(0.0666)
X academics important (standardized)	0.231	***	(0.0576)
X male	-0.167	**	(0.0805)
X math score (standardized)	-0.091		(0.0597)
X SES (standardized)	0.230	***	(0.0489)
Log (Distance)	-1.280	***	(0.0136)
X social life important (standardized)	0.096	***	(0.0081)
X expenses important (standardized)	-0.197	***	(0.0113)
X academics important (standardized)	0.022	**	(0.0102)
X male	-0.019		(0.0141)
X math score (standardized)	0.101	***	(0.0099)
X SES (standardized)	0.124	***	(0.0082)
Log (Spending on Consumption Amenities/FTE)	0.336	***	(0.1084)
X social life important (standardized)	0.178	***	(0.0334)
X expenses important (standardized)	-0.277	***	(0.0487)
X academics important (standardized)	0.030		(0.0413)
X male	-0.111	*	(0.0592)
X math score (standardized)	-0.051		(0.0428)
X SES (standardized)	0.187	***	(0.0348)
Log (Spending on Academics/FTE)	-0.939	***	(0.1678)
X social life important (standardized)	-0.118	***	(0.0432)
X expenses important (standardized)	-0.092		(0.0613)
X academics important (standardized)	0.199	***	(0.0544)
X male	0.176	**	(0.0744)
X math score (standardized)	0.691	***	(0.0567)
X SES (standardized)	0.053		(0.0457)
School Mean SAT (percentile)	-0.008	**	(0.0034)
X social life important (standardized)	0.004	***	(0.0012)
X expenses important (standardized)	-0.012	***	(0.0017)
X academics important (standardized)	0.002		(0.0015)
X male	-0.006	***	(0.0021)
X math score (standardized)	0.034	***	(0.0016)
X SES (standardized)	0.010	***	(0.0012)

Notes: Coefficients are reported with robust standard errors in parentheses. Spending on consumption amenities includes student services and auxilary enterprises (primarily food service and dorms). Academic spending includes both instruction and academic support services. Specification has 10,002,513 observations and include college fixed effects, state unemployment rate, log(high school graduates in state), and dummies for in-state and in-region. Selective admissions is accounded for by weighing each observation in the conditional logit model by the predicted probability that each student would be admitted to the school in the given year. Predicted net price is from auxilliary model estimated with other data. See text. Stated preference is constructed by combining answers to several questions about the importance of various factors in college decision into three categories: social life (including athletics), costs (low cost, availability of financial aid), and academics (course offerings and reputation). *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Relationship between Demand Elasticity and Spending Priorities in 2004

	Dependent variable: Ratio of Consumption Amenity to Academic Spending					
				Robustness		
	Main choice model (includes college fixed effects)			No fixed effects	FT faculty as academic resource measure	Spending effects vary by institution level
	(1)	(2)	(3)	(4)	(5)	(6)
Public institution	-0.153***		-0.124***	-0.128***	-0.136***	-0.149***
	(0.021)		(0.021)	(0.021)	(0.020)	(0.020)
Mean SAT of college	-0.002***		-0.001	-0.001	-0.007***	-0.002**
	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)
Log(Enrollment)	-0.024**		-0.013	-0.010	-0.017*	0.038***
	(0.011)		(0.010)	(0.011)	(0.010)	(0.011)
Log(Consumption + academic spending)	0.025		0.036	0.043	-0.027	0.070**
	(0.028)		(0.032)	(0.033)	(0.028)	(0.032)
Elasticity w.r.t. spending on						
Consumption amenities (standardized)		0.097***	0.068***	0.081***	0.110***	0.086***
		(0.009)	(0.012)	(0.013)	(0.022)	(0.009)
Academic (standardized)		-0.082***	-0.070***	-0.084***	0.023	-0.043*
		(0.011)	(0.022)	(0.028)	(0.018)	(0.022)
Constant	0.640**	0.549***	0.398	0.318	1.386***	-0.197
	(0.267)	(0.007)	(0.347)	(0.360)	(0.290)	(0.344)
Observations	1,227	1,227	1,227	1,227	1,227	1,227
R-squared	0.200	0.106	0.234	0.227	0.246	0.285
State FE	Yes	No	Yes	Yes	Yes	Yes

Notes: Enrollment elasticities in columns (1) to (3) are estimated for each college using estimates from model in Table 5 (specification 2) which includes interactions between college characteristics and student characteristics (male, math score, and SES), and adjustments for admissions selectivity and net price. Enrollment elasticities are normalized to have a mean of zero and standard deviation of one. Specification (5) includes the elasticity with respect to log(full-time faculty per FTE) in place of academic spending elasticity. Robust standard errors reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendices

Appendix A: Data and Sample Construction

Appendix B: Additional Descriptive Evidence on College Amenities

Appendix C: Net Price and College Admissions Models

Appendix D: Additional Robustness and Validity Results

Appendix E: Model and Deriving Institution-specific Demand Elasticities

Appendix A: Data Sources and Sample

The student-level data for this analysis is drawn from two datasets collected by the National Center for Education Statistics (NCES) in the U.S. Department of Education: the National Educational Longitudinal Survey (NELS), which tracks the high school graduating class of 1992 and the Educational Longitudinal Survey (ELS), which tracks the high school graduating class of 2004. Both datasets provided detailed information on student demographics, prior achievement, college application and admission decisions and college enrollment.

Construction of Analysis Sample

Our student sample begins with all of the students in the nationally representative set of 12^{th} graders in 1992 (NELS) and 2004 (ELS). Note that the NELS (ELS) starts by surveying students in 8^{th} (10^{th}) grade, but "freshen" their sample to obtain a nationally representative set of 12^{th} graders. We include in our analysis only students who enrolled in four-year, public or not-for-profit college within two years of expected high school graduation. We then drop students who did not first attend one of the eligible institutions in our sample (described below). We then drop students who have missing information on high school state, socioeconomic status, standardized math score, gender, or race. Finally, we drop from our analysis any student whose choice school was subsequently dropped due to missing key institutional characteristics. When this student's choice school was dropped for missing these variables, we dropped the student entirely from the analysis set. Table A1 shows how the sample size changes for each step in the process above.

From the universe of institutions contained in the IPEDS Institutional Characteristics files in 1992 and 2004, we limit our sample in several ways. First, we limit our sample to public and non-profit private undergraduate four-year schools only, excluding all two-year (or less) schools, all for-profit schools, and schools offering professional degrees only. Second, we drop specialized divinity, law, medical, specialized health (e.g. nursing), and art schools, though we keep engineering, teaching, military, and business schools. We drop schools with an average of fewer than 50 freshmen or 300 FTEs over our two sample years in an effort to eliminate remaining specialized schools which are arguably not in many students' choice set. In practice this drops mostly small seminary and rabbinical schools that were not categorized as such. We drop from our analysis any school for which we do not have information on instructional spending, academic support spending, student services spending, auxiliary enterprise spending, tuition or room and board costs, zip code, enrollment, or average SAT score. Finally, because they will not contribute at all to the estimation when fixed effects are included, colleges that were not attended by at least one student in our micro-data sample in at least one year are dropped. A small number of schools are missing characteristics used to estimate net price (e.g. institutional grant aid) and are also dropped. Table A1 shows how the sample size changes for each step in the process above.

Measures

Our data on college enrollment come from student surveys administered in 1994 for the NELS cohort and in 2006 for the ELS cohort. We define a student's choice school as the first institution she or he attended, according to NELS and ELS surveys. For NELS, students were asked which schools they attended in a 1994 follow-up survey. This is separate from the application survey questions in 1992 asking students in their senior year of high school which post-secondary institutions they applied to and whether they were accepted. The ELS asked students in 2006, two years after graduation, to which schools they applied, were accepted, and attended. Using the enrollment dates provided in the data, we identify the first institution each

student attended, assigning this first institution to be the choice institution. Other student characteristics include sex, race, standardized score on a 12th grade math exam found in both NELS and ELS, high school grade point average, and a SES composite measure, which we standardize within each cohort. The SES composite is constructed by NCES for NELS/ELS respondents from five components (father's and mother's educational levels, father's and mother's occupation, and family income) and has the benefit of being non-missing for most of the raw sample.

We obtain in- and out-of-state tuition, room and board, freshmen fall enrollment, and number of full-time equivalent students from the IPEDS Institutional Characteristics and Enrollment surveys. We obtain spending by category for each institution from the IPEDS Finance survey. As described by Jaquette and Parra (2014), some institutions report financial information aggregated across many campuses in the same system. As a consequence, spending information available from the Delta Cost Project that is harmonized across years is aggregated across all institutions in many public university systems, including the University of Alaska, University of Illinois, University of Massachusetts, University of Maine, University of Missouri, University of Nebraska, University of New Hampshire, City University of New York, Ohio State University, Ohio University, University of Pittsburgh, and University of Texas systems. For this reason, we rely on the raw (unaggregated) data available in the IPEDS Finance surveys. There are three university systems (Penn State University, the University of Connecticut, and Rutgers University) that report combined spending data aggregated across all their branch campuses in these two years. For these institutions, we assign the aggregate average spending per student for the system overall to all institutions in the system.[1] We follow the procedures described by the Delta Cost Project to make the spending measures consistent over time, correcting for changes in accounting and spending reporting practices.

We obtained the average SAT percentile score (or ACT equivalent) of the incoming student body from Cass Barron's Profiles of American Colleges (1992). For 2004, we used the average of the 25th and 75th SAT percentile, which we obtained from IPEDS. Additional institutional characteristics were obtained from various other sources, including the Barron's selectivity datafile (obtained from NCES), number of full-time faculty (IPEDS Salary survey), number of degrees granted by major (IPEDS completion survey), fraction of student in need and that live on campus (College Board's Annual Survey of Colleges), a hedonic measure of the quality of life in the area in which each college is located (reported in Albouy, 2012), school-level admissions rate (Peterson's).

[1] In fact all Rutgers University and Penn State University branch institutions are subsequently dropped from our sample, as they are missing information about average institutional grant aid and thus net price cannot be estimated for them.

Table A1: Sample Construction

Panel A. Number of institutions (starting with constructed sample)	NELS (1992)	ELS (2004)
Total schools in sample	1,409	1457
After dropping schools with missing or zero tuition or room and board costs, missing academic or amenity spending	1,371	1,425
No fallout for missing enrollment or mean SAT information	1,371	1,425
After dropping schools that no student in sample chose	974	1,101
After dropping schools missing institutional characteristics needed to estimate net price	965	1,082
Final institutional sample	**965**	**1,082**

Panel B. Number of Unique Students	NELS (1992)	ELS (2004)
Total students in survey	28,622	16,197
After dropping students not enrolled in 12th grade at time of the 1992 or 2004 survey	17,959	13,370
After dropping students who did not respond to the follow-up survey	16,409	11,984
After dropping students who did not attend any postsecondary school within two years of expected high school graduation	8,571	9,466
After dropping students who did not attend a sample school	5,104	5,757
After dropping students with missing information on key covariates	4,101	5,757
After dropping students whose choice college was missing information	4,077	5,720
After dropping students whose choice college was missing information needed to estimate net price	4,037	5,644
Final student sample	**4,037**	**5,644**

Table A2. Pair-wise Correlations of College Characteristics

	Log In-State Tuition + RBR	Log Out-of-State Tuition + RBR	Log Amenity Spending	Log Academic Spending	Mean SAT
	Correlations in 2004 (n= 1082)				
Log In-State Tuition + RBR	1.000				
Log Out-of-State Tuition + RBR	0.861	1.000			
Log Amenity Spending	0.618	0.601	1.000		
Log Academic Spending	0.532	0.663	0.620	1.000	
Mean SAT	0.500	0.618	0.510	0.647	1.000
	Correlations in 1992 (n=965)				
Log In-State Tuition + RBR	1.000				
Log Out-of-State Tuition + RBR	0.892	1.000			
Log Amenity Spending	0.581	0.599	1.000		
Log Academic Spending	0.461	0.626	0.585	1.000	
Mean SAT	0.509	0.585	0.492	0.609	1.000
	Correlation of difference 2004-1992 (n=812)				
Log In-State Tuition + RBR	1.000				
Log Out-of-State Tuition + RBR	0.857	1.000			
Log Amenity Spending	0.109	0.084	1.000		
Log Academic Spending	0.082	*0.038*	0.356	1.000	
Mean SAT	*0.003*	*0.000*	*-0.004*	*0.088*	1.000

Notes: Each cell is the college-level pair-wise (unweighted) correlation between each pair of variables. Correlations where observations are weighted based on the number of individuals choosing the school in our sample are very similar, both qualitatively and quantitatively. Estimates in italics indicate correlation is not significant at the 95% level. All other correlations are significant.

Appendix B: Additional Descriptive Evidence on College Amenities

This appendix presents additional analysis that describes our spending measures and validates their use as measures of consumption amenities.

In order to obtain a better sense of what types of spending dominate these broad categories, we spoke with representatives at the National Association of College and University Business Officers (NACUBO) and examined the operating budgets from a handful of colleges and universities in our sample. These investigations suggested that expenses associated with athletics, student residence halls, student dining and student activities constitute a large portion of the auxiliary spending. For example, intercollegiate athletics, residential life, and other student services constitute 70% of auxiliary spending at the University of Houston in 2008. The largest categories within student services are typically expenses associated with the admissions office, the financial aid office, and the Dean of Students' Office. See Table B1 for detailed operating budgets on select schools.

This qualitative evidence is consistent with quantitative analyses we conducted. Using detailed financial data relating to expenditures on intercollegiate athletics collected by IPEDS in 1992, we calculate that among the set of four-year institutions that have any intercollegiate sports, about 38% report the spending within student services, 48% report the spending within auxiliary services and the remaining 14% report these athletic expenditures either in instruction or through a foundation or corporation. Among all institutions – including those that do not have any intercollegiate sports – intercollegiate athletic spending represents roughly 10% of expenditures in both the auxiliary and student service categories (see Table B2 for more detail).

In order to better understand the relationship between athletics, student housing and spending in our "amenity categories," we estimated a series of OLS regressions, which are shown in Appendix Table B3. After controlling for institutional sector, selectivity and highest degree offered, we find that the percent of undergraduates living on campus and the number of intercollegiate sports offered at the college are both significantly related with amenity spending. For example, colleges that offer 10 more intercollegiate sports spend roughly 10 percent more per student on auxiliary and student services. Similarly, a 10 percentage point increase in the fraction of students living on campus is associated with 10 percent greater spending in these categories. In addition, we find that the *change* in fraction of students living on campus between 1992 and 2004 is a strong predictor of the *change* in spending on auxiliary and student service.

Appendix Table B4 presents OLS regression estimates that examine the relationship between our amenity spending measure and several different quality of life ratings from the Princeton Review guidebook (PR). The sample for this analysis includes any of the four-year colleges in our analysis sample that also appears in PR in 1992, 1996, 2000, 2004 and 2008. In order to maximize statistical power, we include one observation per college x year, for a total of 1,306 observations.[2] All regressions include fixed effects for year x level x sector x selectivity category, and are weighted by the enrollment of first-time, full-time undergraduates.

The results indicate that there is a positive association between the quality of life ratings a college received in PR and its expenditures on auxiliary and student services. For example, the

[2] Because we do not have expenditure data for 2008, we ascribe the 2008 PR measures to the year 2007 in our sample.

coefficient of 0.023 in column 1 indicates that a movement of 10 percentile points in the distribution of colleges in PR is associated with 2.3 percent higher spending on amenities. Column 5 indicates that this same 10 percentile move is associated with a small increase (0.013) in the ratio of amenity to instructional spending. Similarly, a one unit increase in a PR measure of student happiness is associated with a 12 percent increase in amenity spending. While these magnitudes are not particularly large, the existence of positive and statistically significant associations suggests that these spending measures do have some face validity as indicators of college amenities.

Table B1 - Detailed Budgets for Selected Institutions

School	Year	Budget Category	Amount	Percent
University of Kansas	2015	Auxiliary Funds	$ 44,816,877.00	100%
		Housing System Operations	$ 18,456,270.00	41%
		Health Service	$ 11,121,587.00	25%
		KU Transit System	$ 5,388,817.00	12%
		Campus Dining	$ 3,590,789.00	8%
		Parking Facilities	$ 3,487,157.00	8%
		Recreation Center	$ 2,692,599.00	6%
		Health Fee Maint. Rep & Equip Res	$ 79,658.00	0%
Christopher Newport University	2014	Auxiliary Enterprises	$ 50,113,586.00	100%
		University Housing	$ 18,924,649.00	38%
		Dining Services	$ 12,968,139.00	26%
		Intercollegiate Athletics	$ 8,730,238.00	17%
		Auxiliary Services	$ 5,767,756.00	12%
		Ferguson Concert Hall	$ 2,796,263.00	6%
		Auxiliary Other	$ 500,000.00	1%
		Parking Service	$ 426,541.00	1%
University of Houston	2008	Auxiliary Enterprises	$ 75,259,608.00	100%
		Intercollegiate Athletics	$ 24,888,947.00	33%
		Other Student Services	$ 18,455,099.00	25%
		Residential Life and Housing	$ 9,331,478.00	12%
		University Center	$ 5,653,335.00	8%
		Parking and Transportation	$ 5,551,891.00	7%
		Hotel	$ 5,109,501.00	7%
		Health Center and Pharmacy	$ 3,519,999.00	5%
		Administrative Services	$ 2,380,034.00	3%
		Other Auxiliary Units	$ 369,324.00	0%
University of Texas - Austin	2008	Student Services	$ 13,684,435.00	100%
		Student Financial Services - AUF	$ 2,303,029.00	17%
		Dean of Students - AUF	$ 1,769,006.00	13%
		Admissions - AUF	$ 1,542,128.00	11%
		Registrar - AUF	$ 1,366,515.00	10%
		VP for Student Affairs - Student Services Administration	$ 941,276.00	7%
		Admissions - Student Services Program	$ 677,483.00	5%
		Admissions - Freshman Admissions Center - AUF	$ 623,469.00	5%
		Other smaller categories	$ 4,461,529.00	33%
University of Texas - Austin	2008	Auxiliary Enterprises	$ 189,911,748.00	100%
		Intercollegiate Athletics	$ 53,929,828.00	28%
		Housing and Food Service - Division Office Expenses	$ 48,055,099.00	25%
		Frank C Erwin Jr. Special Events Center	$ 12,900,000.00	7%
		University Health Services	$ 6,476,415.00	3%
		Shuttle Bus Services	$ 5,731,637.00	3%
		Other smaller categories	$ 62,818,769.00	33%

Table B2. Importance of Intercollegiate Sports to Auxillary and Student Services Spending, 1992 (weighted)

Sector X Highest Degree	Number of institutions	Have any intercollgiate sports	Intercollegiate sports expenditure included in… (includes 0's)		Share of spending in this category that is intercollegiate sports	
			Auxillary	Student Services	Auxillary	Student Services
Public Phd	188	0.828	0.574	0.235	0.155	0.056
Public Master	244	0.848	0.273	0.385	0.064	0.107
Public Bach	84	0.847	0.319	0.251	0.044	0.053
Private Phd	132	0.709	0.302	0.273	0.098	0.121
Private Master	353	0.750	0.130	0.451	0.041	0.154
Private Bach	335	0.837	0.107	0.436	0.038	0.133
Total	1,336	0.810	0.388	0.309	0.105	0.091

Notes: Sample is weighted according to FTE enrollment. Unweighted results are similar. A small number of institutions with intercollegiate sports report expenditure in instruction or through a foundation or corporation.

Sources: Authors' analysis of 1992 IPEDS Finance Data

Table B3- Predictors of Amentiy Spending

	1992				1992 and 2004	
	Amenity Spending per Student (Auxiliary + Student Service Categories) (1)	Log(Amenity Spending) (2)	Ratio: Amenity Spending / Academic Spending (3)	Log(Ratio Amenity Spending) (4)	Log(Amenity Spending) (5)	Log(Ratio Amenity Spending) (6)
Percent undergraduates living on campus (divided by 10)	405.9**	0.114**	0.0466**	0.102**	0.0476**	0.0318*
	(32.21)	(0.00782)	(0.00465)	(0.00964)	(0.0176)	(0.0150)
Number of intercollegiate sports (divided by 10)	490.1**	0.125**	-0.00101	0.0170	0.0924+	-0.0186
	(130.3)	(0.0277)	(0.0118)	(0.0271)	(0.0495)	(0.0448)
Percent of undergraduates in the Greek system (divided by 10)	-9.922	0.0106	-0.00516	-0.00246	-0.0751*	0.0256
	(56.03)	(0.00919)	(0.00613)	(0.0121)	(0.0307)	(0.0263)
Fixed effects for institution level x public x Barron's six-category selectivity category	Yes	Yes	Yes	Yes		
College fixed effects					Yes	Yes
Number of observations	1339	1339	1339	1339	2682	2682
R-squared	0.627	0.596	0.406	0.367	0.823	0.764

Robust standard errors in parentheses; s.e. in columns 5 and 6 are clustered by college + p<0.10, * p<0.05, ** p<0.01.
Sample: Regular 4-year institutions with good parent/child relationship that were in the sample in 1992 and 2004.Observations weighted by the enrollment of first-time, full-time undergraduates in the year.

Table B4 - Relationship between Princeton Review Measures and Amenity Spending

		Log(Amenity Spending)				Ratio: Amenity Spending / Academic Spending			
	Means (s.d.)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
%ile on PR Quality of Life (divided by 10)		0.023**				0.013**			
		(0.008)				(0.004)			
PR Measure of Student Happiness			0.122*				0.060**		
			(0.055)				(0.022)		
PR Measure of Student Beauty				0.171**				0.096**	
				(0.055)				(0.027)	
PR Measure of Party School					-0.036				-0.032
					(0.075)				(0.037)
Number of observations		1306	1306	1306	1306	1306	1306	1306	1306
R-squared		0.490	0.484	0.484	0.473	0.287	0.273	0.278	0.261

Notes: Sample includes regular 4-year with good parent/child relationships that were included in the Princeton Review ratings in 1992, 1996, 2000, 2004 or 2008. Weighted by the enrollment of first-time, full-time undergraduates in the year. All regressions include fixed effects for year x institution level x public x Barron's six-category selectivity category. For the happiness measure, schools received a value of 1 if they had a PR indicator of "happy hot", a value of -1 if they received a PR indicator of "happy not" and a value of 0 otherwise. For the beauty measure, schools received a value of 1 if they were in the Top 20 most beautiful colleges, a value of -1 if they were in the Top 20 most unsightly colleges, and a value of 0 otherwise. For the party measure, schools received a value of 1 if they were in the Top 20 party school list, a value of -1 if they were in the Top 20 "stone cold sober" list, and a value of 0 otherwise.

Appendix C: Net Price and College Admissions Models

Predicting Net Price

Our preferred college choice model uses estimated net price rather than college sticker price to account for price discounting, which varies across students, schools, and time and likely influences enrollment. Unfortunately, financial aid packages for chosen and non-chosen schools are not available in the NELS and ELS so we are not able to use students' actual financial aid packages in our estimation. Instead, we use information about the financial aid awards from students in the 1996 and 2004 National Postsecondary Student Aid Study (NPSAS) to estimate the net price that NELS and ELS students would have paid at each institution in our analysis sample. The NPSAS is a nationally representative sample of college students with detailed information about student background, financial aid packages, and the identity of institution attended, to which we merge many institutional characteristics. Since our choice model includes only "traditional" students attending college shortly after high school, our NPSAS sample is restricted to dependent students. We also exclude students missing key covariates. The final full NPSAS sample includes 30,370 individuals in 1996 and 42,262 in 2004.

We first estimate an OLS model with the net price ratio (tuition price minus all grants over price) as the dependent variable and many student and institution characteristics and their interactions on the right hand side using the NPSAS sample, separately by year. Model estimates were then used to predict out-of-sample the net price ratio for all student-school pairs in our NELS/ELS analysis sample. This predicted price ratio was then applied to the sticker price (in- or out-of-state as appropriate) to estimate the predicted net price for all student-school pairs in our NELS/ELS analysis sample.

To examine the potential role of unobserved characteristics that influence both financial aid awards and matriculation decisions, we estimate several different net price models that control for an increasingly rich set of observed student and institutional characteristics. Table C1 lists the student and institution characteristics included in four of these models. Our preferred model is estimated separately for six groups (defined by race X sector X in-state) by year and includes quadratics of standardized test scores, SES, and SAT percentile of the institution, the pair-wise interactions between these three variables, the ratio of institutional grant aid per FTE to tuition, the ratio of state grant aid per FTE to tuition, spending on amenities and academics per FTE, and interactions between these four institutional characteristics and student test scores and SES. Institutional and state grant aid interactions account for need- and merit-based aid programs that vary across states and institutions and over time. We view this as a feasible alternative for capturing state aid programs, as the data is too sparse to reliably estimate state-year fixed effects. Our preferred model also includes all dependent undergraduates (rather than just freshmen) in order to increase sample size and reduce estimation variability. We also explored including gender in the model, though omit it from our preferred models as it had no impact on predicted net price when other controls were already included.

With all the nonlinearities and interactions, the coefficient estimates in the net price model are difficult to interpret (though are available from the authors upon request). However, the patterns are as expected with high-achieving and low-income students predicted to pay less. The final

four rows of Table C1 report the correlation between the predicted net price for our preferred model, three more parsimonious models, and sticker price. Though we use the most flexible of these specifications in our choice model, it is important to note that adding additional richness and flexibility in these models (beyond some basic heterogeneity) does not materially impact predicted aid. Furthermore, in Table D3 we demonstrate that additional flexibility and richness does not materially impact our choice model estimates. This gives us confidence that the remaining sources of unobservable heterogeneity in aid are unlikely to cause substantial bias to our demand model.

Predicting College Admissions

Our preferred choice model addresses bias resulting from selective admissions by estimating a weighted conditional logit model where weights quantify the likelihood that a given alternative is contained in an individual's choice set. For weights, we use the implied predicted probabilities (ψ_{ij}) that individual *i* would be admitted to school *j* if she applied and then estimate the probability that student *i* enrolls in school *j* as

$$\Pr(Enroll_{ij}) = \frac{\psi_{ij} \exp(\delta_{ij})}{\sum \psi_{ik} \exp(\delta_{ik})}$$

Jacob, McCall and Stange (2013) show that, if the number of possible schools is sufficiently large, this will provide a good approximation of the true likelihood obtained the individual's true choice set were observed.[3]

The key challenge to this approach is to obtain credible estimates of the probability of admissions for each student x college pair. To do so, we use detailed micro data on applications and admissions for the set of students included in our analysis, and estimate a very flexible model of admissions that includes dozens of student and school characteristics (and their interactions) that influence a college's admissions decision. The identifying assumption is that, conditional on the detailed set of student and school characteristics we include in the admission and enrollment models, there are no unobservable factors that are simultaneously correlated with the likelihood of admissions and enrollment.

Both the NELS and ELS ask students to list colleges to which they applied and whether they were admitted to each college. We restrict our attention to student applications to the set of "regular" four-year colleges or universities in our main analysis sample. In the NELS, students were asked in 1992 (when they were high school seniors) to list up to 2 schools to which they had applied and to indicate whether or not they had been accepted to each school. In the 1994 follow-up survey, students were asked to list up to 5 schools they had attended since the 1992 survey. In order to capture a more complete set of schools to which the student may have

[3]Simulation results available from the authors show that the correlation between the observation-level likelihood implied by our weighted approach and that implied by a simulation-based approach that integrates out the unobserved choice set is 0.988 overall, with a better approximation for individual-school observations with a high likelihood of acceptance.

applied, we combine information from both of these surveys. Specifically, we include all schools the student listed in the 1992 survey as well as the first two schools we observe the students attending based on the information reported in the 1994 survey (this survey provides enrollment dates which allow us to identify the first two schools). In this way, we observe a maximum of four application schools for each student. Also note that, by construction, a student will have been accepted to any school we observe him or her attending by 1994. In the ELS, students were asked in 2006 (two years after expected high school graduation) to list up to 20 schools to which they applied, and whether they were accepted and/or attended. It also allows them to list the start and end dates of attendance. Fewer than 0.1% of students listed the maximum possible number of schools in ELS, suggesting that we are capturing the full set of application schools for most students. In NELS, by contrast, over half of the students listed two different application schools in the 1992 survey, suggesting that even by including the extra information from the 1994 survey, we are likely missing at least some information on student application behavior. The resulting data set contains 22,934 (12,155) student-college observations from 2004 (1992).

To determine the probability that individual i would be admitted to school j, we estimate a probit model where the dependent variable is a binary indicator for admitted and the right hand side includes many student and institution characteristics and their interactions, separately by year. Model estimates were then used to predict out-of-sample the likelihood of admission for all student-school pairs in our NELS/ELS analysis sample.

To examine the potential role of unobserved characteristics that influence both acceptance and matriculation decisions, we estimate several different admissions models that control for an increasingly rich set of observed student and institutional characteristics. Table C2 lists the student and institution characteristics included in five of these models. Our preferred model is estimated separately for six groups (defined by race X sector X in-state) by year and includes several different measures of student academic ability, including high school GPA, 12th grade math score and the interaction between GPA and math score, student socioeconomic status, several measures of college selectivity, including the SAT percentile score of students in the college, the fraction of students admitted to the college and the log(enrollment). We also include many flexible interactions between student ability and college selectivity. Finally, we also include spending on amenities and academics per FTE and interactions between spending and student test scores and SES. To account for the possibility that admissions officers partially know students' propensity to attend and incorporate this into admissions decisions, we also estimate an admissions model that includes students' self-reported "preferences" for campus social life and academics directly and interacted with amenity and academic spending. These additions have little impact on predicted admissions.

Because of the large number of higher-order terms and interactions, it is not productive to examine coefficients on specific predictors to assess the fit of the model (though model estimates are available from the authors upon request). However, the patterns are as expected with high-achieving students much more likely to be admitted overall and lower admissions rates at selective schools. Table C2 also reports the correlation between the predicted likelihood of admission for our preferred model and four additional models. It is important to note that adding additional richness and flexibility in these models (beyond some basic heterogeneity) does not

materially impact predicted acceptance likelihood. Furthermore, in Table D4 we demonstrate that additional flexibility and richness does not materially impact our choice model estimates. This gives us confidence that the remaining sources of unobservable heterogeneity in aid are unlikely to cause substantial bias to our demand model.

Table C1: Covariates included in Alternative Net Price Models

	Model 1: Single model for all groups (1)	Model 2: Separate model by group (2)	Model 3: Separate model by group, include state and institutional aid per student (3)	Main model (4)
Race X public X in-state group dummy	x			
Separately by group		x	x	x
Standardized math, math^2	x	x	x	x
Standardized SES, SES^2	x	x	x	x
School Mean SAT (percentile), SAT^2	x	x	x	x
Math X School mean SAT	x	x	x	x
Math X SES	x	x	x	x
SES X School mean SAT	x	x	x	x
Institutional grant aid per FTE / In-state tuition			x	x
X math score (standardized)			x	x
X SES (standardized)			x	x
State grant aid per FTE / In-state tuition			x	x
X math score (standardized)			x	x
X SES (standardized)			x	x
Log (Amenity Spending/FTE)				x
X math score (standardized)				x
X SES (standardized)				x
Log (Academic Spending/FTE)				x
X math score (standardized)				x
X SES (standardized)				x
Student sample	Freshmen	Freshmen	Freshmen	All undergraduates
Correlation of Log(net price) with main model 1992	0.96	0.98	0.99	1.00
Correlation of Log(net price) with main model 2004	0.91	0.94	0.97	1.00
Correlation of Log(net price) with sticker price 1992	0.86	0.82	0.80	0.82
Correlation of Log(net price) with sticker price 2004	0.71	0.74	0.72	0.76

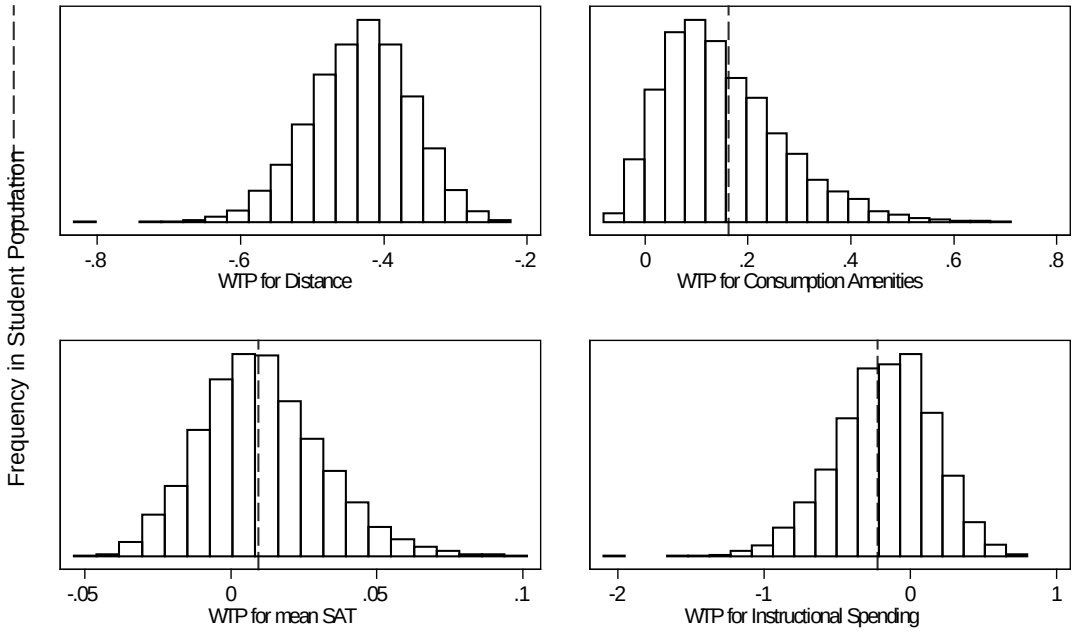
Table C2: Covariates included in Alternative College Admissions Models

	Model 1: Single model for all groups (1)	Model 2: Separate model by group (2)	Model 3: Many interactions (3)	Main model (4)	Model 4:Include "unobserved preferences" (5)
Race X public X in-state group dummy	x				
Separately by group		x	x	x	x
Log (Lagged first time freshman enrollment)	x	x	x	x	x
HS GPA, missing HS GPA	x	x	x	x	x
Standardized math	x	x	x	x	x
Standardized SES	x	x	x	x	x
HS GPA^2			x	x	x
Math ^2			x	x	x
Math X HS GPA			x	x	x
Institution admissions rate	x	x	x	x	x
x HS GPA	x	x	x	x	x
x math score (standardized)	x	x	x	x	x
x math X HS GPA			x	x	x
X SES			x	x	x
X HS GPA^2			x	x	x
X Math ^2			x	x	x
School Mean SAT (percentile)	x	x	x	x	x
x HS GPA			x	x	x
X math			x	x	x
X mathX HSGPA			x	x	x
X SES			x	x	x
X HS GPA^2			x	x	x
X Math ^2			x	x	x
School Mean SAT X institution admissions rate			x	x	x
x HS GPA			x	x	x
X math			x	x	x
X HS GPA^2			x	x	x
X Math ^2			x	x	x
College located in the student's census region	x	x	x	x	x
Log(Distance)	x	x	x	x	x
Log (Amenity Spending/FTE)				x	x
X math score (standardized)				x	x
X SES (standardized)				x	x
X social life important (standardized)					x
X academics important (standardized)					x
Log (Academic Spending/FTE)				x	x
X math score (standardized)				x	x
X SES (standardized)				x	x
X social life important (standardized)					x
X academics important (standardized)					x
Social life important (standardized)					x
Academics important (standardized)					x
Correlation of Pr(accepted) with base model 1992	0.81	0.86	0.97	1.00	0.97
Correlation of Pr(accepted) with base model 2004	0.93	0.95	0.99	1.00	0.99

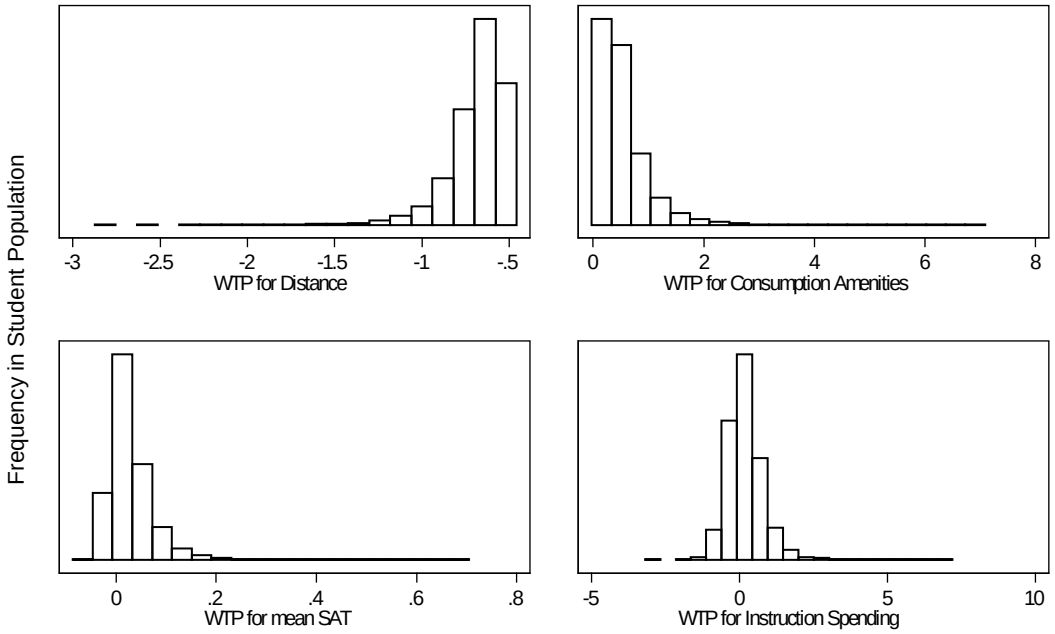
Appendix D. Additional Robustness and Validity Results

Figure D1: Overall Distribution of Willingness-to-Pay for College Attributes

Panel A: With College Fixed Effects

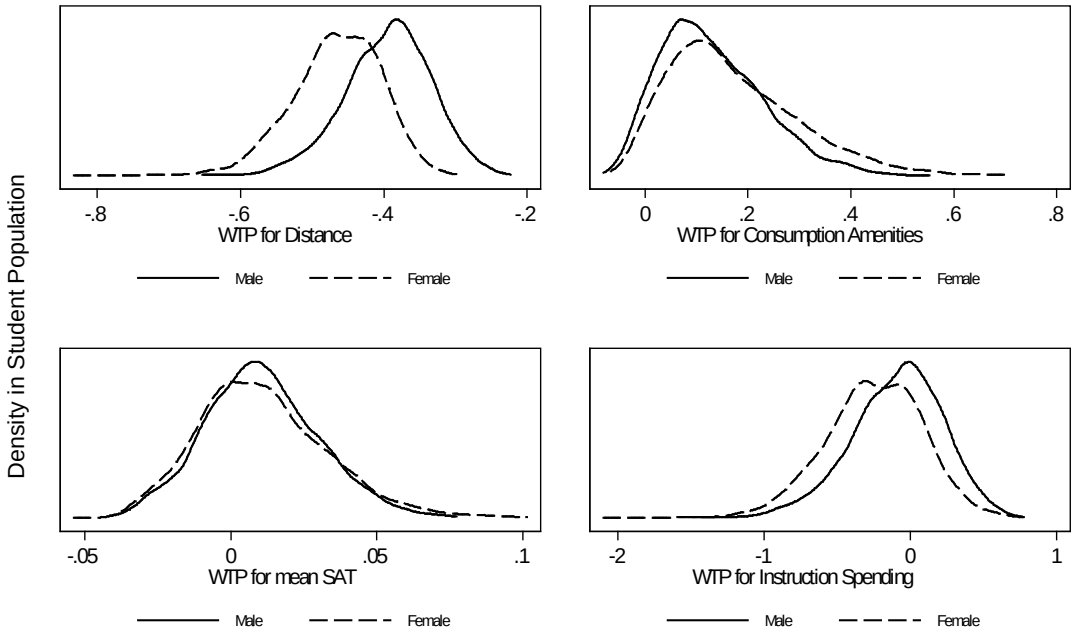


Panel B. No College Fixed Effects



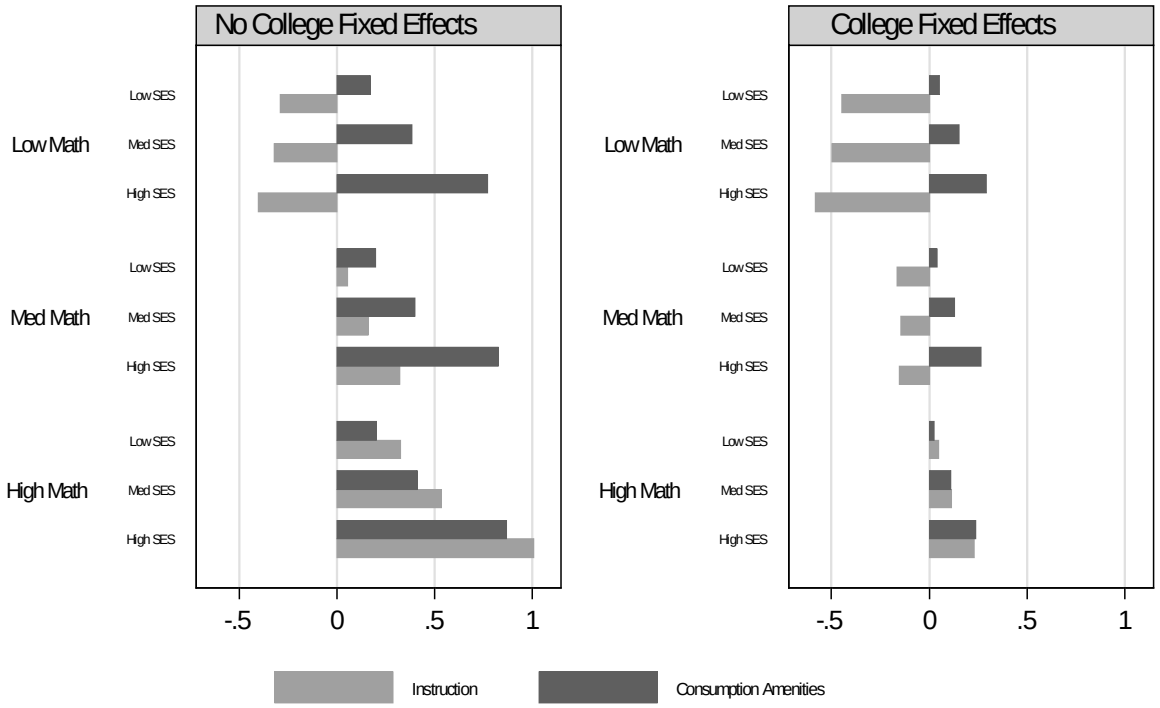
Notes: WTP for spending and distance can be interpreted as the percent increase in cost students are willing to pay to attend a college with a 1% increase in spending or 1% further away. In Panel A, estimates come from the model in Table 5 (Specification 2) which includes interactions between college characteristics and male, math score, and SES. Dashed line indicates value for the WTP when heterogeneity is not permitted, estimated in Table 4 (Specification 4). In Panel B, estimates come from the model in Table 5 (Specification 1) which includes interactions between college characteristics and male, math score, and SES.

Figure D2: Distribution of Willingness-to-Pay for College Attribute, by Sex



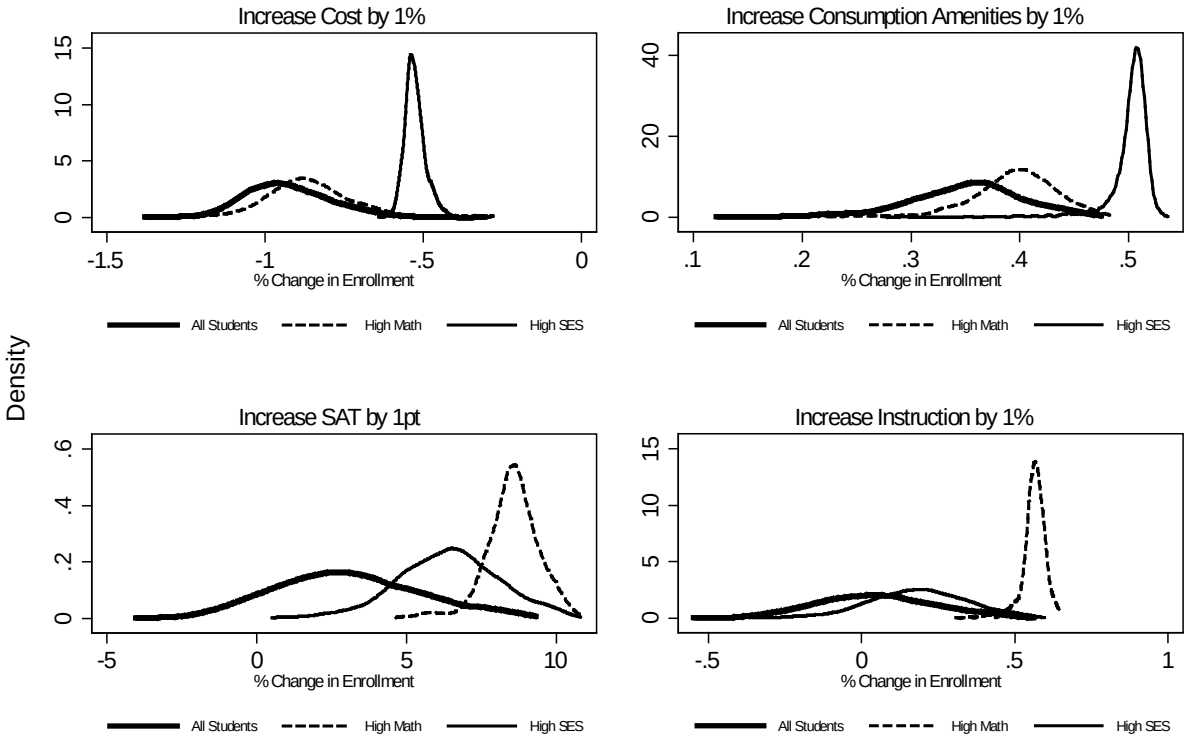
Notes: Notes: WTP for spending and distance can be interpreted as the percent increase in cost students are willing to pay to attend a college with a 1% increase in spending or 1% further away. Estimates come from the model in Table 5 (Specification 2) which includes college fixed effects and interactions between college characteristics and male, math score, and SES.

Figure D3: Median WTP for Consumption Amenities and Instructional Spending, by Group



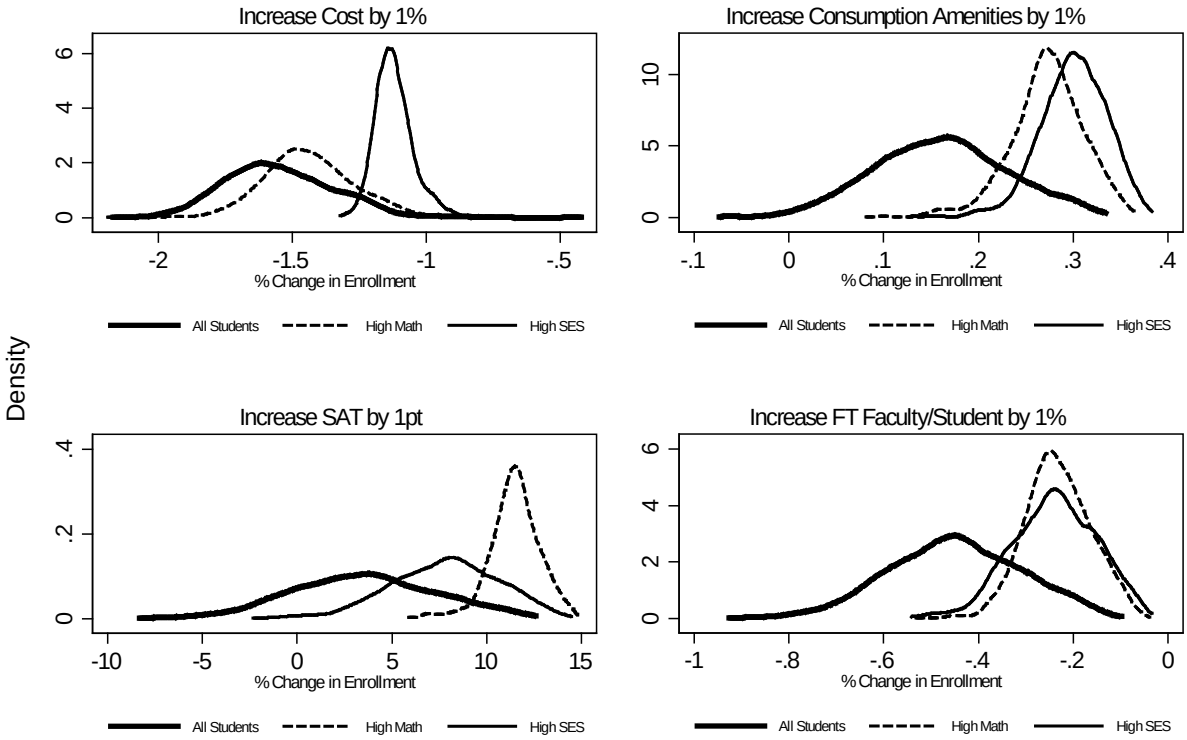
Notes: WTP is calculated as minus the ratio of the coefficients on the spending category and cost. Estimates come from the model in Table 5 (Specification 1 on left, Specification 2 on right) which includes interactions between college characteristics and male, math score, and SES. In each panel, high, medium, and low groups represent terciles by SES and math score.

Figure D4: Distribution of Change in Enrollment Share for High Math and SES Students
In response to change in own characteristic
No College Fixed Effects



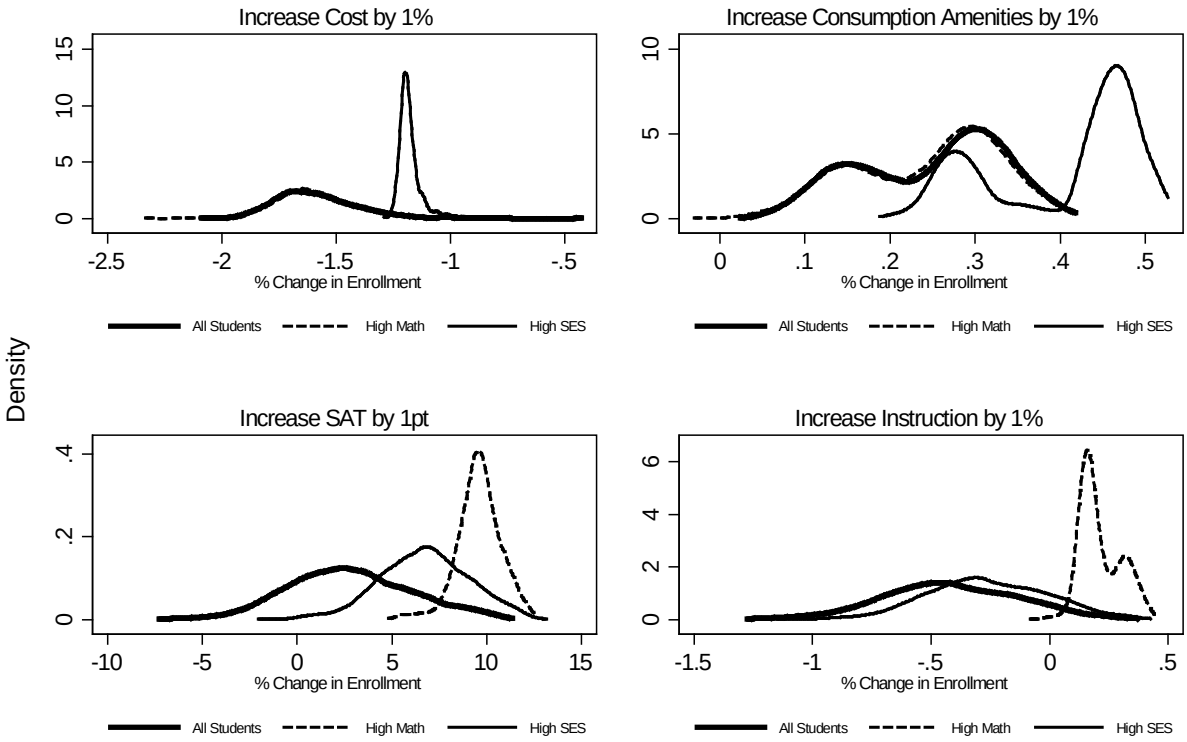
Notes: Each graph plots the distribution of the percent change in enrollment (all students, high math students, high SES students) at each individual college if this college were to change a single characteristic. Enrollment response is simulated using the estimates from the model in Table 5 (Specification 1) which does not include college fixed effects.

Figure D5: Distribution of Change in Enrollment Share for High Math and SES Students
In response to change in own characteristic
FT Faculty per FTE Student is Measure of Academic Quality



Notes: Each graph plots the distribution of the percent change in enrollment (all students, high math students, high SES students) at each individual college if this college were to change a single characteristic. Enrollment response is simulated using the estimates from the model in Table 6 (Specification 3) which includes college fixed effects and interactions between college characteristics and male, math score, and SES.

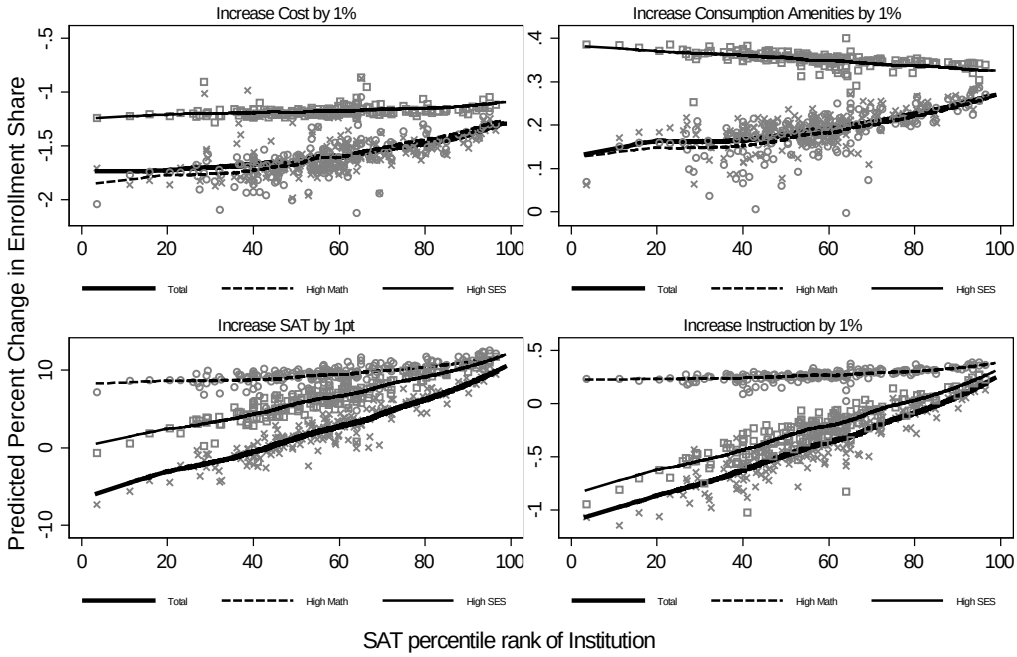
Figure D6: Distribution of Change in Enrollment Share for High Math and SES Students
In response to change in own characteristic
Marginal Effect of Spending Differs by Institution Type



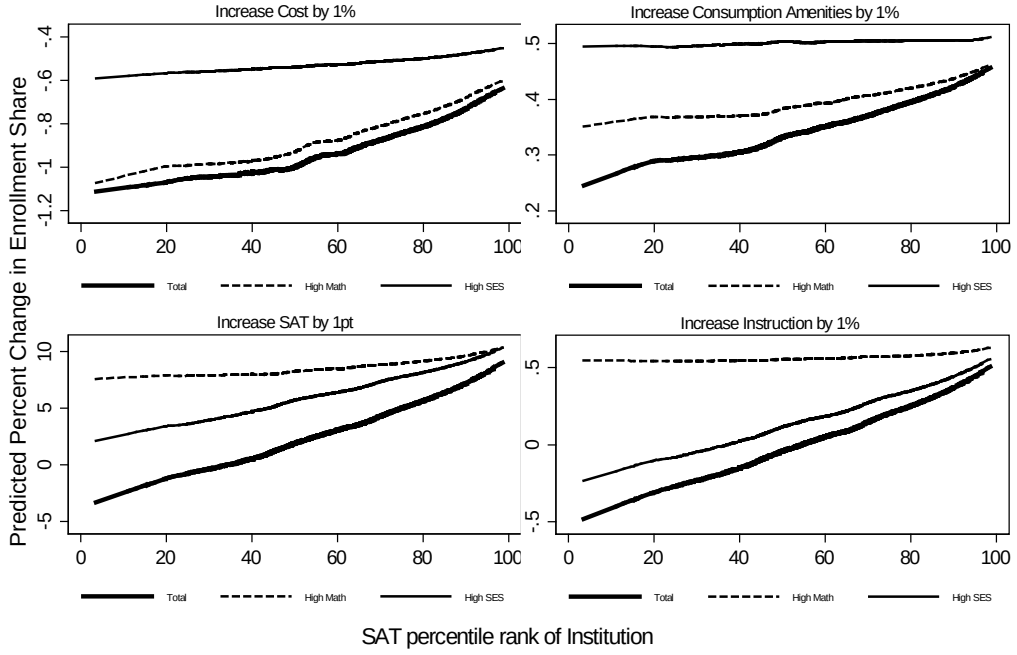
Notes: Each graph plots the distribution of the percent change in enrollment (all students, high math students, high SES students) at each individual college if this college were to change a single characteristic. Enrollment response is simulated using the estimates from the model in Table 6 (Specification 4) which includes college fixed effects and interactions between college characteristics and male, math score, and SES.

Figure D7: Subgroup Enrollment Response to Change in Own College Characteristic by Institution Average Student SAT

A. With College Fixed Effects



B. No College Fixed Effects



C. No Preference Heterogeneity

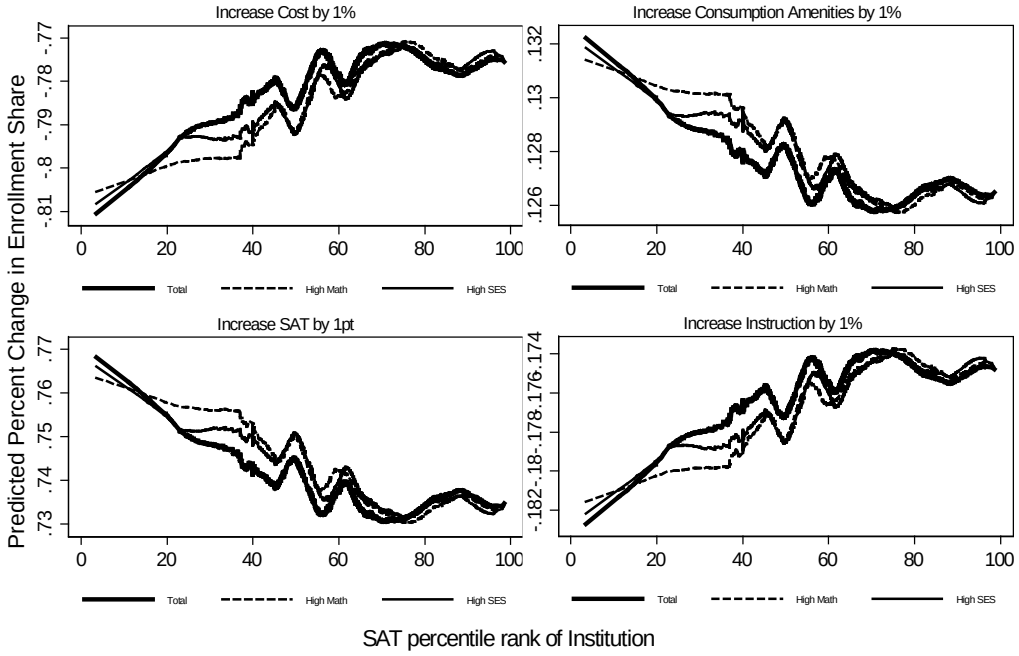


Table D1. Interactions between Spending Measures and Campus Environment

	Interactions with….							
	Quality of life of campus location				Student plans to live at home		% Living on campus, 1992	
	(1)		(2)		(3)		(4)	
	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)
Log (Tuition, Fees, Room & Board)	-0.945 ***	(0.037)	-0.948 ***	(0.038)	-1.028 ***	(0.070)	-0.940 ***	(0.069)
Log (Distance)	-0.726 ***	(0.009)	-0.726 ***	(0.009)	-0.724 ***	(0.011)	-0.726 ***	(0.011)
Log (Spending on Consumption Amenities per FTE)	0.131 ***	(0.026)	0.127 ***	(0.026)	-0.084	(0.083)	0.114	(0.124)
X Locational Quality of Life Index	-0.617 ***	(0.030)	-1.535 ***	(0.394)				
X Student plans to live at home					-0.651 ***	(0.031)		
X % living on-campus in 1992							0.070	(0.318)
Log (Spending on Academics per FTE)	-0.124 ***	(0.033)	-0.118 ***	(0.034)	-0.157	(0.130)	-0.206	(0.219)
X Locational Quality of Life Index			0.960 ***	(0.361)				
X Student plans to live at home					-0.121 ***	(0.040)		
X % living on-campus in 1992							0.149	(0.379)
School Mean SAT (percentile)	0.006 ***	(0.001)	0.006 ***	(0.001)	0.007 ***	(0.002)	0.006 **	(0.002)
Log likelihood	-39510.4		-39510.1		-39118.5		-39511.8	

Notes: All specifications account for probability of admissions, use predicted net price as the measure of cost, include college fixed effects, and control for unemployment rate, log(number of high school graduates), and dummies for in-state and in-region. Coefficients are reported with robust standard errors in parentheses. Spending on student services also includes spending on auxilary enterprises (primarily food service and dorms). Instruction includes both instruction and academic support services. Selective admissions is accounded for by weighing each observation in the conditional logit model by the predicted probability that each student would be admitted to the school in the given year. See text. *** p<0.01, ** p<0.05, * p<0.1.

Table D2: Robustness of Main Model: Alternative Specifications

	Main model (1)		Control for major share (2)		Control for students with need (3)		Student services spending as amenity measure (5)		Auxiliary spending as amenity measure (6)	
	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)
Log (Tuition, Fees, Room & Board)	-1.790 ***	(0.0624)	-1.796 ***	(0.0639)	-1.790 ***	(0.0627)	-1.827 ***	(0.0647)	-1.769 ***	(0.0607)
X male	-0.194 ***	(0.0727)	-0.195 ***	(0.0728)	-0.194 ***	(0.0728)	-0.149 **	(0.0752)	-0.204 ***	(0.0713)
X math score (standardized)	-0.020	(0.0503)	-0.021	(0.0504)	-0.020	(0.0503)	0.020	(0.0522)	-0.036	(0.0490)
X SES (standardized)	0.425 ***	(0.0423)	0.426 ***	(0.0424)	0.425 ***	(0.0424)	0.396 ***	(0.0434)	0.455 ***	(0.0417)
Log (Distance)	-0.892 ***	(0.0125)	-0.892 ***	(0.0125)	-0.892 ***	(0.0125)	-0.892 ***	(0.0124)	-0.890 ***	(0.0126)
X male	0.007	(0.0138)	0.007	(0.0138)	0.007	(0.0138)	0.004	(0.0139)	0.007	(0.0139)
X math score (standardized)	0.112 ***	(0.0092)	0.112 ***	(0.0092)	0.112 ***	(0.0092)	0.109 ***	(0.0092)	0.110 ***	(0.0093)
X SES (standardized)	0.176 ***	(0.0078)	0.176 ***	(0.0078)	0.176 ***	(0.0078)	0.182 ***	(0.0079)	0.176 ***	(0.0079)
Log (Amenity Spending/FTE)	0.196 ***	(0.0415)	0.198 ***	(0.0417)	0.199 ***	(0.0418)	0.089 **	(0.0359)	0.052 **	(0.0259)
X male	-0.041	(0.0548)	-0.042	(0.0549)	-0.041	(0.0548)	-0.085 **	(0.0435)	-0.020	(0.0370)
X math score (standardized)	-0.042	(0.0358)	-0.042	(0.0359)	-0.042	(0.0358)	-0.086 ***	(0.0303)	0.021	(0.0226)
X SES (standardized)	0.132 ***	(0.0293)	0.132 ***	(0.0293)	0.132 ***	(0.0292)	0.113 ***	(0.0243)	0.055 ***	(0.0199)
Log (Academic Spending/FTE)	-0.794 ***	(0.0601)	-0.792 ***	(0.0624)	-0.792 ***	(0.0601)	-0.766 ***	(0.0555)	-0.719 ***	(0.0585)
X male	0.094	(0.0686)	0.095	(0.0686)	0.094	(0.0686)	0.090	(0.0652)	0.090	(0.0683)
X math score (standardized)	0.631 ***	(0.0472)	0.632 ***	(0.0473)	0.631 ***	(0.0472)	0.623 ***	(0.0442)	0.594 ***	(0.0465)
X SES (standardized)	0.050	(0.0394)	0.051	(0.0394)	0.050	(0.0394)	0.090 **	(0.0371)	0.072 *	(0.0393)
School Mean SAT (percentile)	-0.009 ***	(0.0014)	-0.009 ***	(0.0014)	-0.010 ***	(0.0015)	-0.010 ***	(0.0014)	-0.009 ***	(0.0014)
X male	-0.005 ***	(0.0020)	-0.005 ***	(0.0020)	-0.005 ***	(0.0020)	-0.006 ***	(0.0020)	-0.005 ***	(0.0020)
X math score (standardized)	0.030 ***	(0.0013)	0.030 ***	(0.0013)	0.030 ***	(0.0013)	0.030 ***	(0.0013)	0.030 ***	(0.0013)
X SES (standardized)	0.011 ***	(0.0011)	0.011 ***	(0.0011)	0.011 ***	(0.0011)	0.012 ***	(0.0011)	0.012 ***	(0.0011)
Major share in										
Business			-0.150	(0.1419)						
STEM			-0.333 **	(0.1349)						
Health			0.049	(0.2106)						
Social science			-0.597 ***	(0.1868)						
Education			-0.945 ***	(0.1870)						
Other professional			-0.170	(0.1799)						
Fraction of students with need					-0.065	(0.0781)				

Notes: Coefficients are reported with robust standard errors in parentheses. Spending on consumption amenities includes student services and auxilary enterprises (primarily food service and dorms). Instructional spending includes both instruction and academic support services. Selective admissions is accounded for by weighing each observation in the conditional logit model by the predicted probability that each student would be admitted to the school in the given year. Predicted net price is from auxilliary model estimated with other data. See text. *** p<0.01, ** p<0.05, * p<0.1

Table D3: Robustness of Choice Model Estimates to Net Price Model

	Use sticker price (1)		Model 1: Single model for all groups (2)		Model 2: Separate model by group (3)		Model 3: Separate model by group, include state and institutional aid per student (4)		Main model (5)	
	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)
Log (Tuition, Fees, Room & Board)	-2.510 ***	(0.0536)	-2.111 ***	(0.0667)	-1.847 ***	(0.0651)	-1.685 ***	(0.0621)	-1.790 ***	(0.0624)
X male	-0.242 ***	(0.0640)	-0.232 ***	(0.0773)	-0.217 ***	(0.0758)	-0.194 ***	(0.0714)	-0.194 ***	(0.0727)
X math score (standardized)	0.027	(0.0437)	-0.092 *	(0.0526)	-0.026	(0.0520)	0.007	(0.0495)	-0.020	(0.0503)
X SES (standardized)	0.334 ***	(0.0369)	0.519 ***	(0.0453)	0.434 ***	(0.0441)	0.424 ***	(0.0417)	0.425 ***	(0.0423)
Log (Distance)	-0.896 ***	(0.0126)	-0.894 ***	(0.0126)	-0.890 ***	(0.0125)	-0.888 ***	(0.0124)	-0.892 ***	(0.0125)
X male	0.011	(0.0139)	0.010	(0.0139)	0.009	(0.0139)	0.007	(0.0138)	0.007	(0.0138)
X math score (standardized)	0.108 ***	(0.0093)	0.108 ***	(0.0094)	0.112 ***	(0.0093)	0.112 ***	(0.0092)	0.112 ***	(0.0092)
X SES (standardized)	0.174 ***	(0.0080)	0.177 ***	(0.0078)	0.168 ***	(0.0078)	0.170 ***	(0.0078)	0.176 ***	(0.0078)
Log (Amenity Spending/FTE)	0.255 ***	(0.0438)	0.206 ***	(0.0417)	0.199 ***	(0.0416)	0.179 ***	(0.0411)	0.196 ***	(0.0415)
X male	0.005	(0.0579)	-0.034	(0.0556)	-0.035	(0.0555)	-0.044	(0.0546)	-0.041	(0.0548)
X math score (standardized)	-0.026	(0.0378)	-0.061 *	(0.0363)	-0.056	(0.0362)	-0.063 *	(0.0357)	-0.042	(0.0358)
X SES (standardized)	-0.005	(0.0315)	0.159 ***	(0.0293)	0.139 ***	(0.0295)	0.151 ***	(0.0292)	0.132 ***	(0.0293)
Log (Academic Spending/FTE)	-0.773 ***	(0.0595)	-0.794 ***	(0.0598)	-0.761 ***	(0.0594)	-0.780 ***	(0.0594)	-0.794 ***	(0.0601)
X male	0.083	(0.0671)	0.090	(0.0682)	0.089	(0.0682)	0.085	(0.0680)	0.094	(0.0686)
X math score (standardized)	0.563 ***	(0.0467)	0.601 ***	(0.0470)	0.610 ***	(0.0471)	0.590 ***	(0.0470)	0.631 ***	(0.0472)
X SES (standardized)	0.126 ***	(0.0393)	0.019	(0.0394)	0.033	(0.0392)	0.035	(0.0393)	0.050	(0.0394)
School Mean SAT (percentile)	-0.011 ***	(0.0014)	-0.009 ***	(0.0014)	-0.009 ***	(0.0014)	-0.009 ***	(0.0014)	-0.009 ***	(0.0014)
X male	-0.005 ***	(0.0020)	-0.005 **	(0.0020)	-0.005 **	(0.0020)	-0.005 **	(0.0020)	-0.005 ***	(0.0020)
X math score (standardized)	0.029 ***	(0.0013)	0.033 ***	(0.0013)	0.032 ***	(0.0013)	0.031 ***	(0.0013)	0.030 ***	(0.0013)
X SES (standardized)	0.011 ***	(0.0011)	0.011 ***	(0.0011)	0.012 ***	(0.0011)	0.012 ***	(0.0011)	0.011 ***	(0.0011)
Net price model										
Estimated separately by group	N/A		No		Yes		Yes		Yes	
Includes state and institutional aid interacted with math score and SES	N/A		No		No		Yes		Yes	
Includes amenity and academic spending per FTE interacted with math score and SES	N/A		No		No		No		Yes	
Student sample	N/A		Freshmen		Freshmen		Freshmen		All undergraduates	

Notes: Coefficients are reported with robust standard errors in parentheses. Spending on consumption amenities includes student services and auxilary enterprises (primarily food service and dorms). Instructional spending includes both instruction and academic support services. Selective admissions is accounded for by weighing each observation in the conditional logit model by the predicted probability that each student would be admitted to the school in the given year. Predicted net price is from auxilliary model estimated with other data. See text. *** p<0.01, ** p<0.05, * p<0.1

Table D4: Robustness of Choice Model Estimates to Admissions Model

	Do not account for selective admission (1)		Model 1: Single model for all group (2)		Model 2: Separate model by group (3)		Model 3: Many interactions (4)		Main model (5)		Model 4:Include "unobserved preferences" (6)	
	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)	Est.	(S.E.)
Log (Tuition, Fees, Room & Board)	-1.850 ***	(0.0626)	-1.811 ***	(0.0627)	-1.790 ***	(0.0625)	-1.798 ***	(0.0624)	-1.790 ***	(0.0624)	-1.780 ***	(0.0625)
X male	-0.175 **	(0.0726)	-0.178 **	(0.0728)	-0.185 **	(0.0728)	-0.193 ***	(0.0729)	-0.194 ***	(0.0727)	-0.190 ***	(0.0728)
X math score (standardized)	-0.055	(0.0503)	-0.059	(0.0505)	-0.033	(0.0504)	-0.026	(0.0503)	-0.020	(0.0503)	-0.022	(0.0503)
X SES (standardized)	0.439 ***	(0.0422)	0.442 ***	(0.0423)	0.437 ***	(0.0423)	0.426 ***	(0.0424)	0.425 ***	(0.0423)	0.424 ***	(0.0424)
Log (Distance)	-0.921 ***	(0.0125)	-0.895 ***	(0.0125)	-0.895 ***	(0.0125)	-0.894 ***	(0.0125)	-0.892 ***	(0.0125)	-0.892 ***	(0.0125)
X male	0.003	(0.0137)	0.006	(0.0138)	0.007	(0.0138)	0.007	(0.0138)	0.007	(0.0138)	0.007	(0.0138)
X math score (standardized)	0.119 ***	(0.0092)	0.112 ***	(0.0093)	0.113 ***	(0.0093)	0.112 ***	(0.0092)	0.112 ***	(0.0092)	0.112 ***	(0.0092)
X SES (standardized)	0.176 ***	(0.0077)	0.176 ***	(0.0078)	0.176 ***	(0.0078)	0.176 ***	(0.0078)	0.176 ***	(0.0078)	0.176 ***	(0.0078)
Log (Amenity Spending/FTE)	0.204 ***	(0.0416)	0.201 ***	(0.0414)	0.211 ***	(0.0415)	0.224 ***	(0.0415)	0.196 ***	(0.0415)	0.191 ***	(0.0415)
X male	-0.034	(0.0549)	-0.036	(0.0547)	-0.038	(0.0548)	-0.037	(0.0549)	-0.041	(0.0548)	-0.042	(0.0549)
X math score (standardized)	-0.058	(0.0360)	-0.056	(0.0358)	-0.058	(0.0359)	-0.058	(0.0358)	-0.042	(0.0358)	-0.038	(0.0359)
X SES (standardized)	0.141 ***	(0.0292)	0.139 ***	(0.0291)	0.133 ***	(0.0292)	0.134 ***	(0.0293)	0.132 ***	(0.0293)	0.133 ***	(0.0293)
Log (Academic Spending/FTE)	-1.030 ***	(0.0595)	-0.947 ***	(0.0597)	-0.925 ***	(0.0598)	-0.886 ***	(0.0598)	-0.794 ***	(0.0601)	-0.788 ***	(0.0599)
X male	0.073	(0.0676)	0.081	(0.0683)	0.083	(0.0683)	0.084	(0.0685)	0.094	(0.0686)	0.094	(0.0687)
X math score (standardized)	0.710 ***	(0.0471)	0.707 ***	(0.0474)	0.692 ***	(0.0475)	0.662 ***	(0.0473)	0.631 ***	(0.0472)	0.630 ***	(0.0473)
X SES (standardized)	0.059	(0.0389)	0.053	(0.0392)	0.053	(0.0392)	0.060	(0.0393)	0.050	(0.0394)	0.046	(0.0394)
School Mean SAT (percentile)	-0.017 ***	(0.0014)	-0.009 ***	(0.0014)	-0.009 ***	(0.0014)	-0.009 ***	(0.0014)	-0.009 ***	(0.0014)	-0.010 ***	(0.0014)
X male	-0.007 ***	(0.0020)	-0.006 ***	(0.0020)	-0.006 ***	(0.0020)	-0.005 ***	(0.0020)	-0.005 ***	(0.0020)	-0.005 ***	(0.0020)
X math score (standardized)	0.034 ***	(0.0013)	0.031 ***	(0.0013)	0.031 ***	(0.0013)	0.030 ***	(0.0013)	0.030 ***	(0.0013)	0.030 ***	(0.0013)
X SES (standardized)	0.011 ***	(0.0011)	0.010 ***	(0.0011)	0.011 ***	(0.0011)	0.011 ***	(0.0011)	0.011 ***	(0.0011)	0.011 ***	(0.0011)
Admissions model												
Estimated separately by group	N/A		No		Yes		Yes		Yes		Yes	
Includes many interactions between institutional selectivity with math score and SES	N/A		No		No		Yes		Yes		Yes	
Includes amenity and academic spending per FTE interacted with math score and SES	N/A		No		No		No		Yes		Yes	
Includes amenity and academic spending per FTE interacted with "unobserved preferences"	N/A		No		No		No		No		Yes	

Notes: Coefficients are reported with robust standard errors in parentheses. Spending on amenities includes student services and auxilary enterprises (primarily food service and dorms). Academic spending includes both instruction and academic support services. Selective admissions is accounded for by weighing each observation in the conditional logit model by the predicted probability that each student would be admitted to the school in the given year. Predicted net price is from auxilliary model estimated with other data. See text. *** p<0.01, ** p<0.05, * p<0.1

Table D5. Out-of-sample Model Prediction of Share of High SES Freshmen Fall Enrollment

	Dept variable: Share of First-time FT freshmen that are high SES		
Variables	No fixed effects (1)	Main model (2)	Spending effects vary by institution level (3)
$\eta_{high\ SES,cost}$ × log(tuition+fees)	0.3114	0.1419	0.1381
	(0.1948)	(0.0865)	(0.0862)
$\eta_{high\ SES,amenity}$ × log(Amenity $/FTE)	0.1561 ***	0.2147 ***	0.1770 ***
	(0.0474)	(0.0672)	(0.0539)
$\eta_{high\ SES,academic}$ × log(Academic $/FTE)	-0.0282	-0.1442 *	-0.1301 *
	(0.1312)	(0.0868)	(0.0735)
$\eta_{high\ SES,\ SAT}$ × School Mean SAT (percentile)	0.0006 *	0.0003 ***	0.0006 ***
	(0.0003)	(0.0055)	(0.0002)

Notes: Sample includes private non-profit four-year institutions from 2008 to 2012 for which we have estimated enrollment elasticities. Institution-specific elasticity of top-tercile SES students are simulated using the estimated demand models reported in Tables 5 and 6, depending on the specification. Other controls include year controls, institution fixed effects, Institution state unemployment rate, and log enrollment. *** p<0.01, ** p<0.05, * p<0.1

Appendix E: Model Details

Model of College Expenditures by Type

To illustrate how demand pressure may influence institutions' amenity decisions, we develop a simple model of college resource allocation. Let there be j =1 ,…, J colleges and i = 1,2, …, N college students. For simplicity we will assume that there are two (non-price) college attributes: academic quality A and consumption amenities C. Colleges have a price equal to T. For simplicity we will also assume that students are characterized by their income level (I), as well as their preferences for academic quality (α), college consumption amenities (γ), and income (β). We denote the distribution of these characteristics across the population of college students by G, so $N = \int dG(\beta, \alpha, \gamma, I)$.

Assume that colleges maximize net revenues π_j and, for simplicity, that the only revenues that they receive are tuition revenues. Also assume for now that everybody pays the same tuition. Finally assume, perhaps for historical reasons, that colleges have different technologies (costs) in producing academic quality and consumption amenities. Denote this per student cost function by $r_j(A_j, C_j)$. So, college j will choose A_j , C_j and T_j to maximize

$$\pi_j = N_j\left(T_j, A_j, C_j\right) \times \left\{T_j - r_j(A_j, C_j)\right\}$$

where

$$N_j = \int P(y_j = 1 \mid T_j, A_j, C_j, \beta, \alpha, \gamma, I) dG(\beta, \alpha, \gamma, I)$$

and $P(y_j = 1 \mid T_j, A_j, C_j, \beta, \alpha, \gamma, I)$ represents the probability that a student with characteristics α, γ, β and I attends college j and is a result of optimization decisions made by students. To simplify matters, we assume that this probability has a logit form. So,

$$N_j = \int \frac{\exp(\beta(I - T_j) + \alpha A_j + \gamma C_j)}{\sum_{k=1}^{J} \exp(\beta(I - T_k) + \alpha A_k + \gamma C_k)} dG(\beta, \alpha, \gamma, I)$$

If we further assume that costs are additively separable for the two amenities, $r_j(A_j, C_j) = r_j^A A_j + r_j^C C_j$, then the first order conditions for maximizing π_j expressed in terms of elasticities are:

$$\pi\xi_T \frac{N}{T} + N = 0, \ \pi\xi_A \frac{N}{A} - r_A N = 0, \text{ and } \pi\xi_C \frac{N}{C} - r_C N = 0$$

or

$$\pi\xi_T = -T, \ \pi\xi_A = A r_A, \text{ and } \pi\xi_C = C r_C,$$

where ξ_T, ξ_A and ξ_C are elasticities of enrollment with respect to price, academic quality and consumption amenities respectively. Taking the ratio of the latter two gives $\frac{A^*}{C^*} = \frac{\xi_A}{\xi_C} \times \frac{r_C}{r_A}$, and taking the logs of both sides of this equation yields an expression for the optimal ratio between consumption and

academic spending:

$$\ln\left(\frac{C^*}{A^*}\right) = \ln \xi_C - \ln \xi_A + \ln r_A - \ln r_C . \qquad (1)$$

Thus, the optimal ratio between consumption amenities and academic quality will depend positively on the enrollment elasticity with respect to consumption and negatively on the enrollment elasticity with respect to academic quality. [4]

Deriving Institution-specific Demand Elasticities

One source of variation in demand elasticities across institutions is variation in preferences across students combined with differences across institutions in the underlying distribution of student characteristics. Denote the elasticity of expected enrollment at college *j* with respect to academic quality A_j by ξ_j^A. From the definition of elasticity we have:

$$\xi_j^A = \frac{\partial N_j}{\partial A_j} \times \frac{A_j}{N_j} = \int \frac{\partial P(y_j = 1 | T_j, A_j, C_j, \beta, \alpha, \gamma, I)}{\partial A_j} dG(\beta, \alpha, \gamma, I) \times \frac{A_j}{\int P(y_j = 1 | T_j, A_j, C_j, \beta, \alpha, \gamma, I) dG(\beta, \alpha, \gamma, I)} \qquad (2)$$

To show the connection of ξ_j^A to *G* we would like to analyze how ξ_j^A changes for a "small" change in *G*. To keep the analytics simple we assume that students only differ according to academic quality preferences α and that there are only two types in the population 1 and 2 where the fraction of type 1 equals *q*. Given these simplifications, the elasticity becomes:

$$\xi_j^A = \frac{q p_{j1} \xi_{j1}^A + (1-q) p_{j2} \xi_{j2}^A}{q p_{j1} + (1-q) p_{j2}} \qquad (3)$$

where p_{ji} equals the probability that an individual of type *i* attends college *j* and ξ_{ji}^A equals the elasticity of expected enrollment at college *j* for type *i*, *i* =1,2. Thus the institution-specific enrollment elasticity (with respect to a change in characteristic *A*) is a weighted average of type-specific elasticities with weights proportional to each type's prevalence in the population and initial enrollment likelihood.[5] To see how ξ_j^A changes for a small change in the distribution of student types in the population and their initial enrollment shares, we differentiate with respect to q and p_{ji} separately:

$$\frac{\partial \xi_j^A}{\partial q} = \frac{p_{j1} p_{j2} \left(\xi_{j1}^A - \xi_{j2}^A\right)}{\left(q p_{j1} - (1-q) p_{j2}\right)^2} \quad \text{and} \quad \frac{\partial \xi_j^A}{\partial p_{j1}} = \frac{q(1-q) p_{j2} (\xi_{j1}^A - \xi_{j2}^A)}{\left(q p_{j1} + (1-q) p_{j2}\right)^2}. \qquad (4)$$

If we define group 1 as the group with a greater enrollment elasticity with respect to A_j

[4] Mathematical details of these models are available from the authors upon request.

[5] When p_{ji} has a logit form then $\xi_{ji}^A = \alpha_i A_j (1 - p_{ji})$ where α_i is the preference parameter for type i, i=1,2.

$(\xi_{j1}^{A} > \xi_{j2}^{A})$, then ξ_{j}^{A} is increasing with the prevalence of type 1 in the population and their initial likelihood of enrolling at college *j*. This logic can be extended to many different types of individuals and multiple dimensions of college characteristics.