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The Impact of College Quality on Tuition: A Hedonic Analysis

Young O. Dimkpah, Maxwell O. Eseonu, and Uchenna N. Akpom*

Abstract

This paper analyzes the impacts of college quality and location attributes on tuition rates among four-year private institutions in the United States. This study applies hedonic price techniques to estimate the implicit prices of quality attributes of colleges in the United States. The quality attributes of a college appear to be important determinants of tuition in the United States.

Introduction

This study examines the impact of college quality on tuition rates among private four-year colleges in the United States. Over the years the demand for higher education has been increasing; so also have tuition rates. Many studies have focused on the effects of financial assistance on enrollment and recruiting decisions (Parker and Summers 1993). Other studies emphasize the cost of providing higher educational services and the ways in which tuitions are set (Johnson 1976). Though most economists would agree that the provision of higher education is multifaceted, studies that have explored the effects of various attributes on the demand and supply of higher education are few.

In their 1986 study, Hartford and Marcus investigated the effect of college features on tuition rates of private colleges using a hedonic approach. Their study was limited to sample of colleges with enrollment of four hundred full time students or more. Cohn, Rhine, and Santos (1989) referred to the multi-product features of higher education by stressing that degrees from two colleges may differ not only in teaching output but also in the image and prestige of the institutions.

It then posits that when there are differences within educational products due to the differing features of the colleges, one would also expect tuition rates to differ. In a competitive setting, therefore, tuition rates would represent equilibrium between the offer curve of colleges and the marginal willingness of students to pay for college education. The ability of colleges to supply various education characteristics and the willingness of students to pay should determine tuition rates. However, distortions by various subsidies, grants, and financial assistance received by students may affect their marginal willingness to pay.

* Young O. Dimkpah and Maxwll O. Eseonu, School of Business, Virginia State University; Uchenna N. Akpom, Synectics Associates.

In an attempt to keep pace with increases in the cost of providing educational services, private institutions that receive little or no grant money from the government find it necessary to raise tuition occasionally. In this instance, the combination of features each school provides will play a critical role in determining which institutions are hurt more by the increases in tuition. The tool of econometric analysis for this study is a hedonic approach. This approach is more informative in that it focuses on the combinations of attribute each institution should stress in its recruitment exercise to maintain a high level of student enrollment. For instance, if students are willing to pay more to attend an institution with low student/faculty ratio, then the college might do better stressing small class size in its recruitment and designing its offerings to achieve that size. In order to trim the cost of providing higher education, hedonic estimates provide an input into the decision of which attributes the institution should prune. If a low student/faculty ratio is important, then a decision to reduce faculty size given the current student population may not be appropriate.

Hedonic Price Theory

Hedonic price analysis has been used extensively in housing studies. Other applications include automobile quality (Griliches 1961) and the demand for clean air (Murdoch and Thayer 1988). It is assumed that the consumer's utility function depends both on the quantity of the commodity consumed and the attributes offered by the commodity. The consumer seeks the optimal mix of the various attributes given his or her budget constraint.

The tuition a student is willing to pay to obtain a college education is assumed to depend not only on the quantity of education desired but also on the characteristics of the particular institution, including the quality, size, age, location, and prestige of the school as well as the students' characteristics. A Harvard University education may therefore be different from a Southeastern University education even though both are private colleges. Similarly, a Mercer University education at the Macon campus is different from a Mercer university education at its Atlanta campus. Students, therefore, may be willing to pay a higher tuition in order to obtain a Harvard University education and less for a Southeastern University education. Likewise, students may be willing to pay a higher tuition to attend one campus and less for other campuses of the same college. Assuming that tuition depends on the level of characteristics provided by an institution, tuition may then be written as a function of the characteristics determining tuition:

$$T_i = T_i(Z_i) \tag{1}$$

where T_i is tuition paid and Z_i are college attributes. A well specified regression function provides estimates of the relationships. Holding all other factors constant, the implicit price of any particular attribute can be obtained from a linear relationship by partially differentiating the price function with respect to that attribute; hence:

$$\partial T_i/\partial Z_i = P_{Zi} \tag{2}$$

where P_{zi} is the implicit marginal characteristics price associated with a unit change in the characteristic $Z_{i.}$

Empirical Model

In this study, the Box-Cox (1964) transformation method is used to estimate the impact of school quality, location, and student characteristics on tuition rates. This paper therefore presents an approach to understanding variations in private college tuition in the United States.

Many studies use linear and log-linear models to estimate statistical relationships in the demand for education; however, the choice of form is not based on much statistical reasoning. The problem with such constraints is that incorrectly specifying the functional form might cause biased estimates to be obtained.

The Box-Cox transformation used in this study is of the form:

$$T_i(\lambda) = \alpha + \Sigma\, \beta_i Z_i(\lambda) + e \qquad (3)$$

where $T_i(\lambda)$, and $Z_i(\lambda)$ = the Box-Cox transformation:

$$\begin{aligned} T_i(\lambda) &= (T_i^{\lambda} - 1)/\lambda && \lambda \neq 0 \\ &= \ln T_i && \lambda = 0 \\ Z_i(\lambda) &= (Z_i^{\lambda} - 1)/\lambda && \lambda \neq 0 \\ &= \ln Z_i && \lambda = 0. \end{aligned} \qquad (3)$$

α is the constant, β_i are coefficients, and e is the error term, which is assumed to be normally distributed with mean zero and constant variance, σ^2. This functional form yields various commonly used functional forms as special cases.

Regressions were estimated using a range of values for λ ranging form -2 to 2 in increments of 0.1. The best form on the basis of the maximum likelihood function was used to analyze tuition.

The Data

Data for this study are defined in Table 1. The data include information about the location quality and student characteristics of more than 600 private four-year institutions accredited by the regional accrediting agencies in 48 states and the District of Columbia. Specialized institutions such as Christian colleges and seminaries, music and art institutions, and culinary schools were excluded from this sample. Colleges that do not charge tuition, or that charge a comprehensive charge that includes tuition, room and board, and fees, were also excluded.

The major sources of data for this study are Barron's *Profiles of American Colleges* (2000) and *Peterson's Guide to Four-Year Colleges* (2000). More than one thousand private four-year institutions are listed in these sources, but only 684 satisfy our requirements. Though a huge amount of information is provided by these sources, it should be pointed out that biases could exist since these are self-reported data. A comparison of these guides did not reveal significant differences.

The dependent variable for this study is annual tuition and fees for the 1999-2000 academic year. The tuition was used without making adjustments for financial assistance to obtain a net tuition. Some other studies have used tuition net of average financial aid for individual schools. The results have not been significantly different from studies using gross tuition.

Sixteen independent variables were used. The quality variables include GRADSTU, YEARFD, HCOMP, MCOMP, FACDOCT, LIBSIZE, and STUFAC.

TABLE 1. DEFINITION OF VARIABLES

CITY:	1 if college is located within 50 miles of a city with population of 100,000 or more.
GRADSTU:	Proportion of graduate students.
CHURCH:	1 if college is affiliated with a religious group.
HCOMP:	1 if college is ranked as highly competitive.
MCOMP:	1 if college is ranked as moderately competitive.
LIBSIZE:	Number of books in library in thousands.
FACDOCT:	The percentage of faculty with doctorate degrees.
STUFAC:	Student/faculty ratio.
BLACK:	Percentage of total student population that is black.
STUDSIZE:	Total full-time enrollment at the college.
LANDSIZE:	Land size in acres.
PWOMEN:	Proportion of female students.
YEARFD:	Year the college was founded. If a result of merger, the year the oldest college was founded.
NEAST: [a]	CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VT.
MDWEST:	AI, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI.
WEST:	AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY.
SOUTH:	AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA, WV.
FEES:	Annual gross tuition.

[a] 1 if college located in listed states, zero otherwise.

We expect HCOMP, MCOMP, FACDOCT, GRADSTU, and LIBSIZE to have positive effects on tuition, while YEARFD and STUFAC are expected to have negative signs.

GRADSTU is a proxy for research activity taking place at the college. The availability of a graduate school also provides a student an opportunity to continue his or her studies beyond the undergraduate level without the hassles of applying to another school.

YEARFD is used as a proxy for the longevity of the college. An older college may have built a strong reputation over the years. This is expected to have a positive effect on its tuition. STUFAC is a measure of access to faculty by the students. This may not be the best measure since it does not necessarily reflect the average class size. We used it, however, because we could not obtain a better measure from our sources.

FACDOCT measures the percentage of full-time faculty with terminal degrees. It is used here as a proxy for the quality of faculty at the institution. Faculty experience would have been another good measure of faculty quality, but we were unable to obtain that information.

The location variables, NEAST, MWEST, WEST, and SOUTH, are included to measure if regional differences exist in the structure of tuition in the United States. Other variables are CHURCH, BLACK, STUDSIZE, LANDSIZE, and PWOMEN.

Results

The results of the linear, log-linear, and the best functional forms are presented in Table 2. The maximum likelihood estimates for the linear, log-linear, and best-functional forms were -6130, -6158, and -4657, respectively. Based on a χ^2 test using the statistic $-2\ln(L_o/L_a)$, where L_o is the log likelihood for the null hypothesis and L_a is the log likelihood for the alternative hypothesis, the linear and log-linear functional forms were rejected at the 95 percent level of confidence.

TABLE 2. HEDONIC EQUATIONS FOR COLLEGE TUITION AND MARGINAL ATTRIBUTE PRICES

Variable	Linear	Log-Linear	Best (λ =0.1)
		Estimates (t-value)	
CITY	642.502*	0.06429*	0.01614*
	(2.181)	(2.795)	(2.758)
LANDSIZE	0.124	0.00001	0.000003
	(1.248)	(1.496)	(1.476)
FACDOCT	66.913*	0.00499*	0.00286*
	(8.954)	(8.212)	(8.318)
MCOMP	1194.435*	0.12200*	0.03054*
	(3.440)	(4.511)	(4.428)
HCOMP	4268.295*	0.27000*	0.07065*
	(7.674)	(6.228)	(6.395)
CHURCH	-848.471*	-0.03460	-0.00960**
	(2.911)	(1.520)	(1.659)
STUFAC	-158.518*	-0.01093*	-0.00284*
	(5.029)	(4.444)	(4.540)
BLACK	-40.651*	-0.00394*	-0.00099*
	(6.102)	(7.572)	(7.467)
PWOMEN	-11.510	-0.00030	-0.00009
	(1.418)	(0.468)	(0.575)
YEARFD	-5.888*	-0.00126*	-0.00032*
	(4.781)	(4.858)	(4.868)
SOUTH	-3062.486*	-0.22900*	-0.05897*
	(9.105)	(8.736)	(8.827)
WEST	367.436	0.01862	0.00510
	(0.730)	(0.474)	(0.510)
MDWST	-1656.226*	-0.10600*	-0.02782*
	(4.471)	(3.676)	(3.781)
STUDSIZE	-9.206	-0.00083**	-0.00021**
	(1.544)	(1.791)	(1.782)
GRADSTU	-6.791	0.00014	-0.00004
	(0.808)	(0.210)	(0.266)
LIBSIZE	0.206	0.00005	0.000002
	(1.551)	(0.492)	(0.596)
R^2	0.607	0.566	0.573
F	63.371	53.706	55.159
Ln L	-6130.150	-6158.280	-4657.990*

Notes: dependent variable is annual tuition (t values). * Significant at the 99 percent level of confidence. **Significant at the 95 percent level of confidence. [a] value less than 0.001 dependent variable is annual tuition (t values).

The best functional form for this study was obtained for the values of λ equal to 0.1, based on the maximum likelihood estimate. The results show variations in colleges attribute prices in the United States since the best functional form is nonlinear.

The R^2 for the best form is 0.57. Nine of the explanatory variables were significant at the 99 percent confidence level. All significant variables had the expected signs. In addition, the magnitudes of all significant variables were reasonable.

Out of the seven quality attributes, five (HCOMP, NCOMP, FACDOCT, STUFAC, AND YEARFD) were significant at the 99 percent level of significance. Only the presence of graduate students and library size are were insignificant.

The presence of graduate students was assumed to attract a higher-quality faculty and students who plan to further their education beyond the undergraduate level. Because of this, it was included as a quality variable. GRADSTU had a negative sign but did not appear to be a significant determinant of tuition.

The variables HCOMP and MCOMP measure the competitive ranking of colleges by Patterson's guide. Four categories were used ranging from most competitive to noncompetitive. The first two were combined to form HCOMP, and the second two formed MCOMP. The result indicated that improvement from moderately competitive to highly competitive status is associated with an increase in annual tuition.

LIBSIZE indicates the size of the library in thousands of volumes held. A library is one of the most important academic facilities provided by almost every college. It is usually the center of both learning and research on campus. A college with a relatively large library should therefore be more attractive than one with none. This could explain the positive effect of LIBSIZE on tuition.

The quality of a college is sometimes measured by the percent of faculty with doctorate degrees. An increase in the number of faculty with doctorate degrees is associated with increases in annual tuition. The effect of FACDOCT would be expected to vary depending on its current level. Hence, there is a statistically significant positive relationship between the proportions of faculty with doctoral degrees and tuition.

STUFAC measures the degree of contact between faculty and students. Additional faculty per student means not only smaller classes but increased advisory time per student. The result shows an inverse relationship between student/faculty ratio and annual tuition. This may be a flawed measure because it may not necessarily capture the intended contact. Some colleges are known to have average lower-level course class size of more than 50 students, even with low student/faculty ratios. Student/faculty ratio is used because adequate information on average class size could not be obtained.

The year in which the college was founded is represented by the variable YEARFD. It measures the college's experience in providing educational service. It is sometimes associated with the reputation of a college. The results show that tuition is positively related to the age of the college. This can be explained due to the implicit reputation built over the years. As a result of their age, these institutions have acquired huge experience and attracted huge endowments that supplement and subsidize tuition increases.

Among the location attributes, MIDWEST and SOUTH are negatively significant at the 99 percent level compared to NEAST. A college located in the midwestern United States is associated with lower annual tuition than a college located in the northeastern region. Similarly, colleges in the southern regions are associated with lower annual tuition rates compared to the northeast. This supports the view that regional differences exist in the structure of tuition in the United States. Similar results have also been obtained by Harford and Marcus (1986).

BLACK measures the percentage of black students enrolled at the college. Black enrollment is negatively associated with annual tuition. This could be interpreted in one of three ways. The first is that tuition is subsidized for black students. Hence, they pay lower tuition than other students. The second is that the generally poor conditions of predominantly black colleges make them unable to provide desired attributes. This then forces them to reduce tuition in order to attract more students. The third is that black students face discrimination by some colleges that may use

high tuition to keep them out. Religious affiliation is negatively related to tuition. This could be a result of higher external funding for church-affiliated institutions, which subsidizes tuition, or those schools' inability to provide the desired aspects of education.

LANDSIZE measures the size of a college in acres of land occupied. An increase in size seems to increase tuition. This could be capturing the demand for space and aesthetics of the campus. Land size is usually associated with campus features such as parking, stadium, less crowding, and fraternity and sorority housing, which are generally considered desirable.

Conclusion

The study utilizes a hedonic price analysis to estimate the implicit prices of quality attributes of colleges in the United States. The quality attributes of a college appear to be important determinants of tuition in the United States. The study shows that colleges and universities in the United States can compete on the basis of quality attributes.

The results could be helpful in making tuition-setting decisions for colleges. It could also be used to design differential tuition policy. For instance, if the quality of one program in a college is significantly higher than for other programs, then tuition for that program could be set higher assuming other attributes are the same. The universities of Michigan and Virginia charge higher tuition for some of their popular programs than for others.

Potential students can also incorporate the results in comparing colleges when making their selection decisions. If tuition rates charged by two colleges were the same, the student would select the college that offers the best combination of desired attributes.

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