Demand for Education at the University of Nebraska at Omaha by Gender and by Upper and Lower Division Students

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Abstract: This study analyzes demand for higher education by class standing and gender at a Midwestern metropolitan public comprehensive university, specifically the University of Nebraska at Omaha, UNO, as well as the impact of a 1984 legislative bill mandating the transfer of credits from a local two-year college, and the initiation of on-campus student housing. We estimate the impact on demand of variables such as tuition relative to income, the number of potential students, tuition at a nearby community college, measures of the increased income resulting from college graduation, and the opportunity cost of attending college. Three surprising results of our study are that the impact of tuition relative to income is positive and significant for enrollment measured by student credit hours and positive but insignificant for enrollment measured by head count, that education at the nearby community college and at UNO are complementary services and that the impact of the unemployment rate, our measure of the opportunity cost of college education, negative for all of our enrollment measures and negative and significant for all of our enrollment measures except male head count. We then consider the feasibility of implementing at UNO a two-tiered tuition plan, where students would pay more per credit hour for upper-division than lower-division courses.

Introduction

      The Organization for Economic Cooperation and Development recently reported that the United States no longer leads the world in the percentage of the population 25 – 64 who have graduated from college (OECD: 2008). In response to this report, President Obama has stated the goal of making the U. S. again the world leader in college graduates by 2020 (Los Angeles Times: 2009). Also, concern has been expressed that U. S. college tuition increases which have for many years exceeded the general rate of inflation, may reduce the percentage of the U. S. population who complete college (College Board: 2008).

      In this paper, we determine the impact of tuition relative to income and other variables on college enrollments by estimating the demand for education at a Midwestern metropolitan comprehensive university, the University of Nebraska at Omaha, UNO. Also, if demand by upper-division students, juniors and seniors, is more inelastic than demand by lower-division students, freshmen and sophomores, assuming that quantity of demand is inversely related to price, a university could minimize the enrollment reduction resulting from a given increase in tuition revenue by increasing tuition by a larger amount for upper-division students than for lower-division students. To evaluate such a pricing policy, we estimate separate demand functions for upper-division enrollment and lower-division enrollment. To ascertain the impact of a nearby community college, Metropolitan Community College (Metro), on enrollment at UNO we estimate the cross-price elasticity of demand of UNO enrollments with respect to Metro tuition. Finally, to determine if demand for higher education varies by gender we also estimate separate demand functions for men and women.

      Typically, higher education demand models include explanatory variables representing tuition, family income, the prices of competition institutions, and the eligible population or potential students. While this study includes these variables, it also includes local factors that may impact demand for education at UNO, such as a 1984 legislation requiring the transfer of certain credits from community colleges to the University of Nebraska, and the availability since 1999 of on-campus student housing at UNO.

      The Literature Review section that follows presents a sample of the extensive research on the demand for higher education. The review focuses on the variables selected, the estimation techniques employed, results obtained, and conclusions reached. The Data and Model section then describes the sources and construction of the variables and the specification of estimating equations we employ. While many of our estimates, presented in the Results section, have the expected signs and significance, the estimates for three of our explanatory variables are unexpected. First, the unexpected positive signs of the coefficients for the ratio of UNO tuition to income which are significant for all the Student Credit Hour, SCH, enrollment measures imply that the price and income elasticites have respectively unexpected positive and negative signs, and SCHs at UNO are inferior goods that are also Giffen goods. However, for all the head count enrollment measures, HC, all the estimates for this coefficient are statistically insignificant. Second, the estimated cross-price elasticity between tuition at Metro and UNO enrollment implies that community college enrollment was a complementary good, not a substitute good, as expected.   Third, the negative coefficients for the unemployment rate, our measure of opportunity cost of attending college, which is significant for all the enrollment measures except for male head count imply that UNO enrollments

increase with our measure of opportunity cost. Finally in the Conclusions section, we discuss the implications of our results for tuition-pricing policy and recruiting and retention strategies.

Literature Review

Since the mid 1960s, the demand for higher education has been studied to determine the relationship between demand, typically enrollment, and price, income, and other factors. In general, the results of these studies indicate demand is price inelastic and income elastic.

Campbell and Siegel (1967) conducted a seminal study of demand for higher education. They used demand theory to develop the equation:

$$(N_t / E_t)= f(Y_{ht}, P_t)$$

The left-hand variable measured the ratio of aggregate enrollment to eligible participants defined as undergraduate degree enrollment in 4-year institutions in year t, N_t, divided by the "number of people in the 18-24 year age group who are high-school graduates and who are not in the armed forces," in year t, E_t, (p. 485-6). By using the ratio of enrollment to eligibles they were able to alleviate the problem of colinearity between these two variables. Exogenous variables included: real disposable household income in year t, (Y_{ht}); and average real tuition in year t, (P_t). When a log-linear transformation of their demand equation was estimated by ordinary least squares (OLS), estimated own-price elasticity was –0.44, while estimated income elasticity was 1.20. Similar own-price elasticity and income elasticity results were reported in a number of subsequent studies.

Hoenack's (1967) cross-section study of higher education demand in California employed a broad set of exogenous variables. Since an initial analysis revealed that the error variance was not consistent and random, Hoenack corrected this apparent heteroskedasticity, which resulted from marked differences between low- and high-income families, by dividing families into four income groups, and then estimating his demand equation for each group separately. The estimated price elasticity varied "from –1.12 for the lowest income bracket to -0.71 for the highest income bracket" (p. 19-20), indicating that students from lower income families were much more sensitive to changes in tuition price than students from higher income families.

Knudsen and Serville (1978) focused on the impact of "competition" variables, higher education alternatives in the area of each private university in their study. For their log-linear demand equation estimated by OLS, the estimated own-price elasticity of demand was -0.47 with no competing institutions close by, -0.41 with competing private institutions close by, and -1.23 with competing public institutions close by. Indicating that demand for enrollment at private universities was much more responsive to changes in tuition price when competing public institutions were located nearby. Estimated cross-price elasticities of demand were not significantly different from zero, and highly inelastic which may have been due to differences in market segmentation resulting from large tuition price differentials between public and private schools and differences between the product offerings of competing area private schools. Their results indicated that in the absence of competition from public universities, demand was price inelastic. Thus, ceteris paribus tuition increases could be implemented with little, if any,

decrease in demand, and would result in increased institutional revenue. Their income elasticity of demand results varied. Income elasticity was lower (1.2) and thus impacted private enrollments less, where no competition existed, but much higher (2.7) where public competition existed.

Doyle and Cicarelli (1980) also used the log-linear OLS approach to estimate demand for private higher education. They included a competition variable derived from the number of four-year colleges in the state that compete directly with a college. They also added a quality variable that was based on "academic ranking provided by *Barron's Profiles of American Colleges*" (p. 54). Their results indicated that during periods of increasing prosperity enrollment in private colleges should increase while enrollment in public institutions would likely decline.

Rives and Cassidy (1982) conducted a cross-sectional survey of demand for higher education at a single state university campus that focused on the "substitution and allocative effects resulting from various rates of tuition increases" (p. 19). They looked at a broad spectrum of student demographics including age, sex, marital status, college major, class standing, in-migrants, as well as tax implications and sources of college funds. Four rates of tuition price increases were tested: 25%, 50%, 75%, and 100%. At the lowest price increase tested, 25%, own-price elasticity of demand for higher education diminished as student class standing rose: Freshman -1.18, Sophomore -0.86, Junior -0.70, Senior -0.58. Their results imply that the impact of a 25% increase in tuition on upper division enrollment would be much smaller than on lower division enrollment.

Shim (1990), in his study of higher education demand in Mississippi, also used a log-linear OLS approach. He used a ratio of Mississippi college enrollment to high school graduation data to derive his endogenous enrollment variable and included the typical exogenous variables tuition and income. He also included an opportunity cost variable derived from state unemployment rate, and "two dummy variables to account for any impacts between 1965 and 1969 due to the Vietnam War and the recession of 1981 to 1983" (p. 79). Although both dummy variables proved insignificant, the demand for college enrollments was highly price inelastic at –0.01, income elastic at 1.12, and also elastic, 1.21, with respect to opportunity cost measured by unemployment. Enrollment proved insensitive to changes in tuition, but was very responsive to changes in income.

Hsing and Chang (1996) developed three models that included a log-linear demand equation estimated by OLS, focused on demand for higher education at private institutions. They included typical exogenous variables and found that enrollment was tuition inelastic, –0.25, income inelastic, 0.68, inelastic with respect to opportunity costs as measured by the retail wage rate, –0.58, and highly inelastic with respect to labor market condition as measured by the unemployment rate, 0.04. Compared to demand for higher education at public institutions, it appeared that enrollment in private institutions was less sensitive to changes in income. Also, changes in opportunity costs and wage differentials between college and high-school graduates did not appear to deter or enhance enrollment at private institutions.

Like the study conducted by Shim (1990), Allen and Shen (1998) included a dummy variable for both the Vietnam War (1965-1969) and the recession of 1981-1983. Unlike most other studies, their study did not include a variable representing potential students. They focused on elasticity of demand at a single private comprehensive university in the Midwest, Creighton University. They used a two-stage least squares to estimate a log-linear demand

equation. For data from 1959-1993, demand was price inelastic, –0.64, income elastic, 1.80, and highly inelastic with respect to opportunity cost, 0.19; and all these estimates were significant at either the 1% or 5% level, while the dummy variables proved insignificant. They also evaluated competition from public and private alternatives on their enrollment measure, and their results supported the results of Knudsen and Serville. Specifically, cross-price elasticity of private school enrollment with respect to the cost of public alternatives was very low, -.002, and not significantly different from zero, while the cross-price elasticity of enrollment with respect to the cost of private alternatives was significant and inelastic, 0.53.

Watkins (2008) used two-stage least squares to estimate demand and supply functions for public undergraduate higher education for 36 states, where the left-hand variable is defined as the percentage of a state's population between 18 and 24 years of age enrolled full-time at a 4-year public institution. The right-hand variables in his demand equation include tuition at public institutions, income, tuition at private institutions, the state wide unemployment rate, a measure of the difference in the lifetime earnings of college and high-school graduates, real earnings per job in manufacturing as a measure of the opportunity cost of attending college, state financial aid divided by the population between 18 and 24 years of age, and the percentage of the population categorized as black or Hispanic. Since tuition at public institutions and income were highly collinear for his data, Watkins includes tuition at public institutions as a percentage of per capita income instead of both tuition and income in his demand function. For his log-linear demand function, tuition at public institutions as a percentage of income has the expected negative sign, is significant, but enrollments are highly inelastic, –0.146 to -0.185, with respect to this variable.

In summary, these works exhibit generally consistent estimates of the impact on the demand for higher education of variables such as tuition, income, opportunity costs, potential students, competition, and the price of substitutes. Based on the previous works, we next define the variables used to conduct our analysis and describe our estimation methodology.

Data and Models

Most of the studies discussed in the previous section estimated log-linear demand functions by ordinary least squares (OLS). For example, Campbell and Siegel (1967), Radner and Miller (1970), Knudsen and Seville (1978), Doyle and Cicarelli (1980), and Shim (1990) all used this demand function and estimation technique. Allen and Shen (1998) used two-stage least squares to estimate this demand function. To facilitate the comparison of our estimates with the results of the previous studies, we employ the same demand function and OLS estimation technique.

In developing our estimating equations, we defined the variables in ways that reduced the colinearity inherent in time series data. By lagging population data 5 years in defining the potential students variable, colinearity between population and enrollment was reduced. Our income and tuition variables were highly collinear, and similar to Watkins (2008) we included the ratio of tuition to income instead of both tuition and income. Like many of the previous researchers, we re-specified our linear OLS equations by taking the logs of all variables, to reduce the heteroskedasticity inherent in data such as income (Pindyck & Rubinfeld 1998). To confirm the homoskedastic nature of each model, the squares of the residuals were plotted.

Finally, to check for colinearity, for each model, each of the exogenous variables was regressed on the other exogenous variables. This check confirmed that none of the correlations was sufficiently large to be problematic.

Six log-linear models were developed and estimated by OLS using annual data from 1977 through 2007. The left-hand variables were demand for education at UNO measured as (1) undergraduate student credit hours and (2) undergraduate head count. The exogenous variables selected included: the ratio of UNO's tuition per credit hour to Nebraska per capita income, tuition per credit hour at Metro to represent the price of a hypothesized substitute good, a proxy for potential students, the Nebraska state unemployment rate to represent opportunity costs, and a measure of the income of college graduates relative to high-school graduates to represent the expected benefits of a college education. The number of potential students for a given year is proxied by the estimated total population or total population by gender aged 15 to 34 years old who resided five years previously in Douglas County, the county in which UNO is located and Sarpy County, a nearby county in which a significant number of UNO students reside. Thus, this variable is an estimate of the number of 20 to 39 year-olds, the age group from which most UNO students are drawn, who resided in these counties in a given year. This variable is a good proxy for the eligible population since approximately seventy percent of UNO students are from Douglas County and the majority of the remaining students are from Sarpy County, while very small percentages are from each of a number of counties in Nebraska, the state of Iowa, other states, and foreign countries. The increased income of college graduates is measured by the ratio of college graduate average annual earning to high school graduate average annual earning. Two dummy variables were also included to capture differences in demand resulting from (1) the fall, 1984 effective date of Legislative Bill 980 (LB 980) which mandated acceptance by the University of Nebraska of community college transfer credits, and (2) the availability beginning in the fall of 1999 of on-campus student housing at UNO. Variables used in the models are listed and defined in the Data Appendix at the end of this paper. Table 1 reports the results of estimating our demand models, and Table 2 reports the correlation matrix for our left-hand and right-hand variables.

First, we investigated the impact of the exogenous variables on enrollment by class standing and total enrollment measured by Student Credit Hours, SCH. Exogenous variables included: our proxies for potential students *(E_5)*, UNO tuition price relative to income *(P)*, tuition at Metro *(S)*, our proxies for opportunity costs *(O)*, and expected benefits of graduating from college *(F)*, and two dummy variables, one for LB 980 (D_{84}) and one for on-campus housing (D_{99}).

The following equations were used to estimate the effects of the four exogenous variables on total enrollment and lower-division enrollment measured by student credit hours:

$$T = \varsigma + \alpha \log (E_5) + \beta \log (P) + \delta \log (O) + \vartheta \log (F) + \gamma \log (S) + D_{84} + D_{99} + \xi$$
$$L = \varsigma + \alpha \log (E_5) + \beta \log (P) + \delta \log (O) + \vartheta \log (F) + \gamma \log (S) + D_{84} + D_{99} + \xi$$

The following equation was used to estimate demand for upper-division enrollment measured by student credit hours. (Unlike the lower division and total demand model, both dummy variables and the alternative 2-yr institution tuition variable were excluded as they were believed to be relevant to demand by lower-division, but not upper-division students):

$$U = \varsigma + \alpha \, log \, (E_5) + \beta \, log \, (P) + \delta \, log \, (O) + \vartheta \, log \, (F) + \xi$$

To determine if there were differences in the demand for education at UNO by gender we specified models of enrollment by gender and total enrollment measured by head count, HC. At UNO, data by class standing is maintained by student credit hour (SCH). Since the average number of credit hours students enroll for has varied over time, SCH more accurately measures demand than HC. Because data by gender has not been consistently maintained by SCH, but has been maintained by HC, enrollment data by gender was measured by HC not SCH. The following versions of this model: one for male enrollment measured by headcount (G_M) with potential male enrollees *(E_{M5})* as an explanatory variable, one for female enrollment measured by headcount (G_F) with potential female enrollees *(E_{F5})* as an explanatory variable, and one for total head count (G_T) were estimated:

$$G_M = \varsigma + \alpha \, log \, (E_{M5}) + \beta \, log \, (P) + \gamma \, log \, (S) + \delta \, log \, (O) + \vartheta \, log \, (F) + D_{84} + D_{99} + \xi$$
$$G_F = \varsigma + \alpha \, log \, (E_{F5}) + \beta \, log \, (P) + \gamma \, log \, (S) + \delta \, log \, (O) + \vartheta \, log \, (F) + D_{84} + D_{99} + \xi$$
$$G_T = \varsigma + \alpha \, log \, (E_5) + \beta \, log \, (P) + \gamma \, log \, (S) + \delta \, log \, (O) + \vartheta \, log \, (F) + D_{84} + D_{99} + \xi$$

For all the models, we expect negative coefficient estimates for the ratio of UNO tuition to per capita income, and positive coefficients for Metro tuition, our proxies for the number of potential students, the expected economic benefits of graduating from college, the opportunity cost of attending college, and the dummy variable for the on-campus student housing; and we expect a negative coefficient estimate for the dummy variable for LB 980.

Results

The results of estimating all six models by OLS are reported in Tables 1 and 2. As reported in Table 1, the upper and lower-division and total SCH models fit the data well as indicated by the large f-statistics of 51.8, 6.6 and 12.7 respectively. In addition, the values of R-squared imply that the model explains 87% of upper-division and 57% of lower division and 79% of total variation in SCH. Thus, even with fewer right-hand variables, the upper-division model explains a larger proportion of the variance in enrollment than the lower-division model. That is, the included factors explain a larger percentage of the variance in upper-division SCH than in lower-division SCH. The Durbin-Watson statistic of 1.29, 1.3, and 1.16 for the three models respectively indicates that the presence of positive serial correlation could be neither accepted nor rejected in any of models.

In all the SCH models, the positive coefficient estimates for UNO tuition relative to income, and negative estimates for our measure of opportunity cost, the unemployment rate, are significant and have signs that contrary to our expectations. The positive estimated coefficients for UNO tuition relative to income are characteristic of a Giffen good. Consistent with a Giffen good, the sign of this coefficient indicates that UNO SCH is an inferior good, although demand is estimated to be inelastic. This unusual result may be caused by the high correlation between tuition at UNO and the cost of the more luxurious substitute service, SCH at the other primarily residential campus of the University of Nebraska. Since UNO is located in the state's largest city where many students' families reside and where employment is readily

Table 1
Student Credit Hours by Class Standing Regression Results

	Constant	Future Expectations	DUM 1984	DUM 1999	Eligible Participants Lagged 5 yrs.	Ratio UNO Tuition to Income	Substitute Price of 2-yr College	Opportunity Costs	R^2 F-stat
LOWER DIVISION ENROLLMENT	-4.95	0.91	-0.11	0.07	1.62	0.37	-0.15	-0.18	0.57
(t-stat)	(1.08)	(3.66)	(2.11)	(2.12)	(3.90)	(2.57)	(3.18)	(13.11)	6.64
UPPER DIVISION ENROLLMENT	6.83	0.32	NT	NT	0.69	0.66	NT	-0.2	0.87
(t-stat)	(3.07)	(2.04)			(2.72)	(9.32)		(5.09)	51.8
Total Enrollment	-1.62	0.74	-0.10	0.38	1.42	0.48	-0.09	-0.19	0.79
(t-stat)	(-0.38)	(3.27)	(2.11)	(1.22)	(3.74)	(3.61)	(2.19)	(3.70)	12.67

Coefficient provided with t-stat in parenthesis. NT: Not Tested.

Table 2
Head Count Enrollment by Gender

	Constant Future Expect	DUM 1984	DUM 1999	Eligible Participants Lagged 5 yrs.	Ratio UNO Tuition to Income	Substitute Price of 2-yr College	Opport Costs	R^2 F-stat
MALE ENROLL	-7.36 0.58	-0.15	-0.03	1.64	0.32	-0.17	0.1	0.68
	(5.14) (2.01)	(2.47)	(0.73)	(3.33)	(1.93)	(3.11)	(1.61)	6.83
FEMALE ENROLL	-13.51 1.0	-0.2	0.01	2.15	0.29	-0.14	-0.21	0.73
(t-stat)	(3.07) (3.88)	(3.64)	(0.14)	(5.0)	(1.82)	(3.04)	(3.38)	8.67
TOTAL ENROLL	-11 0.80	-0.17	-0.01	1.89	0.3	-0.016	-0.15	0.69
(t-stat)	(2.36) (3.16)	(3.28)	(0.37)	(4.47)	(2.03)	(3.41)	(2.67)	7.34

Coefficient provided with t-stat in parenthesis.

available, while the other campuses are located in smaller cities, students could respond to increases in tuition relative to income by increasing the number of SCHs completed at UNO and reducing the number completed at the other campuses of the University of Nebraska. The negative coefficient for opportunity cost, measured by the state unemployment rate, suggests that as unemployment increases the negative impact of reduced family resources exceeds the positive impact of reduced opportunity cost. The estimates for both UNO tuition relative to income and opportunity cost reflect the inferior nature of UNO SCH. Higher costs relative to income cause UNO SCH to increase and higher opportunity costs, a lower unemployment rate, both cause UNO SCH to increase because the negative income effects overwhelm the substitution effects.

The unexpected negative estimates for tuition at a nearby community college in the lower-division and total SCH models as well as all the HC models, discussed later, imply that community college enrollment is a complementary service to UNO, not as expected, a substitute service. Perhaps this should not come as a surprise, as students can greatly reduce the cost of college, by living with their family, and attending Metro before or simultaneously with UNO. The economics of the low-tuition cost combination of Metro and UNO, combined with reduced living costs and the better employment opportunities while attending college may be compelling for many students. As expected, coefficients of the dummy for legislative bill LB 890 mandating the transfer of credit from a Nebraska community college to the University of Nebraska are all negative and significant at the 5% level for all the SCH models.

As expected, the coefficient estimates for all the SCH models for our proxies for the number of potential students and the benefits of graduating from college were positive and significant.   A one percent increase in our measure of potential student population increases lower division SCH by 1.6%, total SCH by 1.42% and upper-division SCH by a much smaller 0.69%. A one percent increase in our measure of the difference between the incomes of college and high school graduates increases lower-division SCH by 0.91%, total SCH by 0.74% and upper-division SCH by 0.32%. The estimated impact of the initiation of on-campus student housing on lower-division SCH is positive and significant, but not significant for total SCH.

For the male and female and total headcount models reported in Table 2, the large f-statistics, 6.8, 8.7 and 7.3 respectively, show that all these models fit the data well. In addition, the R-squared values indicate that the models explained 68% of the variation in male enrollment, 73% of the variation in female enrollment, and 69% of the variation in total enrollment. The values of the Durbin-Watson statistic, 1.3 for the male model, 1.2 for the female model and 1.2 for the total headcount model, neither accept nor reject the presence of positive serial correlation in either model. Values of the residuals indicate the standard errors were homoskedastic in all three gender models.

The coefficient estimates for total headcount are similar to the estimates for total SCH except that the coefficient of UNO tuition relative to income is not significant at the 5 percent level for any of the headcount models. The coefficient estimates for the male and female models are similar to the estimates for total head count and each other except that in the male headcount model the coefficients for our measure of the benefits of completing college and opportunity cost of college are not significant, but are significant for the female headcount model. These coefficient estimates suggest that female enrollments are more sensitive to economic variables than male enrollments. The difference by gender in the significance of the

estimated coefficient for opportunity cost, measured by the state unemployment rate, suggests that as unemployment increases the negative impact of reduced family resources exceeds the positive impact of reduced opportunity cost for females, but not for males. Perhaps, during times of increased unemployment, women are more likely than men to postpone higher education and instead devote more hours to market and/or household work. In general, the other coefficient estimates have the expected signs and magnitudes. Unlike the lower-division SCH model the coefficient for initiation of on-campus housing is insignificant for all of the headcount models. An explanation for this difference significance may be that this amenity increased the number of full-time lower-division students but reduced the number of part-time lower-division students, and full-time students on average enrolled in more credit hours per student than part-time students. Thus, this amenity significantly increased lower-division SCH, but did not have a significant impact on head count.

Conclusions

While many of our estimates are consistent with the literature, several differed from the literature and our expectations. A surprising implication of our estimates is that for UNO, increases in tuition relative to income increase SCH. Alternatively, focusing on the denominator of the ratio of UNO tuition relative to income, our estimated negative income elasticities of demand for SCH at UNO differ from the large positive income elasticities of demand usually reported. Additionally, SCH at UNO is negatively related to the unemployment rates, indicating that a decrease in the opportunity cost of attending UNO causes a decrease in UNO SCH. Again, these results highlight the difference between the demand for education at a metropolitan comprehensive university and more traditional residential universities. Thus, tuition at UNO can increase at a faster rate than income without reducing and perhaps increasing UNO SCH, and tuition at UNO in particular has not had a significant impact on college completion in the U.S. Finally, the result that tuition increases at Metropolitan community college reduce UNO enrollment was surprising. That is, Metro offers a complementary service to UNO.

The difference in the price elasticity of demand for lower and upper-division SCH combined with the higher average costs of producing upper-division SCH due to smaller class sizes and a smaller proportion of courses offered by lower cost part-time faculty, suggests that tuition for upper division classes should be higher than tuition for lower division classes. As our estimates indicate, larger increases in tuition for upper-division than lower division courses might actually increase UNO's total SCH as well as tuition revenue. However, given the members of the university community's strong commitment to equity manifested as equal tuition for all undergraduate courses, and the low percentage of UNO upper-division undergraduate SCH relative to total undergraduate SCH, it is unlikely that such a differential tuition policy will adopted.   The following scenario illustrates the much larger increase in upper-division tuition required to achieve a given increase in total tuition revenue when lower-division tuition increases is smaller than upper division tuition increase. If a 5 percent increase in total tuition revenue is required, initially tuition for upper division and lower division courses are equal, and for simplicity we assume that the required tuition increases have no impact on SCH. Given that on average from 2000 to 2005 lower-division SCH made up 70 percent and upper-division SCH made up 30 percent of the total UNO undergraduate SCH**,** lower division

SCH was on average 2.33 times as large as upper-division SCH. Under these assumptions, the required percentage change in upper division tuition would have to equal, 16.67 percent minus 2.33 times the percentage increase in lower division tuition. Where 16.67 percent is the percentage change in upper division tuition required for a 5 percent increase in total tuition revenue when lower-division tuition is unchanged, and for each one percent increase in lower division tuition the required increase in upper-division tuition is reduced by 2.33 percent since lower-division SCH is 2.33 times as large as upper-division SCH. Thus, for this scenario a two percent increase in lower-division tuition would have to be combined with an 11.33 percent increase in upper-division tuition. Given the strong equity norms of the university community, and given such a large difference in tuition, it is doubtful that these increases would be adopted. In situations where upper and lower-division enrollments were more balanced, differential tuition increases might be more easily adopted. Also, one should be careful about using our results to predict the impact of large changes in tuition.

Our estimates suggest possible revisions for recruiting and retention efforts. UNO needs to emphasize its value, good quality at a low price combined with the employment and cultural opportunities of a large city. UNO should be able to enhance recruiting and retention by tying its academic programs and extracurricular activities to the employment opportunities and amenities of Omaha, Nebraska.

Estimating the demand for education at UNO in isolation may have influenced our results. Extending our research to estimating the demand for education at the three University of Nebraska campuses with large undergraduate enrollment, the University of Nebraska Lincoln, the University of Nebraska at Omaha, and the University of Nebraska at Kearney, along with the Nebraska State Colleges and the larger Nebraska community colleges would allow us to better understand the interaction among enrollments at the various institutions. This work could then be extended to the demand for education at other Middle Western metropolitan comprehensive universities.

References

Allen, Robert F. and Shen, Jianshou. "Some New Evidence of the Character of Competition Among Higher Education Institutions." *Economics of Education Review,* October 1999, 18(4), pp. 465-70.

Campbell, Robert and Siegel, Barry N. "The Demand for Higher Education in the United States, 1919-1964." *The American Economic Review,* June 1967, 57(3), pp. 482-94.

Carnegie Commission on Higher Education. "The Open Door Colleges: Policies for the Community Colleges, a special report and recommendations. McGraw-Hill Book Company, New York, 1970.

Carnegie Commission on Higher Education. "Demand and Supply in U. S. Higher Education." McGraw-Hill Book Company, New York, 1975.

Chang, Hui S. and Hsing, Yu. "A Study of Demand for Higher Education at Private Institutions in the US: A Dynamic and General Specification." *Education Economics,* December 1996, 4(3), pp. 267-78.

College Board. 2008. Trends in College Pricing 2008, http://professionals.collegeboard.com/profdownload/trends-in-college-pricing-2008.pdf.

Corazzini, Arthur J. and Dugan, Dennis J. and Grabowski, Henry G. "Determinants and Distributional Aspects of Enrollment in U. S. Higher Education." *Journal of Human Resources,* Winter 1972, 7(1), pp. 39-59.

James, Frank. 2009. "Obama puts spotlight on education deficit." *Los Angeles Times*, February 25, 2009, http://articles.latimes.com/2009/feb/25/nation/na-obama-education25.

Hsing, Yu and Chang, Hui S. "Testing Increasing Sensitivity of Enrollment at Private Institutions to Tuition and Other Costs." *American Economist,* Spring 1996, 40(1), pp.40-45.

Knudsen, Odin K. and Servelle, Paul J. "The Demand for Higher Education at Private Institutions of Moderate Selectivity." *American Economist,* Fall 1978, 22(2), pp. 30-34.

Organization for Economic Cooperation and Development (OCED). 2008. Education at a Glance 2008 Indicators Table A1, http://www.oecd.org/document/9/0,3343,en_2649_39263238_41266761_1_1_1_1,00.htm.

Pindyck, Robert S. and Rubinfeld, Daniel L. "Econometric Models and Economic Forecasts." The McGraw-Hill Companies, Inc., New York, Fourth Edition, 1998.

Radner, Roy and Miller, Leonard S. "Demand and Supply in U. S. Higher Education: A Progress Report." *American Economic Review,* May, 1970 60(2), pp. 326-34.

Radner, Roy and Miller, Leonard S., et. al. "Demand and Supply in U. S. Higher Education." The Maple Press Company, New York, 1975.

Rives, Janet M. and Cassidy, G. W. "Factors Affecting the Demand for Higher Education at Public Institutions." *America Economist,* Fall 1982, 26(2), pp.17-24.

Shim, Ki R. "A Simple Demand Function for Higher Education." *Atlantic Economic Journal*, December 1990, 18(4), pp. 79.

Vasigh, Bijan and Hamzaee, Reza G. "Testing Sensitivity of Student Enrollment with Respect to Tuition at an Institution of Higher Education." *International Advances in Economic Research,* May 2004, 10(2), pp. 133-49.

Data Appendix

Endogenous Variables

(G_F): Gender Female Enrollment (FEMALEHC): Total undergraduate population classified as female, has been published annually in the *Delivery Site Enrollment Headcount – Fall Semester 1963 through 2007* and was provided by the Office of Institutional Research, University of Nebraska at Omaha.

(G_M): Gender Male Enrollment (MALEHC): Total undergraduate population classified as male, by headcount, has been published annually in the *Delivery Site Enrollment Headcount – Fall Semester 1963 through 2007* and was provided by the Office of Institutional Research, University of Nebraska at Omaha.

(G_T): Total Enrollment (TOTALHC): Total undergraduate population, by headcount, has been published annually in the *Delivery Site Enrollment Headcount – Fall Semester 1963 through 2007* and was provided by the Office of Institutional Research, University of Nebraska at Omaha.

(L): Lower Division Enrollment (LOWERACTSCH): Yearly actual lower division student credit hours data has been recorded and maintained by the Institutional Research Department at UNO since the 1983-84 Annual Audit Indicators report. Lower division SCH data for fall 1977, 1978, and 1979 were taken from the May 1980 Audit Indicators report. Since, on average, enrollees in spring semesters take 84.1% as many credit hours, in the fall semester, the fall figures were multiplied by a factor of 1.841 to derive annual lower division student credit hours. Similarly, lower division SCH data for fall 1980, 1981, and 1982 were taken from December 1983 data published in the January 1984 Audit Indicators report and multiplied by the factor of 1.841 to derive annual lower division student credit hours. Other years, beginning with the school year 1983-84 through 2007-08 were taken from actual numbers maintained and reported in each Annual Audit Indicators report without any manipulation. Data for the school years 2006-07 and 2007-08 were obtained from Enrollment Records published by the Office of Institutional Research, University of Nebraska at Omaha.

(T): Total Undergraduate SCH Enrollment (UNDERACTSCH): Yearly actual undergraduate student credit hours data has been recorded and maintained by the Institutional Research Department at UNO since the 1983-84 Annual Audit Indicators report. Undergraduate SCH data for fall 1977, 1978, and 1979 were taken from the May 1980 Audit Indicators report. Since, on average, enrollees in spring semesters take 84.1% as many credit hours, in the fall semester, the fall figures were multiplied by a factor of 1.841 to derive annual undergraduate student credit hours. Similarly, undergraduate SCH data for fall 1980, 1981, and 1982 were taken from December 1983 data published in the January 1984 Audit Indicators report and multiplied by the factor of 1.841 to derive annual undergraduate student credit hours. Other years, beginning with the school year 1983-84 through 2007-08 were taken from actual numbers maintained and reported in each Annual Audit Indicators report without any manipulation. Data for the

school years 2006-07 and 2007-08 were obtained from Enrollment Records published by the Office of Institutional Research, University of Nebraska at Omaha.

(U): **Upper Division Enrollment (UPPERACTSCH):** Yearly actual upper division student credit hours data have been recorded and maintained by the Institutional Research Department at UNO since the 1983-84 Annual Audit Indicators report. Upper division SCH data for fall 1977, 1978, and 1979 were taken from the May 1980 Audit Indicators report. Since, on average, enrollees in spring semesters take 84.1% credit hours, as compared to the fall semester, the fall figures were multiplied by a factor of 1.841 to derive annual upper division student credit hours. Similarly, upper division SCH data for fall 1980, 1981, and 1982 were taken from December 1983 data published in the January 1984 Audit Indicators report and multiplied by the factor of 1.841 to derive annual upper division student credit hours. All other years, beginning with the school year 1983-84 through 2007-08 were taken from actual numbers maintained and reported in each Annual Audit Indicators report without any manipulation. Data for the school years 2006-07 and 2007-08 were obtained from Enrollment Records published by the Office of Institutional Research, University of Nebraska at Omaha.

Exogenous Variable Data

(D$_{84}$): **Dummy 1984 (DUM1984):** The value of zero was assigned as the data point for each year from 1977 through 1983, while the value of one was assigned as the data point for each year from 1984 through 2007, since LB980 allowed the transfer of certain credits from Metropolitan Community College to the University of Nebraska beginning in the fall of 1984, as discussed at http://www.mccneb.edu/businessandcommunity/timeline and in the History of Nebraska Community Colleges' State Aid Distribution Formula located at http://www.ncca.state.ne.us/system/FORMULA.

(D$_{99}$): **Dummy 1999 (DUM1999):** The value of zero was assigned as the data point for each year from 1977 through 1998, while the value of one was assigned as the data point for each year from 1999 through 2007, since on-campus residential housing became available for students in the fall of 1999.

(E$_5$): **Eligible Potential Students Lagged 5 Years (TOTELIGIB5):** Nebraska population (age 15-34 years) data were compiled from *Population By Age and Sex* for years 1970, 1980, 1990, 2000, as reported by the Nebraska Department of Economic Development at http://www.neded.org. Selecting age categories of 15-19 years, 20-24 years, 25-29 years, and 30-34 years, percentages of the state's population in each category were calculated by using a weighted average method for the years between each decade data point 1970, 1980, 1990, and 2000 where data was not available. The weighted average population for each age category for each intervening year was calculated by multiplying the previous decade's population by the number of years remaining until the decade ended, multiplying the next decade's population by the number of years since the beginning of the decade, adding the weighted previous decade's and next decade's populations, and dividing by 10.. The calculated annual totals for each age group were summed to derive the annual Nebraska total population ages 15-34 Years. Dividing the Nebraska total

population ages 15-34 by the Nebraska Total Population yielded the percent Nebraska population Ages 15-34 Years. The *Nebraska Population Totals by County,* for Douglas County, and Sarpy County, Nebraska, also reported by the Nebraska Department of Economic Development at http://www.neded.org included data for 1960, 1970, 1980, 1990, and 2000 - 2007. Intervening years were interpolated using the weighted average method for the years between each decade data point as described above. Next, the sum of Douglas and Sarpy County populations were calculated. Finally, since incomplete population by age group was available for Douglas and Sarpy counties, the annual sum of Douglas and Sarpy county population total ages 15-34 years was calculated by multiplying the percent Nebraska population ages 15-34 years by the sum of Douglas and Sarpy county population for each year. The population aged 15-34 years was selected in order to closely parallel enrollment by age categories as reported by the Board of Regents annual Fact Books, published by the Institutional Research Department, 1982-2006. The age categories that from Fall 1981 through Fall 1993 made up over 80% of the student population were: 16-19 yrs., 20-24 yrs., 25-29 yrs., and 30-34 yrs. The age categories that from Fall 1994 through Fall 2004 made up over 80% of the student population were as follows: 14-19 yrs., 20-24 yrs., 25-29 yrs., and 30-34 yrs. Douglas and Sarpy counties population data by age and gender for 2006 and 2007 were obtained directly from the U. S. Census Bureau at www.census.gov . These data were lagged five years, such that the data set includes data points for 1972 through 2003. This variable, or a derivation of it, was selected for use as a proxy for the proportion of the population within the geographical constraints of the target market and within the age group most likely to potentially participate in higher education in all estimation models.

(E$_{F5}$): **Eligible Female Potential Students Lagged 5 Years (FEMALELIGIB5):** This variable is comprised of the *(E$_5$)* data. Each data point was then multiplied by the percentage of females in Douglas County, to determine an approximation of the total number of females, defined by age group, within both Douglas and Sarpy counties, in Nebraska.

(E$_{M5}$): **Eligible Male Potential Students Lagged 5 Years (MALELIGIB5):** This variable is comprised of the *(E$_5$)* data. Each data point was then multiplied by the percentage of males in Douglas County, to determine an approximation of the total number of males, defined by age group, within both Douglas and Sarpy counties, in Nebraska.

(F): **Future Expectations (COLLHS):** Several sources were required to provide sufficient data on the wage differential between high school graduates and college graduates for the period 1970-2007, either used directly as the ratio of college graduate average annual earnings to high school graduate average annual earnings or used to derive this ratio, for use as a proxy for expected future benefits of attending college now. The first source was the Indicator of the Month Report published by the National Center for Education Statistics under the auspices of the U. S. Department of Education, Office of Educational Research and Improvement, *Annual Earnings of Young Adults, by Educational Attainment,* Report NCES 1999-009 (June 1999). This report provided the ratio directly for both Males and Females (from which the mean averages for both genders were derived) for the years 1970, 1972, 1974, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1991, 1992, 1993, 1994, 1995, and 1996. For the missing years between

1970 and 1996 the ratio was interpolated. The ratio of college graduate average annual earnings to high school graduate average annual earnings were calculated by using a weighted average method for years between 1996 and 2000 where raw data was not available. This weighted average method for these 3 years was calculated by multiplying the 1996 data point by the number of years remaining until 2000, multiplying the 2000 data point by the number of years since 1996, summing the two amounts and dividing the total by 4. Other sources used were The Condition of Education 2007, 2008, 2009 reports published by the National Center for Education Statistics under the auspices of the U. S. Department of Education, Institute of Education Sciences. *The Annual Earnings of Young Adults* (Table 20-2), located in Appendix I Supplemental Tables, page 158, Report NCES 2007-064; page 128, Report NCES 2008-031; and (Table A-17-1) page 174, Report NCES 2009-081; provided median annual earnings of workers age 25-34 by educational attainment for years 2000-2005 from which the ratio of college graduate average annual earnings to high school graduate average annual earnings was derived by dividing the college graduate median annual earnings by the high school graduate median annual earnings.

(O) **Opportunity Cost (UNEMPLU):** Unemployment rate data (1976-2007) for the state of Nebraska were obtained from the Bureau of Labor Statistics, Table A-1 *Employment Status of the Civilian Non-institutional Population by State,* located in the Average Annual Series under Statewide Data, at http://stats.bls.gov/lau. Consistent data for Douglas and Sarpy Counties within the state of Nebraska were limited. Annual unemployment rates for Douglas County, Nebraska for 1990 through 2005 were located at http://www.econstats.com/BLS/blsla however no data for Sarpy County were located. Although in general the Douglas County unemployment was higher than the state rate for nearly every year between 1990 and 2007, Douglas County experienced a lower unemployment rate than the Nebraska state unemployment rate in 1998 and 1999. After reviewing research completed by others, especially that completed by Allen and Shen (1998), since their work measured demand for enrollment at a private university in Douglas County, Nebraska and they used state unemployment rate data, Nebraska unemployment rate data was selected for use in this study. Nebraska unemployment rate data was located at http://stats.bls.gov/lau, below statewide data, under *Employment status of the civilian non-institutional population by state,* in average annual series.

(P) **UNO Tuition Price Relative to Income (UNOINC):** Nominal tuition data were obtained directly through the Office of Institutional Research at the University of Nebraska at Omaha, from the Assistant Vice Chancellor for Finance, *Tuition Rates and General Student Fees, 1977-78 through 1993-94,* and from annual UNO Course Catalogues, 1995 – 2008, and converted to 1983 dollars. To convert from current to real values with a base year of 1983, the *Consumer Price Index- All Urban Consumers* Series ID: CUUR0200SA0, Not Seasonally Adjusted, for Midwest Urban Consumers, all Items, Base Period 1982-1984=100, from the Bureau of Labor Statistics, located at http://bls.gov/cpi was multiplied by each corresponding UNO tuition data point to derive real UNO tuition. *CA-04Per Capita Personal Income by State*, in current U. S. Dollars, published annually by the Bureau of Economic Analysis, under the auspices of the U. S. Department of Commerce. Data were located at http://www.bea.gov, within regional, under State and Local Area Personal Income, below Local Area Annual Estimates. New estimates for

all years 1969-2007 were released by the Bureau of Economic Analysis on April 22, 2010 and these revised data were used. To convert from current to real values with a base year of 1983, the *Consumer Price Index- All Urban Consumers* Series ID: CUUR0200SA0, Not Seasonally Adjusted, for Midwest Urban Consumers, all Items, Base Period 1982-1984=100, from the Bureau of Labor Statistics, located at http://bls.gov/cpi was multiplied by each corresponding annual income data point to derive annual Nebraska per capita personal income. Finally, values obtained for the real price of tuition at UNO were divided by the values obtained for the real Nebraska per capita personal income data points to derive the ratio of real UNO tuition relative to real income.

(S) **Substitute Metropolitan Community College Real Tuition (METROREAL):** The Director of Accounting Services at Metropolitan Community College (METRO) provided *Nominal Tuition Rates per Credit Hour 1974 to 2007*. Data were then adjusted to 1983 dollars by multiplying the appropriate CPI rate provided in the *Consumer Price Index- All Urban Consumers* Series ID: CUUR0200SA0, Not Seasonally Adjusted for Midwest Urban Consumers, all Items Base Period 1982-1984=100 from the Bureau of Labor Statistics, located at http://bls.gov/cpi; by the nominal price of tuition.