E C O N O M I C S   B U L L E T I N

A comparative analysis of the demand for higher education: results from a meta-analysis of elasticities

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Abstract

Studies of the demand for higher education have produced numerous estimates of the tuition and income elasticities. Because of widespread variation in the models estimated, this paper performs a meta-analysis of the literature to uncover the extent to which study characteristics influence elasticities. In addition to being more inelastic in the short-run, the results reveal that demand is least responsive to tuition and income in the United States. Also, the measure of quantity and price, coupled with the method of estimation, have important effects on the tuition elasticity. Nonetheless, there are many study characteristics that have little impact on elasticity estimates.

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1. Introduction

Recent reductions in state appropriations to higher education have led many institutions to significantly increase tuition in an effort to bolster revenue. However, whether or not tuition increases meet revenue targets depends upon the tuition elasticity of demand. In particular, if the tuition elasticity is lower than expected, then tuition revenue will exceed its target – or if the tuition elasticity is higher than expected, tuition revenue will fall short of its target.

Yet the volume and heterogeneity of elasticity estimates in the literature makes it difficult to arrive at an appropriate elasticity upon which revenue projections are based. For example, while some studies (e.g., Hight (1975), Chang and Hsing (1996), and Allen and Shen (1999)) find the demand for higher education to be relatively sensitive to tuition, other studies (e.g., Levine et al. (1988), Paulsen and Pogue (1988), and Quinn and Price (1998)) find demand to be relatively insensitive to tuition. In light of this, the purpose of this paper is to enhance our understanding of higher education by performing a meta-analysis of the demand literature. Similar to meta-analyses of the demand for other products (see, for example, Espey (1998), Kremers et al. (2002), Gallet and List (2003), and Gallet (2006)), this involves collecting estimated price (i.e., tuition) and income elasticities of higher education from the literature and treating them as dependent variables in a meta-regression, with study attributes serving as independent variables. With our results in hand, the policymaker will be better informed of which modeling procedures have the greatest impact on elasticities; hence, depending on the scenario, we can be more or less confident of an assumed elasticity when making revenue projections.

Specific questions addressed in our meta-analysis include: (1) How different are short-run and long-run elasticity estimates? (2) Are elasticity estimates sensitive to the functional form chosen for demand? (3) Do differences in data across studies (such as the measure of quantity and price, level of aggregation, and characteristics of students and institutions) affect elasticity estimates? (4) Does the method of estimation, or corrections for serial correlation, heteroskedasticity, or multicolinearity, affect elasticity estimates? And (5), does the culture of the profession, proxied by the type of journal the study appears and the year of publication, affect elasticity estimates?

The remaining sections of the paper are organized as follows. Section 2 discusses the data collected for the meta-analysis. Section 3 presents the meta-regression model, while Section 4 discusses the estimation results. Concluding comments are provided in Section 5.

2. Data

The data used for this survey were collected from 60 studies of higher education. These studies were identified using several steps. First, an initial search of the literature using *EconLit* led to numerous candidate studies. The reference sections of these studies, as well as several literature reviews (e.g., Jackson and Weathersby (1975), Leslie and Brinkman (1987), Becker (1990), and Heller (1997)), revealed additional studies. Finally, a search of the Internet led to a few more studies. In total, these 60 studies (see Table 1) reported 295 estimated tuition elasticities and 154 estimated income elasticities.

With a mean tuition (income) elasticity of -0.60 (1.07), coupled with a standard deviation of 1.00 (1.97), there is substantial variation in the elasticity estimates in the literature. In an effort to understand this variation, the literature was sifted through to identify key differences in study attributes. The frequencies of these attributes are reported in Table 2. For example, of the 295 (154) tuition (income) elasticity estimates, 269 (137) are short-run estimates, while 26 (17) are long-run estimates. Also, while most elasticity estimates come from a double-log specification of higher education demand (i.e., 190 of the 295 tuition elasticity estimates and 92 of the 154 income elasticity estimates), other functional forms are also used in the literature – namely, linear, semi-log, and Box-Cox.[1]

When it comes to the data used to estimate the demand function, there are several differences across studies. For instance, unlike meta-analyses of product demands, such as gasoline (see Espey (1998)) and cigarettes (see Gallet and List (2003)), there is much more variation in the measures of quantity and price for higher education. In particular, while most tuition elasticities come from specifications using total enrollment as the dependent variable, other variations in quantity include total applications received by an institution, the ratio of private university enrollment to public university enrollment, the percentage of individuals admitted to an institution who choose to attend that institution, the percentage of the total population enrolled in higher education, the percentage of the typical college-going age group (i.e., 18-24) enrolled in higher education, the percentage of high school graduates enrolled in higher education, the percentage of all college students enrolled at a particular institution or in a particular country, the percentage of bachelor's degree recipients choosing to pursue a graduate degree, and the percentage of enrollment that is minority. As for price, most tuition (217) and income elasticity (91) estimates come from demand functions using tuition. Yet other measures of price, namely tuition minus financial aid, tuition plus other fees (e.g., room and board), or a dummy variable (e.g., coinciding with a major change in the cost of pursuing higher education), are also used in the literature. Finally, some estimates of the income elasticity come from studies not including tuition as a regressor.

Turning to other data issues, most estimates of the tuition (128) and income elasticities (71) are based on U.S. country-level data, although some elasticity estimates come from data at the state-

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[1] It is important to note that many studies estimate the impact of various factors on the probability an individual enrolls in an institution of higher education. Although such studies typically address the effect of tuition and income on the enrollment decision (e.g., the impact of an $X increase in tuition on the enrollment probability (labeled the student price response coefficient)), several reasons led to their exclusion from this meta-analysis. First, Jackson and Weathersby (1975), Leslie and Brinkman (1987) and Heller (1997) have already reviewed this line of research and discussed tendencies in the literature to affect the impact of tuition on the enrollment probability. Yet no study to date has empirically evaluated the impact of study attributes on the elasticities of demand. Second, when comparing the effect of tuition on the enrollment probability across studies, the student price response coefficients must be standardized to account for differences in time and location. For example, a $100 increase in tuition will likely have a much different effect on the enrollment probability of a student in 1960 versus a student in 2000. Also, the student price response coefficients from other countries are typically converted into U.S. dollar equivalents. However, since standardization techniques may introduce bias into the student price response coefficients, elasticities are appealing when conducting a statistical meta-analysis because they are unitless. Third, although some of these studies do report elasticity values (defined as the ratio of the percentage change in enrollment probability to the percentage change in tuition), the majority do not. Hence, rather than include some estimates of elasticity yet exclude others, and thereby introduce potential bias into the model, it was decided to exclude these studies altogether.

or province-level, or at the individual institution, student, or major field of study (e.g., engineering, economics, etc.) levels. Also, it is most common for estimates to come from time-series data, as opposed to cross-sectional and panel data.

Since elasticity estimates often coincide with a particular student demographic or an institutional characteristic, we also paid attention to such issues when surveying the literature. For example, of the 295 tuition elasticity estimates, 17 were based on male students while 16 were based on female students.[2] Further, other elasticity estimates correspond specifically to non-white students, non-residents, first-year students, and/or graduate students.[3] Finally, studies often control for differences in elasticities across characteristics of academic institutions. For instance, we came across 22 (8) tuition (income) elasticities corresponding to two-year institutions, while 66 (36) tuition (income) elasticities correspond to private institutions.[4]

Similar to Espey (1998), Gallet and List (2003), and Gallet (2006), we also find variation in the estimation techniques across studies. In particular, most estimates of the tuition (214) and income (116) elasticities come from models estimated using ordinary least squares (OLS). Yet other methods (i.e., two stage least squares (2SLS), three stage least squares (3SLS), maximum likelihood estimation (MLE), seemingly unrelated regressions (SUR), and generalized least squares (GLS)) have also been used to estimate higher education demand. Moreover, in addition to accounting for serial correlation or heteroskedasticity in the error term, some elasticity estimates come from models that adjust for multicollinearity.

Lastly, since Gallet and List (2003) finds the culture of the profession has some influence on cigarette demand elasticities, we also made note of various aspects of the publication in which the higher education elasticity appeared. In particular, we found that 88 (48) tuition (income) elasticities were published in journals that focus on education issues (i.e., *Economics of Education Review*, *Education Economics*, *Research in Higher Education*, the *Canadian Journal of Higher Education*, and the *Journal of Educational Research*), as opposed to more general journals. Also, relatively few tuition (51) and income elasticities (23) were reported in premier Economics journals, as proxied by the Scott and Mitias (1996) list of the top 36 journals in Economics.

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[2] Controlling for gender, Koshal et al. (1976) and Canton and de Jong (2002) find little difference between male and female enrollment responses to tuition and income.

[3] For example, Heller (1998) finds non-white students to be more responsive to tuition changes than white students, while Noorbakhsh and Culp (2002) find non-resident students to be more sensitive to tuition and income than resident students. Also, in light of first-year students having invested less time in the pursuit of a higher degree, the conventional view is that they should be more responsive to price changes. Indeed, Chressanthis (1986) finds this to be the case. Finally, Layard and Petoussis (1985) and Agarwal and Winkler (1985) find elasticities to be higher in absolute value for undergraduate students compared to graduate students.

[4] Comparing two-year to four-year institutions, Corman and Davidson (1984) and Heller (1998) find elasticities are higher in absolute value at two-year institutions. As for differences between private and public institutions, Hopkins (1974) finds elasticities are higher in absolute value for private institutions.

3. Meta-regression model

In light of the variety of study attributes, a meta-regression model is estimated.[5] This involves treating the tuition and income elasticity estimates as dependent variables and study attributes as independent variables. In particular, the elasticity estimates are regressed upon a series of dummy variables, each of which is used to capture a particular characteristic listed in Table 2 (i.e., the dummy variable equals one if a characteristic applies to an elasticity estimate, zero if not).

Before moving to the estimation results, several caveats of the model need mentioning. First, since later studies often build off of the results of earlier studies, as an additional indicator of the influence of the profession on the elasticity estimate, we also include the year of publication as a regressor. Second, a perusal of Table 2 shows there are several study attributes for which the number of observations is zero (e.g., percent of bachelor's degree population in the case of the income elasticity). Such characteristics are excluded from the respective elasticity regression.[6] Third, since we are predominantly dealing with dummy variables on the right side of the meta-regression equation, results are interpreted relative to the base case (i.e., all dummy variables set equal to zero). Moreover, since several categories in Table 2 encompass all observations, one of the dummy variables in each of these categories is omitted to serve as the base case.[7] Fourth, due to heteroskedasticity of the error term in each meta-regression, standard errors were adjusted using White's (1980) correction method. Fifth, a positive (negative) estimate of the coefficient of a respective dummy variable means that particular study characteristic increases (decreases) the elasticity estimate. Accordingly, since tuition elasticities tend to be negative, whereas income elasticities tend to be positive, this implies a positive coefficient estimate leads to a more inelastic (more elastic) tuition (income) elasticity. The opposite holds for a negative coefficient estimate.

4. Estimation results

Estimation results for the meta-regression of each elasticity are provided in Table 3. Before discussing individual parameter estimates, we performed a series of F-tests of the joint significance of the coefficients associated with each of the categories listed in Table 2. These results are provided at the bottom on Table 3. At the 10% level of significance or better, for the tuition elasticity regression the coefficients are jointly significant for most categories, with the exception of the

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[5] Stanley (2001) provides an in-depth discussion of the merits of meta-analysis as applied to the Economics literature.

[6] In addition to excluding characteristics for which there are zero observations, due to failure of the rank condition, the dummy variable for field of study had to be dropped from the tuition and income elasticity regressions, as well as the dummy variable for the percent of enrollment that is minority from the income elasticity regression.

[7] Accordingly, the base case elasticity corresponds to a long-run estimate from a linear specification of demand, with quantity measured as total enrollment and price measured as tuition. The data is time-series in nature, non-U.S. country-level, and does not account for the student and institutional characteristics outlined in Table 2. Lastly, the elasticity is estimated with OLS, does not account for error corrections or multicolinearity, and is not published in an Education journal or a top 36 Economics journal.

student characteristics, institution characteristics, and publication categories. As for the income elasticity, except for the quantity, aggregation, nature of data, and student characteristics categories, all other joint tests are significant. Hence, overall we can say that study attributes have varying degrees of influence on the tuition and income elasticities. The role of individual characteristics is discussed below for each elasticity.

4.1. Tuition elasticity

Table 3 shows that many of the individual coefficient estimates are significantly different from zero. For example, given the coefficient of the dummy variable coinciding with short-run estimates is significantly positive, consistent with the literature, the tuition elasticity is more inelastic in the short-run than in the long-run. Also, compared to the linear specification of demand, the double-log specification of demand tends to generate more inelastic estimates of the tuition elasticity. Yet other functional forms generate tuition elasticities that are not statistically different from the linear form.

With respect to the various data categories, the tuition elasticity is particularly sensitive to measures of quantity and price, as most of the alternatives to total enrollment increase the tuition elasticity (although quantity measured as the ratio of private to public university enrollment decreases the tuition elasticity), whereas including other fees with tuition or measuring tuition changes with a dummy variable have opposing effects on the tuition elasticity. Also, the use to state/province data increases the tuition elasticity, and relative to the rest of the world, the U.S. demand for higher education is more tuition inelastic. Yet whether the data is cross-sectional, time-series, or panel has little noticeable effect on the tuition elasticity.

Consistent with Heller (1998), we do find individually that non-white students are more responsive to tuition than students in general. Nonetheless, consistent with the F-test results, other student characteristics (i.e., gender, residency status, first-year, and graduate status), as well as institutional characteristics (i.e., community college and private institution), fail to significantly affect the tuition elasticity.

When it comes to the estimation method, however, much of the variation across the literature does influence the tuition elasticity. In particular, the tuition elasticity is higher when 3SLS, MLE, or SUR estimation is undertaken, while 2SLS and GLS decrease the tuition elasticity. Also, adjustments for serial correlation and heteroskedasticity produce more inelastic tuition elasticities. Finally, consistent with the F-test result, the type and quality of publication outlet, as well as the date of publication, matter little when it comes to the tuition elasticity.

4.2. Income elasticity

Compared to the tuition elasticity, although significance is sparser, there are nonetheless several individual study characteristics that do affect the income elasticity. In particular, similar to the tuition elasticity, the income elasticity is more inelastic in the short-run than the long-run. Also, a semi-log functional form dampens the income elasticity, while the double-log and Box-Cox forms do not significantly influence the income elasticity.

Unlike the tuition elasticity, however, except for using the private-to-public enrollment ratio, tuition plus other fees, and a dummy variable to measure cost changes, variations in how quantity and price are measured have little influence on the income elasticity. Moreover, the degree of aggregation and the nature of the data (be it time-series, cross-sectional, or panel) fail to affect the income elasticity. Yet we can say the income elasticity is lower in the U.S., particularly at two-year institutions, while it is higher for first-year students.

Finally, estimation of higher education demand using MLE, coupled with correction for serial correlation, reduces the income elasticity, whereas estimation using GLS increases the elasticity. And income elasticities published in top 36 Economics journals are lower by a marginally significant amount compared to those published in other journals. All other coefficients, however, fail to be significantly different from zero.

5. Conclusion

The 60 studies surveyed reveal patterns that help explain some of the variation in elasticity estimates across the literature. For example, for both tuition and income elasticities, short-run estimates are more inelastic than long-run estimates. Also, quantity demanded is less responsive to tuition and income in the U.S. than other countries; and, particularly noticeable in the case of the tuition elasticity, how quantity and price are measured, coupled with the estimation method, are important determinants of the tuition elasticity.

Yet the results also indicate that elasticities are somewhat insulated from a variety of factors. In particular, with many of the coefficients being individually insignificant, elasticities are less responsive to the degree of aggregation, the use of time-series, cross-sectional, or panel data, demand specific to particular student groups and institutions, and characteristics of the publication outlet.

Such results highlight the potential bias in simply relying on a single elasticity estimate when designing revenue policy. Rather, the policymaker should understand that revenue projections are very much tied to the methods upon which demand is estimated. As such, perhaps the best approach is to provide several revenue projections, accounting for different elasticity assumptions.

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Table 1. Studies included in Meta-analysis[a]

Author(s)	Year Published	Author(s)	Year Published
Agarwal and Winkler	1985	Koshal	1973
Alexander and Frey	1984	Koshal	1975
Allen and Shen	1999	Kosha et al.	1976
Berger and Kostal	2002	Koshal and Koshal	1994
Bezmen and Depken	1998	Koshal and Koshal	1999
Buss et al.	2004	Kroncke and Ressler	1993
Campbell and Siegel	1967	Layard and Petoussis	1985
Canton and de Jong	2002	Lehr and Newton	1978
Chang and Hsing	1996	Levine et al.	1988
Cheslock	2001	MMAPC	1969
Chressanthis	1986	Mattila	1982
Christofieds et al.	2001	McPerson and Schapiro	1991
Corman and Davidson	1984	Morgan	1983
Doyle and Cicarelli	1980	Murphy and Trandel	1994
Duchesne and Nonneman	1998	Noorbakhsh and Culp	2002
Funk	1972	Ostheimer	1953
Galper and Dunn	1969	Parker and Summers	1993
Grubb	1988	Psacharopoulos	1973
Handa	1972	Paulsen and Pogue	1988
Heller	1998	Quigley and Rubinfeld	1993
Hight	1975	Quinn and Price	1998
Hoenack	1971	Shim	1990
Hoenack et al.	1973	Strickland et al.	1984
Hoenack and Pierro	1990	Sulock	1982
Hopkins	1974	Tannen	1978
Hsing and Chang	1996	Toutkoushian and Hollis	1998
Hu and Stromsdorfer	1973	Tuckman	1970
Huijsman et al.	1986	Wasylenko	1984
King	1993	Wu	1982
Knudsen and Servelle	1978	Yang	2004

[a] In an effort to conserve space, only those studies that are cited in the body of the paper are included in the reference section. A complete list of references, including those in Table 1, is available upon request.

Table 2. Frequency of Variables

Category	Variable	Number of Observations: Tuition	Number of Observations: Income
Elasticity Estimate:	Long-run	26	17
	Short-run	269	137
Functional Form:	Linear	58	44
	Double-log	190	92
	Semi-log	42	13
	Box-cox	5	5
Data:	Quantity:		
	Total enrollment	61	41
	Total applications	18	6
	Ratio of private to public enrollment	7	9
	Percent of admits that enroll	9	2
	Percent of total population	31	22
	Percent of age 18-24 population	60	26
	Percent of highschool graduates	57	44
	Percent of all college students	46	2
	Percent of bachelor's degree population	4	0
	Percent of enrollment that is minority	2	2
	Price:		
	Tuition	217	91
	No tuition	0	7
	Tuition net financial aid	22	19
	Tuition plus other fees	55	34
	Dummy variable	1	3
	Aggregation:		
	Country	128	71
	State/Province	85	40
	Institution	65	26
	Field of study	14	14
	Individual student	3	3
	Location:		
	US	232	116
	Rest of world	63	38

Table 2. Continued

Category	Variable	Number of Observations: Tuition	Number of Observations: Income
	Nature of Data:		
	Time-series	153	92
	Cross-sectional	64	40
	Cross-sectional-time-series	78	22
	Student Characteristics:		
	Men	17	17
	Women	16	12
	Non-white	20	2
	Non-resident	49	10
	First-year	79	46
	Graduate	38	4
	Institution Characteristics:		
	Two-year	22	8
	Private	66	36
Estimation:	Method:		
	OLS	214	116
	2SLS	13	7
	3SLS	2	2
	MLE	13	13
	SUR	14	14
	GLS	39	2
	Corrections:		
	Serial correlation	84	40
	Heteroskedasticity	22	19
	Multicollinearity	32	1
Publication:	Education journal	88	48
	Top 36 economics journal	51	23
Total Observations:		295	154

Table 3. Meta-regression results[a]

Category	Variable	Elasticity: Tuition	Elasticity: Income
Elasticity Estimate:	Short-run	0.70 (2.52)	-1.10 (3.50)
Functional Form:	Double-log	0.56 (1.84)	-0.68 (1.50)
	Semi-log	0.28 (0.90)	-2.02 (2.99)
	Box-cox	-0.35 (0.31)	0.13 (0.14)
Data:	Quantity:		
	Total applications	1.08 (2.98)	-0.10 (0.06)
	Ratio of private to public enrollment	-2.47 (3.01)	2.08 (1.98)
	Percent of admits that enroll	0.73 (1.66)	-2.30 (1.06)
	Percent of total population	-0.19 (0.51)	0.99 (0.94)
	Percent of age 18-24 population	0.09 (0.37)	0.82 (1.18)
	Percent of highschool graduates	0.28 (1.69)	-0.69 (0.59)
	Percent of all college students	0.74 (1.76)	-2.68 (0.87)
	Percent of bachelor's degree population	1.03 (2.39)	---
	Percent of enrollment that is minority	1.56 (4.14)	---
	Price:		
	No tuition	---	-0.31 (0.46)
	Tuition net financial aid	0.16 (0.46)	0.17 (0.30)
	Tuition plus other fees	-0.66 (3.53)	1.41 (2.09)
	Dummy variable	2.63 (2.74)	-3.71 (1.92)
	Aggregation:		
	State/Province	0.76 (2.20)	0.47 (0.66)
	Institution	0.33 (1.14)	1.28 (0.89)
	Field of study	---	---
	Individual student	0.48 (0.80)	0.48 (0.80)
	Location:		
	US	1.64 (2.10)	-2.77 (1.82)
	Nature of Data:		
	Time-series	0.39 (1.46)	0.82 (0.85)
	Cross-sectional	-0.05 (0.19)	0.49 (0.54)
	Student Characteristics		
	Men	0.16 (1.18)	-0.16 (0.41)
	Women	0.19 (1.22)	0.21 (0.50)
	Non-white	-0.21 (2.65)	-1.79 (1.54)
	Non-resident	0.35 (1.06)	0.62 (0.87)
	First-year	-0.07 (0.51)	1.43 (1.91)
	Graduate	-0.48 (1.28)	2.46 (1.52)

Table 3. Continued

Category	Variable	Elasticity	
		Tuition	Income
	Institution Characteristics:		
	Two-year	-0.07 (0.81)	-3.81 (2.53)
	Private	0.13 (0.83)	0.34 (0.85)
Estimation:	Method:		
	2SLS	-1.04 (2.49)	1.30 (1.42)
	3SLS	0.80 (2.06)	-1.89 (1.27)
	MLE	1.26 (1.87)	-1.88 (2.46)
	SUR	1.33 (2.23)	-0.28 (0.19)
	GLS	-1.13 (2.91)	1.57 (1.85)
	Corrections:		
	Serial correlation	1.22 (3.14)	-1.65 (2.10)
	Heteroskedasticity	0.75 (2.20)	-0.93 (1.22)
	Multicollinearity	0.50 (0.88)	-2.96 (1.50)
Publication:	Education journal	-0.31 (1.55)	-0.42 (0.40)
	Top 36 economics journal	-0.46 (1.31)	-1.26 (1.66)
	Date of publication	-0.01 (1.32)	-0.06 (1.30)
F (Functional Form)		2.98	2.49
F (Quantity)		5.37	1.25
F (Price)		7.11	2.82
F (Aggregation)		2.30	0.83
F (Nature of Data)		2.33	0.35
F (Student Characteristics)		1.35	1.34
F (Institution Characteristics)		0.38	5.34
F (Method)		7.82	1.98
F (Corrections)		5.44	2.96
F (Publication)		1.88	3.14
R-square		0.48	0.64
Sample size		295	154

[a] t-statistics in absolute value in parentheses. Tests of the joint significance of the coefficients of each category are also provided. For example, F (Functional Form) corresponds to the F-value created when restricting all coefficients of the functional form variables to equal zero.