An Economic Model of Public Expenditures on Public Higher Education

By Dong-Kun Kim

Introduction

There has been a great amount of studies dealing with the determinants of government expenditures. While most of the studies have used cross-sectional regression analysis, only a few of the studies provide an adequate theoretical basis for the specification of the variables to be put into a regression equation [1][2][10]. It is believed that the regression analysis be only used to test whether or not the data supports a relationship between variables that has been states as being logical, with clear reasoning as to why and how the cause and effect relationship should exist. The distinction between dependent and independent variables should be based on a logical, theoretical framework that explains the distinction. Therefore, the development of a theoretical model is needed first, and then an appropriate statistical model may be developed so as to adequately test the theoretical model.

This study proceeds in two stages. The first stage is to construct a theoretical model of public expenditures so as to identify the specific factors which influence fiscal efforts supporting higher education. Based on the assumptions employed in the "individualistic approach" of public finance developed by Buchanan [5][6], the aggregate (market) demand and supply functions of public higher education are considered. Then, by the application of the "reduced-form" approach, the empirical model of expenditures introduced. The second stage is to test the empirical model developed and to measure empirically the significance of these factors on state fiscal actions. The statistical methods employed are covariance analysis. The data are collected from all 50 U.S. states for the periods of 1961-62, 1963-64, 1965-69. This study combines time-series and cross-sectional analyses.

* The author is assistant professor of Economics and Finance, University of Tennessee at Martin.

Model

The public expenditure for providing a public good at equilibrium is the product of the equilibrium price and its equilibrium quantity (i.e., $E=P.Q$). The variation of public expenditures is due to the shifts of the demand and/or supply schedules of the public good. Now, the whole model is summarized as follows:

Aggregate demand function $=Q_D=f(P,A)$

Aggregate supply function $=Q_S=g(P,B)$

Equilibrium $=Q_D=Q_S$ at eq. P

Expenditure equation $=E=P.Q=h(A,B)$

Q_D is quantity demanded for and supplied of public higher education. P is the price per unit of public higher education. A and B are vectors of demand and supply variables. E is total public expenditures.

The outputs of higher education are defined in terms of university objectives and functions. There are basically two conceptual approaches to the output: (1) higher education is a production process whereby a raw material (student) is proceeded through stages of production (level of courses) and (2) higher education is the production (and distribution) of new knowledges to individuals. Thus, the institutions of higher education either produce educated individuals or produce new knowledges.(1) The price of public higher education is defined as the tax paid by an individual consumer for the education. Tuition charges may be a part of the price of higher education.

Demand function

The demand for higher education is viewed as being determined by the same set of categories that have been used in studies of household demand although the specific variables representing them are somewhat different. Demand, as used here, means a desire to participate in higher education. The following aggregate demand function can be considered:

$$Q_D=a_0P^{-a_1}\ Y^{a_2}\ N^{a_3}\ M^{a_4}$$

$$\text{or } \ln Q_D=\ln a_0-a_1 \ln P+a_2\ln Y+a_3\ln N+a_4\ln M \qquad (1)$$

where $a_1 \cdots\cdots a_4>0$

(1) In our model, homogeneous quantity is associated with output, by assumption, so that the quality variation of higher education may not be as important.

Y is state-wide personal income per capita by state as the "ability-to-pay" variable. N is the population of youth at ages of 18-22 as the "preference" variable. M is the Federal aids to the public institution of higher education by state. P is assumed to have an inverse relationship with Q_D. Considering public education as a normal good, the income demand for the public education is assumed to be positive. It is assumed that there is a positive relation between population and the need for education, and, thus, N is assumed to be positively associated with Q_D. Federal aids may be considered to be a measure of the extent to which ability-to-pay is used [4]. M is assumed here to be positively related with Q_D.

Supply function

The supply of higher education is dependent upon the price of output, the prices of inputs, and the production function. The university production function like an industry production function, will be associated with two basic factors of production: labour (faculty) and capital (physical asset). The aggregate supply function is expressed as:

$$Q_S = b_0 P^{b_1} S^{b_2} C^{b_3} Z^{b_4}$$

$$\text{or } \ln Q_S = \ln b_0 + b_1 \ln P + b_2 \ln S + b_3 \ln C + b_4 \ln Z \qquad (2)$$

$$\text{where } b_1 \ \& \ b_3 > 0: \ b_2 \ \& \ b_4 < 0$$

S is the average salary of faculty employed in the public university by state. C is the value of physical assets of public institutions by state per student. Z is the ratio of faculty and student of public institutions by state (i.e., number of faculty per 100 students). P is assumed to have a positive relationship with Q_S. The price is set so that the price per unit is equal to the marginal cost of the last unit. It is expected that the marginal cost of state government service is mainly determined by wage rate of labour [3]. assuming that the rental rate per unit of capital is the same over all political units. Therefore, one would expect a change in the average salaries of faculty (price of labour) to be inversely related to Q_S.(2) C and Z are directly related to the production function. If school capictal is productive, then additional capital causes the short-run supply curve to shift downward, and the long-run supply curve will be downward sloping. In this case, the

(2) It is assumed in this study that any change in S would not reflect productivity change, other things being constant.

physical assets will affect the output positively. According to the concepts of output mentioned earlier, a rise in the number of teachers (workers) for the same number of students (materials) would be accompanied by rising costs per unit of output (per graduate). This would suggest a fall in productivity according to normal measurements since the cost per student tends to rise.(3) Thus, it is expected that the same type of result and direction can be obtained by an increasing number of teachers in university production as industrial production. It is, therefore, assumed that an increase in Z will decrease Q_S at a given price.(4)

Expenditure Equation

Solving equation (1) and (2) for price (P) and quantity (Q) yields:

$$\ln P = [(\ln a_0 - \ln b_0) + a_2 \ln Y + a_3 \ln N + a_4 \ln M - b_2 \ln S - b_3 \ln C - b_4 \ln Z]/[a_1 + b_1] \tag{3}$$

$$\ln Q = [b_1 \ln a_0 + a_1 \ln b_0) + b_1 a_2 \ln Y + b_1 a_3 \ln N + b_1 a_4 \ln M + a_1 b_2 \ln S + a_1 b_3 \ln C + a_1 b_4 \ln Z]/[a_1 + b_1] \tag{4}$$

$$\ln E = \ln(P \cdot Q) = \ln P + \ln Q$$

which is the sum of equations (3) and (4). Therefore,

$$\ln E = r_1 + r_2 \ln Y + r_3 \ln N + r_4 \ln M + r_5 \ln S + r_6 \ln C + r_7 \ln Z \tag{5}$$

where

$$r_1 = (b_1 \ln a_0 + a_1 \ln b_0) + (\ln a_0 - \ln b_0)$$

$$r_i = a_i \frac{(1+b_1)}{(a_1+b_1)},\ i=2, 3, \text{ and } 4$$

$$r_i = b_i - 3 \frac{(a_1-1)}{(a_1+b_1)},\ \ i=5, 6, \text{ and } 7$$

The equation (5) is our linear natural-log expenditure model of higher education. It shows the relation of the reduced-form coefficients, r's, to the structural coefficients, a's, and b's.

Hypotheses and Statistical Results

The statistical hypotheses may be described by a set of linear multiple

(3) As Seymour E. Harris stated in [8], it may be possible to operate more efficiently and economically by having one class of 100 students rather than five of 20 each.

(4) One may point out that there is the problem of improving the quality of the product with the increase in the faculty-student ratio. In this study, however, the quality aspect of output has not been considered as to be altered.

regression equations.

$$1nE_{ij}=r_1+r_2 1nY_{ij}+r_3 1nN_{ij}+\cdots r_7 1nZ_{ij}+1nU_{ij}$$

where

i=years(1…6)

j=states(1…50)

E_{ij} denotes the public expenditures on public higher education less the amout of federal aid for the jth state in the ith year. U signifies the random term. With a log transformation, the regression coefficients are interpreted as the elasticity concept. The reduced form coefficient hypotheses are summarized in Table 1.

Table 1

Effects of Variables on Expenditures

Variables	Assumptions	Hypotheses	
Y	$a_2>0$	$r_2>0$	
N	$a_3>0$	$r_3>0$	
M	$a_4>0$	$r_4>0$	
		(1)	(2)
S	$b_2<0$	$r_5<0$	$r_5>0$
C	$b_3>0$	$r_6>0$	$r_6<0$
Z	$b_4<0$	$r_7<0$	$r_7>0$

(1): if $a_1>1$ and $b_1>0$

(2): if $0<a_1<1$ and $b_1>0$

Table 2 represents the statistical results for the national and three regional 6-year studies. The first step is to run the analysis of covariance on the data by the classical least-square approach. The empirical data, for each of the 50 U.S. states and for each of 6 years, are pooled. It is a national 6-year study. The next is to classify 50 states by three groups in terms of population density.(5) Then, the analysis of covariance is used again for each of three groups with the same variables employed. It is a regional 6-year study.

(5) The reason of grouping states by population density is that the sampling within the similar density group would be relatively homogeneous. It is based on the ground that population density may influence not only preference (Demand) but also productivity (Supply) characteristics.

Table 2　**Regression Coefficients (α), Beta coefficients (β), and Multiple Coefficients of Determinants (R^2)**

		Y	N	M	A	C	Z	R^2
Total (50) States)	α	.32#	.53#	.46#	−.70#	.10 *	−.23#	.94
	β	.06	.58	.48	−.08	.03	−.05	
Group I (17 States)	α	.96#	.73#	.36#	−1.89#	−.26	−.36#	.92
	β	.20	.70	.41	−.23	−.08	−.10	
Group II (16 States)	α	.67#	.52#	.53#	−1.10#	.04	.06	.97
	β	.16	.54	.56	−.15	.01	.02	
Group III (17 States)	α	.53#	.58	.43#	.13	.52#	−.18	.97
	β	.07	.57	.48	.01	.14	−.03	

NOTE: 50 U.S. states are grouped by population per square mile as of the end of 1969: Group I-(0.1-40.9); Group II-(41.0-100.9); and Group III-(101.0-over).

-Significant at 0.01 level.

* -Significant at 0.10 level.

An encouraging result from the overall analysis is that the model explains more than 90 per cent of the variation in public higher educational spending. It supports our argument that total expenditures are determined by demand and supply simultaneously, based on a pattern of rational economic motives. In the national 6-year study, all three demand variables are positively associated and statistically significant at the 0.01 level. Average faculty salaries and faculty-student ratio are negatively associated, while physical assets are positively associated. The results are consistent with the reduced-form coefficient hypotheses shown in Table 1, under the circumstance that demand is elastic with respect to price ($a_1>1$). These results also indicate that the assumed structural relationships in the demand and supply functions can be accepted. The interesting result is that the beta coefficients of demand variables are relatively higher than those of supply variables. It indicates that the demand variables, in general, are more important in affecting the variation in the higher education expenditures than the supply variables.

The separate results for the three regional 6-year studies are uniquely similar to those for the national 6-year study. It thus provides a strong base to reconfirm the findings from the national 6-year study being accepted.

Conclusions

It is surprising that the demand curve is found to be generally elastic with respect to price. Although it is difficult to estimate the effect of price on student attendance, one would expect that upper-income students are sensitive to price (i.e., tuition in this case) for their choice of private institutions instead of public institutions, while lower-income students are far more sensitive to price for their decision of whether or not to attend college. The price elasticity conclusion is of tremendous significance in the field because, given most projections of demand and supply variables for the 1970's and 1980's, the conclusion means higher education should expect significant decreases in output due to price-caused changes in the quantity demanded.

If the institutions of higher education will be faced with continued inflation due to general economic conditions, average faculty salaries will increase. Thus the supply curve will shift upward to the left. The demand curve being price elastic means that such upward shifts of supply curve will have even greater impact upon the quantity of output than if the demand curve were price inelastic. As an investment in human capital and in new knowledge, these circumstances may deter economic growth in the more distinct future unless demand is stimulated by some means.

References

(1) Barr, J.L. and Davis, O.A., "An Elementary Political and Economic Theory of the Expenditures of Local Governments, "*The Southern Economic Journal*, XXXIII (October, 1966), pp. 149-165.

(2) Birdsall, W.C. "A Study of the Demand for Public Goods" in *Essays in Fiscal Federalism* ed. by Richard A. Musgrave (Washington, D.C.: The Brookings Institution, 1965). pp. 135-194.

(3) Borcherding, T.E. and Deacon, R.T., "The Demand for the Services of Non-Federal Governments," *American Economic Review*, Vol. LXII (December, 1972). pp. 891-901.

(4) Brazer, Harvey E., *City Expenditures in the United States* (National Bureau of Economic Research, 1959).

(5) Buchanan, James M., *The Demand and Supply of Public Goods* (Chicago: Rand McNally and Company, 1968).

(6) ——————————, *Public Finance in Democratic Process* (Chapel Hill: The University of North Carolina Press, 1967).

(7) Burkhead, Jesse, *et. al.*, *Input and Output in Large City High Schools* (Syracuse: Syracuse University Press, 1967).

(8) Harris, Seymour E., "Financing Higher Education: An Overview" in U.S. Congrees, Joint Economic Committee, *The Economics and Financing of Higher Education in the United States* (Washington, D.C.: Government Printing Office, 1969). pp. 467-506.

(9) Hirsch, Werner Z., "The Supply of Urban Public Service" in *Issues in Urban Economics* ed. by H.S. Perloff and L. Wingo, Jr. (Baltimore: The John Hopkins Press, 1968).

(10) Siegel, Barry N., "On the Positve Theory of State and Local Expenditures," *Public Finance and Welfare* ed. by P.L. Kleinsorge (University of Oregon, 1966). pp. 171-186.