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高等教育品質與規模經濟之研究 ※

Higher Education in Taiwan:
Quality, Cost Efficiency and Economies of Scale

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高等教育品質與規模經濟之研究

計畫中文摘要

高等教育改革為近年來我國教育革新之重點工作，舉凡教育品質之加強，課程架構之重整，師資設備之提昇，組織功能之檢討，財務資源之改革等，均為國人關注之重點。行政院教育改革審議委員會諮詢報告建議高等教育應以市場機能發揮數量調節的作用，提供各種不同類型功能的學府，賦予大學財務自主的權利，以及財務規劃的責任。教育部對於高等教育之改革策略亦提到大學應重新調整適應，更具彈性機能及營運制度。各校如何兼顧品質與營運績效應為當務之急。在大學院校面臨教育改革政策逐漸改變及市場競爭日益劇烈的情況下，如何維持良好教育品質的同時，更具備有效的財務規劃，使學校的資源做最有效的分配運用，讓國家高等教育的精神能真正落實，乃一值得探討的課題。

本研究之目的在於探討國內公私立大學院校之教育品質與規模經濟及多元經濟的現象，期望藉此課題的探討，尋求高等教育之最適經營規模。

關鍵詞：教育品質、規模經濟、高等教育、成本函數、資源分配

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Higher Education in Taiwan: Quality, Cost Efficiency and Economies of Scale

Introduction

Concerns about the quality and cost efficiency of higher education have taken on a significant and pervasive form in the past decade in Taiwan. In view of the shrinking government funding available for higher education and the rapidly changing context of higher education, as alerted by the national Educational Reform Committee, the colleges and universities face an urgent need to address the quality of education issues. They need to reexamine their missions and academic functions and streamline their administrative and financial systems, in tune with the market forces, if they are to survive and serve the needs of their stakeholders in a highly competitive environment.

The lack of previous studies presents several obstacles to our understanding the cost structure of the higher education institutions (HEIs). First, only few studies have employed multiproduct cost function techniques till recently, most early studies regarding scale economies used only single-output cost functions. Second, all studies have fallen short of a rigorous analysis of scale and scope economies. Product-specific scale economies were estimated only in recent studies by Cohn et al (1989), de Groot, McMahon, and Volkwein (1991), Nelson and Heverth (1992) and Dundar, H. (1993). Cohn et al. (1989) and de Groot, McMahon, and Volkwein (1991) used institutions as the unit of analysis for their cost functions. Nelson and Heverth (1992) employed data from a single university to analyze departmental costs. Dundar, H. (1993) analyzed cost structures of three departmental fields (17 departments) in 18 public research universities.

Cohn et al. (1989) were the first to study the costs of higher education by estimating flexible-fixed cost quadratic (FFCQ) functions for 1195 public and 692 private HEIs in U.S. They estimated two separate cost functions for public and private institutions. FTUE and FTGE were used as proxy measures of teaching outputs, and research grants were used as a proxy measure of research output.

De Groot et al. (1991) analyzed cost functions of a subsample of 147 doctorate-granting universities with a major emphasis on research. A translog cost function is employed in this study. Teaching output is full-time-equivalent graduate enrollment. The study employed the number of publications as a proxy measure of research output instead of research grants. The most striking differences was the inclusion of a program quality measure for graduate programs by introducing a program quality variable as an independent explanatory variable of total costs in this study. The peer ratings of program quality were employed as proxy for quality.

Nelson and Heverth (1992) included average class size as an explanatory variable in a multiproduct translog cost function. The study utilized data from a single university over the period between1979 and 1983, and used departments as the unit of analysis. The use of student credit hours as a measure of output, and the percentage of faculty time devoted to research as a measure of research output.

In sum, cost functions studies have provided important information for decision-makers about resource allocation and improving efficiency. The most important problem in any cost study about HEIs is the methodological difficulties and insufficient resources to measure the outputs of higher education institutions. Another significant problem is that well-defined educational cost and production functions for HEIs are yet to be developed. This study was a first attempt to analyze the complex issues of quality, cost efficiency and economies of scale in higher education in Taiwan. Its main purpose was to empirically examine the cost efficiency of the country higher education institutions in terms of teaching and research as their products.

The answer to the research question is derived by seeking answers to the following specific questions:

1. What are the average and marginal costs of different outputs in different institutions?
2. Are there ray economies of scale at university level?
3. Are there complementarities among all outputs through their joint production?
4. What are the optimum level and mix of outputs for different types of

universities?

5. How does the quality of a university and its products affect its costs?

Methodology

The most common proxy to measure the teaching output is using the number of students (Maynard 1971, Verry and Davies 1976). The number of student credit hours has been the second most common measure (Nelson and Heverth 1992), and the number of graduates has also been used as a proxy (Verry and Davies 1976, de Groot et al. 1991).

For the research output, we still either lack a crude quantity index or a quality index. First, the number of articles, and/or books published (Verry and Layard 1975, Verry and Davies 1976, de Groot et al. 1991). Second, the amount of research grants that received from government or other agencies (Brinkman 1981, Cohn et al. 1989). Third, hours spent by staff on personal research (Verry and Layard 1975, Verry and Davies 1976, Nelson and Heverth 1992). Finally, citation index may be used to create a proxy of research output.

The lack of appropriate measures for the quality of outputs is one important reason why estimates of production and cost functions in higher education have not been well developed. Attempts must be made with quality measures to provide better and more reliable approximations about the true nature of the cost structures of colleges and universities. Cohn et al. (1989) did not attempt to control the quality of teaching output because they argued that there was no reliable measure of teaching quality. De Groot et al. (1991) attempted to study the impact of graduate program quality, but the quality of undergraduate education and research were ignored.

None of the studies reviewed has ever employed a measure for the impact of the public service output of higher education. This may lead to biased estimates of the costs of outputs and the existence of economies of scale and scope. However, due to the lack of data on the corresponding output, public service is always excluded.

In this study, we also focus on measuring teaching and research output. A multiproduct translog cost function was specified to include two outputs, namely, the numbers of students enrolled (Y_T) and research projects conducted (Y_R); three input prices, labor (P_L), capital (P_K) and material (P_M); and with two quality proxies for instruction (Q_T) and research (Q_R).

The multiproduct translog cost function specified in this study is as follows:

$$\begin{aligned}\ln C &= A_0 + \sum_i A_i \ln Y_i + \sum_j B_j \ln P_j + \sum_k E_k \ln Q_k \\ &+ \frac{1}{2}\sum_i \sum_s A_{is} \ln Y_i \ln Y_s + \frac{1}{2}\sum_j \sum_r B_{jr} \ln P_j \ln P_r + \frac{1}{2}\sum_k \sum_l E_{kl} \ln Q_k \ln Q_l \\ &+ \sum_i \sum_j F_{ij} \ln Y_i \ln P_j + \sum_i \sum_k G_{ik} \ln Y_i \ln Q_k + \sum_j \sum_k H_{jk} \ln P_j \ln Q_k \\ &+ \sum_n D_n DUM_n\end{aligned}$$

(1)

Where i, s = T and R; j, r = L, K, and M; k, l = T and R. DUM is the dummy variable for each university with n = N1,…,N10 and P1,…,P18. The cost share of each input (S_j) can be computed from the Shephard's lemma:

$$\begin{aligned}S_j &= \partial \ln C / \partial \ln P_j \\ &= P_j X_j / C \\ &= B_j + \sum_r B_{jr} \ln P_r + \sum_i F_{ij} \ln Y_i + \sum_k H_{jk} \ln Q_k\end{aligned}$$

(2)

Where j = L, K, M. The sum of input shares must be equal to one, that is, $S_L+S_K+S_M= 1$. Equations (1) and (2) constitute a system of equations for estimation. The characteristics of the symmetricity of parameters and the homogeneity of degree one in input prices require the following restrictions be satisfied (Zardkoohi, Rangan, and Kolari, 1986):

$$\begin{aligned}&\sum_j B_j = 1, \quad \sum_j B_{jr} = 0, \quad \sum_j F_{ij} = 0, \quad \sum_j H_{jk} = 0 \\ &A_{is} = A_{si}, \quad B_{jr} = B_{rj}, \quad E_{kl} = E_{lk}\end{aligned}$$

(3)

Due to the adding-up restriction of the input shares, one share equation is dropped from the system to avoid singularity in the variance of residuals. The full information maximum likelihood estimation method (FIML) is utilized to ensure the invariance property of the estimated parameters in disregarding which share equation is dropped from the system.

The appropriateness in using the translog cost function can be checked with the magnitudes and signs of the Allen-Uzawa's elasticities of substitution and the price elasticities of conditional input demand. Allen-Uzawa's elasticities of substitution (σ_{jr}) can be written as (Binswanger, 1974):

$$\sigma_{jr} = 1 + \frac{B_{jr}}{S_j S_r} \quad , \quad j \neq r \tag{4a}$$

$$\sigma_{jj} = \frac{B_{jj} + S_j(S_j - 1)}{S_j^2} \tag{4b}$$

When $\sigma_{jr} > 0$, inputs are substitutes. While $\sigma_{jr} < 0$, inputs are complimentary. σ_{jj} must be negative and the matrix of elasticities of substitution has to be negative semidefinite to comply with regularity conditions. The price elasticities of conditional input demand (ε_{jr}) can be written as:

$$\varepsilon_{jr} = \sigma_{jr} S_r \quad , \quad j \neq r \tag{5a}$$

$$\varepsilon_{jj} = \sigma_{jj} S_j \tag{5b}$$

ε_{jr} and ε_{jj} represent the cross- and own-price elasticities of input demand. The difference between the price elasticities of conditional input demand and the elasticities of substitution is that when an input price changes, the former assumes the level of output remains constant, while the latter allows output to change (Berndt and Wood, 1975).

In the translog cost function, the effects of changes in output on the cost of production can be measured by the cost elasticities (CE):

$$CE_i = \partial \ln C(Y) / \partial \ln Y_i \quad (6)$$

Cost elasticity for each output has to be positive which implies an increase in output will always increase the production cost.

Ray economies of scale show that when a composition of output is assumed to remain fixed while its size is allowed to vary, the reduction in the average costs relative to marginal costs results in costs savings. In the case of multiproduct translog cost function, ray economies of scale (RSCE) is defined as the sum of cost elasticities for all outputs (Caves, Christensen and Swanson, 1981):

$$RSCE(Y) = \sum_i \partial \ln C(Y) \; / \partial \ln Y_i \quad (7)$$

If RSCE < 1, economies of scale in production prevails. While RSCE > 1 and RSCE = 1 indicate diseconomies and constant returns to scale of production.

When product mix is allowed to change as scale increases, expansion path scale economies (EPSCE) between two output bundle A and B can be defined as the elasticity of incremental cost with respect to incremental output along the expansion path AB (Berger, Hanweck, and Humphrey, 1987):

$$EPSCE(Y^A, Y^B) = \sum_i \left[\frac{Y_i^B - Y_i^A}{Y_i^B} \cdot \frac{C(Y^B)}{C(Y^B) - C(Y^A)} \cdot \frac{\partial \ln C(Y^B)}{\partial \ln Y_i} \right] \quad (8)$$

EPSCE < 1 indicates scale economies on the expansion path AB, while EPSCE > 1 indicates diseconomies.

Economies of scope indicate that the cost advantages to firms of producing a large number of diversified products as against specializing in the production of a single output. To produce a given combination of products $Y^{\mathbf{B}}$ as opposed to produce only one product either Y_T^B or Y_R^B, the economies of scope (SCP) can be defined as follows (Panzar and Willig, 1981):

$$SCP(Y^B) = \left[C(Y_T^B, 0) + C(0, Y_R^B) - C(Y^B)\right] / C(Y^B)$$
(9)

If SCP > 0, the cost of specialization is greater than diversification which indicates economies of scope. If SCP < 0, diseconomies of scope prevails.

A more likely division of output is to divide a larger institution, say B, into two smaller institutions A and D such that $Y^A + Y^D = Y^B$. Expansion path subadditivity (EPSUB) gives the proportional cost increase from two-institution instead of one-institution production of Y^B (Berger, Hanweck, and Humphrey, 1987):

$$EPSUB(Y^B) = \left[C(Y^A) + C(Y^D) - C(Y^B)\right] / C(Y^B) \qquad (10)$$

If EPSUB < 0, the institution B is not competitively viable. Conversely, if EPSUB > 0, either institution A or D has inducements to expand its output to Y^B.

Note that the conventional scale and scope measures RSCE(Y) and SCP(Y^B) are special cases of the expansion path measures EPSCE(Y^A, Y^B) and EPSUB(Y^B). RSCE is a special case of EPSCE, when RSCE(Y^B) = EPSCE(0, Y^B). While C(Y^A)=C(0, Y_R^B) and C(Y^D) = C(Y_T^B, 0), EPSUB reduces to SCP.

Data

A total of 28 higher education institutions (10 public and 18 private) in Taiwan were included in the study. Time-series and cross-sectional data for this study were collected from archival sources and government document for the period of 1992 to 1996. The multiproduct translog cost function includes two outputs: teaching (Y_I) and research (Y_R), three input prices: labor (P_L), capital (P_K), and material (P_M), and two quality proxies: instruction (Q_I) and research (Q_R). Variable definitions and sources of data are as follows.

Output variables: Teaching output (Y_I) includes both undergraduate and graduate enrollments. Research output (Y_R) is the number of research projects granted from the National Science Foundation.

Input price variables: Price of Labor is computed by dividing total salary and compensation by the number of full-time faculty, part-time faculty, and staff members. Price of capital is obtained by dividing capital expenditures, which includes maintenance and depreciation by fixed assets. Price of material is the expenditure on materials divided by the number of students, faculty, and staff members.

Quality of output variables: Teaching quality proxy employs the lowest score for each institution from the joint entrance examination. Research quality proxy employs the percentage of full-time faculty members receiving the research award granted by the National Science Foundation.

Data for the enrollments, faculty and staff members were collected from the Educational Statistics of the Republic of China, published by the Ministry of Education. Salary and compensation, material, and capital expenditures data were collected from the Accounting office of the Ministry of Education. The numbers of research projects and research award were obtained from the National Science Foundation. The lowest score of the joint entrance examination were obtained from the National Examination Committee.

Results

The FIML estimation results of the translog cost function and the input share equation system are shown in Table 1. The covariance matrix of the estimated parameters is adjusted by White's heteroscadesticity-consistent method to ensure correct statistical inferences. The fit for the cost function is quite well with R^2 equal to 0.9903. Forty-two parameter estimates out of sixty-two in total are statistically significant. The estimated parameters of the dummy variables for the public institutions are all positive and significant, and with an average of 0.3855 which is significantly higher than 0.0732 for the private institutions. It indicates that the public institutions use more costs to produce the same amount of output than the private.

1. Elasticities of substitution and price elasticities of conditional demand

The results of the Allen-Uzawa's elasticities of substitution are shown in Table 2. The own elasticity of each input is negative and significant. The characteristic roots of the elasticity matrix are 0, -0.168, and –5.591, which implies the matrix is semidefinite, as required by the regularity conditions. The estimated price elasticities of conditional demand are shown in Table 3. Own elasticities are all negative and significant. Cross elasticities are positive and significant, which indicates substitutability between labor and capital, and between capital and material. The substitutability between labor and material is not significant..

2. Cost elasticities

An increase in teaching output has significant effects on the production cost as

Table 1 Estimated Parameters of the Translog Cost Function

Parameter	Estimate	Standard Error	t-statistic	P-value
A_0	19.3420	8.8038	2.1970 **	0.028
A_I	1.0091	0.4411	2.2875 **	0.022
A_R	0.3471	0.1578	2.1995 **	0.028
B_L	-1.1280	0.1935	-5.8280 ***	0.000
B_K	0.6903	0.2007	3.4393 ***	0.001
B_M	1.4377	0.1608	8.9381 ***	0.000
E_I	-5.8733	4.1288	-1.4225	0.155
E_R	1.1397	0.4193	2.7181 ***	0.007
A_{II}	0.0590	0.0294	2.0106 **	0.044
A_{IR}	-0.0347	0.0225	-1.5425	0.123

Parameter	Estimate	Standard Error	t-statistic	P-value
A_{RR}	0.0020	0.0122	0.1664	0.868
B_{LL}	0.1767	0.0046	38.7549 ***	0.000
B_{KK}	0.0384	0.0043	9.0375 ***	0.000
B_{MM}	0.1459	0.0044	33.2439 ***	0.000
B_{LK}	-0.0346	0.0034	-10.3232 ***	0.000
B_{LM}	-0.1421	0.0041	-34.8948 ***	0.000
B_{KM}	-0.0038	0.0021	-1.7989 *	0.072
E_{II}	1.3678	1.0229	1.3372	0.181
E_{IR}	-0.3024	0.1018	-2.9701 ***	0.003
E_{RR}	0.0041	0.0169	0.2438	0.807
F_{IL}	-0.0399	0.0045	-8.8710 ***	0.000
F_{IK}	-0.0104	0.0029	-3.5242 ***	0.000
F_{IM}	0.0502	0.0040	12.6467 ***	0.000
F_{RL}	-0.0014	0.0046	-0.2979	0.766
F_{RK}	0.0101	0.0036	2.7781 ***	0.005
F_{RM}	-0.0087	0.0034	-2.5575 **	0.011
G_{II}	-0.1501	0.0954	-1.5721	0.116
G_{IR}	0.0240	0.0148	1.6178	0.106
G_{RR}	0.0122	0.0126	0.9729	0.331
H_{IL}	0.2661	0.0421	6.3131 ***	0.000
H_{IK}	-0.0126	0.0386	-0.3273	0.743
H_{IM}	-0.2534	0.0355	-7.1319 ***	0.000
H_{RL}	-0.0113	0.0065	-1.7464 *	0.081
H_{RK}	0.0052	0.0049	1.0685	0.285
H_{RM}	0.0060	0.0048	1.2591	0.208

(to be continued)

Table 1 Estimated Parameters of the Translog Cost Function (Continued)

Parameter	Estimate	Standard Error	t-statistic	P-value
D_{N1}	0.2640	0.0691	3.8193 ***	0.000
D_{N2}	0.2608	0.0674	3.8695 ***	0.000
D_{N3}	0.3407	0.0762	4.4730 ***	0.000
D_{N4}	0.2932	0.0565	5.1880 ***	0.000
D_{N5}	0.8128	0.1002	8.1125 ***	0.000
D_{N6}	0.3348	0.0818	4.0940 ***	0.000

Parameter	Estimate	Standard Error	t-statistic	P-value
D_{N7}	0.5470	0.0733	7.4588 ***	0.000
D_{N8}	0.3936	0.0513	7.6722 ***	0.000
D_{N9}	0.1545	0.0474	3.2620 ***	0.001
D_{N10}	0.4542	0.0889	5.1116 ***	0.000
D_{P1}	0.0575	0.0481	1.1956	0.232
D_{P2}	-0.0935	0.0390	-2.3990 **	0.016
D_{P3}	0.0494	0.0337	1.4659	0.143
D_{P4}	-0.0491	0.0339	-1.4503	0.147
D_{P5}	-0.0268	0.0494	-0.5426	0.587
D_{P6}	0.1046	0.0494	2.1172 **	0.034
D_{P7}	0.0410	0.0272	1.5073	0.132
D_{P8}	0.1608	0.0358	4.4974 ***	0.000
D_{P9}	0.1699	0.0371	4.5826 ***	0.000
D_{P10}	0.2979	0.0773	3.8545 ***	0.000
D_{P11}	-0.0593	0.0431	-1.3776	0.168
D_{P12}	0.2059	0.0571	3.6037 ***	0.000
D_{P13}	0.1635	0.0407	4.0208 ***	0.000
D_{P14}	0.0157	0.0433	0.3637	0.716
D_{P15}	-0.0465	0.0292	-1.5912	0.112
D_{P16}	0.1908	0.0488	3.9141 ***	0.000
D_{P17}	0.0628	0.0246	2.5504 **	0.011
Equation	R^2	S	LM Het	DW
Total Cost	0.9903	0.0814	0.5774	2.1093
Labor Share	0.8457	0.0325	0.0273	2.1582
Capital Share	0.5966	0.0252	30.2184 ***	2.1283

Notes: (1) ***, **, and * denote that estimates are significantly differently from zero under 1%, 5%, and 10% significance levels respectively.

(2) Material share equation is dropped from the system in estimation. Standard errors of the estimated parameters are adjusted by White (1980) method. S denotes the standard error of regression. LM Het is the lagrangian multiplier heteroscadesticity test. DW is the Durbin-Watson test.

Table 2 Allen-Uzawa Elasticities of Substitution

Inputs	Labor	Capital	Material
Labor	-0.0321 *** (0.008)		

Capital	0.3414 *** (0.063)	-5.4714 *** (0.832)	
Material	-0.0036 (0.028)	0.7258 *** (0.152)	-0.2557 ** (0.118)

Notes: (1) Standard errors are in parentheses.
(2) ***, **, * Denote that estimates are significantly differently from zero under 1%, 5%, and 10% significance levels respectively.

Table 3 Price Elasticities of Conditional Input Demand

Inputs	Labor	Capital	Material
Labor	-0.0236 *** (0.006)	0.0243 *** (0.004)	-0.0007 (0.005)
Capital	0.2513 *** (0.046)	-0.3909 *** (0.059)	0.1395 *** (0.029)
Material	-0.0026 (0.021)	0.0518 *** (0.010)	-0.0491 ** (0.022)

Notes: Same as in Table 2.

Table 4 Cost Elasticities of Outputs and Quality Proxies

	Teaching Output	Research Output	Teaching Quality	Research Quality
Total	0.6201 *** (0.048)	0.0238 (0.025)	0.4624 *** (0.160)	0.0012 (0.023)
Public	0.6259 *** (0.051)	0.0350 (0.031)	0.1584 (0.283)	-0.0219 (0.034)
Private	0.6453 *** (0.043)	0.0172 (0.017)	0.5584 *** (0.134)	0.0068 (0.019)

Notes: Same as in Table 2.

shown in Table 4. There are no difference between the cost elasticities for the public and the private institutions. The cost elasticities for research output are not significant in all cases. Teaching quality has significant effects on the cost only for the combined sample and the private institutions. The efforts in improving teaching quality do take costs for the private institutions but not for the public institutions. Research quality is not significant in increasing costs.

3. Ray economies of scale

The estimated ray economies of scale are shown in Table 5. The higher education institutions in Taiwan all exhibit economies of scale. The estimate for the public institutions (0.6609) is higher than the one for the private (0.6629), but the difference is not significant. Among the twenty-eight institutions, the estimates range from 0.5979 for the no. 13 private institution (P13) to 0.7107 for the no. 7 private institution (P7).

4. Expansion path scale economies

Four sizes of institutions are classified according to the output of teaching. Class 1 to class 4 institutions represent the institution with the number of enrollment over fifteen thousand, between fifteen and ten thousands, between ten and five thousands, and less than five thousands students, respectively. The twenty-eight institutions are classified into each class according to its size and the mean values of each variables are computed within each class accordingly. The results shown in Table 6 indicate that, except the case of expanding from class 3 to class 2, changing product mix as scale increases exhibits scale economies.

5. Economies of scope

As shown in Table 7, the estimates for economies of scope are all positive and significant which indicates diversification in production is cost saving in higher education institutions in Taiwan.

6. Expansion path subadditivity

In Table 6, the results of output division in the sense of dividing a larger institution into smaller ones rather than specializing in producing only one product, show that a larger institution is always competitively viable in Taiwan higher education industry.

Table 5 Estimates for Ray Economies of Scale

Institution	Estimate	Standard Error	t-statistic	P-value
Total	0.6439	0.0407	15.8288 ***	0.000
Public	0.6609	0.0488	13.5457 ***	0.000
Private	0.6626	0.0376	17.6247 ***	0.000
N1	0.6322	0.0331	19.0986 ***	0.000
N2	0.6331	0.0374	16.9284 ***	0.000
N3	0.6663	0.0333	20.0198 ***	0.000
N4	0.6074	0.0561	10.8235 ***	0.000
N5	0.6045	0.0696	8.6879 ***	0.000
N6	0.6287	0.0429	14.6538 ***	0.000
N7	0.6327	0.0555	11.4081 ***	0.000
N8	0.6326	0.0479	13.2131 ***	0.000
N9	0.6142	0.0282	21.8098 ***	0.000
N10	0.6504	0.0404	16.1032 ***	0.000
P1	0.6235	0.0231	26.9940 ***	0.000
P2	0.6511	0.0235	27.7203 ***	0.000
P3	0.6229	0.0462	13.4964 ***	0.000
P4	0.6448	0.0229	28.1707 ***	0.000
P5	0.6234	0.0268	23.2731 ***	0.000
P6	0.6603	0.0569	11.6016 ***	0.000
P7	0.7107	0.0373	19.0366 ***	0.000
P8	0.6261	0.0467	13.4068 ***	0.000
P9	0.6334	0.0467	13.5674 ***	0.000
P10	0.6896	0.0352	19.6119 ***	0.000
P11	0.6293	0.0211	29.8792 ***	0.000
P12	0.6366	0.0620	10.2663 ***	0.000
P13	0.5979	0.0575	10.3900 ***	0.000
P14	0.6805	0.0393	17.3033 ***	0.000
P15	0.6395	0.0340	18.8052 ***	0.000
P16	0.6378	0.0542	11.7640 ***	0.000
P17	0.6419	0.0348	18.4354 ***	0.000

P18	0.6581	0.0388	16.9545 ***	0.000

Notes: Same as in Table 2.

Table 6 Estimates for Expansion Path Scale Economies and Subadditivity

Institutions A	Institutions B	EPSCE(Y^A, Y^B)	EPSUB(Y^B)
2	1	0.5787 *** (0.035)	0.0870 ** (0.039)
3	2	1.1268 *** (0.033)	0.3496 *** (0.036)
4	3	0.6601 *** (0.024)	0.0630 *** (0.022)

Notes: Same as in Table 2.

Table 7 Estimates for Economies of Scope

Institution	Estimate	Standard Error	t-statistic	P-value
Total	0.2323	0.0350	6.6349 ***	0.000
Public	0.1794	0.0683	2.6249 ***	0.009
Private	0.2485	0.0197	12.6284 ***	0.000
N1	0.3079	0.0514	5.9903 ***	0.000
N2	0.2571	0.0502	5.1239 ***	0.000
N3	0.4626	0.0631	7.3317 ***	0.000
N4	0.2243	0.0624	3.5915 ***	0.000
N5	0.2522	0.1071	2.3549 **	0.019
N6	0.2216	0.0591	3.7457 ***	0.000
N7	0.2057	0.0673	3.0578 ***	0.002
N8	0.2395	0.0342	7.0133 ***	0.000
N9	0.3435	0.0290	11.8339 ***	0.000
N10	0.2314	0.0680	3.4035 ***	0.001
P1	0.5273	0.0239	22.0250 ***	0.000
P2	0.5405	0.0126	42.9517 ***	0.000
P3	0.2243	0.0379	5.9148 ***	0.000
P4	0.4343	0.0135	32.0968 ***	0.000
P5	0.4742	0.0293	16.1866 ***	0.000
P6	0.1713	0.0229	7.4673 ***	0.000
P7	0.3471	0.0215	16.1746 ***	0.000
P8	0.2298	0.0225	10.1926 ***	0.000
P9	0.2206	0.0268	8.2403 ***	0.000
P10	0.6277	0.0682	9.2098 ***	0.000
P11	0.4528	0.0154	29.3543 ***	0.000

P12	0.1801	0.0553	3.2584 ***	0.001
P13	0.2179	0.0571	3.8145 ***	0.000
P14	0.9948	0.0125	79.6396 ***	0.000
P15	0.3851	0.0411	9.3731 ***	0.000
P16	0.1950	0.0331	5.8858 ***	0.000
P17	0.3076	0.0227	13.5401 ***	0.000
P18	0.2554	0.0184	13.8488 ***	0.000

Notes: Same as in Table 2.

Conclusion

This study shows that the cost structure of the higher education institutions in Taiwan can be examined by the translog cost function. Some conclusions are reached for this study:

1. HEIs in Taiwan exhibit both economies of scale and scope. There is no difference between the public and the private institutions in terms of the degrees of the economies of scale and scope. The efforts in improving teaching quality do take costs for the private institutions but not for the public institutions. Research quality is significant only for the private institutions. But, our lack of understanding about cost minimization requires one to be very careful in arriving at definitive conclusions, and in interpreting results as being approximate rather than actual representations of cost minimization principles.
2. Multiproduct cost analysis at the institutional level has little to offer policy makers because of the differing production processes of each department. Further research by using the department as the level of analysis need to be conducted in order to compare the cost structures of different types of departments.

Some limitations of this study are followed:

1. The definition of the cost incurred in the HEIs is not clear. There exists many different types of costs and can be estimated in many different ways. In this paper,

we define cost to include salary and compensation, capital and material expenditures.

2. The outcomes of education are not clearly defined and difficult to measured. Almost all studies have employed either only approximate or proxy variables for teaching and research outputs. The lack of certain data regarding the quality of outputs, non-budgeted research output, and non-budgeted public service output further precludes the use of qualitative measures for HEIs.
3. HEIs as non-profit organizations do not minimize their costs. Rather than minimizing their costs, HEIs spend all their available revenue for the sake of increasing quality and prestige. The significance of the revenue on this point was not considered in this study.

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Higher Education in Taiwan :
Quality, Cost Efficiency and Economies of Scale

Abstract

Concerns about the quality and cost efficiency of higher education have taken on a significant and pervasive form in the past decade in Taiwan. This study was a first attempt to analyze the complex issues of quality, cost efficiency and economies of scale in higher education in Taiwan. Its main purpose was to empirically examine the cost efficiency of the higher education institutions to include teaching and research as their products. A total of 28 higher education institutions (10 public and 18 private) in Taiwan were included in the study. Time-series and cross-sectional data for this study were collected for the period from 1992 to1996. The multiproduct translog cost function was specified to include two outputs, namely, the number of enrollments and research projects; three input prices, labor, capital, and materials; and two quality proxies, instruction and research. Differences between public and private institutions in term of cost efficiency were considered. The relationship between the educational quality and economies of scale was also emphasized.

The empirical findings of this study would hopefully encourage legislative policy debate on the educational quality issues, and contribute to awareness and discussion about these issues within the higher education community in Taiwan.

Keywords: Educational quality；Higher Education；Cost function；Economies Scale and Education；Resource allocation