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Evaluation in Cost Efficiency in Thai Public Universities

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Abstract

Thai government budget allocation usually bases on customary guideline. Adjustment is made each year to accommodate expected inflation and raise of permanent staff's salary. Public universities' budgets are granted on the same principle except for new projects which are approved according to good justification. Since salary accounts for 70-80% of the total annual budget, performances of faculty and supporting staff confine the success of the organizations. Public universities carry multifunctions i.e. academic, research, social services and culture conservation. In light of tight resource, the National Budget Bureau is in the process of reconsidering budget allocation method.

This paper is to analyse cost efficiency in producing a graduate in science, social science, research activities and other tasks conducted by 30 new public universities. Data Envelop Analysis is employed. The results can pinpoint efficient unit cost of each output which could be used for benchmarking by less efficient universities.

1. Introduction

After the economic crisis, Thailand has placed an emphasis on restructuring government agencies to assure greater efficiency in their operation. Most universities in Thailand were previously organizations under government supervision through the Bureau of University Affairs, and now they are under the Ministry of education after the Bureau was dissolved for the objective of unified system efficiency. Some public universities having faced the situation of tight government budget and increasingly intense competition, tried to get more flexibility in their administration by reorienting themselves to become independent of government budget and bureaucratic system. Meanwhile, some especially various Ratchabhat Universities seek to remain in the traditional public institution system. In light of budget resource constraint and growing competition for the same resource, public universities confront the question how they should adjust or reorient themselves to assure operational efficiency. Generally, public universities share the common missions of producing graduates, undertaking researches, cherishing national arts and culture and providing social services. For the

Ratchabhat University group in particular producing graduates is the priority commitment and hence quantity and quality of their graduates deserve particular attention to determine their performances.

Cost efficiency is the most conventional concept of efficiency engaged in studies of organization performance. Given the importance of efficiency measures as a tool for policy makers and markets participants, cost efficiency in the production of graduates of public universities is relatively more practical for performance measurement and interpretation as it is based on the available quantitative data. In contrast, quality or qualitative information about the graduate is difficult to determine. Since the cost of producing graduate varies across various universities, this study seeks to pursue a step forward by analyzing the cost efficiency in two different fields of study, social science and science, of various Ratchabhat Universities**.**

The purposes of this paper are twofold: (1) to calculate measures of cost efficiency of public universities using deterministic frontier methods and (2) to explain the calculated efficiency scores of individual university. This paper itself in divided into six main sections. Section 2 reviews existing literature on cost efficiency. Section 3 describes briefly the basic concepts. Section 4 presents the model specified and data used while Section 5 presents and interprets the empirical findings. Section 6 presents main conclusions.

2. Literature Review

Concept of production cost efficiency as a measure of performance has been applied to various cases of public and private organizations and most popularly in the field of banking as demonstrated by the works of Berger and DeYoung(1997)-The United States; Ausina(1999)-Spain; Turati(2003)-Europe; Camanho and Dyson(2003)-Portugal; Suhaimi(2004)-Malaysia; Fries and Taci(2004)-East Europe; Podpiera(2005)-the Crech Republic; Rao(2005)-The United Arab Emirates; Wong, Fong, Wong and Choi(2006)-Hong Kong; and Fierentino, Karmann and Koetter(2006)-German. Others applied in the field of health care unit and hospital such as the works of Linna and Hakkinen(1995)-Finland; and Reinikka and Svensson(2000)-Uganda. This concept has also been extended for the study on credit unions in Australia by Worthington(2000); financial buyers in the United States of America(2002) library in the United Kingdom; business processes by Gebauer, Schober(2005); and investment firms in Italy by Basili and Fontini(2005).

Specifically in the field of education, found are the works of Casu and Thanassoulis(2006)-The United Kingdom; and Horne and Hu(2008)-Australia. The former case employed Data Envelopment Analysis framework to identify practices leading to cost-efficient central administrative services by evaluating cost efficiency of 108 universities(England(86), Wales(7), Scotland(13) and Northern Ireland(2)). Casu and Thanassoulis found that, the on average, UK universities show inefficiency of 27%. Moreover, the results indicate that despite the fact that universities vary substantially in size, there is not a great issue of scale efficiency. For the second study, Horne and Hu estimate the cost efficiency of 36 universities over the period of 1995-2002 using stochastic frontier analysis. The main finding is that universities are not operating efficiently as measured by cost efficiency.

Studies using production cost efficiency principle in Thailand were under taken for domestic and foreign banks(2005) by Cantapong and Menkhoff; and life insurance industry by Karim, Abd Jhantasana and Chanta(2005). Chantapong and Menkhoff estimated and compared cost efficiency of domestic and foreign banks in Thailand using bank-panel data between 1995 and 2003. The estimated results suggest that the unit cost of production of domestic and foreign banks are the same, although the two types of banks focus on different areas of the banking business. Based on bank operating efficiency, the findings indicate that the production costs of domestic and foreign banks are different. However, in terms of cost efficiency, foreign banks did not perform better than domestic banks.

However, none of the available papers has investigated the cost efficiency of universities in Thailand. This paper estimates the deterministic cost frontier to investigate the cost efficiency of 32 public universities in Thailand

3. Basic Concepts

The approach employed in the current study to empirically construct measures of cost efficiency is based upon the deterministic frontier analysis. Deterministic model proposed by Aigner and Chu(1968) can be written as

$$y_i = f(x_i, \beta) \cdot \exp\{\mu_i\} \quad ; \quad \text{i} = 1,2,\ldots,\text{n} \tag{1}$$

where y_i = scalar of output of producer i

x_i = vector of inputs used by producer i

$f(\cdot)$ = optimal production function

β = vector of parameters

μ_i = non-negative random variables independent of the production inefficiency of producer i

Estimation of parameters in this model came from application of mathematical programming and regression techniques. Aigner and Chu(1968) proposed the integration of techniques for parameter estimation. The linear programming addresses the minimal sum of errors of observable outputs of most efficient producers while the quadratic method deals with the minimum sum of squared proportionate deviations of observable outputs of the highest output levels (Kumbhakar and Lovell, 2000). This method has advantage in helping relax Farrell's notion on constant return-to-scale. However, its major shortcoming is the absence of criteria and consistency in parameter estimation (Kumbhakar and Lovell, 2000). Schmidt(1976) noted that when assumption on the distribution of various disturbances is clearly defined, the frontier function can be estimated by maximum likelihood(ML) method for corrected ordinary least squares(COLS) and modified ordinary least squares(MOLS) regressions. The parameter estimation by deterministic production frontier model involved such two stages as follows.

In the first stage OLS is used for estimation and in the second stage, the slope value of OLS intercept will be adjusted to assure the estimated frontier approaches the data or has no positive or zero residual (Kumbhakar and Lovell, 2000, p.70). This model's parameters except content term should be consistent with the estimates by OLS method. OLS (Greene, 1997). This method, however, dose not account for the effect of measurement error and statistical deviation. Since the total deviation from the frontier is one-sided error component for the reason that this is the component involving inefficient producer (Settlage, Dixon and Thomsen, 2000).

The deterministic parametric model in other functional forms include the production frontier proposed by Afriat(1972) and Richmond(1974) where technical efficiency is measured by the one-sided disturbance term which is assumed to have half-normal or exponential distribution. Meanwhile the ordinary least squares(MOLS) method is similar to two-stage COLS in that the intercept obtained from OLS estimation will be moved upward. The main problem of deterministic frontier models lies in the statistical properties of the estimates of the unknown parameters and the omission to measure the impact of randoming for the reason that total output variation is not associated with input variation in explaining technical inefficiency.

Consequently, Stochastic Frontier Model has been used to deal with various problems and shortcomings.

Cost efficiency can be measured in terms of a frontier. The cost frontier is a function which gives the minimum cost for any level of output (Saunders, 2002). If a university is on the frontier, it will be 100% cost efficient. If it is not on the frontier, then its distance from the frontier indicates the level of efficiency. University which is above the frontier, in order to be 100% efficiency, must lower its cost without reducing its output until it reaches the frontier. The estimation of production cost frontier in this study is based on Cobb-Douglas Cost efficiency Model.

4. Data and Methodology

4.1 Data and variables

The data applied in this study are derived from the National Budget Bureau. The sample consists of 32 observations of public universities calling Ratchabhat university for the year of 2007. Outputs of these Ratchabhat Universities include (1) graduates in social science degree (2) graduates in science degree (3) art and culture preservation (4) social services. This particular study covers only the first two outputs because the relevant data are comprehensive and readily available enough for quantitative treatments while the other two outputs are difficult to deal with due to questionable measurement criteria for both output and factor inputs.

(A) production of graduates in social science

Primary statistics from all 32 Ratchabhat Universities provided a basic conclusion that in 2007 their total cost of producing the graduates in social science degree was 159,373,800.78 bath to turn out 2,554.81 graduates per university on the average. Chankasem campus spent the most at 257 million baht to produce 2,843 graduates while Ratchabhat University at Kalasin spent the least at 58 million baht to produce 120 graduates(Table 1)

Table 1: Descriptive statistics of total cost of producing graduates and number of graduates in social science degree, 32 Ratchabhat Universities in 2007

Variables	Maximum	Minimum	Average	Standard deviation
Total cost(baht)	57,848,893.75	256,876,981.51	159,373,800.78	52,754,244.40
Number of graduates (persons)	120.00	10,649.00	2,554.81	2,632.34

Source: National Budget Bureau and Calculation

(B) Production of graduates in science degree

All 32 Ratchabhat Universities in 2007 had the average figures of 108,436,706.22 baht total production cost and 1,095.19 graduated persons. RU at Udon Thani could produce the largest number of graduales in the field of sciences at 4,399 persons followed by RU at Phranakhon and Piboon Songkram which produced 4,281 and 2,601 graduates respectively while RU at Roi Ed could produce the least only 71 graduates(Table 2).

In terms of total cost for producing graduate in science degree in each university, RU at Nakhon Pathom incurred the most at about 501 million baht while RU at Chaiyabhum spent the least at 28 million baht.

Table 2: Total cost of producing graduates and number of graduates in science degree, 32 RUs in 2007

Variables	Maximum	Minimum	Average	Standard deviation
Total cost(baht)	27,860,100.00	500,677,780.02	108,436,706.22	81,192,104.95
Number of graduates (persons)	60.00	4,399.00	1,095.19	1,149.45

Source: National Budget Bureau and Calculation

4.2 Empirical model

The production cost function of each RU in this study takes the Cobb-Douglas form and it can be expressed in log form as follows

$$\ln T = \ln A + \beta_1 \ln Y + \varepsilon$$

where $\ln T$ = log value of total cost of producing graduates of Ratchabhat University j

$\ln A$ = constant

$\ln Y$ = log value of number of graduates produced by Ratchabhat University j

β_1 = cost elasticity per graduate

ε = error term and $\varepsilon = u + v$

5. Empirical results

Deterministic frontier analysis was performed to determine the optimal scale of producing graduates in social science and science degrees to minimize production cost of each Ratchabhat University. The results can be summarized as follows.

(A) Production of graduates in social science

The data on total production cost $(\ln T)$ and number of graduates in social science $(\ln Y)$ were used to estimate cost function in Cobb-Douglas form by Maximum likelihood technique. The estimated cost frontier with $\ln A$ and β_1 on x and y axes demonstrates the parameter values of the relationship between total production costs and outputs in social science. As shown in Table3, the estimate of the parameter (β_1) and the constant term are found to be statistically significant. This implies that a 1% change in number of graduates will correspond to a 0.24% change in total cost in the same direction. If we need to increase the number of graduates by 20% then the total cost of production will increase by 4.8% .

The sigma-squared (σ_s^2) value is obtained from the sum of σ_v^2 and σ_u^2, or the sum of the variance from measurement error and other random effects and the variance from inefficiency. While gamma (γ) is defined by σ_u / σ_s to indicate the extent of inefficiency contributing to the total variance. The investigation on the case of all 32 Ratchabhat Universities revealed γ to have the value of 0.000029 meaning that in a unit of total variance, only 0.000029 unit is responsible by inefficiency variance and the rest by measurement error and other random effects (Table 3) . However, the analytical results from this model application cannot distinguish the levels of efficiency among different Ratchabhat Universities since the γ value is not statistically significant. If all public universities are similar in their performance, the policy to improve efficiency has to do with all institutes.

Table 3: Estimates of cost frontier of social science graduates production by 32 Ratchabhat Universities

Variables	Parameter	Standard deviation	t-statistic
$\ln A$	17.032	0.973	17.503***
β_1	0.242	0.060	4.052***
σ_s^2	0.098	0.024	4.046***
γ	0.000029	0.040	0.001
log likelihood function = -8.19			

Source: calculation by Frontier version 4.1
Note: ***, **, * statistically significant at 99, 95 and 90%

Table 4 shows the cost efficiency scores(calculated from table 3) of all 32 Ratchabhat University which have the average value of 1.001350 meaning that the overall Ratchabhat University system incurred a production cost in producing social science graduates about 0.00135 unit or 0.135% over the full efficiency level. To be fully technical efficient, an organization must operate on the cost frontier where cost efficiency score is equal to 1.0 the bench marking score

Table 4: Cost efficiency scores of 32 Ratchabhat Universities in the production of graduates in social science

Ratchabhat University	Cost efficiency score
1. Kanchanaburi	1.001350
2. Kalasin	1.001347
3. KumpangPhet	1.001352
4. ChanKasem	1.001354
5. Chaiyabhum	1.001343
6. Chiang Rai	1.001354
7. ThepSadtri	1.001353
8. Thonburi	1.001350
9. NakhonPathom	1.001350
10.NakhonRatchasrima	1.001352
11.NakhonSridrammarat	1.001352
12.NakhonSawon	1.001348

Table 4(continued)

Ratchabhat University	Cost efficiency score
13.SomdetChaopaya	1.001356
14.Burirum	1.001351
15.Phranakhon	1.001348
16.PiboonSongkram	1.001347
17.WaraiArongkorn	1.001342
18.PhetChaboon	1.001349
19.Phuket	1.001348
20.MahaSarakam	1.001352
21.Yala	1.001350
22.Ratchanakarin	1.001349
23.Roi-ate	1.001345
24.RumpaiPunnee	1.001356
25.SakhonNakhon	1.001347
26.SongKhla	1.001349
27.SuanSununtra	1.001352
28.SuratThanee	1.001349
29.ChomBueng Village	1.001352
30.UdonThani	1.001348
31.Uttradit	1.001354
32.UbonRatchathanee	1.001347
mean	1.001350

Source: calculation by Frontier version 4.1

(B) production of graduates in science degree

Initially, the application of empirical model to the data of all 32 Ratchabhat Universities failed to a logical cost frontier. Consequently, three observations namely Ratchabhat at Roi Ed, Ratchabhat at Chaiyabhum and Ratchabhat RampaiPunnee were excluded from the analysis because the latter two universities produced very small numbers, 60 and 71 respectively of graduates in science in comparison to other Ratchabhat Universities, while Ratchabhat at RumpaiPunnee underreported the cost figure as it did not keep record about expenditure spent

out of support budget category and other miscellaneous expenses. The data from the remaining 29 observations were still subject to the analysis using Cobb-Douglas model.

The analytical procedure also followed that of social science case. The total expenditure for producing graduates in science $(\ln T_6)$ and the number of graduate outputs $(\ln Y)$ of various Ratchabhat Universities were processed in Cobb-Douglas model for estimation of a cost function. The resulted β_1 has the value of 0.165(Table 5) meaning that a 1% change in the number of graduates produced, the total cost of turning out graduates in science degree will change in the same direction by 0.165%. In other words, if the number of graduates increases by 20%, total production cost will increase by 3.3%. As described earlier the sigma-squared (σ_s^2) value equals to the sum of variance due to measurement error and other random effects and variance due to inefficiency, and gamma (γ) is the value of σ_u/σ_s ratio to indicate the extent of the variance due to inefficiency in contributing to the total variance. The estimates of efficiency of the 29 Ratchabhat Universities in producing graduates in science have the σ_s^2 value or total variance of 0.307 and γ value of 0.620 which means every unit of total variance, 0.620 unit comes from inefficiency and the rest from measurement error and other random effects (Table 5).

Table 5: Estimates of cost frontier of science graduates production by 29 Ratchabhat Universities

Variables	Parameter	Standard deviation	t-statistic
ln A	16.983	0.549	30.935***
β_1	0.165	0.087	1.900*
σ_s^2	0.307	0.137	2.249**
γ	0.620	0.310	1.997*
log likelihood function = -16.59			

Source: calculation by Frontier version 4.1
Note: ***, **, * statistically significant at 99, 95 and 90%

From table 6, it is evident that the estimates of cost inefficiency in the production of graduates in science degree by the 29 Ratchabhat Universities were relatively more clearly measured and higher in values compared to the case of science in terms of both average and individual university. The average cost efficiency of the 29 Ratchabhat Universities scored 1.469 indicating that on the average they spent 0.469 unit or 46.9% over the possible or optimal efficiency level and they should reduce their production cost by 46.9% to be efficient.

However, different Ratchabhat Universities appear to be quite different in cost efficiency in the production of graduates in science degree; with scores ranging between 1.113 and 3.143. Ratchabhat at Burirum was the best of all in terms of cost efficiency with the score of 1.113 from producing 2,336 graduates in science with 37 million baht total expenses. However, it still needs to reduce cost by 0.113 unit to be on the cost frontier with the score of 1.0 which is the benchmarking of optimal efficiency. The poorest performer was Ratchabhat at NakhonPathom with the cost efficiency score of 3.143. It produced 2,017 graduates using as high as 501 million baht. Its cost is 2.143 units higher than the efficiency frontier and it needs to cut its expenditure down to 159.4 million baht to be efficient.

The empirical results also suggest that the cost frontier model application is relatively more robust in the study on cost inefficiency in producing graduates in science as the model can capture higher value of cost inefficiency, compared to the lower cost inefficiency value in the case of social science.

Table 6: Cost efficiency scores of 29 Ratchabhat Universities in the production of graduates in science

Ratchabhat University	Cost efficiency score
1. Kanchanaburi	1.364
2. Kalasin	1.255
3. KumpangPhet	1.229
4. ChanKasem	1.680
5. Chiang Rai	1.375
6. ThepSadtri	1.304
7. Thonburi	1.308
8. NakhonPrathom	3.143
9. NakhonRatchasrima	1.525
10.NakhonSridrammarat	1.376
11.NakhonSawon	1.446
12.SomdetChaopaya	1.566
13.Burirum	1.113
14.Phranakhon	1.356

Table 6(continued)

Ratchabhat University	Cost efficiency score
15.PiboonSongkram	1.410
16.WaraiArongkorn	1.260
17.PhetChaboon	1.444
18.Phuket	1.231
19.MahaSarakam	1.824
20.Yala	1.460
21.Ratchanakarin	1.614
22.SakhonNakhon	1.291
23.SongKhla	1.505
24.SuanSununtra	1.525
25.SuratThanee	1.376
26.ChomBueng Village	1.320
27.UdonThani	1.424
28.Uttradit	1.666
29.UbonRatchathanee	1.210
Mean	1.469

Source: calculation by Frontier version 4.1

6. Conclusion

Using a dataset including 32 public universities (Ratchabhat University) in Thailand, this paper investigates the cost efficiency applying the deterministic cost frontier approach. The estimated cost function reveals that the increase in number of graduates either in social science or science will require higher total expenditure of public universities in Thailand. The level of cost efficiency for producing graduates in social science ranges between 1.001342 and 1.001356. It can be said that all the public universities perform so closely in terms of efficiency that none can be distinguished as more or less efficient. To enhance efficiency, therefore, becomes a common target for all universities. Furthermore, the main finding of this study indicates that universities are not operating efficiently, as measured by cost efficiency. Specifically, the levels, of cost efficiency for producing graduates in science vary highly from

the score of 1.113 to 3.143. The empirical findings also suggested that the cost frontier model can explain better in the case of graduate in science compared to social science.

The policy recommendation emerged from this study's findings include the need for various Ratchabhat Universities to reduce the cost of producing gradates especially in the field of science. The cost was generally overly higher than the efficient level due to the continual decrease in number of students enrolling to study in science to the extent that some disciplines have no student enrolment. The decline in science popularity is in part due to students' perception that the field of science is more difficult to study than social science but the graduates of both fields are employed at similar level of salary so it is not worthwhile to study science. The crucial challenge for the national interest is how to encourage students to study more in the field of science which is still imperative for the country's development and this should be addressed as a long term national policy.

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