Efficiency of Public Hospitals in Thailand: in Search of a Cost Efficient Frontier*

Direk Patmasiriwat**

Abstract

This paper reports a comparative study on cost efficiency of public hospitals in Thailand under the Ministry of Public Health, based on 711 sampled hospitals classified under i) regional hospitals, ii) provincial hospitals, iii) community hospitals. Two methods of data analysis are: stochastic cost frontier and data envelopment analysis. Our findings indicate: an average efficiency score for the regional hospitals were found to be 94%, compared with 64% for provincial hospitals, and 81% for community hospitals. Of note was that there were signs of underutilization of resources in many public hospitals as indicated in the graphical analysis that showed a pattern of decreasing unit cost. These also imply there are scope for cost savings, e.g., by raising utilization rates. Our results should however be considered preliminary as our model might unintentionally contained weaknesses, for instances, certain types of hospital services were not counted as "outputs", and being located in special environments, e.g., on island or the remote areas with sparse population. Despite the high unit cost, there are justifications for hospital on ground of social objectives.

Keywords: *Public Hospital, Cost efficiency, Stochastic Cost Frontier, Data*

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ประสิทธิภาพของโรงพยาบาลของรัฐในประเทศไทย การค้นหาหน่วยงานที่บริหารต้นทุนอย่างมีประสิทธิภาพ

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บทคัดย่อ

บทความเสนอรายงานผลการศึกษาเปรียบเทียบประสิทธิภาพการบริหารต้นทุนของสถานพยาบาลของรัฐ จากกรณีตัวอย่าง 711 แห่ง ที่สังกัดกระทรวงสาธารณสุข จำแนกออกเป็นโรงพยาบาลระดับศูนย์ โรงพยาบาลจังหวัด และโรงพยาบาลชุมชน โดยใช้แบบจำลองstochastic cost frontier และ data envelopment analysis เป็นกรอบการวิเคราะห์ ผลการศึกษาบ่งชี้ว่า โรงพยาบาลศูนย์มีระดับประสิทธิภาพสูงสุด 94% โดยประมาณ เปรียบเทียบกับโรงพยาบาลจังหวัด 64% และโรงพยาบาลชุมชน 81% ซึ่งสะท้อนว่ามีโอกาสที่จะประหยัดต้นทุนได้หากปรับปรุงประสิทธิภาพการบริหารต้นทุนให้เท่ากับระดับแนวหน้า สาเหตุหนึ่งของความด้อยประสิทธิภาพอาจจะมาจากการขนาดการให้บริการต่ำกว่าที่ควรจะเป็น ซึ่งยืนยันได้จากกต้นทุนต่อหน่วยที่ลดลงตามลำดับและผลการทดสอบคุณสมบัติ “ต้นทุนต่อหน่วยลดลง”อย่างไรก็ตามการศึกษานี้ควรถือว่าเป็นผลเบื้องต้น เนื่องจากแบบจำลองนี้อาจมีจุดอ่อนบางประการที่มิได้ตั้งใจ เช่น ไม่ได้นำบริการบางประเภทมานับเป็นผลผลิต นอกจากนี้สถานพยาบาลบางแห่งมีลักษณะและเหตุผลการจัดตั้งพิเศษ เช่น บนเกาะ หรือการตั้งโรงพยาบาลในชนบทห่างไกลและประชากรจำนวนน้อย อย่างไรก็ตามเป็นความจำเป็นที่จะต้องจัดให้มีบริการรักษาพยาบาลด้วยเหตุผลทางสังคม

คำสำคัญ: *โรงพยาบาลของรัฐ ประสิทธิภาพการบริหารต้นทุน แบบจำลอง stochastic cost frontier และแบบจำลอง data envelopment analysis*

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Introduction

This paper reports the progress of a research program entitled *"Health Financing to Support Universal Health Coverage in Thailand,"* whose main objective is to monitor and to evaluate the efficacy of public hospitals under the Ministry of Public Health, Thailand. Efficiency is a major concern for policy makers and budget planners, as inefficient operations connote a "leaky bucket" situation in the sense that more money is spent than is necessarily required. Inefficiency is, however, not uncommon in hospital management; output slack and excessive input can arise from many causes, for instance, over-bedding, over-staffing, over-stocking of material supplies, and others. It is generally agreed that private managers in a competitive market take efficiency seriously, as it is vital to their survival—it is however less clear whether the public organization manager would take efficiency as seriously. In the Thai context, public hospitals receive a large portion of revenue from the annual government budget and they can also earn revenue from fees for services. In this sense, their survival does not crucially depend on profit and loss. This paper has two goals: first, to measure the cost efficiency of Thai public hospitals using cross-sectional data and two quantitative techniques to compare costs against hospital outputs; secondly, to trace the linkage between inefficiency and capacity utilization through unit cost analysis. Our units of analysis comprise 711 public hospitals, of which 23 units were regional hospitals, 58 units provincial hospitals, and 630 units community hospitals. All cost and output figures reported in this study refer to fiscal year 2006.

The paper is organized into 6 sections: section II first discusses the concepts of cost, economies-of-scale, and capacity utilization in the hospital context. Section III reports on the descriptive statistics regarding public hospitals and performs a comparative analysis and takes note of the dissimilarities or similarities among

different groups of hospitals. Section IV reports on the cost efficiency estimates based on two types of quantitative techniques; namely, stochastic cost frontier and data envelopment analysis. The findings from the quantitative approach should be taken as preliminary; we realize that qualitative investigation may be necessary in order to deepen our understand of the special conditions that might be applicable to individual hospitals with special environments. There are social reasons for operating public hospitals in remote areas or those that are located on islands for equity objectives despite sparse populations and high unit costs. Section V discusses ways to improve hospital efficiency measurement with panel data and to revise our model to include variables that are relevant from case studies. In this connection, a dialogue between economists and evaluators hospital managers is strongly recommended—we can always learn from field study through discussion and dialogue.

Conceptual Framework

Cost Curve and Efficient Scale of Operation

The costs of public hospitals can be grouped under fixed components and variable components. By definition the average fixed cost decreases as the scale of operation increases, whereas the variable costs tend to increase in response to operational increases. Following Wagstaff and Barnum (1980), the cost curve is assumed to take a U-shape, as portrayed in Figure 1. Moving along this curve is equivalent to moving from one short-run average cost to another. At point '1' $\delta C / \delta K < 0$; and at point '3', $\delta C / \delta K > 0$. A short quotation from Wagstaff and Barnum: "… *if one estimates a short-run total (or average) cost function and finds that a hospital is operating to the right of the minimum point of the partial relationship between cost and capital stock, one can conclude that the hospital is over-capitalized…" (pp.3-4)*

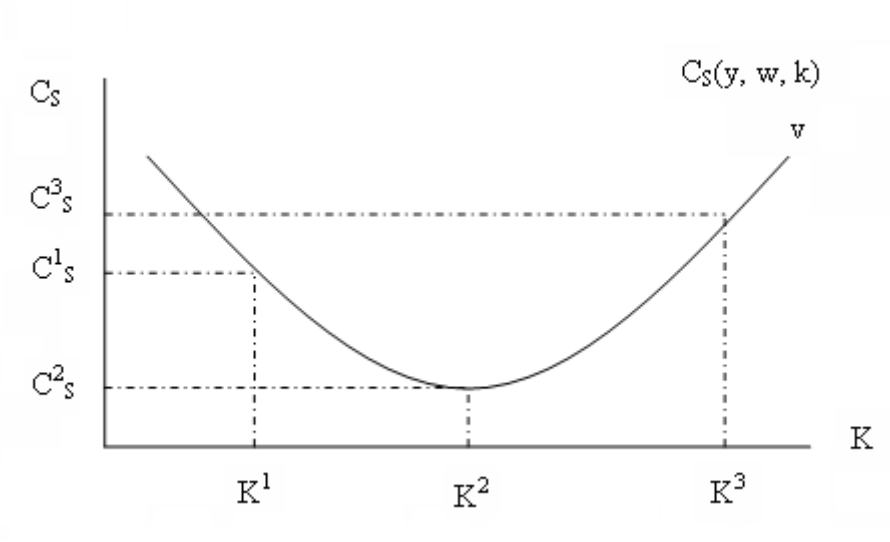


Figure 1: A typical U-shaped cost curve

Technical- and Allocative-Efficiency

Technical efficiency (TE) refers to a situation in which a production unit could obtain the maximum output from an operation that uses a given bundle of inputs. Another concept is called allocative efficiency (AE) which refers to the situation where production unit employs the right combination of factor inputs (capital and labor) given factor prices at the margin. Another quotation: *"In principle both types of inefficiency might be present in the hospital sector and it is useful for policy-makers to know the extent of any such inefficiency in the hospital sector as a whole, as well as any variation across hospitals. It is also of interest, of course, to know whether there is any variation between one sub-sector (e.g., the private sector) and another (e.g. the public sector)…" (p.4)*

In this study we shall limit our analysis to TE only. This is mainly because we do not have adequate information about the factor prices that individual hospitals

face and thus AE cannot be inferred.[1] Some review of previous research, Feldstein (1967)] applied the econometric model to study the hospital production function with following form: $\ln y_i = b_0 + \Sigma_j \beta_j \ln x_{ij} + V_i$, where y is output, the x_j refer to inputs, β's output elasticities, and v_i an error terms; and took an investigation of residual terms. Those hospitals with zero residuals were assumed to be about "average" in TE, whereas those hospitals with positive (negative) residuals were said to perform "above-average" (or "below-average"). Wagstaff and Barnum commented that the stochastic frontier model[2], $\ln y_i = b_0 + \Sigma_j \beta_j \ln x_{ij} + V_i + U_i$, where u_i is one-sided and reflects inefficiency, which is constrained to be non-positive, might be more appropriate.

Elasticity of Cost with Respect to Output

Elasticity of total cost with respect to output is denoted by:

$$\varepsilon = (\delta C/C) / (\delta y/y) = (\delta C/\delta y).y\ (1/C) = \delta \ln C / \delta \ln y$$

Another way of expression this is that elasticity is equal to the ratio of the marginal cost to the average cost. If economies of scale exist, then $\varepsilon < 1$ and average costs fall.

[1] AE requires that for each pair of input j and m, $MP_j / MP_m = w_j / w_m$, where MP_j is the marginal product of the j^{th} input and w_j is the price for the j^{th} factor input.

[2] The stochastic frontier model has been developed since 1970s and been applied for measuring hospital efficiency, for instances, Worthington (2004), Yong and Harris (1999) and Zukerman et.al. (1994).

Unit of Analysis: Costs and Outputs

The present research project compiled output and expenditure data from nearly 900 public hospital units under the Ministry of Public Health.[3] We have removed those observations with incomplete data from our dataset. Hospital expenditures were reported in detailed items; we have however regrouped them into 6 headings for ease of interpretation; namely: a) wages and salaries, b) personnel compensation, c) operating expenses, d) medication and material costs, e) water and electricity, and f) other expenditures. For convenience, we shall refer to them as cost1, cost2,…, cost6 respectively. Regarding outputs, public hospitals provide services in 3 areas; namely, health care, health promotion, and disease prevention. Two types of output were used in our efficiency analysis: outpatient (OP) and inpatient (IP).

Empirical Study

First we report on the comparative statistics of output and cost data by types of public hospitals. The regional hospitals and the provincial hospitals provide tertiary care and operate on a larger scale, as indicated in the number of beds, the number of outpatient and inpatient treatments, and the amount of hospital expenditures. The annual costs of the regional hospital range from 788 to 2,500 million baht, and averaged 1,330 million baht, while the OP treatment cases averaged 468,182 and IP cases 251,747 units (man/day). The scale of provincial hospitals was about 40 percent to that of regional hospitals. Their expenditures averaged 499 million

[3] It should be mentioned that there are more numbers of public hospital in Thailand that are under responsibility of various ministries, for instances, the Ministry of Education (university-hospitals), the Ministry of Defence, local governments, and the National Office of Police.

baht, with an average number of treatment cases of 247,299 for OPs and 108,277 IP man/days. Community hospitals are smallest in scale. Hospital expenditures averaged 66 million baht and their treatment was 78,722 for OPs and 12,902 IP man-days.

Table 1: Comparative Statistics on Output and Cost Data by Types of Public Hospital

Variable	Obs	Mean	Std. Dev.	Min	Max
		Regional hospital			
Bed	23	713.4	167.1	433	1019
OP	23	468181.6	114803.2	266682	728862
IP	23	251747.4	69111.28	158417	419856
cost1	23	386.00	120.00	233.00	721.00
cost2	23	89.00	29.70	50.40	162.00
cost3	23	85.80	81.20	22.30	314.00
cost4	23	405.00	155.00	169.00	701.00
cost5	23	26.10	9.59	16.30	54.80
cost_total	23	1330.00	413.00	788.00	2500.00

Table 1: Comparative Statistics on Output and Cost Data by Types of Public Hospital (Continued)

Variable	Obs	Mean	Std. Dev.	Min	Max
		Provincial hospital			
Bed	58	339.9	112.0	85	549
OP	58	247299.3	97127.2	78558	564556
IP	58	108227.3	49105.4	14250	276263
cost1	58	166.00	59.80	6.16	306.00
cost2	58	37.30	21.00	1.20	119.00
cost3	58	28.80	26.80	0.59	137.00
cost4	58	134.00	71.80	4.23	341.00
cost5	58	10.30	4.57	0.85	21.30
cost_total	58	499.00	199.00	30.10	1090.00
		Community hospital			
Bed	628	43.1	26.9	10	182
OP	630	78722.1	44251.0	1327	393610
IP	630	12902.1	11034.3	12	86589
Cost1	630	22.70	12.10	0.47	94.00
Cost2	630	7.08	5.46	0.20	87.80
Cost3	630	3.96	4.76	0.23	71.40
Cost4	630	14.40	12.00	0.16	153.00
Cost5	630	1.31	0.99	0.02	10.90
Cost_total	630	65.80	43.30	7.06	447.00

Notation: bed = number of beds
OP = outpatient
IP = inpatient (man/day)

Cost Function and a Test of Decreasing Cost

The optimal scale of operation is one of the major concerns of manager, including hospital managers and budget planners.[4] Cost analysis is useful for managers as from it the stage of the capacity utilization of an organization can be inferred. In our study we assume that the hospital cost function follows Cobb-Douglas functional form; that is,

$$Cost = a * (OP)^b * (IP)^c ;$$

The right hand side is the total cost of the hospital; on the left hand side, OP=outpatient care provided and IP=inpatient care provided. We transformed the relation by taking log to take a log-linear functional form. An ordinary least squares (OLS) was applied to estimate parameter a, b, and c, respectively, and to test the property of constant-cost (i.e., b + c = 1). From preliminary data exploration, we are convinced that it would be more efficient to estimate cost functions separately by 3 types of hospital rather than pooling them altogether.[5]

[4] The concepts of hospital costs and their brown-down items are very well discussed in Evans (1991) and Grannemann and Brown (1991)

[5] This issue is commonly referred in econometric textbook as whether or not to pool data.

Table 2: Cost Curve Estimation for Regional Hospitals

Number of obs = 23						
F(2, 20)	=	30				
Prob > F	=	0				
R-squared	=	0.75				
Adj R-squared = 0.725						
Root MSE	=	0.15117				
Lncost	*Coef.*	*Std. Err.*	*T*	*P>t*	*[95% Conf.*	*Interval]*
Lnop	0.4489	0.1632	2.75	0.012	0.1084	0.7894
Lnip	0.6229	0.1496	4.16	0.001	0.3107	0.9350
_cons	7.3962	1.8028	4.1	0.001	3.6356	11.1568
		Testing the condition:		b + c =1		
F(1,20) =	0.26					
prob > F	0.616					

Notation: lncost = log of total cost, lnop = log of OP cases, lnip = log of IP cases

Our estimates, as shown in Table 2, indicate that the regional hospitals were operating at the constant return to scale. The estimated coefficient of c implies that the major costs (62%) of regional hospitals were spent on inpatient care. Homoscedasticity was tested; however, we could not reject the assumption of constant variance across hospitals.

Table 3: Cost Curve Estimation for Provincial Hospitals

Number of obs = 58						
F(2, 55)	=	53.37				
Prob > F	=	0				
R-squared	=	0.6599				
Adj R-squared	=	0.6476				
Root MSE	=	0.32371				
Lncost	*Coef.*	*Std. Err.*	*T*	*P>t*	*[95% Conf.*	*Interval]*
Lnop	0.2949	0.1802	1.64	0.10	-0.0662	0.6561
Lnip	0.6580	0.1322	4.98	0.00	0.3931	0.9229
_cons	8.7300	1.3887	6.29	0.00	5.9470	11.5131
		Test: b + c =1				
F(1,55) =	0.18					
prob > F	0.6739					

Notations: same as in Table 2

The regression cost estimate for provincial cases (Table 3) was similar to the regional hospitals; we could not reject the assumption of constant return to scale (b+c = .95). These estimates should, however, be viewed with caution, as the test for homogeneity must be rejected: the constant variance did not hold. Later we used the robust regression technique in order to obtain a sense of sensitivity of the estimated parameters and we found, in the provincial hospitals, that the coefficient for IP markedly dropped (in the robust estimate). Of note is that the constant return to scale did not hold. The provincial hospitals were then interpreted as operating under decreasing costs instead of the constant unit cost, which will be a subject for further discussion.

Table 4: Cost Curve Estimation for Community Hospitals

Number of obs =630						
F(2, 627) =934.58						
Prob > F	=	0				
R-squared	=	0.7488				
Adj R-squared	=	0.748				
Root MSE	=	0.28886				
Lncost	*Coef.*	*Std. Err.*	*T*	*P>t*	*[95% Conf.*	*Interval]*
Lnop	0.5153	0.0337	15.29	0	0.4492	0.5815
Lnip	0.2488	0.0214	11.6	0	0.2067	0.2909
_cons	9.8279	0.2462	39.92	0	9.3445	10.3113
			Test: b + c =1			
F(1,627) =	129.27					
prob > F	0					

It is worth mentioning that the estimated coefficients for community hospitals were marked differently from those of regional and provincial hospitals. Further, the constant cost hypothesis was clearly rejected. By and large, community hospitals were operating under decreasing costs which implies the state of underutilization. The estimated parameters for b = .52 and c=.25. These estimates indicate that the cost would increase by 77% in response to 100% increase in the scale of operations (IPs and Ops). These estimates lend support to our hypothesis that community hospitals may be operating in inefficient scale and there are scope to expand the scale of operations. This note is preliminary; we realize that our model may be incomplete in the sense that the types of services performed by some hospitals

were not counted, for instances, health education, health promotion, disease prevention, etc.

Table 5: Comparative Cost Shares by Types of Public Hospital

Variable	Obs	Mean	Std. Dev.	Min	Max
		Regional Hospitals			
s1	23	0.2917	0.0387	0.2389	0.3849
s2	23	0.0685	0.0181	0.0395	0.0992
s3	23	0.0625	0.0544	0.0199	0.2343
s4	23	0.2998	0.0547	0.2091	0.3938
s5	23	0.0197	0.0035	0.0129	0.0281
		Provincial Hospitals			
s1	58	0.3409	0.0741	0.1679	0.5387
s2	58	0.0737	0.0274	0.0093	0.1400
s3	58	0.0559	0.0418	0.0195	0.2280
s4	58	0.2569	0.0638	0.1278	0.4723
s5	58	0.0211	0.0061	0.0104	0.0406
		Community hospitals			
s1	630	0.3671	0.0822	0.0551	0.6738
s2	630	0.1143	0.0427	0.0047	0.3347
s3	630	0.0599	0.0308	0.0106	0.3554
s4	630	0.2114	0.0587	0.0055	0.4335
s5	630	0.0199	0.0055	0.0027	0.0678

S1 = wage & salary / total costs

S2 = personnel compensation / total costs

S3 = operating expenses (such as training) / total costs

S4 = medication and materials / total costs

S5 = utility expenses / total costs

Here we shall compare and discuss the cost share statistics (s1,s2,…., s5) between the three types of public hospitals. Similarity was observed in the cost share of water and electricity, with an average of 2 percent with little deviations. The cost shares differ widely in the cases of personnel cost share which averaged to 37 percent, but the cost shares for community hospitals significantly higher than the cases of regional and provincial hospital. The cost share of medication and materials which averaged to 30 percent, with the regional hospitals lied on higher end.

Table 6: Hospital Cost Estimation by the Robust Regression Method[6]

Regional hospital

Number	of	Obs	=	23		
F(2,		20)	=	24.85		
Prob >	F		=	0		

Lcost	*Coef.*	*Std. Err.*	*T*	*P>t*	*[95% Conf.*	*Interval]*
Lop	0.4428	0.1781	2.49	0.022	0.0712	0.8143
Lip	0.6211	0.1633	3.8	0.001	0.2805	0.9617
_cons	7.4997	1.9672	3.81	0.001	3.3963	11.6032

Provincial hospital

Number	of	Obs	=	57		
F(2,		54)	=	81.25		
Prob >	F		=	0		

Lcost	*Coef.*	*Std. Err.*	*T*	*P>t*	*[95% Conf.*	*Interval]*
Lop	0.3129	0.1168	2.68	0.01	0.0786	0.5471
Lip	0.5004	0.0880	5.69	0	0.3240	0.6769
_cons	10.3578	0.9088	11.4	0	8.5358	12.1799

Community hospital

Number	of obs	=	629
F(2,	626)	=	1326.85
Prob >	F	=	0

[6] Huber weighting was adopted: in principle, cases with smaller residuals receive weights of 1, and those cases with larger residuals, regardless of being positive or negative, receive smaller weights.

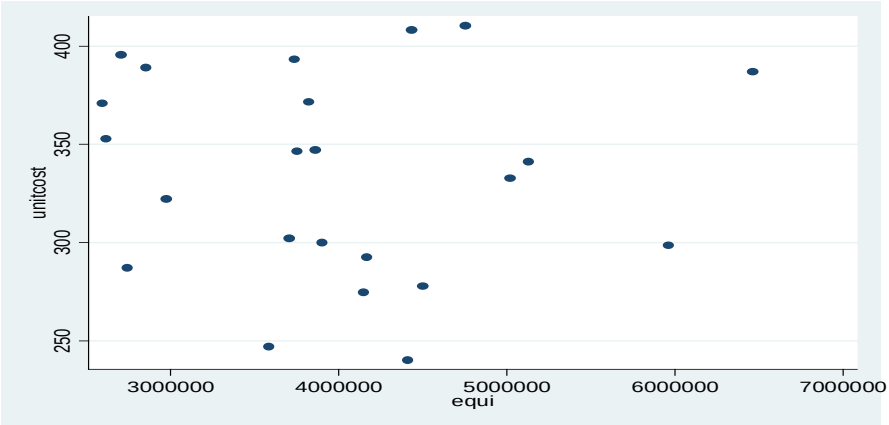
Table 6: Hospital Cost Estimation by the Robust Regression Method[6] (Continued)

Lcost	*Coef.*	*Std. Err.*	*T*	*P>t*	*[95% Conf.*	*Interval]*
Lop	0.4257	0.0314	13.57	0	0.3641	0.4873
Lip	0.3565	0.0208	17.13	0	0.3156	0.3974
_cons	9.8249	0.2211	44.45	0	9.3908	10.2590

Robust regression was applied here to check the sensitivity of our estimated parameters from the OLS. In the case of regional hospitals, the estimated parameters changed little; but in the cases of provincial and community hospitals we observed changes in the estimated parameter from the OLS. Next we shall present the graph of scatter plots of the unit cost versus the scale of operation in order to infer the decreasing cost or constant cost.

Scatter Plot of Unit Cost versus Operational Scale of Hospital

The scatter plot of unit cost and size of service delivery (Regional Hospitals)

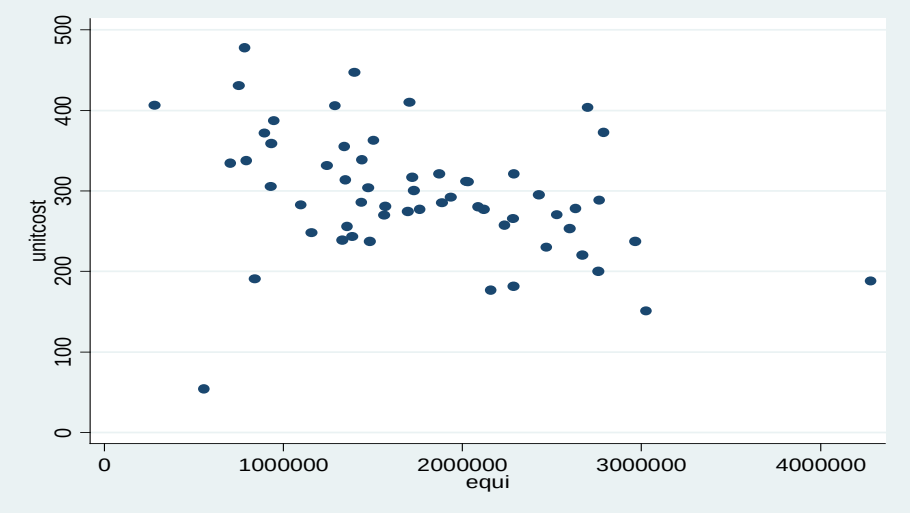


Vertical axix: unit cost per **OP-equivalent** (assuming 1 IP = 14 OPs)

Horizontal axis: OPE **(OP-equivalent)**

[6] Huber weighting was adopted: in principle, cases with smaller residuals receive weights of 1, and those cases with larger residuals, regardless of being positive or negative, receive smaller weights.

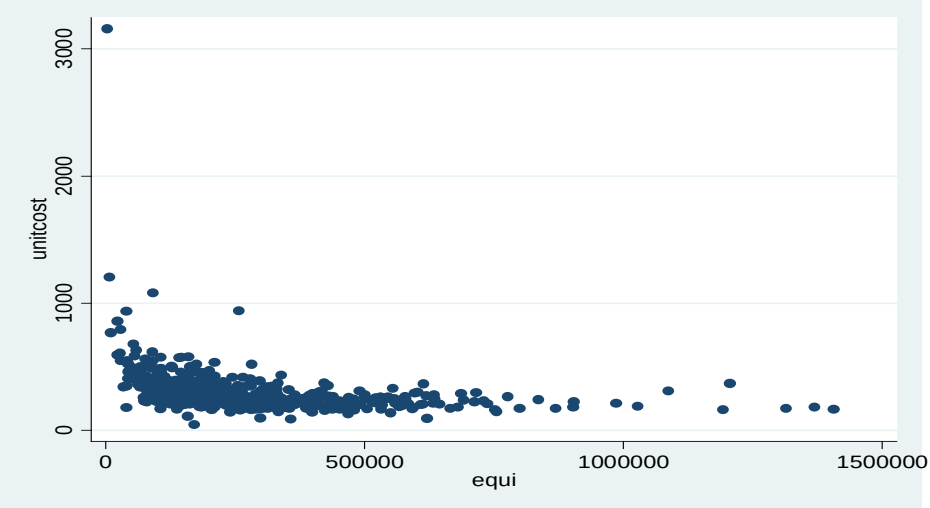
The scatter plot of unit cost and size of service delivery (Provincial Hospitals)



Vertical axis: unit cost per **OP-equivalent** (assuming 1 IP = 14 OPs)

Horizontal axis: OPE **(OP-equivalent)**

The scatter plot of the unit cost and the scale of operations (Community Hospitals)

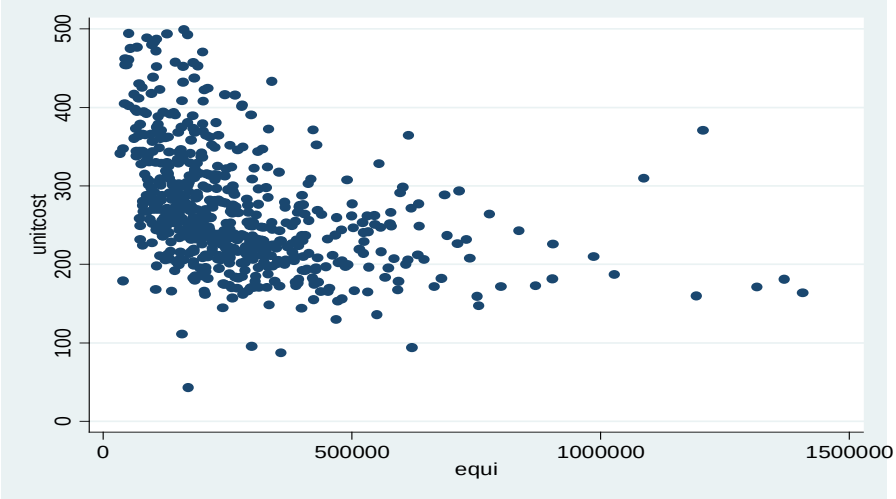


Vertical axis: unit cost per **OP-equivalent** (assuming 1 IP = 14 OPs)

Horizontal axis: OPE **(OP-equivalent)**

The scatter plot of unit cost and size of service delivery (Regional Hospitals)

Note: Outlier costs are trimmed



Vertical axis: unit cost per **OP-equivalent** (assuming 1 IP = 14 OPs)

Horizontal axis: OPE **(OP-equivalent)**

Table 7: Unit cost of OPE

Unit: baht per OP equivalent

	Unit cost per OP-equivalent				
		mean	Sd	min	max
Regional hospital	23	334.32	51.55	240.22	410.38
Provincial hospital	58	294.90	76.89	53.99	477.65
Community hospital	630	292.42	163.50	42.95	3157.52

Cost Efficiency Measurement

This section reports our estimate of cost efficiency based on the nonparametric approach, namely the Data Envelopment Analysis (or DEA).[7] Efficiency can be traced by two approaches; namely, output-orientation and input-orientation. Here we adopt the input-orientation (cost efficiency) for the following reasons: first, the financial data (hospital expenditures) are closely monitored by hospital managers and these data must be reported by bureaucratic rules on a monthly or quarterly basis, we tend to believe that the cost figures should be fairly accurate; secondly, hospital costs are expressed in monetary terms (baht), accordingly the data can be added up directly—instead if we chose to take the output approach, we must assign "weights" for IP unit and OP unit which are obviously not equivalent in term of resource utilization; thirdly, the cost efficiency score is meaningful for budget planner and easy to interpret; for example, a cost-efficient score of 0.85 indicates there is a scope for reducing cost by 15%, by ways of cutting "excess input" or by reducing "output slack".

Regional hospitals, which comprise 23 units

Method: DEA (input orientation)

VRS (variable returns to scale)

Our findings:

- efficiency score (mean value) = .9421
- efficiency score (median value) 1.000

[7] The origin of DEA can be traced back to Farrell (1957) who initiated the concepts of frontier and "inefficiency" measure from the deviation from the frontier. His works inspired others to develop the model for measurement by using the linear programming techniques. Seiford and Thrall (1990) provided a comprehensive review of the application of DEA for frontier analysis in different fields and in different countries. Valdamis et.al. (2004) applied DEA for measuring the relative efficiency of public hospitals in Thailand.

- minimum .7275
- standard deviation .0847

Provincial hospitals, which comprise 58 units

Method: DEA (input orientation)

VRS (variable returns to scale)

Findings:

- efficiency score (mean value) = .6378
- efficiency score (median value) .6221
- minimum .1849
- standard deviation . 2277

Table 8: Efficiency score of Regional Hospitals, Costs, and Service Provisions

DEA findings: efficiency score, costs, out-patients, and in-patients (Regional Hospitals)

Svcode	Pvcode	Zone	type	Efficiency score	Op1	ip1	Bed	cost_L1	Cost_L2	opcost
10660	14	4	1	1	358375	170381	433	270000	66100	213000
10661	19	5	1	1	612653	234848	680	338000	91800	507000
10662	20	9	1	0.73	537521	278249	825	509000	118000	774000
10663	21	9	1	1	403184	164410	555	272000	60300	359000
10664	22	9	1	0.78	362622	249771	733	403000	72800	744000
10665	25	8	1	1	266682	167842	505	233000	74900	386000
10666	30	13	1	1	583586	419856	1019	721000	98800	1050000
10667	31	13	1	1	346116	231338	590	255000	60700	284000
10668	32	13	1	1	459405	231889	652	318000	58300	368000
10669	34	14	1	1	460939	392919	1000	594000	136000	860000
10670	40	12	1	1	567651	317974	867	399000	162000	552000
10671	41	10	1	1	624346	321719	806	448000	100000	605000
10672	52	1	1	1	728862	214902	800	421000	132000	432000
10673	53	2	1	0.85	356675	178284	563	292000	79100	388000
10674	57	1	1	1	484650	263122	756	392000	82700	346000
10675	60	3	1	1	401571	286500	653	408000	50400	449000
10676	65	2	1	1	620014	295118	904	516000	90900	770000
10677	70	6	1	0.86	445187	241146	855	417000	65400	502000
10678	72	6	1	1	341342	187919	585	271000	52400	358000
10679	73	6	1	0.87	470807	234442	552	360000	77000	637000
10680	80	16	1	0.82	477675	262203	863	430000	110000	470000
10681	84	15	1	0.93	482586	286942	760	382000	124000	533000
10683	92	16	1	1	375727	158417	453	234000	84200	307000

Notation and definition

Cost_L1 = wage and salaries unit: '000

Cost_L2 = personnel compensation expenses

Opcost = operating expenses

Table 9: Efficiency score of Provincial Hospitals, Costs, and Service Provisions

DEA findings: efficiency score, costs, out-patients, and in-patients (Provincial Hospitals)										
Svcode	Pvcode	zone	type	Efiiciency Score	op1	ip1	bed	cost_L1	Cost_L2	opcost
10685	11	8	2	1	479347	142215	385	306000	21300	193000
10687	13	4	2	0.95	371661	133186	377	188000	65200	184000
10688	14	4	2	1	261701	47551	160	87400	26400	77400
10690	16	5	2	0.6	314335	128883	390	220000	39100	247000
10691	16	5	2	1	246009	77247	284	148000	2948	110000
10692	17	5	2	0.45	207047	87703	310	184000	28200	143000
10693	17	5	2	0.22	123423	44782	218	125000	22000	90900
10694	18	5	2	0.55	220689	118921	367	196000	30000	170000
10695	19	5	2	0.43	243060	105371	315	202000	28200	236000
10696	23	9	2	0.51	150461	88134	312	170000	36500	124000
10697	24	8	2	0.66	316421	174815	503	245000	57000	301000
10698	26	8	2	0.69	284378	100644	314	184000	21700	148000
10699	27	8	2	0.66	205363	77422	225	87800	42500	115000
10700	33	14	2	0.64	285567	165273	476	216000	62100	326000
10702	36	13	2	0.79	334366	149432	470	210000	54800	207000
10703	37	14	2	0.71	214551	81555	270	102000	27500	90100
10704	39	10	2	0.6	187512	69206	228	77600	33100	85400
12275	40	12	2	0.18	78558	14250	250	43100	6496	32400
10705	42	10	2	0.7	313796	122496	324	184000	31900	243000
10706	43	10	2	0.48	209301	118648	349	186000	34000	312000
10708	45	12	2	0.8	387900	183984	549	242000	72500	380000
10709	46	11	2	1	260286	197565	505	185000	64000	202000
10710	47	11	2	0.76	231898	174132	539	215000	47600	230000
10711	48	11	2	0.45	178614	83476	327	179000	20200	129000
10712	49	11	2	0.29	199066	85500	301	241000	45400	210000
10713	50	1	2	1	412339	276263	524	261000	82500	414000
10715	54	1	2	0.55	291689	142623	438	257000	38300	240000

Table 9: Efficiency score of Provincial Hospitals, Costs, and Service Provisions (Continued)

DEA findings: efficiency score, costs, out-patients, and in-patients (Provincial Hospitals)										
Svcode	Pvcode	zone	type	Efiiciency Score	op1	ip1	bed	cost_L1	Cost_L2	opcost
10716	55	1	2	0.79	198432	149046	430	195000	16900	172000
10717	56	1	2	0.85	381351	153426	373	213000	39900	263000
10718	56	1	2	0.53	200914	53392	225	111000	30100	84800
10719	58	1	2	0.35	103551	49313	130	101000	12200	70800
10720	61	3	2	0.46	158424	93851	350	156000	33200	148000
10721	62	3	2	0.61	266209	119239	334	169000	54100	194000
10722	63	2	2	0.5	194253	107746	321	159000	22300	202000
10723	63	2	2	0.7	295219	102286	310	158000	45100	213000
10724	64	2	2	0.44	218900	80083	325	153000	36000	165000
10726	66	3	2	0.54	200671	130072	405	186000	48800	218000
10727	67	2	2	1	260193	135586	502	105000	3626	110000
10728	70	6	2	0.31	169594	51890	304	129000	31600	98300
10729	70	6	2	0.59	275625	87819	420	193000	44700	161000
10730	70	6	2	0.66	258449	93678	340	136000	26700	161000
10731	71	6	2	0.71	293851	167036	440	197000	47000	250000
10732	71	6	2	0.68	226401	72620	240	114000	32600	97000
10733	72	6	2	0.48	166680	66519	210	112000	16300	86600
10734	74	7	2	1	564556	158897	509	267000	78900	339000
10736	76	7	2	0.6	285454	128836	408	231000	35900	191000
10737	77	7	2	0.44	198117	88562	278	138000	35700	143000
11320	77	7	2	0.52	117369	51638	200	79400	9605	51700
10738	81	17	2	0.6	202245	111364	324	136000	31400	144000
10740	82	17	2	0.24	128660	46739	177	91300	23000	101000
10741	83	17	2	1	507692	156644	503	234000	119000	346000
10742	84	15	2	1	133420	30290	85	6164	1201	5668
10743	85	15	2	0.75	218662	90207	324	137000	27200	93000
10744	86	15	2	1	338337	172867	509	190000	46300	192000
10746	91	19	2	0.31	163853	54791	186	113000	31900	97500
10747	93	16	2	0.65	275046	143292	347	192000	50100	196000

Table 9: Efficiency score of Provincial Hospitals, Costs, and Service Provisions (Continued)

DEA findings: efficiency score, costs, out-patients, and in-patients (Provincial Hospitals)

Svcode	Pvcode	zone	type	Efiiciency Score	op1	ip1	bed	cost_L1	Cost_L2	opcost
10750	96	18	2	0.65	157351	100445	320	159000	58300	115000
10751	96	18	2	0.37	174540	37730	177	98100	32600	75900

Definition

Cost_L1 = wage and salaries unit: '000

cost_L2 = personnel compensation expenses

Opcost = operating expenses

Table 10: Estimates of Community Hospital Costs (Stochastic Frontier Method)

Stochastic Cost Frontier: normal / half-normal model

Number of obs = 628

Wald chi2(3) = 2008.27

Prob > chi2 = 0

Log likelihood -72.398605

Coef.	Std. Err.	Z	P>z	[95% Conf.	Interval]
Lncost_total					
Lnbed	0.16228	0.03051	5.32	0	0.10249	0.22208
Lnop	0.45813	0.03553	12.89	0	0.38849	0.52778
Lnip	0.25369	0.02740	9.26	0	0.19998	0.30740
_cons	9.64800	0.26112	36.95	0	9.13620	10.15979
Lnsig2v					
Lnbed	-0.01180	0.00419	-2.82	0.005	-0.02001	-0.00360
_cons	-2.42917	0.17101	-14.21	0	-2.76433	-2.09400
Lnsig2u					
_cons	-2.90441	0.33107	-8.77	0	-3.55329	-2.25553
Sigma_u	0.23405	0.03874			0.16921	0.32376

It appears that community hospitals were, in general, operating under a decreasing cost and this implied underutilization of resources. Of note: we have performed diagnostic test with respect to homoscedasticity of error terms, the null hypothesis of constant variance of errors is rejected. This suggests that there may be room for improvement (for sake of the precision of model estimate), for instances, by disaggregation of case studies, that is, by separating the cost functions into different groups rather than pooling all units together (628 units), there may be potential gain in term of estimation.

The inefficiency scores of each community hospital can be inferred from the SCF; the overall inefficiency scores (called u_hat, as shown in Table 10) stood at 0.186, implying that the community hospitals as a group are operating at a 0.814 efficiency score, which is fairly high.

Table 11: Inefficiency score: community hospitals

U_hat				
	Percentiles	Smallest		
1%	0.06896	0.03537		
5%	0.10143	0.05868		
10%	0.11189	0.05893	Obs	628
25%	0.13456	0.05952	Sum of Wgt.	628
50%	0.16552		Mean	0.18615
		Largest	Std. Dev.	0.07935
75%	0.21540	0.55131		
90%	0.28620	0.62266	Variance	0.00630
95%	0.32708	0.62752	Skewness	1.97088
99%	0.46260	0.68681	Kurtosis	9.51941

Table 12: Distribution by efficiency scores

Range of inefficiency	Unit	Mean	SD	Min	Max
0 - 5%	1	0.0354	.	0.0354	0.0354
5-10%	25	0.0820	0.0126	0.0587	0.0977
10-15%	203	0.1270	0.0137	0.1000	0.1496
15-20%	202	0.1721	0.0142	0.1502	0.1996
20-25%	99	0.2225	0.0147	0.2005	0.2495
25-30%	50	0.2759	0.0140	0.2506	0.2999
30-40%	34	0.3375	0.0267	0.3021	0.3995
40-50%	4	0.6221	0.0555	0.5513	0.6868
>50%	25	0.0820	0.0126	0.0587	0.0977

Limitations and Recommendations for Further Research

The quantitative techniques (DEA and SCF) as used in this paper are only a first step of investigation and to understand variations in hospital costs that are operating under different conditions and the relationship between hospital costs and hospital outputs. We compare costs versus outputs; both methods perform iterative search for the “cost frontier”, i.e., those units that are most efficient measured by output slack or excess input, and measure degree of inefficiency. Output measures as used here are OPs and IPs—we realize that both variables are at best imperfect measure of hospital outputs, there are, in fact, other types of hospital output that we did not include in this study. Public hospitals perform researching, teaching, and health promotion and prevention (P&P). OPs and IPs were assumed to be standardized and identical for all public hospitals. It is desirable to add qualitative variables, for instance, the relative weights (RWs) which refer complexity and severity

of health care cases—and require different levels of financial resource to treat the patients. Another important variable that may help improve our estimation is about hospital utilization rates, for instances, bed occupancy. The utilization rates can vary from one hospital to another and this could affect the efficiency scores. Hospital utilization rates are unlikely to be identical and standardized; imagine a particular community hospital that situated in remote area and sparse population, the utilization rate for this hospital unit can be low or being classified as outlier. If this hospital were operated under commercial rule, it may be advised to scale down or to merge with another hospital. For public objective, this hospital may be continued on ground of social and health security as the citizens in remote areas are entitled to receive health care when ill similarly to the citizens in urbanized areas.

Our funding agency, HISRO, has been interested in disseminating understanding of the measurement of hospital efficiency to hospital managers. A series of workshops was conducted in three regions (Phitsanulok in the North, Rayong in the Central Area, and Suratthani in the South between April and May 2008, in which 20-30 participants from public hospitals and those in charge of health policy and planning engaged). The idea of holding workshops was to exchange views of and obtain comments about ways to improve the models or correct the misunderstanding of researchers. The research team believes in the adaptive capacity of people and managers—they can improve their performance given the recognition of weaknesses that can be observed when compared with other units. Additionally, they can take advantage of ”learning by doing” or “learning by imitating” or “learning by sharing”’ from the leading and cost-frontier units.

Concluding Note

This paper assumes the modest objective of contributing to the measurement of hospital efficiency through research with primary focus on cost efficiency in public hospitals. Public hospitals are classified under regional, provincial, and community hospitals. First, we estimate cost functions using three groups to draw inferences about the nature of increasing or decreasing cost operations. To our interpretation, provincial and community hospitals might have operated at less than full capacity, as a result, their unit costs tend to higher than the regional hospitals. The regional hospitals performed better in the sense that they were in general operating under full capacity. The stochastic cost frontier and data envelopment analysis are adopted in this study to measure efficiency scores. The cost efficiency scores for public hospitals in general were fairly high; yet, we identified those units that were performed far below the cost frontier. We realize the drawbacks and limitations of our analytical tools as we did not include “other outputs” and qualitative dimensions. We believe in the adaptive capacity of people and assume that hospital managers, like business managers, would like to improve their efficiency by trying to cut output slack or excess inputs once they realize that there were loopholes in their operations. In the nutshell, this paper wants to promote a sense of awareness on cost efficiency and suggests there is analytical model that could deepen our understanding on hospital finance.

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