



รายงานฉบับสมบูรณ์

โครงการวิจัยศึกษาต้นทุนบริการของโรงเรียนแพทย์ : เรื่อง ประสิทธิภาพทางเทคนิคและปัจจัยที่กำหนดประสิทธิภาพ ทางเทคนิคของโรงพยาบาลศูนย์ในประเทศไทย

ภายใต้ชุดโครงการพัฒนารูปแบบและอัตราการจ่าย
สถานพยาบาลในระบบหลักประกันสุขภาพถ้วนหน้า

จัดทำโดย

สำนักงานวิจัยเพื่อการพัฒนาหลักประกันสุขภาพไทย(สวปก.)

เครือข่ายสถาบันวิจัยระบบสาธารณสุข (สวรส.)

ได้รับการสนับสนุนจาก

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ประสิทธิภาพทางเทคนิคและปัจจัยที่กำหนดประสิทธิภาพทางเทคนิค

ของโรงพยาบาลศูนย์ในประเทศไทย

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บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาประสิทธิภาพทางเทคนิคและปัจจัยที่กำหนดประสิทธิภาพทางเทคนิคของโรงพยาบาลระดับมหาวิทยาลัย 7 แห่ง โรงพยาบาลศูนย์ 24 แห่ง และโรงพยาบาลทั่วไปของกระทรวงสาธารณสุขในประเทศไทยโดยใช้ข้อมูลของโรงพยาบาลทั้งหมด 74 แห่งในปีพ.ศ. 2552

ขั้นแรกการวัดประสิทธิภาพทางเทคนิคโดยการวิเคราะห์แบบ Data Envelopment Analysis ผลการวิเคราะห์พบว่า มี 53 โรงพยาบาลจาก 74 โรงพยาบาลที่มีค่าประสิทธิภาพทางเทคนิคที่แท้จริงสูงสุดคิดเป็น 71.62% ของโรงพยาบาลทั้งหมดที่ศึกษาเมื่อเรียงลำดับเปอร์เซ็นต์โรงพยาบาลที่มีค่าประสิทธิภาพทางเทคนิคที่แท้จริงจากมากไปน้อยพบว่าโรงพยาบาลระดับมหาวิทยาลัยมีค่าเปอร์เซ็นต์ประสิทธิภาพทางเทคนิคที่แท้จริงสูงสุดใน 3 กลุ่ม และสูงกว่าโรงพยาบาลศูนย์โรงพยาบาลทั่วไปตามลำดับ (85.7%, 83.3%, and 62.8%) ในขณะที่เปอร์เซ็นต์ประสิทธิภาพทางขนาดเรียงลำดับจากมากไปน้อยพบว่าโรงพยาบาลศูนย์โรงพยาบาลระดับมหาวิทยาลัย และโรงพยาบาลทั่วไปตามลำดับ (75.0%, 71.4%, and 44.2%)

ขั้นที่สองการศึกษาปัจจัยที่กำหนดประสิทธิภาพทางเทคนิคของโรงพยาบาลทั้ง 3 กลุ่มโดยใช้เทคนิคการวิเคราะห์สมการถดถอยแบบ ordinary least square estimation พบว่าอัตราส่วนจำนวนเตียงต่อแพทย์จำนวนแพทย์และอัตราส่วนพยาบาลต่อแพทย์ทั้ง 3 ปัจจัยมีผลต่อค่าประสิทธิภาพที่แท้จริงอย่างมีนัยสำคัญทางสถิติโดยปัจจัยที่มีผลในทางบวกต่อค่าประสิทธิภาพที่แท้จริงมากที่สุดคืออัตราส่วนจำนวนเตียงต่อแพทย์แต่ปัจจัยที่มีผลในทางลบต่อค่าประสิทธิภาพที่แท้จริงคือ อัตราส่วนพยาบาลต่อแพทย์ในขณะที่ปัจจัยมีผลต่อค่าประสิทธิภาพทางขนาดอย่างมีนัยสำคัญทางสถิติคือ จำนวนครั้งของผู้ป่วยในคุณค่าน้ำหนักสัมพัทธ์ของกลุ่มวินิจฉัยโรคร่วม

คำสำคัญ : ประสิทธิภาพทางเทคนิค; ปัจจัยที่กำหนดประสิทธิภาพทางเทคนิค; โรงพยาบาล; ประเทศไทย

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Hospital Production Function

Technical Efficiency and Its Determinants of University, Regional, and General Hospitals in Thailand

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Abstract

Input-orientated Data Envelopment Analysis was used to measure the technical efficiency of 7 university hospitals, 24 regional hospitals and 43 general hospitals in Thailand in year 2009. The results revealed there were 53 efficient hospitals (71.62%) from 74 total hospitals; in addition, the percentages of efficient hospitals in order of highest to least percentage were university, regional, and general hospital (85.7%, 83.3%, and 62.8%). While the percentages of scale efficiency ($SE = 1$) in order of highest to least percentage were regional, university, and general hospitals (75.0%, 71.4%, and 44.2%).

The next step was to identify the determinants of hospital efficiency with regression analysis using ordinary least squares (OLS). The results revealed three significant explanatory variables for TEVRSi scores such as bed-physician ratio, numbers of physicians, and nurses-physician ratio. The most positive influential determinant of TEVRS scores was bed-physician ratio; however, the negative influential determinant of TEVRS scores was nurse-physician ratio. While the significant explanatory variable for scale efficiency (SE_i) scores was the in-patient visits adjusted with median relative weight of DRG.

Key words: Technical efficiency; DEA; Determinant; Hospital

Introduction

1.1 Problem and its significance

University hospitals have a lot of specialists, sub-specialists and paramedics who service both health care and academic services. They provide numerous high technology medical equipments and buildings to serve all sophisticate activities. Public regional hospitals in Thailand also serve both health care and medical education services while most general hospitals serve only health care service. So unit cost of university hospitals should be higher than regional and general hospitals. This study is one in three parts of comparable study about unit cost of treatment between university hospitals and large public hospitals including regional and large general hospitals which operate equal or more than 200 beds in Thailand. The part one is the study of technical efficiency and its determinants of these hospitals to select the efficient hospitals for further studies. The part two is the cost function to determine the significant factors involving the total cost of treatment of hospitals. In addition, the part three is the unit cost calculation of targeting hospitals to decide the magnitude of the cost difference between university hospitals and large public hospitals.

1.2 Research questions

1. What are the levels of technical efficiency scores of 11 university hospitals, all public regional and general hospitals in Thailand?
2. What explanatory variables do affect the efficiency scores of 11 university hospitals, all public regional and general hospitals?

1.3 Research objectives

1. To identify technical efficiency of 11 university hospitals, all public regional and general hospitals (≥ 200 beds) in Thailand
2. To identify the factors affecting on the efficiency of 11 university hospitals, all public regional and general hospitals (determinants of hospital efficiency)

Literature Review

2.1 Theoretical Data Envelopment Analysis

Data Envelopment Analysis (DEA) is the most popular technique which uses the concept of linear programming to evaluate the efficiency score of many businesses by construction of a non-parametric piecewise surface, or frontier, over the data to calculate efficiencies relative to this surface. DEA can measure the hospital efficiency of multiple inputs and outputs model (Bhat, Verma, & Reuben, 2001).

1. Concept of hospital efficiency measurement:

- 1) Output-orientated measurement or maximal possible output from a given set of inputs assumes that the firm can change quantities of inputs, while quantities of outputs are fixed, to meet the most efficient point.
- 2) Input-orientated measurement or minimal possible input from a given set of output assumes that quantities of outputs can change to match with the most efficiency point while quantities of inputs are fixed.

2. Previous study on hospital efficiency measurement

Data envelopment analysis (DEA) was used to compare the frontiers of hospitals in the US in 1994 and 1995. The results revealed teaching hospitals were more efficient than non-teaching hospitals (Grosskopf, Margaritis, & Valdmanis, 2001, & 2004).

3. Previous study on hospital efficiency in Thailand

All 805 public hospitals in Thailand in year 2001 and 2006 were studied by usage of the data envelopment analysis. The large hospitals were more efficient than small ones and the average pure technical efficiency score of all public hospitals was 67.3% (Charunwatthana, 2007).

Research Methodology

Study design and samples

This was a descriptive study employing econometric techniques for its analysis. A cross section model with secondary data of all 74 hospitals from the year 2009 was used for input-orientated measurement, data envelopment analysis (DEA) and regression analysis using ordinary least squares

(OLS). The available data included 7 university hospitals, 24 regional hospitals and 43 general hospitals which had more than 200 beds so the whole hospitals were 74 hospitals.

Analysis technique:

This study consisted of two stages. The first stage was to measure the technical efficiency of interesting hospitals with the data envelopment analysis (DEA) using input-orientated measurement. There were 6 input mixes and 6 output mixes were used to evaluate the hospital efficiency. Six aggregated inputs included the numbers of beds, physicians, nurses, other personnel, capital cost, and material cost while six aggregated outputs included the numbers of out-patient visits, in-patient visits adjusted median relative weight of diagnostic related group (DRG), graduated medical student, graduated residents, publicized researches, and inverse hospital standardized mortality ratio. The results of DEA shows the technical efficiency under constant return to scale assumption (TECRS) scores, pure technical efficiency or technical efficiency under variable return to scale (TEVRS) scores, scale efficiency (SE) scores, and the patterns of scale inefficiencies which have two patterns of scale inefficiencies that are increasing return to scale (irs) and decreasing return to scale (drs).

The second stage was to identify the factors affecting on the efficiency of these hospitals (determinants of hospital efficiency) with regression analysis using ordinary least squares (OLS). Technical efficiency under variable return to scale assumption (TEVRS) and scale efficiency (SE) were dependent variables while seven explanatory variables as the hospital efficiency determinants were estimated the magnitude and direction of their relation. There were seven explanatory variables as following: bed-physician ratio (B/P), the numbers of physicians, the numbers of physicians in form of square, nurses-physician ratio (N/P), other personnel-physician ratio (OP/P), out-patient visits (O), and in-patient visits adjusted with median relative weight of diagnostic related group (IRW). There were two interesting relations as following:

1) Relation between 5 explanatory variables and TEVRS

$$TEVRS_i = c_0 + c_1 * B/P_i + c_2 * P_i + c_3 * P_i^2 + c_4 * N/P_i + c_5 * OP/P_i + e$$

2) Relation between 2 explanatory variables and SE

$$SE_i = c_0 + c_1 * \ln(O_i) + c_2 * \ln(IRW_i) + e$$

Data required

All secondary data in year 2009 was annual report from each hospitals and Health Insurance Group, Ministry of Public Health. The aggregated inputs, abbreviations, operational definitions and units were shown as table 1 while the aggregated outputs, abbreviations, operational definitions and units were presented as table 2. In addition, some explanatory variables of TEVRS scores, abbreviations and operational definitions were revealed as table 3.

Table 1 Aggregated inputs, abbreviations, operational definitions and units

Aggregated inputs	Abbr.	Operational definitions	Units
• Numbers of beds in hospital i in year 2009	B_i	Counts every beds for in-patient services in each hospital in year 2009	beds
• Numbers of physicians in hospital i in year 2009	P_i	Counts every physicians in each hospital in year 2009 (including interns, refunding physicians, and residents)	persons
• Numbers of physician staffs in hospital i in year 2009	PS_i	Counts every physician staffs in each hospital in year 2009 (not including interns, refunding physicians, and residents)	persons
• Numbers of nurses in hospital i in year 2009	N_i	Counts every registered and technical nurses in each hospital in year 2009	persons
• Numbers of other personnel in hospital i in year 2009	OP_i	Counts every other personnel in each hospital in year 2009 (not including physicians, and nurses)	persons
• Capital cost in hospital i in year 2009	CC_i	Includes cost of buildings, equipments, vehicles and depreciation in each hospital in year 2009	bahts
• Material cost in hospital i in year 2009	MC_i	Includes cost of supplies, operation and maintenance in each hospital in year 2009	bahts

Table 2 Aggregated outputs, abbreviations, operational definitions and units

Aggregated outputs	Abbr.	Operational definitions	Units
• Numbers of out-patient visits in hospital i in year 2009	O_i	Counts every beds for in-patient services in each hospital in year 2009	visits
• Numbers of in-patient visits in hospital i in year 2009	I_i	Counts every visit that was admitted in in-patient care units for whole year in each hospital in year 2009	visits
• Median adjusted relative weight of diagnostic related group (DRG) in hospital i in year 2009	RW_i	The proxy of related-patient types treated to the resources they consumed in each hospital in year 2009	-
• Numbers of graduated medical student in hospital i in year 2009	MS_i	Counts every graduated medical student in each hospital in year 2009	persons
• Numbers of graduated or trained residents in hospital i in year 2009	R_i	Counts every graduated or trained residents in each hospital in year 2009	persons
• Numbers of publicized researches (domestic, international) in hospital i in year 2009	PR_i	Counts every publicized researches (domestic, international) in each hospital in year 2009	researches
• Hospital standardized mortality ratio	$HSMR_i$	Hospital standardized mortality ratio (MR) = Observed deaths/ Expected deaths $\times$ 100	-

Table 3 Some explanatory variables of TEVRS scores, abbreviations and operational definitions

Explanatory variables of TEVRS scores	Abbr.	Operational definitions
●Bed-physician ratio of hospital i in year 2009	B/P_i	The proportion of numbers of beds and numbers of physicians (beds/physician) was a proxy for size determination of input combination between bed and physician.
●Numbers of physicians in hospital i in year 2009 in form of square	P_i^2	This form of square in equation used to find out the maximum/ minimum numbers of physicians to provide TEVRS scores.
●Nurses-physician ratio of hospital i in year 2009	N/P_i	The proportion of numbers of nurses and numbers of physicians (nurses/physician) was a proxy for size determination of input labor combination between nurse and physician.
●Other personnel-physician ratio of hospital i in year 2009	OP/P_i	The proportion of numbers of other personnel and numbers of physicians (other personnel/physician) was a proxy for size determination of input labor combination between other personnel and physician.

Results and Discussion

Descriptive analysis of the input mix and output mix of DEA

There were seventy four hospitals included in this study and the range of numbers of beds was 209-2,198 beds. Descriptive statistics of types of hospitals and numbers of beds were shown in table 4.

Table 4 Descriptive statistics of types of hospitals and numbers of beds

Types of Hospitals	Collected Data (hospitals)	Beds		
		Min.	Mean	Max.
• University hospitals	7	526	1,137.3	2,198
• Regional hospitals	24	452	710.4	1,072
• General hospitals (≥ 200 beds)	43	209	374.2	564
Total	74			

There were six multiple inputs as presented in table 5 and table 6 below such as the numbers of beds, physicians, nurses, other personnel, capital cost, and material cost. Only the numbers of beds were normal distribution so a probability distribution of beds used a mean as table 5. While the remained multiple inputs were skewed so a probability distribution of them used a median as table 6.

Table 5 Descriptive statistics of input mix of DEA (normal distribution)

Descriptive statistics	Input mix of DEA
	Bed
Numbers	74
Mean	555.42
Standard deviation	313.298
Minimum	209
Maximum	2,198
	0.052

Table 6 Descriptive statistics of input mix of DEA (skewed)

Descriptive statistics	Input mix of DEA				
	P	N	OP	Ccost	Mcost
Numbers	74	74	74	74	74
Median	67.00	434.50	1,032.50	39,214,622.00	3.93E8
Percentile 25 th	39.00	325.00	697.75	26,248,022.50	2.08E8
Percentile 75 th	121.75	631.00	1,605.50	68,983,182.00	6.81E8
Minimum	11	174	325	9,923,651	80,911,200
Maximum	1,447	4,874	6,726	541,899,733	5,264,786,910
One-sample K-S test - Asymp. sig. (2-tailed)	0.000	0.000	0.002	0.000	0.000

Results of DEA model: input-orientated measurement

The results of DEA showed the efficiency scores of each group of hospitals as table 7 below. There were 53 from 74 hospitals or 71.62% in this study that the technical efficiency under variable return to scale assumption was 1 (VRS = 1). The percentage of technical efficiency under variable return to scale assumption (VRS = 1) of university hospitals was the highest percent in three groups while the percentage of VRS of general hospitals was least. However, the percentage of scale efficiency (SE = 1) of regional hospitals was maximum in three groups, while the percentage of SE of general hospitals was still minimum.

Table 7 Descriptive statistics of efficiency scores of each group of hospitals

Efficiency scores	Regional hospitals		General hospitals (≥ 200 beds)		University hospitals	
	Frequency	%	Frequency	%	Frequency	%
VRS < 1	4	16.7	16	37.2	1	14.3
VRS = 1	20	83.3	27	62.8	6	85.7
Total	24	100.0	43	100.0	7	100.0
SE < 1	6	25.0	24	55.8	2	28.6
SE = 1	18	75.0	19	44.2	5	71.4
Total	24	100.0	43	100.0	7	100.0

Table 8 Results of DEA model: input-orientated measurement of 24 regional hospitals

No.	CRS	VRS	SE	RTS
1	0.952	0.966	0.985	irs
2	1	1	1	-
3	0.963	1	0.963	irs
4	0.867	0.88	0.986	irs
5	0.959	1	0.959	drs
6	1	1	1	-
7	1	1	1	-
8	1	1	1	-
9	1	1	1	-
10	1	1	1	-
11	1	1	1	-
12	1	1	1	-
13	1	1	1	-
14	1	1	1	-
15	1	1	1	-
16	1	1	1	-
17	1	1	1	-
18	1	1	1	-
19	1	1	1	-
20	1	1	1	-
21	1	1	1	-
22	1	1	1	-
23	0.785	0.787	0.998	irs
24	0.815	0.845	0.964	irs

There were 18 from 24 regional hospitals which their all three efficiency scores equaled 1 (TECRS, TEVRS, and SE scores) such as hospital number 2, 6-22 as table 8. There were 2 from 24 regional hospitals which their TEVRS scores equaled 1 but their SE scores were less than 1 such as hospital number 3, 5. Hospital number 3 had increasing return to scale pattern which meant if it increased its size of hospital, it would be efficient. However, hospital number 5 had decreasing return to scale pattern which meant if it decreased its size of hospital, it would be efficient. While there were 4 from 24 regional hospitals which all three efficiency scores were less than 1 such as hospital number 1, 4, 23, and 24. All hospitals had

increasing return to scale pattern (hospital number 4, 23) which meant if they increased their some input-mix and increased their size of hospitals, they would be efficient.

Table 9 Results of DEA model: input-orientated measurement of 43 general hospitals

No.	CRS	VRS	SE	RTS
25	0.857	0.898	0.954	irs
26	0.838	0.857	0.979	irs
27	0.907	1	0.907	irs
28	0.847	0.944	0.897	irs
29	0.688	0.714	0.963	irs
30	0.803	0.929	0.864	irs
31	0.894	1	0.894	irs
32	0.95	0.98	0.97	irs
33	0.665	0.716	0.93	irs
34	0.684	0.72	0.949	irs
35	1	1	1	-
36	1	1	1	-
37	0.985	0.994	0.991	drs
38	1	1	1	-
39	1	1	1	-
40	0.966	0.98	0.986	irs
41	1	1	1	-
42	1	1	1	-
43	1	1	1	-
44	0.881	0.902	0.977	irs
45	1	1	1	-
46	1	1	1	-
47	1	1	1	-
48	1	1	1	-
49	1	1	1	-
50	1	1	1	-
51	1	1	1	-
52	1	1	1	-

No.	CRS	VRS	SE	RTS
53	0.781	0.812	0.962	irs
54	1	1	1	-
55	1	1	1	-
56	1	1	1	-
57	0.989	1	0.989	irs
58	0.788	1	0.788	irs
59	1	1	1	-
60	0.766	0.839	0.912	irs
61	0.998	1	0.998	irs
62	0.967	0.989	0.978	irs
63	0.748	1	0.748	irs
64	0.916	1	0.916	irs
65	0.807	0.809	0.997	irs
66	0.873	0.884	0.987	irs
67	0.995	1	0.995	irs

There were 19 from 43 general hospitals which their all three efficiency scores equaled 1 (TECRS, TEVRS and SE scores) such as hospital number 35, 36, 38, 39, 41-43, 45-52, 54-56 and 59 as table 9. There were 8 from 43 general hospitals which their TEVRS scores equaled 1 but their SE scores were less than 1 such as hospital number 27, 31, 57, 58, 61, 63, 64, and 67. All of them had increasing return to scale pattern which meant if these hospitals increased their size of hospitals, they would be efficient.

Table 10 Results of DEA model: input-orientated measurement of 7 university hospitals

No.	CRS	VRS	SE	RTS
68	1	1	1	-
69	0.812	0.905	0.897	irs
70	1	1	1	-
71	0.934	1	0.934	irs
72	1	1	1	-
73	1	1	1	-
74	1	1	1	-

There were 5 from 7 university hospitals which their all three efficiency scores equaled 1 (TECRS, TEVRS and SE scores) such as hospital number 68, 70, 72-74 as table 10. There was 1 from 7 university hospitals which its TEVRS score equaled 1 but its SE score was less than 1 such as hospital number 71. This hospital had increasing return to scale pattern which meant if it increased its size of hospital, it would be efficient. While there was only 1 from 7 university hospitals which its all three efficiency scores were less than 1 such as hospital number 69. This hospital had increasing return to scale pattern which meant if this hospital increased its some input-mix and increased its size of hospital, it would be efficient.

Results of regression analysis using ordinary least squares

1) Relation between 5 explanatory variables and TEVRS

$$TEVRS_i = c_0 + c_1 * B/P_i + c_2 * P_i + c_3 * P_i^2 + c_4 * N/P_i + c_5 * OP/P_i + e$$

Table 11 OLS estimation for TEVRS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.920057	0.040640	22.63912	0.0000
B/P	0.029233	0.007068	4.136113	0.0001
P	0.000346	0.000153	2.259977	0.0270
P ²	-1.81E-07	1.02E-07	-1.772571	0.0808
N/P	-0.023409	0.005806	-4.031714	0.0001
OP/P	-0.002498	0.001663	-1.502539	0.1376

R-squared = 0.276616 F-statistic = 5.200517

There were three significant explanatory variables for TEVRS_i scores such as bed-physician ratio (B/P), numbers of physicians (P), and nurses-physician ratio (N/P) as table 11. It can explain that if bed-physician ratio increased one unit, TEVRS_i scores tended to increase 0.0292 units, giving other things were constant. If physician increased one person, TEVRS_i scores tended to increase 0.0003 units, giving other things were constant. If nurse-physician ratio increased one unit, TEVRS_i scores tended to decrease 0.0234 units, giving other things were constant. The most positive influential determinant of TEVRS scores was bed-physician ratio; however, the most negative influential determinant of TEVRS scores was nurse-physician ratio.

2) Relation between 2 explanatory variables and SE

$$SE_i = c_0 + c_1 * \ln(O_i) + c_2 * \ln(IRW_i) + e$$

Table 12 OLS estimation for SE

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.684370	0.139442	4.907933	0.0000
Ln(O)	0.004906	0.016750	0.292883	0.7705
Ln(IRW)	0.022456	0.011081	2.026587	0.0465

R-squared = 0.184916

F-statistic = 8.053814

It can explain that if the in-patient visits adjusted with median relative weight of DRG (IRW) increased one percent, SEi scores tended to increase 0.0224 units, giving other things were constant as table 12.

Conclusion and Recommendation

Conclusion

The results of measurement of the technical efficiency in three groups of hospitals in this study showed there were 53 from 74 hospitals or 71.62% in this study that the technical efficiency under variable return to scale assumption was 1 (VRS = 1); in addition, the percentages of technical efficiency under variable return to scale assumption (VRS = 1) in order of highest to least percentage were university, regional, and general hospital (85.7%, 83.3%, and 62.8%). So the further studies should select the data from 53 efficient hospitals to study the cost function to determine the significant factors involving the total cost of treatment and the unit cost calculation to decide the magnitude of the cost difference between university hospitals and large public hospitals. While the percentages of scale efficiency (SE = 1) in order of highest to least percentage were regional, university, and general hospitals (75.0%, 71.4%, and 44.2%).

The results of identification of factors affecting on the efficiency of these hospitals (determinants of hospital efficiency) showed three significant explanatory variables for TEVRSi scores such as bed-physician ratio (B/P), numbers of physicians (P), and nurses-physician ratio (N/P). The determinants of hospital efficiency in order of highest to least scores were bed-physician ratio (B/P), nurses-physician ratio (N/P), and numbers of physicians (P). The most positive influential determinant of TEVRS scores was bed-physician

ratio; however, the most negative influential determinant of TEVRS scores was nurse-physician ratio. While the significant explanatory variable for scale efficiency (SEi) scores was the in-patient visits adjusted with median relative weight of DRG (IRW).

Limitation of the study

There are some limitations in this study as following:

- 1) A small numbers of the observations. There were only 7 university hospitals in this study so it was difficult to conclude on behalf of the university hospital.
- 2) Time limitation. There were three months for data collection in this study.

Recommendations

In all three groups of hospital, there are efficient hospitals more than inefficient hospitals so the efficient hospitals can be the target hospitals for evaluation cost function in next step.

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