TECHNICAL EFFICIENCY IN PUBLIC DISTRIC HOSPITALS IN VIETNAM

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Abstract

The objectives of this study aimed to measure the Technical Efficiency (TE) of public district hospitals (PDHs) and to determine factors affecting the hospitals' efficiency. Input-Oriented Data Envelopment Analysis (DEA) model was applied to evaluate the efficiency scores of 52 PDHs in 6 provinces of Vietnam in 2014. Then, Tobit regression model was employed to explore determinants.

Results of the DEA indicated that there were considerable variations of efficiency scores in terms of return to scale assumptions. The mean pure technical efficiency (VRSTE) and overall technical efficiency (CRSTE) were 81.9% and 77.2%, respectively. While, mean scale efficiency (SE) was 94.7%. In this study, 35 (67.3%) of DPHs were running inefficiently. In addition, the pattern of scale inefficiency showed that a majority (39) of the PDHs were increasing return to scale efficiency.

Results of the Tobit regression model revealed that non-medical staff-physician ratio (NMSPR), inpatient admission-physician ratio (IPAPR) were significant correlated to VRSTE at 95% Confidence Interval. While, bed occupancy rate (BOR), outpatient visit-physician ratio (OPVPR) and revenue from user fee-total revenue ratio (RUFTRR) were found insignificant. However, their signs were similar to what was expected. Exclusion or omitted variables might be possible reasons for insignificancy in this regression model.

Keywords: Technical Efficiency, Data Envelopment Analysis (DEA), Tobit Regression, Public District Hospitals, Vietnam.

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Introduction

Before the reform process, the Vietnamese hospitals were fully funded by the government. However, with the introduction of user fees and health insurance (HI) programmes, the financial structure of hospitals has been diversified. On the one hand, hospitals now have financial support from the state budget, the other financial sources of user charges and HI reimbursement. On the other hand, the government subsidies to hospitals have progressively declined, causing the increasing importance of the alternative financial sources of user fees and health insurance. As a result, Vietnamese hospitals are facing financial burdens, and to overcome these pressures they are expected to improve their performance.

Among a health network of 910 public hospitals (PHs) in the whole country, district hospitals accounted for 48.4% (440 hospitals) (General Statistics Office, 2012). The majority of Viet Nam's large rural population seeks treatment from public district hospitals (PDHs) (London, 2013). It showed an important role of PDHs in the health care system. Some studies on technical efficiency have been implemented in Vietnam for 15 years, focus on central and provincial hospitals (Pham, 2011; Pinar, 2008) or particular provinces (e.g. Hanoi, Ho Chi Minh City) (Nguyen, 2004). Hence, there is an essential requirement for empirical analysis measuring hospital efficiency in a national-wide scale at the district level and exploring the determinant factors of hospitals' efficiency.

Results from the study aim to provide a database for hospital managers understand shortcomings of their hospitals. After that they could decide how to allocate all resources efficiently either by increasing their outputs or reducing initialization of their inputs. In addition, findings from determinant factors are valuable not only to hospital managers but also to researchers and health policy makers to inform resources allocation.

This paper is organized as follows. The section 2 reviews existing literatures, section 3 describes methodology and data, section 4 mentions the results and discussion, and conclusion and suggestion is presented in section 5.

Literature Review

There have been a number of researches on efficiency in the health care sector.

In **Turkey**, two studies were conducted to examine the TE of acute general hospitals (Korkut Ersoy, 1997) and public hospitals (PHs) (Sahin & Ozcan, 2000). They found that over 90% of Turkish acute general hospitals were inefficient. The inefficient hospitals used far more inputs and produced fewer outputs than their efficient counterparts. According to (Sahin & Ozcan, 2000), more than half of PHs (55%) were inefficient. The inefficient hospitals could save over 600 million dollars over five years if they reduced the number of unused beds, specialist, other health labor, and the overspent funds.

In **Kenya**, Kirigia *et al*., (2002) used two basic DEA models: CRS and VRS, to examine the technical efficiency of 54 PDHs in the financial year 1998/1999. The results showed that 74% of the total PHs was TE and 70.5% achieved scale efficiency.

Among 21 public hospitals and 17 health centers in **Ghana**, 47% of hospitals and 70% of health centers were technically inefficient and their scale inefficient accounted for 59% and 47%, respectively. The findings indicated that the hospitals could improve efficiently by reducing their current number of medical, technical, subordinate staffs and beds, or increasing numbers of maternal and child care visits, deliveries and discharges. Health centers could become more efficient by increasing maternal and child health visits, deliveries, fully-immunized children, and outpatient curative visits (Osei *et al*., 2005).

In **Namibia**, Zere *et al*., (2006) investigated the TE of Namibian 26 district hospitals during the period 1997-2001. The authors reported that more than half of the district hospitals were inefficient due to both pure technical inefficiency and scale inefficiency. The prevalent inefficiency was due to the increasing returns to scale. To become efficient, hospitals should reduce their excess inputs used by 26-37 per cent or by merging some small hospitals after expanding the primary care units.

In **Vietnam,** Nguyen et al., (2004) analyzed the efficiency performance among 17 hospitals and 27 medical centers in different provinces in 2002. Hospitals presented more efficiently than medical centers by the mean scale efficiency scores were 77.4% and

58.7%, respectively. There was no influence by locations in Hanoi or Ho Chi Minh City on the efficiency. But the impact of net capital-labor ratio conveyed that these facilities appear to operate in labor-intensive ways. The another studies in Vietnam by (Pinar, 2008) and (Pham, 2011) showed the evidence of improvement productivity of Vietnamese hospitals during the period from 1998-2006, a progress of 1.4% per year. The average overall and pure technical efficiencies were 66.4% and 72%, respectively. These studies also found out the explanatory factors from regulatory change (user fee and autonomy) and hospital-specific characteristics (location) affected on 101 hospitals.

In fact, there are no precious studies on technical efficiency and determinant factors in PDHs in Vietnam. This study, therefore, will focus to discovery this topic.

Methodology and Data

1. Methodology

Data Envelopment Analysis (DEA) is a liner programming technique that can explicitly consider the multiple outputs and inputs of a hospital, which could gain an overall evaluation of hospital TE (H. David Sherman, 1984). This study chooses DEA to measure the Vietnamese PDHs' TE for the two main reasons. First, in some previous studies implemented in Thailand (Vivian et al., 2004), in Ghana (Osei et al., 2005), in Namibia (Zere et al., 2006), and in Benin (Joses et al., 2010), DEA is used popularly with middle and low income countries like Vietnam. These studies prove that DEA doesn't require relating inputs to outputs; they can have very different units. Second, DEA is less "data-intensive" than other econometric methods because it does not require a large sample size and data on prices of inputs and outputs. Therefore, it is suitable when there is insufficient health sector information.

The study is implemented in two stages. The first stage is to measure the technical and scale efficiency of PDHs in Vietnam with DEA using input-oriented measurement. The result of this first step will show the technical efficiency scores of each hospital**.** In the second stage, because of efficient DMUs having a DEA efficiency score of 1 and a relatively large number of fully efficient DMU being estimated, the distribution of efficiency is

truncated above from unity. Therefore, Tobit regression model is used to explore more detail about determinants of technical efficiency (Pinar, 2008). The technical efficiency scores are used as a dependent variable. Explanatory variables have identified by assuming critical way to describe the efficiency of these hospitals.

2. Data & Variables

The study uses the secondary data for the target population of 52 PDHs out of 78 PDHs and health care centers due to the elimination of some inaccurate and missing values. Data was collected via questionnaire interviews by Health Strategy and Policy Institute in the Vietnam District and Commune Health Facility survey 2015 under supervision of World Bank**.** The time period was from January to December 2014**.**

Table 1: Description of Data Source

Region	Province	Poverty Rate	Per Capital Income	Number of DMUs
Red River Delta	Hanoi	1.0	2994.9	20
Northern Highlands	Dien Bien	35.2	819.4	1
North and South Central Coast	Binh Dinh	9.9	1719.0	2
Central Highlands	Dak Lak	12.3	1639.2	10
Southeast	Dong Nai	0.7	2576.7	9
Mekong Delta	Dong Thap	7.5	1665.5	10
Vietnam Nationality		7.8	1999.8	52

Source: (1) MOLISA Poverty Rate; (2) Vietnam Household Living Standard Survey 2012

According to other studies of (Chen, 2006; Ferrari, 2006; J. Harris, 2000), three inputs are selected as a proxy of different factors: recurrent and capital resource. The number of clinical departments is employed as an overall indicator of the capital input. The number of medical staffs and non-medical staffs are considered as recurrent resource. Following the study of (Pham, 2011), three aggregated output variables were used including: The number of outpatient visits counts for both the scheduled and

unscheduled visits in outpatient department within a year. The number of inpatient days is given as another output which showed different features and consume more resources than outpatient visit. And, the number of surgical operations is employed to show the different mixtures of inputs. These outputs are represented for outpatient and inpatient care in different combinations.

Table 2: Descriptive Statistics for Variables

	Mean	Standard Deviation	Minimum value	Maximum value
Inputs				
Departments	9.56	4.49	4	27
Medical Staffs	204.48	116.65	66	685
Non-medical staffs	41.98	27.93	10	123
Outputs				
Outpatient visits	20,378.7 7	59,874.12	21	407,324
Inpatient days	89,303.4 2	56,879.29	22476	345,269
Surgical operation	1,368.37	1,818.71	0	8,728

The selection of explanatory variables are likely to associate with organizational and policy environmental factors. Bed Occupancy Rate (BOR) is measured as a proxy of utilization of hospital resources. Higher BOR shows that most of the beds in the hospital are being utilized by the patients throughout the year. It should be positive because it creates more outcomes by using resources (Chang et al., 1998). The non-medical staff-physician ratio (NMSPR) expresses the combination of inputs between other personnel and physician. The expected sign is negative because of the redundancy's other staffs

(State Audit of Vietnam, 2016). The outpatient visit-physician ratio (OPVPR) and the inpatient admission-physician ratio (IPAPR) are proxies for determining the effect of outpatient and inpatient service provided by a physician. The more a doctor examines OPD and IPD patients, the better is hospital efficiency. It is positive related with efficiency (Ozcan et al., 1994). Finally, the revenue from user fees-total revenue ratio (RUFTRR) is a proxy to show the impact of the user fee and autonomy policy on hospitals' efficiency. The more revenue from user fees is, the more autonomy for hospitals is. It is expected positively. All expected signs correlated VRSTE scores are summarized in Table 3, as below:

Table 3: The expected signs of determinant variables of VRSTE scores

Dependent variables	**Determinant variables of VRSTE scores**				
	BOR	NMSPR	OPVPR	IPAPR	RUFTRR
VRSTE scores	+	-	+	+	+

Result and Discussion

1. Results from DEA

The efficiency scores of 52 PDHs in Vietnam were explored using DEAP Version 2.1 software. Table 4 shows the descriptive statistic of technical and scale efficiency scores for the given research study.

Table 4: Descriptive Statistic of Technical and Scale Efficiency

	CRSTE	**VRSTE**	**SE**
Mean	0.772	0.819	0.947
Median	0.778	0.834	0.973
Maximum	1.000	1.000	1.000
Minimum	0.441	0.486	0.441
Observations	52	52	52

The results reveal that the average overall technical efficiency (CRSTE) and the pure technical efficiency (VRSTE) are 77.2% and 81.9%, respectively. However, it can be seen that there is a wide gap between inefficient and efficient hospitals in CRSTE and VRSTE. The gap is from 44.1% and 48.6%, in turn, comparing to 100%. Table 5 below will explain about this gap. Inefficiency levels ranging from 18.1-22.8% are detected. This implies that if inefficient hospitals were to operate as efficient as their peers on the best-practice frontier, the health system could have gained efficiency amounting to 18.1-22.8% of the total resources used in running hospitals.

The mean scale efficiency is quite high, accounted for 94.7% in 2014. This suggests that the sample hospitals move closer to the most productive scale. And there is a little room for the inefficient hospitals to improve their performance by operating at the optimal scale.

Table 5: Average technical efficiency scores by regions

	Red River Delta	Northern Highlands	North and South Central Coast	Central Highlands	South East	Mekong Delta
CRSTE	0.756	0.441	0.709	0.857	0.756	0.782
VRSTE	0.776	1.000	0.725	0.939	0.801	0.805
SC	0.975	0.441	0.979	0.915	0.947	0.970

Table 5 shows that the mean CRSTE scores of hospitals located in Central Highland and Mekong Delta regions are 85.7% and 78.2%, correspondingly; and the mean VRSTE scores are 93.9% and 80.5%. These scores are slightly higher than those of hospitals located in Red River Delta, South East and North and South Central Coast regions. All five regions show their TE much higher than Northern Highlands region's one. These results suggest that hospitals located in the different regions may have performed differently.

Table 6: Frequency and distribution of Technical and Scale Efficiency Scores

	CRSTE		VRSTE		SE	
Efficiency Range	Freq.	%	Freq.	%	Freq.	%
100%	8	15.4%	17	32.7%	9	17.3%
80-99%	15	28.8%	11	21.2%	40	76.9%
60-79%	18	34.6%	14	26.9%	2	3.8%
< 60%	11	21.2%	10	19.2%	1	2.0%
Total	52	100%	52	100%	52	100%

According to Table 6, a majority of PDHs run in their overall technical and scale inefficiency, accounted for 44 (84.6%) and 43 (82.7%), respectively. There are about 20% PDHs in case of very low efficiency (<60%).

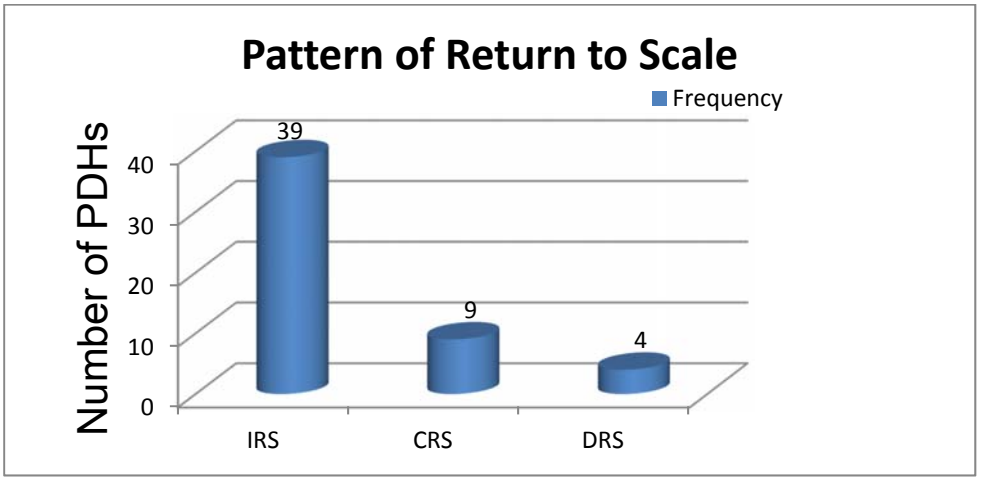

Figure 1: Return to scale pattern of public district hospitals

As can be seen from the figure 1, there are 9 PDHs indicated constant return to scale (CRS). It equals merely 17.3% had most the productive size for the given input-output combination. The increasing return to scale (IRS) accounted for 39 (75%) PDHs which were expected for their expansion. Only 4 (7.7%) PDHs should have the scale down in order to be transformed as the most productive scale size.

As compared with the findings of previous studies on the performance of PDHs, the efficiency findings of this study are similar to the hospital efficiency in those studies. First, according to the study on hospital efficiency during three years: 2011, 2012 and 2013 in Vietnam (Hideaki, 2018), the mean VRSTE scores of PDHs was 0.793 comparing to 0.819 in 2014 in this study. It shows that Vietnamese PDHs have experienced an upward trend in TE. This indicates that levels of hospital efficiency scores are getting better over time. Second, when compared to another study in Namibia (Zere et al., 2006), the DEA models estimated for the period 1997/98 to 2000/2001 indicate average CRSTE scores ranging from 62.7% to 74.3%. Inefficiency levels ranging from 26–37% are witnessed. It pretty similar with the inefficiency levels of 22.8% in PDHs of Vietnam in 2014. However, while the overall technical inefficiency in Namibian PDHs was equally attributed to pure technical inefficiency and scale inefficiency, the overall technical inefficiency in Vietnamese PDHs was mainly attributed to pure technical inefficiency.

a. Tobit Regression Analysis Results ,

The results, after running the Tobit regression analysis using eViews 9 software, revealed in Table 7, using VRSTE scores as dependent variables at Confidence Interval 95%.

Table 7: Tobit Regression results, dependent variable: VRSTE input-oriented model

Variable	Coefficient	Std. Error	z-Statistic	Prob.
BOR	-0.000562	0.001089	-0.516490	0.6055
NMSPR	-0.338876	0.076221	-4.445947	0.0000
OPVPR	8.42E-06	2.14E-05	0.393520	0.6939
IPAPR	0.001537	0.000275	5.595959	0.0000
RUFTRR	0.120350	0.347099	0.346731	0.7288
C	0.701813	0.114035	6.154348	0.0000

Table 7 presents that non-medical staff-physician ratio (NMSPR) and inpatient admission-physician ratio (IPAPR) are significant, whereas bed occupancy rate (BOR),

outpatient visit-physician ratio (OPVPR) and revenue from user fees-total revenue ratio (RUFTRR) are insignificant. The NMSPR variable reversely correlated to VRSTE scores because its coefficient had a negative sign. This is understandable in the current Vietnamese context with a largely redundant number of government officers in the operating apparatus. The IPAPR variable is positively related with efficiency. In other words, the more a doctor treats IPD patients, the better is hospital efficiency. Besides, most of determinant variables have the same signs as expected, exception BOR. This is explained by the current overload in Vietnamese hospitals. Overall; it can explain that if IPAPR raised a unit, VRSTE scores tended to go up 0.001537 units, giving other things were constant. If NMSPR decreased one unit, VRSTE scores tended to increase 0.338876 units, giving other things were constant. And, the most influent explanatory variable of VRSTE scores was NMSPR ratio because its coefficient had the highest value among significant variables.

Conclusion & Suggestion

This study analyzed the technical efficiency of PDHs in six regions of Vietnam and provided an overview of their efficiency performance in 2014. Policy makers in health care sector and hospital managers can improve the inefficient PDHs in proper directions by analyzing inputs and outputs of each inefficient PDH.

The results from regression analysis displayed in wide range areas regarding human resource distribution and health care service. The excess medical and non-medical labor forces should be considered. The productivity of physicians in inpatient department could bring to concerns of hospital managers, to decide how to allocate all resources efficiently in order to have a technically efficient hospital.

In cases of inefficient PDHs, the pattern of scale inefficiency should be analyzed for the policy makers and hospital managers. A guideline should be developed to improve the scale efficiency in a proper direction. Such as: the IRS pattern hospitals should be improved through up-sizing, while the DRS pattern counterparts should be

upgraded through down-sizing. In addition, details of each inefficient hospital should be explored and analyzed with individual information from DEA and regression analysis.

If the Ministry of Health sets the national policy for standardization in each level of public hospital, the hospital efficiency monitoring and benchmarking should be routinely measured and reported annually or per 2 years. This is a sensitive issue for inefficient hospitals. So, the report should not identify inefficient hospitals but the results should be in other words or in the classified groups such as: good, moderate, fair, poor depending on levels of efficiency score. These criteria are set for benchmarking, standardization and the improvement of organization, not for blame.

The selection of observations for an evaluation of hospital efficiency should be careful. Because, it is relatively compare together in chosen multiple inputs or outputs. So the comparable hospitals should have the same context for fairness of evaluation.

The results of DEA and regression analysis are used to evaluate the efficiency of organizations so they directly impact to observers both positive and negative results. So, the correct data for calculation are very important.

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