Effects of Changes in Public Policy on Efficiency and Productivity of General Hospitals in Vietnam

by

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Abstract: The health sector reform programme which began in Vietnam in 1989 in order to improve the efficiency of the health system has altered the way in which Vietnamese hospitals operate. The programme put the spotlight on input savings. This study aims to examine the relative efficiency of hospitals during the health reform process and assess – by looking at the relative efficiency of hospitals – the effects of the regulatory changes. The study employs the DEA two-stage approach referring to data from 101 general public hospitals over the period 1998-2006. The study revealed that there was evidence of improvement in the productivity of Vietnamese hospitals over the period 1998-2006, with a progress in total factor productivity of 1.4% per year. Furthermore, the differences in hospital efficiency can be attributed to both the regulatory changes and hospital-specific characteristics. The user fees and autonomy measures were found to increase technical efficiency. Provincial hospitals were revealed to be more technically efficient than their central counterparts and hospitals located in the North East, South East and Mekong River Delta regions performed better than hospitals from other regions.

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1. Introduction

Efficiency in the provision of health care is a major issue facing the health systems across different countries. The demand for health care is large and increasing over time due to a growing and an ageing population. However, resources for health care provision are limited and governments have limited resources to finance the rising demand for increased and better quality services. Accordingly, a wide range of health sector reforms has been undertaken across countries since the 1980s in order to create a competitive market environment and improve the efficiency of the health systems (World Bank, 1987; Ancarani *et al.,* 2008). Theoretically, the health sector reform – based on regulation theories such as public interest theory (Peltzman, 1976; Kahn, 1988; Spulber, 1989), regulatory capture theory (Feroz, 1987; Reagan, 1987), and economic theory of regulation (Stigler, 1968, 1971; Posner, 1974; Meier, 1985) – can affect the survival and even change the goals of hospitals, and then hospitals tend to respond to these changes through their improvement of productive efficiency. Therefore, the improvement of efficiency of the health systems, including the hospital sector, is the central concern of health decision makers, facility managers, and the public; and the topic of the impacts of reform process, in terms of regulatory changes, on hospital efficiency is frequently discussed across different health systems.

However, the results of these reforms are different depending on the specific contexts. The amount of variation in countries' approaches to reform – focusing on changes to the finance of health services, changes in the incentive structure, or changes in the organisational structure of the health care system – indicates that there is no consensus on an optimal reform programme, nor on how much account a programme should take of country-specific factors. Even when reform frameworks appear to go in the right direction, some issues in the implementation of reform remain (Berman, 1995). The results from previous studies on the impacts of reform on hospital efficiency have been mixed. In some cases it has been argued that reform programmes have improved hospital efficiency (Maniadakis *et al.,* 1999; Chu *et al.,* 2004) whereas other programmes – such as those of the US, the UK, and Finland – have been argued to have had virtually no impact on efficiency (Bradford and Craycraft, 1996; Ferrari, 2006; Linna, 1998). In some other cases, health reform programmes have even been argued to have led to a reduction in measured efficiency (Steinmann and Zweifel, 2003).

Among the regulatory changes of the health sector reform process, the changes to the finance of hospitals are considered an important influence on hospital efficiency, and are of interest to many researchers, to the public and to regulators. The regulatory changes in hospital financing can include changes in the payment method of hospitals from the retrospective to prospective base or from the global budget to activity-based mechanism, the introduction of capitation contracts, and the restructuring of the financing system with the implementation of a health insurance programme. These changes restructure hospital finance, thereby altering hospital operations in terms of medical input and service provision. Chang (1998) and Rosko (1999) indicate that changes in the financing mechanism of public hospitals can increase financial pressures and highlight hospital performance improvement. Many empirical studies show that regulatory changes in the finance of hospitals have no or few positive impacts on hospital efficiency. For example, Chern and Wan (2000) and Borden (1988) found that the prospective payment mechanism has no positive effect on hospital efficiency. However, some positive relationships between changes in financial policy and hospital efficiency were found in the studies on capitation contracts by Chu *et al.,* (2004), on activity-based financing programmes by Biørn *et al.,* (2003), and the national health insurance programme by Chang (1998).

The Vietnamese hospital sector has undergone considerable structural and institutional changes as a result of the recent health sector reform process. These structural and institutional changes have resulted from the transformation of the economy from a centrally-planned one to a market-based one, from the lack of health service provision, and under-funding. The combination of these things led to deficiencies and inefficiencies in the health system. Therefore, since the 1990s a series of structural and institutional reforms has been introduced, whose main objectives were to meet the increasing demand for health services, and to boost the efficiency and productivity of the health system in general – and hospitals in particular – by restructuring the financing mechanism, reducing government intervention, and introducing elements of market forces into the health care system. These changes in both structural and institutional conditions altered the way in which Vietnamese hospitals operated and have put the spotlight on resource savings. Along with the approval of private hospitals, the most obvious changes in the past two decades in the hospital sector are the changes in financing and in managerial structure, through the introduction of user fees and health insurance programmes, and the granting of managerial autonomy to public hospitals.

Before the reform process, the Vietnamese hospitals were entirely funded by the government. However, with the introduction of user fees and health insurance programmes, the financial structure of hospitals has been diversified. This has had mixed effects on hospitals. On the one hand, hospitals now have, along with financial support from the state budget, the other financial sources of user charges and health insurance reimbursement. On the other hand, the government subsidies to hospitals have gradually decreased, resulting in the growing importance of the alternative financial sources of user fees and health insurance. As a result, Vietnamese hospitals are facing financial pressures, and to overcome these pressures they are expected to improve their performance. In other words, it is hoped that the nature of user fees and health insurance, and the systems that they create, will encourage improvements in performance of hospitals. The change in managerial structure, for example the greater right to use operational expenditure and revenues or the new flexibility in employing the necessary personnel, is also hoped to encourage the further improvement of hospital performance.

Inspired by an empirical literature which has investigated the effect of the health reform process on hospital efficiency, the Vietnamese hospital sector during this period of structural change provides an interesting case study with which to investigate efficiency and assess the determinants of hospital efficiency. The study, therefore, aims to analyse the relative efficiency of hospitals during the health reform process, particularly with regard to the change in the financial and managerial structures in the hospital sector, and give an answer for the question: have the regulatory changes in their financial and managerial structure improved the efficiency and productivity of Vietnamese hospitals over the period 1998-2006?

This study is organised as follows. Section 2 gives a brief overview of the health care system in Vietnam. Section 3 reviews the existing literature on hospital performance. The model of the relations between production efficiency and regulatory changes in financial and managerial structures is outlined in section 4. Section 5 provides the data envelopment analysis methodology, the data set and the results of the hospital efficiency analysis. Section 6 presents the result of the Tobit regression analysis concerning the effects of regulatory changes on hospital efficiency and Section 7 discusses the conclusions and implications of this study.

2. The Vietnamese Health Care System during the Reform Period

The Vietnamese health system, based on the national administrative structure, is vertically divided into four tiers: central, provincial, district, and communal. These tiers are closely related to each other, with the higher tiers assisting the lower ones in terms of providing professional medical operations and techniques. At the central tier, the Ministry of Health governs the health system and is responsible for managing and monitoring the performance of the various sections of the health system. At the second tier, there are 64 Provincial Health Services, which are responsible for the strategic management of health care services in their provinces as well as for supervising the performance of public hospitals, preventive health centres, and medical and pharmaceutical training units. There are 659 District Health Bureaus at the level below the Provincial Health Services. These District Health Bureaus oversee the operations of district hospitals, district preventive care centres and communal health centres in their provision of basic health care to the district inhabitants. Finally, communal health centres are the first point of contact for communal residents at the communal tier and are supervised by District Health Bureaus.

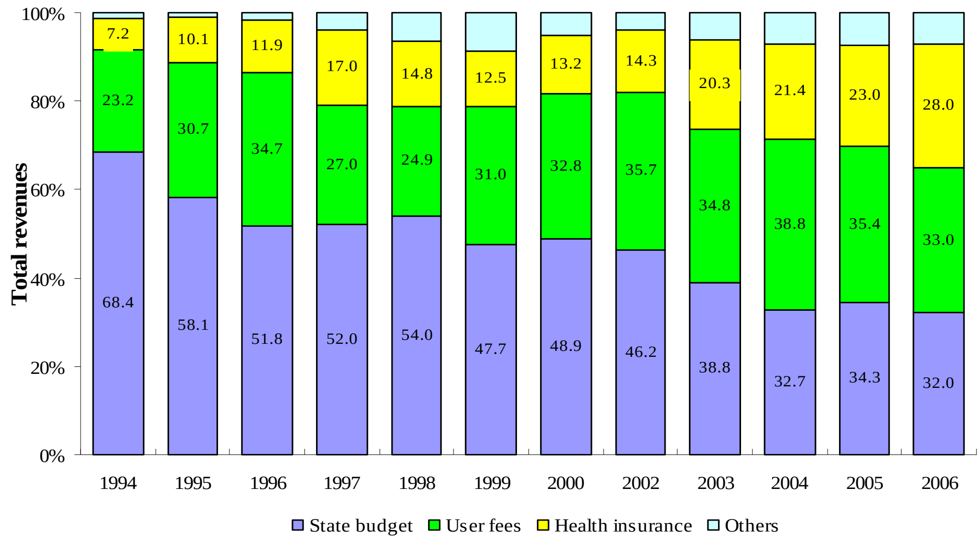
Health care services are carried out by both private and public health providers in the Vietnamese health care system. The public health providers include health care centres and public hospitals. The private health providers consist of private clinics and private hospitals. Among these public and private health care providers, hospitals play important roles in the health system, especially in the improvement of the overall health of the public. There are 1,053 hospitals with 143,999 beds active in the health care system, including 1,002 public hospitals and 51 private hospitals. Of these public hospitals, there are 79 hospitals managed by other ministries such as the Ministry of Industry, Ministry of Transportation, Ministry of Post and Telecommunication, and Ministry of Agriculture. The remainder belongs to the Ministry of Health, which include 30 central, 304 provincial and 589 district hospitals distributed on the basis of administrative territories and demand for services across 61 provinces in 8 regions. The private hospitals, including 36 general hospitals and 15 specialty hospitals, aim to deliver health services to middle- and high-income people.

Vietnam has been spending a significant proportion of its wealth on health, approximately 5.1% of gross domestic product (GDP) per year. Currently, the health care finance comes from two sources, public and private ones. The former source consists of revenue from direct and indirect taxes and the latter source consists of direct payments from patients and health insurance schemes. Of these two sources, health care expenditure has been increasingly financed by private sources. During the period 1990-2005, the government spent, on average, around 1.5% of its GDP on health, accounting for only 5% to 7% of the annual government spending, and the role of the government in financing the health sector has gradually decreased, from 32.7% of total health expenditure in 1998 to 22.6% in 2005. The total private spending on health, however, has increased 2.7 times in nominal terms, from US$ 0.76 billion to 2.06 billion. This means that the private percentage of health expenditure has risen from 67.3 % in 1998 to 77.4% in 2005.

Most of the public funds and a large part of the private funds are spent on public health facilities, in which public hospitals consume approximately 40% of the total health expenditure. The structure of financial sources for public hospitals, as presented in Figure 1, therefore, can partly illustrate both the public and private expenditure on health. It can be observed in the figure that public hospitals have four financial sources: the state budget, reimbursement from health insurance, direct patient payments (user fees), and domestic or foreign aid. The figure also shows that the government budget is still an important financial source for public hospitals during 1994-2006. However, the proportion provided by the government budget in terms of the total financial sources of public hospitals has considerably declined from 68.4% in 1994 to 32% in 2006. The most important financial source – although only by a small margin – is now direct patient payments. The percentage of user fees in financing hospitals has increased over time, from 23.2% of total revenues of public hospitals in 1994 to 33% in 2006. The percentage of revenue coming from health insurance reimbursement has also gradually increased from 7.2% to 28%.

To summarise, the public sector still plays a crucial role in the provision of health services. However, the private sector, through direct payment or health insurance schemes, now contributes more financially to the health system than the public one. In terms of the volume of resources consumed, though, the performance of public facilities, particularly public hospitals, is still more important than private health providers in determining the performance of the health care system.

Figure 1: Financial Sources in Hospitals 1994-2006



Source: Vietnam Ministry of Health

3. Hospital Efficiency: Literature Review

There has been an extensive amount of literature examining the performance of the health care sector. Studies, which focus on efficiency and productivity using frontier techniques, have been undertaken in all areas of the health sector: from primary care to secondary care, tertiary care to nursing home care, as well as from the overall health system to health care providers, administration bodies, and subgroups in health care providers such as departments and professionals. The review of efficiency studies in the health care sector has been undertaken in the studies of Hollingsworth *et al.* (1999), Hollingsworth (2003), and Worthington (2004). Of the empirical studies on efficiency in the health care sector, many have investigated the performance of hospitals in relation to the health reform process, particularly in financing reform. These empirical studies analysed the performance of hospitals under regulatory changes in hospital finance of the US, Norway, Spain, and Taiwan among others.

In the US, the effects of the prospective payment mechanism, based on diagnosis-related groups, on hospital efficiency, were first assessed in the Borden (1988) study. The new payment mechanism was implemented in turn by 52 New Jersey hospitals during a three-year period, so hospitals were grouped depending on the year that reimbursement was initially employed. The author purported to examine two hypotheses: that the efficiency of all the hospitals was not different, irrespective of starting year of new reimbursement implementation; and that there was no improvement in hospital efficiency over time. The results supported the latter hypothesis that the new mechanism had no positive effect on efficiency. In addition, it was found that those hospitals that had experienced the shortest time in the new programme had the lowest average efficiency level over years, whilst the other hospitals had the same level of efficiency, irrespective of the length of time since implementation.

Chern and Wan (2000) studied the impact of the implementation of a prospective payment system on a sample of 80 non-profit Virginian hospitals. Their findings supported the results of Borden’s study (1988) that there was no positive effect gained from the implementation of prospective payment system on hospitals. It was also found that the prospective payment system slightly reduced the efficiency scores of the hospitals and expanded the gap between the inefficient and efficient hospitals. The authors suggested that the new policy, to some extent, influenced the economies of scales and resulted in the higher percentage of large-sized hospitals among efficient hospitals, and that each hospital seemed to have developed a distinctive strategy in response to the new prospective payment system policy.

The effects of the changes in the financing method for hospitals, in particular the implementation of capitated contracting, on 246 Californian hospitals' efficiency were examined in Chu *et al.* (2004). The results from the DEA and two simultaneous Tobit and Probit regression analyses revealed that those hospitals that had had the capitated contracting were less efficient than those not involved. It was also found that the efficiency of hospitals increased alongside higher involvement with this contracting. The authors suggested that this may have been due to the fact that inefficient hospitals were likely to participate in capitation in order to improve their efficiency, or that the efficient hospitals already had better management methods than using capitated contracting.

Aside from some studies of the impacts of regulatory changes in hospital finance on hospital efficiency in the US, researchers have also been interested in the financing reforms in the hospital sectors in Spain, Norway and Taiwan. The technical efficiency of public Spanish hospitals under 'Program-Contracts' financing reforms was examined and the relationship between technical efficiency and unit costs was evaluated by Lopez-Valcarcel and Perez (1996). They employed DEA models and the cost stochastic frontier model upon data from 75 hospitals during the three years of 1991-1993. They found in both the DEA and cost frontier models that the technical efficiency of the hospitals improved over the period being analysed after the introduction of program-contracts. The results from the Tobit regression model, used to investigate the importance of hospital size, location and subcontracts on hospital efficiency, indicated that hospitals located in Madrid were more efficient than others elsewhere, and hospitals subcontracting out services performed better than others. In addition, the findings revealed that technical efficiency was significantly associated with unit costs, whilst subcontracting and the rate of capacity utilisation did not significantly affect the unit costs.

In Norway, Biørn *et al.* (2003) used the panel data of 48 somatic hospitals from the 9 years of 1992-2000 to analyse the impact of the activity-based financing policy and some hospital characteristics on hospital efficiency. The findings supported the hypothesis that technical efficiency, on average, improved under the initiative of the activity-based financing programme. However the effect of the programme on cost efficiency was found to be inconsistent. The authors also found that there was no significant difference in efficiency between the hospitals with or without activity-based financing contracts in the years following the introduction of the policy.

In Taiwan, hospital efficiency was investigated in relation to the National Health Insurance programme in the studies of Chang (1998) and Chen (2006). Chang (1998) examined the effects of the implementation of National Health Insurance, which restructured the finance of hospitals and impacted on three hospital characteristics – scope of services, proportion of retired veteran patients and the occupancy rate – on the relative efficiency of 6 government-owned hospitals in Taiwan during the five-year period of 1990-1994. The hospitals' efficiency scores as calculated by the DEA model were regressed using econometric regression models. The findings indicated that the overall efficiency of government-owned hospitals improved during the implementation of the National Health Insurance programme. It was found that scope of services and proportion of retired veterans were significantly negatively related to hospital efficiency, whilst the occupancy rate was significantly positively associated with hospital performance.

The effect of the National Health Insurance (NHI) reform in Taiwan on hospital efficiency and productivity was further evaluated by Chen (2006). He used the DEA CRS and VRS models, Malmquist index approach, Tobit, and OLS regression models on data from 40 hospitals, including 18 public and 22 private hospitals, during the pre-launched, launched and post-launched period of NHI policy from 1994 to 1998. It was found that a large number of hospitals regressed in terms of productivity due to the decrease in technological and quality attributes, whilst they became more efficient over the period studied. The study also revealed that National Health Insurance implementation was significantly positively related to hospital productivity and quality, but negatively associated with efficiency due to the increased utilisation of resources. Public hospitals were found to be less efficient in the single-period assessment but gained more efficiency and less service quality in the mixed-period investigated.

Although these studies have found that regulatory reforms, particularly changes in hospital finance, have a significant effect on hospital efficiency in developed countries there is no research relating to the hospital sector in Vietnam. There is a study being conducted to measure the efficiency of Vietnamese hospitals; however it does not take into account the impacts of regulatory changes and hospital characteristics on hospital efficiency. This study, therefore, is an attempt to fill the gap in the existing literature relating to Vietnamese hospitals and tries to explore the determinants influencing the efficiency of hospitals.

4. The Model

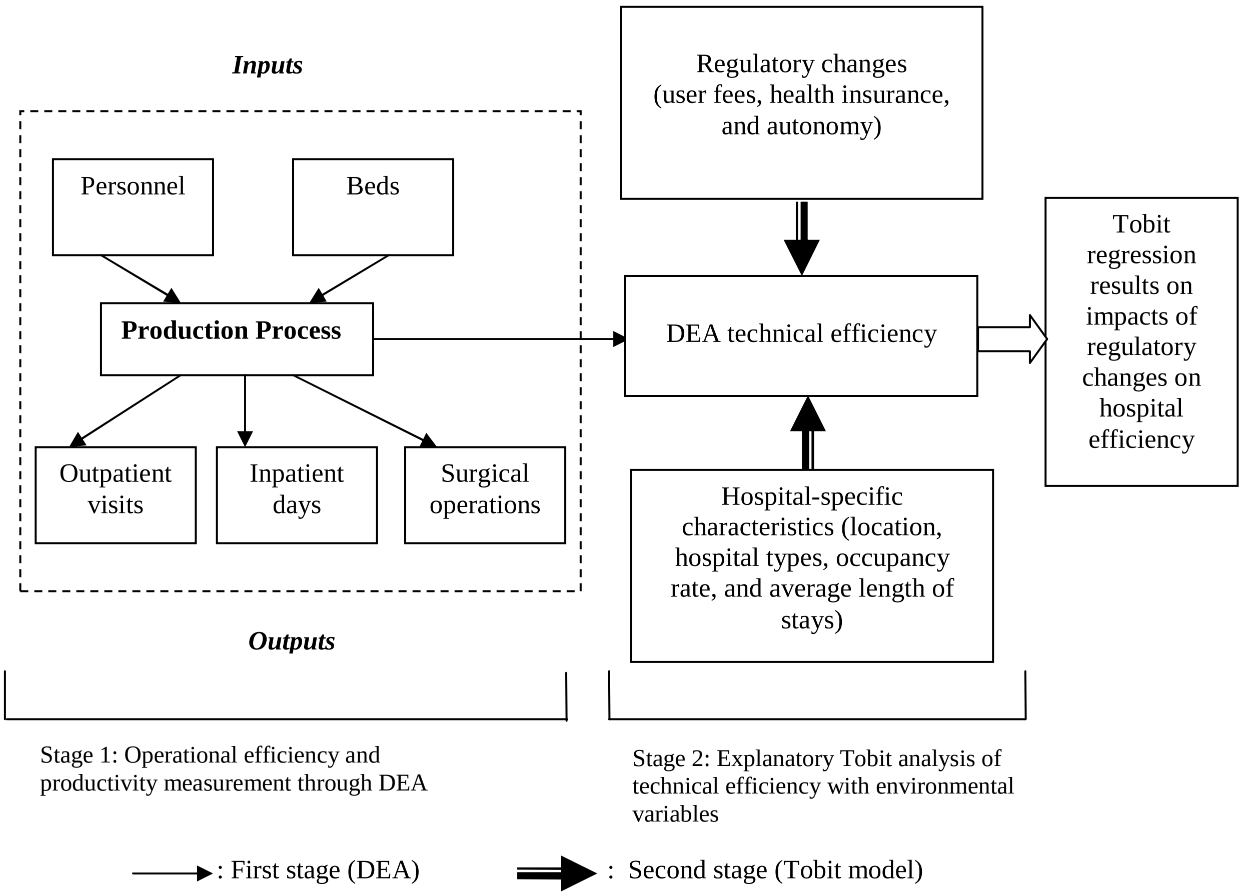
To measure efficiency of health care organisations, two different frontier methodologies, stochastic frontier analysis (SFA) and data envelopment analysis (DEA), are widely used. These methods were developed based on the concepts of efficiency measurement introduced by Farrell (1957). Farrell (1957) distinguished two mutually exclusive and exhaustive sources of productive efficiency: technical efficiency and allocative efficiency, which are then combined to provide a measure of total economic efficiency. The key to measuring technical efficiency and allocative efficiency is the estimation of the best practice production frontier (isoquant) against which each individual decision making unit (DMU) is to be compared. Accordingly, SFA and DEA methodologies use different techniques to envelope data, either statistical or mathematical programming, respectively. To that end, they make different accommodations for the structure of production technology, for random noise and for the measurement of efficiency.

There is a longstanding debate on how to measure the technical efficiency of health facilities. The cornerstone of the discussion is the problem of choosing the appropriate methodology, either DEA or SFA, for constructing an efficient frontier that encompasses best-practice hospitals, so that other hospitals can subsequently be compared with this efficiency benchmark. Some comparisons between frontier techniques in measuring hospital efficiency have been made (e.g. Chiriko and Sear, 2000; Jacobs, 2001; Gannon, 2005, among others). These studies showed that despite the intense research efforts, there is still no consensus to the best method for measuring frontier efficiency in hospitals. What the researchers have done so far is to highlight the strengths and weaknesses of these two techniques, but there is a lack of agreement regarding a preferred frontier model. Therefore, this paper will choose the DEA approach in order to measure the efficiency of the Vietnamese hospitals for the two following reasons. First, as indicated by Osei *et al.* (2005) in their study of efficiency in Ghana hospitals and Valdmanis *et al.* (2004) in their study of efficiency in Thai hospitals, the application of DEA is likely to be suitable in low-income countries. They showed that DEA analysis is useful when working with insufficient health sector information, and particularly when the price data is missing.

Second, the preference for DEA is driven by considering its advantages and disadvantages as opposed to SFA. The important advantage of the DEA method is that it requires no pre-specification of a functional form, resulting in no prior requirement of distributional form for the inefficiency terms. It can simultaneously accommodate multiple inputs and outputs, and enable a decomposition of the efficiency measurement into several components. This provides an aid to management in its search for sources of inefficiency. Furthermore, DEA is less ‘data-intensive’ than econometric methods because it does not require a relatively large sample size, information on prices of inputs and outputs, nor transformation of input and output physical units into any other single unit measure. However, DEA also has some drawbacks. It is sensitive to outliers and measurement errors. DEA is deterministic; hence, it also assumes that no random error exists in data.

Although it has some problems, DEA seems to be more appropriate to measure the efficiency than SFA in hospitals where there is multiple-output production and it is difficult to obtain input and output price data or to set behavioural assumptions such as profit maximisation or cost minimisation (Coelli *et al.,* 2005). Therefore, in order to measure efficiency and productivity of Vietnamese hospitals as well as to explain the relationships between hospital efficiency and regulatory changes and hospital characteristics, the two-stage DEA approach was used. Figure 2 below depicts the two-stage framework of this study.

Figure 2: Steps of Two-Stage Analysis for Investigating Hospital Efficiency



In the first-stage DEA of the study, two inputs (beds and personnel) and three outputs (outpatient visits, inpatient days, and surgical operations) are used to measure hospital efficiency and productivity. As the concentration of this study is the technical efficiency of Vietnamese hospitals, hence, the production process employed is based on the process approach, in which the intermediate outputs provided by hospitals are used. The selection of these input and output variables is also derived from consultancy of hospital managers and administrators of functional departments of the Vietnamese Ministry of Health. The main results from the DEA are the technical efficiency scores for individual hospitals and total factor productivity during the sample period 1998-2006. In the second stage of the study, the efficiency scores obtained from the DEA first stage are used as dependent variables and they are regressed against a set of environmental variables (regulatory changes in financial and managerial structures of hospitals and hospital-specific characteristics) using a Tobit model.

5. The DEA First Stage Analysis

5.1 The DEA Methodology and Malmquist Total Factor Productivity Index

Data envelopment analysis method (DEA) constructs production frontiers and measures the efficiency of a decision making unit (DMU) relative to these constructed frontiers using a mathematical programming technique. This method was first developed by Charnes *et al.* (1978) (CCR model), based on the work of Farrell (1957) on efficiency measurement. The CCR model assumes a production technology with constant returns to scale, implying that any proportional change in inputs usage results in the same proportional change in outputs. It was then extended by Banker *et al.* (1984) (BCC model). The BCC model relaxes the assumption of constant returns to scale to allow for variable returns to scale. The paper, in the first stage, employs the BCC model to measure the relative efficiency of hospitals. The input-oriented BCC model is formulated as follows:

$$\begin{aligned} &\text{Min } E_o = \theta_o \\ &\text{subject to } \sum_{k=1}^{n} \lambda_k X_{ik} \le \theta_o X_{io} \quad \forall i \\ &\qquad \sum_{k=1}^{n} \lambda_k Y_{rk} \ge Y_{ro} \quad \forall r \end{aligned} \tag{1}$$

$$\sum_{k=1}^{n} \lambda_k = 1$$
$$\lambda_k \geq 0 \quad \forall k,\ r,\ i$$

where: θ_o represents the efficiency score of *DMU₀,* which is within a range from zero to one and a higher score implies a higher efficiency; λ_k is non-negative values related to the k^{th} DMU.

In this stage, the DEA-based Malmquist total factor productivity (TFP) index approach (Färe *et al.,* 1994) is also used to measure the productivity changes of DMUs at different points in time, identify the sources of productivity changes, and decompose total productivity change into technical efficiency change (the catch-up effect) and technological change (the frontier shift effect). The TFP change index between period (t) and period $(t+1)$ is given by:

$$M_I(Y^{t+1}, X^{t+1}, Y^t, X^t) = \frac{D_I^{t+1}(Y^{t+1}, X^{t+1})}{D_I^t(Y^t, X^t)} \left[\frac{D_I^t(Y^{t+1}, X^{t+1})}{D_I^{t+1}(Y^{t+1}, X^{t+1})} \frac{D_I^t(Y^t, X^t)}{D_I^{t+1}(Y^t, X^t)} \right]^{1/2} \quad (2)$$

where the notion D_I denotes the input-based distance function, and M_I is the product of technical efficiency change and technological change. The part outside the square brackets of the equation represents the technical efficiency change between period (t) and period $(t+1)$, which denotes the ratio of Farrell technical efficiency in period $(t+1)$ over the technical efficiency in period (t). Technical efficiency change indicates whether a unit comes closer to (or further away from) its production frontier when moving from period (t) to period $(t+1)$. The remaining part inside the square brackets is a measure of technological change. It is the geometric mean of the shift in the production frontier observed at Y^t and the shift in the production frontier observed at Y^{t+1}. Technological change indicates whether the production frontier has shifted between two periods (t) and $(t+1)$ evaluated.

5.2 Input and Output Data

Data for this study were obtained from the database on the hospitals of the Vietnamese Ministry of Health and cover a period of 9 years from 1998-2006. The sample hospitals used in this study were the 101 general public hospitals over a total of 116 hospitals belonging to the sample under consideration. Central general hospitals and provincial general hospitals, operating as either the tertiary or main secondary centres, were chosen because they consume the largest part of the health resources in the health care system and their performance will have a significant influence on the health services provided and the health status of the overall population. The general district hospitals were taken out of the sample because they are of a small size and provide fewer kinds of health services than the sampled hospitals. The health services provided in district hospitals are also much less complicated and at a lower quality than that of the central and provincial counterparts. The specialty central and provincial hospitals have distinct missions, unique production processes, and serve distinct patients as compared to each other and to general hospitals, which would have resulted in a heterogeneous sample. In addition, due to the elimination of some inaccurate and missing values, 15 provincial hospitals were excluded. As a result, the sample had 101 hospitals, including 9 central hospitals monitored by the Ministry of Health and 98 provincial hospitals monitored by Provincial Health Services.

Regarding the output variables, following the hospital efficiency studies by Hu and Huang (2004), Chang *et al.* (2004), hospital outputs in this study are proxied by outpatient visits (Y1), inpatient days (Y2) and surgical operations (Y3) performed. Firstly, outpatient visits (Y1) are chosen as an output, which include both the scheduled visits to physicians and the unscheduled visits to the emergency room of hospitals. Secondly, health services for inpatients have different features and consume more resources than outpatient services, therefore, inpatient health services is another output of hospitals. This study follows the argument of Granneman *et al.* (1986) that the inpatient day factor is a more medically homogeneous unit than the inpatient factor; therefore the use of inpatient days (Y2) can provide a more favourable hospital output. Finally, the surgical operation output (Y3) is used because it requires different combinations of inputs than medical care, such as specialised equipment and personnel. The sample hospitals in this study are the main tertiary and secondary referral health centres in the health system, hence, surgical operations are obviously an important type of health service provided. All of these output measures are aggregate, and measuring hospital outputs by such aggregate variables does not capture case-mix variation and quality of services provided. Even though the use of a case-mix index such as diagnosis-related-groups (DRGs) applied in many health systems may handle the problem, the absence of data makes its use limited in Vietnam as well as in most developing countries (Zere *et al.,* 2006; Pilyavsky *et al.*, 2006).

Regarding the input variables, inputs used in assessment of hospital efficiency often fall into two categories: recurrent resources and capital resources. The numbers of personnel and hospital beds are considered as proxies for recurrent and capital resources used in hospitals, respectively; and therefore they are widely employed in the studies of hospital efficiency (e.g. Ferrari, 2006; Chen, 2006; Harris II *et al.,* 2000). This notion of hospital inputs is also supported by Worthington (2004) in the review of health sector efficiency literature. The use of these inputs can be explained by the fact that the hospital production process, as mentioned above, is largely administrative, delivers the health care services, and extensively uses the qualified labour and beds to produce health outputs.

According to Byrnes and Valdmanis (1994) and Steinmann and Zweifel (2003), production needs to be defined in terms of actual quantities of inputs used rather than available stocks. Hence, this study employed actual inputs that are broadly consistent with other studies of hospital efficiency (e.g. Ersoy *et al.,* 1997; Chang *et al.,* 2004; Zere *et al.,* 2006). The number of actual hospital beds used to provide health services and surgical operations are employed as an overall indicator of the capital input (X1). However, due to unavailability of disaggregate data on personnel, only the total number of hospital's personnel, including physicians and non-physicians working in the hospitals, is used as a proxy of human capital. In some literature, the operating expenses after excluding the payroll, capital (bed) expenses and depreciation have also been used as an input in measuring hospital efficiency (Harrison and Sexton, 2006; Zere *et al.,* 2006). However, in the context of Vietnamese health system, there is no clear separation of operational expenses away from bed expenses and depreciation, therefore, the use of this input factor can cause the double counting issue. As a result, this input is excluded.

Table 1 displays the summary statistics of the input variables used in the efficiency measurement, including mean, standard deviation and extreme values over the period 1998-2006. Descriptive statistics of the inputs suggest increases in the average amount of personnel and hospital beds used as well as increases in the amount of hospital outputs, including outpatient visits, inpatient days and surgical operations over the sample period.

Table 1: Descriptive Statistics for Variables

	Mean	**Standard Deviation**	**Minimum value**	**Maximum value**
Inputs				
Beds (X1)	424.53	233.19	60	1567
Personnel (X2)	455.99	306.14	35	2830
Outputs				
Outpatient visits (Y1)	9496.93	24512.54	80	221221
Inpatient days (Y2)	167961.97	106327.33	15195	850183
Surgical Operations (Y3)	5421.25	5886.50	86	37583

5.3 Results

Efficiency Results

In this stage, the efficiency of 101 general hospitals in Vietnam is examined in terms of their ability to provide outputs with minimum input consumption using the DEA-BCC model. The results are presented in Table 2. As the BCC model assumes variable returns to scale, the average variable-returns-to-scale efficiency (pure technical efficiency) for the total sample hospitals by year is reported. For completeness, the average efficiency score under the assumption of constant returns to scale (overall technical efficiency) and scale efficiency are also represented.

Table 2: Annual Average Efficiency Scores

	VRSTE	CRSTE	SCALE	Number of VRSTE = 1
1998	0.710	0.652	0.919	9
1999	0.672	0.599	0.898	5
2000	0.677	0.620	0.920	6
2001	0.685	0.619	0.906	8
2002	0.704	0.635	0.907	9
2003	0.731	0.661	0.909	11
2004	0.722	0.674	0.934	13
2005	0.781	0.748	0.958	12
2006	0.801	0.767	0.960	19
Average	0.720	0.664	0.924	

The results reveal that the average pure technical efficiency increased from 71% in 1998 to 80.1% in 2006. The efficiency had a slight decrease initially (1998-1999), and then increased steadily between 2000 and 2003 before falling down again during the period 2003-2004. Afterwards, it rose sharply for the last two years. Overall, Vietnamese hospitals have experienced an upward trend in pure technical efficiency during the sample period 1998-2006. In addition, the average overall technical efficiency across the entire sample period for all hospitals was 66.4%, and the scale efficiency was 92.4%. This implies that the levels of hospital efficiency scores are getting better over time. An explanation for this could lie in the fact that further changes in health insurance measures were introduced in 1998, 2002 and 2005, and autonomy in public hospitals was granted in 2002.

Furthermore, pure technical efficiency is investigated in terms of location and hospital types. The results are presented in Table 3 and Table 4, respectively. Table 3 shows that the central hospitals have experienced an increase in technical efficiency from 2002, after a slight reduction in 1999. The average pure technical efficiency of central hospitals increased from 66.1% in 1998 to 81.8% in 2006, whilst the average pure technical efficiency of provincial hospitals increased by 8.4% over the sample period. Overall, the provincial hospitals have performed better than their central counterparts during the period under consideration. Table 4 shows that the mean efficiency scores of hospitals located in North East, South East and Mekong River Delta regions are 74%, 74.1% and 73.2%, respectively, which are slightly higher than those of hospitals located in other regions. These results imply that hospitals located in the North East, South East and Mekong River Delta regions have generally performed better than hospitals from other regions. These results seem to suggest that changes in financial and managerial measures may have improved the technical efficiency of public hospitals and that the location factor and the hospital types may also have affected hospital efficiency. The impact of these factors will be further investigated in the second-stage analysis.

Table 3: Annual Average Technical Efficiency Scores by Hospital Types

	Central hospitals	**Provincial hospitals**	**All hospitals**
1998	0.661	0.715	0.710
1999	0.650	0.674	0.672
2000	0.671	0.677	0.677
2001	0.672	0.686	0.685
2002	0.694	0.705	0.704
2003	0.721	0.732	0.731
2004	0.743	0.720	0.722
2005	0.809	0.779	0.781
2006	0.818	0.799	0.801
Mean	**0.715**	**0.721**	**0.720**

As noted earlier in Section 4, the DEA efficiency results are sensitive to outliers and measurement errors. Therefore, this stage analyses the robustness of the efficiency scores using the jackknife technique (Magnussen, 1996; Zere *et al.,* 2006). The efficient hospitals are removed one at a time from the analysis and the efficiency measures are recalculated. The similarity of the efficiency ranking between the model prior to deleting any efficient hospitals and new models, having removed each of the efficient hospitals, is then tested by using the Spearman rank correlation coefficients. If the efficient hospitals are influential, the results should be varied and not correlated. Subsequently, the value of 0 implies that there is no correlation between the rankings. The value of 1 (or -1) indicates that the ranking are exactly the same (or reverse), implying no influence of outliers on hospital efficiency.

Table 4: Annual Average Technical Efficiency Scores by Regions

	Red River Delta	North East	North West	North Central Coast	South Central Coast	Central Highland	South East	Mekong River Delta
1998	0.704	0.695	0.666	0.756	0.684	0.668	0.707	0.744
1999	0.651	0.648	0.700	0.656	0.638	0.602	0.694	0.716
2000	0.619	0.728	0.680	0.634	0.615	0.612	0.729	0.679
2001	0.655	0.719	0.595	0.667	0.658	0.609	0.707	0.708
2002	0.694	0.737	0.622	0.669	0.701	0.624	0.722	0.711
2003	0.696	0.747	0.677	0.652	0.725	0.712	0.752	0.767
2004	0.691	0.740	0.634	0.664	0.688	0.726	0.757	0.746
2005	0.762	0.806	0.749	0.753	0.803	0.825	0.809	0.749
2006	0.794	0.840	0.890	0.778	0.804	0.824	0.793	0.767

Jackknifing analysis has been done on a year-by-year basis for the above pure technical efficiency and overall technical efficiency. The results[1] yield the value ranges of Spearman rank order correlation coefficient from 0.998 to 1, which are significantly different from zero at 1% level of significance. This suggests that no efficient hospital influences the efficiency of other hospitals and the efficiencies obtained from the sample are reasonably robust, at least on an ordinal scale of ranking of the hospitals.

In order to shed further light on whether the efficiencies of the sample hospitals changed with the further changes of financial and managerial measures in the hospital system, the nonparametric Kruskal-Wallis test is undertaken. The null hypothesis is that there is no median difference in technical efficiency across the 9 years under consideration. The alternative hypothesis is that at least one subgroup has a different distribution. The results are presented in Table 5. As shown in Table 5, the chi-square results for overall technical efficiency, pure technical efficiency and scale efficiency are 138.2, 85.5 and 122.6, respectively, which are greater than the 0.01 level of significance. This implies that at least one pair of the efficiency medians is not equal, and that the technical efficiency in the sample hospitals changed with the further introduction of financial and managerial changes in the Vietnamese health system.

[1] Due to the large number of Spearman rank correlation coefficients estimated in individual years, the results will be available upon request.

Table 5: Kruskal-Wallis Test of DEA Efficiency by Year

Year	Rank Sum of VRSTE	Rank Sum of CRSTE	Rank Sum of SCALE
1998	44391	44185.5	42150
1999	35832	32593	35397.5
2000	37219.5	36640	42394.5
2001	40216	38191	38327
2002	43325	41176	40953.5
2003	47569.5	46034.5	38780
2004	46097.5	48164	66861
2005	57718	61878.5	53498
2006	61226.5	64732.5	55233.5
Chi-squared	85.504	138.261	122.569
Probability	0.0001	0.0001	0.0001

Malmquist total factor productivity results

The results of the Malmquist indices and all of its components are presented in Table 6 below. It includes the geometric means of all the indices as well as the cumulative indices for the entire period 1998-2006. The results of the Malmquist productivity indices show that the general hospitals have on average experienced positive technical efficiency change during the sample period. The geometric mean of technical efficiency is 1.022, which represents an increase of 2.2% per year. This suggests that on average the hospitals are getting closer (experiencing efficiency improvement) to the frontier. However, the hospitals have on average experienced negative technological change during the sample period, thus offsetting somewhat the technical efficiency progress. The geometric mean technological change is 0.992, representing a decrease of 0.8% per year. This implies that the production frontiers have generally not achieved favourable shifts over the entire sample period. Accordingly, the combination of progression in technical efficiency change and regression in technological change is an increase in total productivity over time, with an average annual productivity growth rate of 1.4% per year.

Table 6: Malmquist Productivity Indices and its Components

Year	Technical efficiency change (EFFCH)	Technological change (TECHCH)	Change in pure technical efficiency (PECH)	Change in scale efficiency (SECH)	Total factor productivity change (TFPCH)
1998 – 1999	0.922	1.045	0.946	0.975	0.964
1999 – 2000	1.033	0.953	1.005	1.028	0.984
2000 – 2001	0.995	1.023	1.012	0.983	1.018
2001 – 2002	1.028	1.008	1.028	1.000	1.037
2002 – 2003	1.040	0.949	1.038	1.003	0.987
2003 – 2004	1.019	0.963	0.988	1.032	0.981
2004 – 2005	1.119	0.961	1.089	1.028	1.075
2005 – 2006	1.029	1.040	1.026	1.002	1.069
Mean	1.022	0.992	1.016	1.006	1.014
1998-2006*	1.189	0.938	1.133	1.050	1.114

Note: * *Cumulative indices for period 1998-2006*
Other indices are geometric average of the entire hospital sample

6. The Second Stage Analysis

6.1 The Econometric Model

As mentioned in Section 4, the DEA efficiency scores are regressed on a vector of explanatory variables. There are two regression models commonly used to investigate the determinants of technical efficiency: Ordinary Least Squares (OLS) regression and Tobit regression (Tobin, 1958). However, 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. As a result, the dependent variable (efficiency scores) in the regression model becomes a limited dependent variable. In such a case, applying OLS regression is inappropriate (Gujarati, 2003, p.616) so a Tobit censored regression model is used instead (Chilingerian, 1995; Chilingerian and Sherman, 2004). Therefore, a panel Tobit regression model is employed in this study to examine whether and how environmental factors such as regulatory changes in financial and managerial structure and hospital characteristics affect hospital efficiency. These independent variables are three regulatory change factors: the user fee measure (UFR), the health insurance measure (HIR), the hospital autonomy measure (AUD), and five hospital characteristic factors: location (NE, NW, NCC, SCC, CH, SE, and MRD), occupancy rate (OCC), average length of stays (ALOS), and hospital type (TYPE). In order to normalise the DEA distribution and convenience for computation, the DEA efficiency scores derived from equation (1) are transformed into inefficiency scores and left a censoring point concentrated at zero by taking the reciprocal of DEA efficiency score minus one.

$$\text{Inefficiency score} = \left(\frac{1}{\text{Technical efficiency score}} \right) - 1 \tag{3}$$

Hence, the following panel regression model is specified to conduct Tobit analysis:

$$\begin{aligned} INEFF = \beta_0 + \beta_1 UFR + \beta_2 HIR + \beta_3 AUD + \beta_4 NE + \beta_5 NW + \beta_6 NCC + \beta_7 SCC \\ + \beta_8 CH + \beta_9 SE + \beta_{10} MRD + \beta_{11} OCC + \beta_{12} ALOS + \beta_{13} TYPE + \varepsilon \end{aligned} \tag{4}$$

where:

- INEFF: The reciprocal of technical efficiency minus one
- UFR: The ratio of revenues from user fees to total revenues
- HIR: The ratio of revenues from health insurance to total revenues
- AUD: The autonomy dummy, AUD equals to 1 if a hospital operating in period 2003-2006; otherwise 0
- NE: Equal to 1 if a hospital is located in the North East region; otherwise 0
- NW: Equal to 1 if a hospital is located in the North West region; otherwise 0
- NCC: Equal to 1 if a hospital is located in the North Central Coast; otherwise 0
- SCC: Equal to 1 if a hospital is located in the South Central Coast; otherwise 0
- CH: Equal to 1 if a hospital is located in the Central Highland region; otherwise 0
- SE: Equal to 1 if a hospital is located in the South East region; otherwise 0

- MRD: Equal to 1 if a hospital is located in the Mekong River Delta; otherwise 0
- OCC: Bed occupancy rate of a hospital
- ALOS: Average length of stays of a hospital
- TYPE: Equal to 1 if a hospital is the general provincial hospital; otherwise 0

A summary of descriptive statistics for the inefficiency scores and the potential explanatory variables used in the regression estimation is presented in Table 7. The dummy explanatory variables such as autonomy, location and hospital type are not presented in this table.

Table 7: Descriptive Statistics for Tobit Regression Analysis

	Mean	**Standard Deviation**	**Maximum**	**Minimum**
INEFF	0.447	0.291	1.511	0
UFR	0.414	0.137	0.843	0.063
HIR	0.165	0.077	0.450	0.014
OCC	106.472	20.765	198.16	36.17
ALOS	7.746	2.297	19.889	3.111

Coelli *et al.* (2005, p.194) indicate that in DEA second-stage methodology the regression analysis for environmental factors against the DEA efficiency scores may have biased results. This occurs if the explanatory variables used in the regression model are highly correlated with the variables used in the DEA model. Therefore, in order to avoid biased results, correlations between hospital inputs and outputs and a set of explanatory variables are calculated. The Pearson correlation coefficient has been used to investigate the correlation between explanatory variables as well as the correlation between explanatory variables and hospital inputs and outputs. The results[2] suggest that there is no strong correlation between these variables, and it is unlikely there will be problems of multicollinearity in the regression model.

[2] The results are available upon request

As mentioned in Section 1, the Vietnamese health system has been restructured through the health sector reform process. During this process, there has been a range of regulatory measures implemented. Among the changes in government regulations in the health care system, the user fees, health insurance and autonomy are directly related to the operations of public hospitals. In addition to the state budget, the introduction of user fees and health insurance has provided two other financial sources for hospitals, resulting in change in the financing structure of public hospitals. The granting of autonomy has reduced the control of the government on public hospitals, thereby changing the hospitals' managerial structure. As this research focuses on evaluating the performance of public hospitals in relation to such changes, these three changes in regulatory measures are investigated, and thus, three testable hypotheses are set up as follows:

The positive relationship between user fees and hospital efficiency is expected. Chang (1998) indicates that as health reform is focused on changes in the financing mechanism of public hospitals, public hospitals cannot receive funds from the government to break even. As a result, in order to become financially independent, each hospital has to reduce its operating costs by improving its efficiency. Furthermore, the fee levels or payment rates approved by the Ministry of Health or local government for Vietnamese hospitals are often set below the actual costs of health services, resulting in the increase of financial pressures on hospitals. As mentioned by Rosko (1999), in such a case the user fee share of revenues will be inversely associated with inefficiency.

The expected impacts on inefficiency scores of health insurance measures cannot be easily predicted. This is because health insurance is also a financial measure, which changes the financing structure of hospitals; therefore, the above justification of user fees can be applied to health insurance. This means that health insurance may have a positive effect on hospital efficiency. However, Biørn *et al.* (2003) and Chen (2006) indicate that the payment method based on a low powered fee-for-service system may give rise to serious inefficiencies in the hospital sector through raising the prices of health services and therefore reducing incentives to control costs. Accordingly, health insurance may have a positive or negative effect on inefficiency.

The relationship between autonomy and hospital efficiency, represented by dummy variable, is expected to be positive. Greater autonomy makes public hospitals become more similar to those in a market system. Furthermore, the more management decisions are under the control of hospital managers, the more incentive hospitals have to improve performance. This means that the autonomy measure encourages hospitals to improve their efficiency. This positive correlation between autonomy and organisations' efficiency has been found in some studies on public organisations of Perelman and Pestieau (1988) and Gathon and Perelman (1992), among others.

Furthermore, some hospital characteristics are also examined. The results from the DEA efficiency measurement in Section 5 show that hospitals located in some regions such as the North East, South East and the Mekong River Delta are more efficient than hospitals from five other regions. Therefore, it is expected that hospitals from the North East, South East and Mekong River Delta regions have a higher operating efficiency than hospitals from the Red River Delta, North West, North Central Coast, South Central Coast, and Central Highland regions. As far as the hospital type is concerned, it is expected that the provincial hospitals are relatively more efficient than the central counterparts. This is because the central hospitals are more tightly under the control of the Ministry of Health than the provincial hospitals and central hospitals are the major teaching and tertiary health centres. These roles may require a large consumption of resources and higher administration costs. In addition, as hospital beds are a capital resource of a hospital, it therefore seems reasonable to assume that hospitals with greater occupancy rates are likely to use this resource more efficiently than those with lower occupancy rates. Accordingly, the bed occupancy rate is expected to have positive effects on hospital efficiency. However, the occupancy rate is related to the length of stays in such a way that high occupancy rate can be due to long stays for a single treatment. Therefore the average length of stays (ALOS) is also included in the

Tobit model. It is expected to be negatively associated with hospital efficiency, thus showing that the shorter the length of stay, the more efficient hospitals are.

6.2 Results

It is important to note that the potential explanatory variables are not highly correlated with each other or with the hospital input and output variables used in the first-stage DEA analysis and that the dependent variables in the Tobit model are the inefficiency scores. Therefore, a positive sign of coefficients indicates an increase in inefficiency whilst the negative sign implies a reduction of inefficiency. In other words, a positive coefficient is associated with the efficiency decline and a negative coefficient is related with the efficiency increase. The results of the Tobit model for explaining determinants of technical inefficiency scores are given in Table 8. As can be seen in Table 8, all three regulatory change variables significantly affect hospital efficiency. However, whilst the user fees (UFR) and autonomy (AUD) variables yield negative coefficients, the health insurance variable (HIR) yields a positive coefficient.

The share of user fees in total revenues (UFR), representing the change in financial measure of hospitals consistently yields a negative coefficient as expected, and is significantly different from zero. This result suggests that the application of user fees not only encourages health service provision but also leads to some additional technical efficiency. It also implies that hospitals that provide a lot of health services through the user fees method seem to be more careful not to waste resources because the charges for health services provided is less than the actual costs.

Table 8: Parameter Estimates of Tobit Model

	Parameter	Coefficients	Z-statistics
UFR	β_1	-0.114	-2.300***
HIR	β_2	0.270	3.130***
AUD	β_3	-0.087	-8.510***
NE	β_4	-0.118	-5.750***
NW	β_5	-0.190	-7.090***
NCC	β_6	-0.008	-0.340
SCC	β_7	0.141	5.540***
CH	β_8	-0.089	-3.100***
SE	β_9	-0.158	-7.300***
MRD	β_{10}	-0.142	-5.570***
OCC	β_{11}	-0.011	-40.460***
ALOS	β_{12}	-0.003	-1.050
TYPE	β_{13}	-0.036	-1.710*
Constant		1.819	35.030***
Log Likelihood		355.9933	

*Note:*** indicates significant different from zero at the 1%*
** indicates significant different from zero at the 10%*

The coefficient estimate for health insurance is positive and statistically significant in explaining the technical inefficiency of the sampled hospitals. This suggests that the provision of health care under the health insurance schemes is inversely associated with hospital efficiency. A possible explanation for a negative impact is that the increase in output levels due to greater demand, and from the hospital an overuse of health services to maximisie their revenues, was offset by the shortage of incentives to control costs in the low powered fee-for-service system. The negative effect may also be explained by some constraints during the implementation process. In particular, the decline in efficiency may be attributed to the following factors. First, the payments by the health insurer, Vietnam Social Security Institute, to hospitals are frequently delayed, thereby discouraging the provision of health services for insured patients and causing some financial difficulty for hospitals. Second, some fees for health services are set differently in different regulatory documents, resulting in inconsistent fees – both those charged by hospitals and those paid by the insurer to hospitals. In addition, many new advanced and expensive health services have not been agreed to be paid for by the insurer. All of these constraints may increase administration costs and operating costs for the hospitals.

Meanwhile, the coefficient representing the autonomy dummy is negative and significant. The sign of this coefficient is as expected. This implies that the granting of autonomy to public hospitals is correlated with a higher level of hospital efficiency. It also suggests that the new regulation appears to have created a more favourable management environment and that hospitals have responded positively to their new incentive environment in the predicted way. Indeed, the new regulations are likely to have encouraged the hospitals to try to make more efficient use of their human resources, to control expenditure more tightly and provide higher service quality. As a result, the more management decisions that come under the control of hospital managers, the better their hospitals can perform.

Most of the regional dummy variables are statistically significant, indicating general patterns of efficiency by geographical location when hospitals are compared to others of a similar size. Compared with the Red River Delta region, the hospitals located in the North East, South East and Mekong River Delta regions are more efficient. These regions are wealthier and more densely populated and have more public and private hospitals located within them than other regions. Therefore, the negative coefficients suggest that hospitals located in these regions are likely to have more favourable conditions to improve their efficiency than hospitals located in other regions. In particular, the density of hospitals in the North East, South East and Mekong River Delta regions is considerably high, implying a low market concentration and high competitive pressures. This may result in better performance for hospitals located in these regions. Furthermore, patients from these regions may have a greater ability to pay for hospital services than patients from poorer regions, resulting in a higher demand of health services from hospitals. People in lower income regions, on the other hand, tend to prefer self-medication, use over-the-counter drugs or traditional care due to the lower cost of these alternative treatments.

The effects of other hospital-specific characteristics, including occupancy rate and hospital type, are clearly significant in explaining inefficiency. Occupancy rate measures the utilisation of a hospital's beds, therefore, keeping the beds full means that hospitals have produced a lot of outputs (inpatient days, surgical operations) from their available inputs (beds and personnel). Given the way in which efficiency is defined and measured, the bed occupancy rate has a statistically significant negative coefficient as expected. This finding implies that the higher the ratio of a hospital's beds used relative to other hospitals, the higher the efficiency of that hospital is.

The coefficient associated with hospital type is negative and significant as expected. It is important to note that the central hospitals are used as the base; hence this finding indicates that central hospitals operating under direct administration of the Ministry of Health have significant positive contributions to technical inefficiency. In other words, the central hospitals are less efficient than their provincial counterparts. This result is supported by the DEA efficiency results that the provincial hospitals had higher efficiency scores than their central counterparts. A possible explanation is that central hospitals are tertiary care centres, which provide more complicated and higher quality health services than provincial counterparts. Furthermore, the central hospitals are also the main centres that undertake the teaching and researching mission in the health care system. This may result in the extensive use of resources by central hospitals. However, due to the unavailability of data on service complexity, service quality and teaching and researching mission, these factors cannot be tested.

Finally, the regression result indicates that the average length of stay (ALOS) is negative in explaining technical inefficiency, which goes against the *a priori* hypothesis. However, it is not statistically significant.

7. Discussion and Conclusions

This study is an attempt to provide an empirical picture of the efficiency of Vietnamese hospitals during the period of reform process and the impacts of regulatory changes and hospital-specific characteristics on hospital efficiency. The findings revealed that the productivity and efficiency of Vietnamese hospitals improved over the period 1998-2006, with a progress of total factor productivity of 1.4% per year. The regulatory changes in financial and managerial structure were found to have mixed impacts on hospital efficiency. The user fees and autonomy measures increased technical efficiency, whilst the implementation of health insurance reduced hospital efficiency. Furthermore, provincial hospitals were found to be more technically efficient than their central counterparts; and hospitals located in the North East, South East and Mekong River Delta regions were reported to perform better than hospitals from other regions.

Overall, these findings suggest that the Vietnamese hospitals have benefited from the regulatory changes instituted during the reform process. These findings may have the following managerial and policy implications. First, this analysis identifies policies that are effective in bringing about changes in productivity and efficiency, thereby assisting policy makers in choosing the best regulatory framework for the ongoing health sector reform process. It also provides a necessary step towards a comprehensive evaluation of the impact of the health reform programme on the performance of the health care system. Second, this analysis shows that measurement of hospital performance cannot simply look at the efficiency measurement itself. It should also include the assessment of relevant hospital operating characteristics, as all these factors are significantly associated with hospital efficiency.

The study can be further expanded by comparing the results obtained in this research, based on the DEA method, with those from alternative techniques such as econometric stochastic frontier analysis (SFA). Further research on the relationship between quality and efficiency or efficiency and equity may also be worthy of examination. Further research in all these objectives would be able to provide a comprehensive picture of hospital performance.

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