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Technical Efficiency of Public and Private Hospitals in Vietnam: Do Market-Oriented Policies Matter?

Hideaki Kitaki*

Abstract

This study examined how ownership and the degree of competition in the market were related to pure technical efficiency, using micro-level hospital data from six regions in Vietnam that were collected by an original survey. According to the results, the provincial hospitals have significantly higher efficiency than the district hospitals, while the private hospitals have significantly lower efficiency than the district hospitals. Moreover, the number of competing hospitals has a statistically significant negative correlation with the efficiency of the hospitals, and so does the number of competing private hospitals. On the other hand, the degree of concentration in the market has no significant correlation with efficiency. Those results may imply that competition raises problems with resource allocation among the hospitals in Vietnam.

JEL Classification: I11, I18

Keywords: technical efficiency, ownership, competition, DEA, bootstrap method

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1. Introduction

Nowadays the efficiency of medical institutions is of great interest to many countries, since they suffer from a rapid increase in health care expenditures. The situation in Vietnam is no exception. The total health expenditures of Vietnam increased from 5.4 percent of GDP in 2005 to 7.1 percent in 2014 (World Health Organization 2017). Indeed, the total health care expenditure grew by 18.7 percent per year on average during the period. In addition to that, the share of people aged 65 and over in Vietnam was forecasted to reach as high as 21.0 percent in 2050,[1] while it was estimated to be 6.7 percent in 2015 (United Nations 2015). As discussed in Oxley (2009), aging brings several new challenges to health care delivery, such as an increase in the demand for health care for chronic disease and coordination between health care and long-term care. Those challenges will add pressure to the national health care system of Vietnam to become more efficient in the future, as aging gradually changes the structure of health care demand.

One of the remarkable characteristics of health care delivery in Vietnam is its high dependency on the public sector which basically consists of central, provincial, district, and commune-level medical institutions. The number of public hospitals was 1,095[2] in 2012, including 820 general hospitals, while there were 155 private hospitals in 2013 (Ministry of Health 2013). This proves that public medical institutions play a substantial role in health care delivery.

However, the situation has been changing as a result of several health care reforms since the 1990s. The points of those reforms are twofold. The first point is related to the autonomy of public hospitals. The government of Vietnam launched a public health insurance program in 1993, four years after the introduction of user fees; it introduced a schedule of user fees for

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1 The forecast is the medium variant case.
2 The number is calculated as the sum of the number of general hospitals, special hospitals, traditional medicine hospitals, leprosariums, sanatoriums, and rehabilitation facilities.

consultations and physical examinations, inpatient days, technical services, and lab tests in 1995 (Lieberman and Wagstaff 2009). Subsequently, Decree 10/2002/ND-CP provided public hospitals with limited financial autonomy which allowed them to recover operating costs, reduce staff, and increase salaries for workers through surplus revenues; the autonomy was later extended by Decree 43/2006/ND-CP so that they would be provided with autonomy and accountability in operations, organization, human resources, and financing of all public services (Oanh et al. 2015). Those policies jointly made it possible for public hospitals to act, at least partially, like private hospitals and compete with each other.[3]

The second point is associated with emerging private hospitals. Non-state providers were officially recognized as a part of the Vietnamese health care system by the state ordinance in 1993 (Hort et al. 2011). The recent growth of private hospitals is particularly remarkable. The number of private hospitals increased by more than 50 percent in only four years, from 102 in 2009 to 155 in 2013 (Ministry of Health 2010; Ministry of Health 2013). Together with the extension of autonomy of public hospitals, this brought competition between public and private hospitals in the market, especially in urban areas where many of the private hospitals are located.

Those reforms are, in principle, considered to improve efficiency in hospitals by encouraging competition in the market. In other words, they intend to make the health care system of Vietnam more market-oriented than before. However, their impacts on hospital efficiency have not been analyzed sufficiently. The effect of competition may not be so simple, since it depends on the framework of the health care system. For instance, the impact of competition in the market on hospitals is likely to vary according to ownership, which affects their incentive structure.

[3] According to Lieberman and Wagstaff (2009), Decree 43/2006/ND-CP provided hospital directors with full control over manpower and subordinate units as well as power to set fees within a band; it was applicable to health facilities that were not able to recover any of their recurrent costs through user fee revenues.

This study aims to provide empirical evidence to address the extent to which competition and ownership are related to the efficiency of hospitals in Vietnam. In particular, it focuses on the pure technical efficiency of provincial, district, and private general hospitals in the local market. The analysis is based on the pooled data as of 2011, 2012, and 2013, which was collected in six regions by an original survey. As a part of the methodology of the analysis, DEA (Data Envelopment Analysis) is employed to measure the technical efficiency of the samples.

The paper develops as follows. First of all, Section 2 provides an overview of health care delivery in Vietnam. Next, preceding studies are reviewed in Section 3. The analytical framework is presented in Section 4. Section 5 explains the original survey for data collection. In Section 6, data and explanatory variables used in the analysis are summarized. Section 7 describes the results of model estimation, followed by Section 8 in which their interpretation and implication are discussed. Section 9 is the conclusion.

2. Overview of health care delivery in Vietnam

The system of health care delivery in Vietnam is characterized by the mixture of two groups of providers, *i.e.* public and private medical institutions, each of which follows a different regulatory framework. This section will present several important factors to illustrate how health care delivery in Vietnam works, especially in relation to hospitals. To summarize the conclusion first, the current framework of health care delivery of Vietnam implies that public hospitals, which receive subsidies from the government on the basis of various levels of autonomy, compete against private hospitals, which have full autonomy and no subsidies, and that they are likely to compete for human resources as well as for patients.

Classifications of medical institutions. Vietnam has four tiers of public medical institutions: central, provincial,[4] district, and commune-level, with the exception of those managed by the organizations other than either the Ministry of Health (MOH) or the Department of Health (DOH) of a province. Basically, the central-level institutions are managed by MOH and the others are managed by the DOH of the province where they are located. The central, provincial, and district-level institutions are classified into those for either general treatment or specialized treatment.[5] In particular, general hospitals provide both inpatient and outpatient health care. All of them must have at least two of the following departments—internal medicine, surgery, obstetrics and pediatrics—in order to be granted an operational license. Central and provincial general hospitals usually have more specialties than district hospitals. At the commune level, commune health centers (CHCs) provide primary care and health-related services, including maternity health and infectious disease prevention.

In contrast to public medical institutions, private medical institutions, including hospitals and clinics, have no structural classification based on administrative units. Generally speaking, private hospitals have a variety of scales, equipment, and specialties. They also have various types of ownership, such as private-owned, joint-stock, and fully foreign-owned. Moreover, all of them appear to be founded as for-profit institutions. This was underpinned by the original survey stated in Section 5. Hort et al. (2011) also reported that none of the non-state hospitals in their case studies of Ho Chi Minh City was not-for-profit, though the decree allowing non-state hospital operation stipulated that hospitals should operate as not-for-profit entities.

[4] In Vietnam, municipalities or centrally-run cities are regarded as an administrative unit equivalent to a province. In this paper, provincial-level medical institutions include municipality-level ones.

[5] General treatment institutions include general hospitals and regional polyclinics. Special treatment institutions include sanatorium, leprosarium, special hospitals, traditional medicine hospitals, special clinics, and maternity homes.

Differentiation of roles among hospitals. In Vietnam, there exists a referral system among different levels of public medical institutions under the public health insurance scheme. People are requested to register with their local medical institutions, typically either a district hospital or a CHC, which they contact first in need of treatment of primary care. In principle, hospitals at a high level, such as provincial and central hospitals, are expected to provide secondary or tertiary care under the system. However, in reality, a patient can go directly to a provincial hospital or a central hospital without any referrals, if she pays more than the copayment of public health insurance which a patient with a referral from a primary care medical institution at a lower level pays. Alternatively, a patient can choose a private hospital instead of a public one just in order to avoid the referral system, if she can accept that public health insurance will only cover the cost of treatment which would be equivalent to that of a public hospital at the same level. This implies that not only private hospitals but also public hospitals at different levels compete for patients with each other in the same health care market.

Regulation and management of hospitals. Public hospitals are under control of the authorities with respect to operation and management, including finance, investments, and the price of health care service. For instance, all of the public hospitals must obtain approval of their investment plans from MOH, or both DOH and the local People's Committee; they are not allowed to set their own service prices because MOH and the Ministry of Finance have devised a list with price ranges for each health care service (Oanh et al. 2015). From a viewpoint of financing operating costs, the degree of autonomy of public hospitals is threefold: fully self-financed institutions which have revenue sources to cover their entire operating costs; partially self-financed institutions; and fully-subsidized institutions which have poor or no revenue sources to cover their operating costs. However, as discussed later in Section 8, the number of fully self-financed institutions is quite small. Most public hospitals still receive subsidies from the government, even if a public hospital manager has great autonomy to control medical resources as a result of the regulatory reforms. On the other hand, the regulation of private hospitals with respect to operation and management is much weaker than that of public hospitals. They have complete autonomy over their finances and investments as well as freedom to set their service prices, instead of no right to receive subsidies from the government. In that sense, private hospitals are not on an equal footing with public hospitals in terms of conditions of competition in the health care market.

Human resources. All health care professionals, including doctors, nurses, and pharmacists, are required to obtain a license to engage in the designated medical activities in Vietnam. In particular, a medical doctor in Vietnam is equivalent to a physician usually called a doctor in the other countries, while there is another health professional called an assistant doctor.[6] The number of medical doctors per 10,000 people is steadily increasing, from 7.20 in 2010 to 7.34 in 2012 (Ministry of Health 2013). However, in general, medical doctors tend to be concentrated in urban areas, which leads to shortage of human resources in rural areas. The share of medical doctors working in four big municipalities, *i.e.* Hanoi, Da Nang, Ho Chi Minh City and Can Tho, is as high as approximately 20 percent (Ministry of Health 2013). In fact, many district hospitals and CHCs have not been able to recruit any medical doctors for many years, while their migration to other localities continues (Ministry of Health and Health Partnership Group 2013). It is likely that the situation is partly a result of competition to attract human resources among hospitals in urban areas where they may face more competition for patients than rural areas.

[6] A medical doctor is a physician who graduated from a medical doctor course at a medical university (6-year training course or equivalent). They include those who completed post-graduate level education, such as Ph.D. and Master's courses. An assistant doctor is a physician that graduated from a general physician assistant course at a medical college or a medical secondary school, typically trained for 2 or 3 years.

3. Review of preceding studies

There exists a substantial number of empirical studies which examined whether competition or ownership is related to the technical efficiency of hospitals. However, they did not necessarily yield the same conclusions about it. First, let’s take studies of the United States as an example. Register and Bruning (1987) analyzed non-long-term-care hospitals except federal government hospitals in large SMSAs (Standard Metropolitan Statistical Areas) and found no significant difference in efficiency between for-profit and not-for-profit hospitals. Valdmanis (1990) showed that public hospitals were more efficient than private not-for-profit hospitals, using data from acute-care general hospitals with 200 or more beds in SMSAs of Michigan with a population greater than 500,000. Ozcan, Luke and Haksever (1992) used data from acute-care general hospitals in all SMSAs and obtained the result that government hospitals tended to comprise a larger percentage of the efficient hospitals than private for-profit and not-for-profit hospitals regardless of regions, market sizes, or hospital scales. Chirikos and Sear (1994) reported that the net advantage of for-profit hospitals on efficiency was significant and positive in less competitive markets and that such an advantage disappeared in very competitive markets, based on analysis of short-term acute-care hospitals in Florida. They also showed that the efficiency of the hospitals was significantly lower in markets with more vigorous competition.

The situation is quite similar with respect to other developed countries. Dalmau-Matarrodona and Puig-Junoy (1998) conducted an analysis of hospitals in Catalonia, Spain. They reported that the number of competitors in the market presented a significant positive contribution on efficiency and that neither ownership nor the degree of concentration in the market made any difference. Another study of EU countries is Tiemann and Schreyögg (2009), which used the data of acute-care hospitals in Germany. They showed that the degree of concentration in the market had a significant positive association with efficiency and that public hospitals operated at a significantly higher level of efficiency than private for-profit and not-for-profit hospitals. Chua, Palangkaraya and Yong (2011) analyzed data from hospitals in Victoria, Australia. They found a significant negative link between efficiency and the number of competing private hospitals as well as between efficiency and the degree of concentration in the market.

Regarding developing countries, Masiye (2007) found no significant difference in efficiency between government-owned hospitals and other types of hospitals, including mission and private hospitals, in Zambia. Maredza (2012) showed that both public hospitals and for-profit hospitals were more efficient than the other types of hospitals in Zimbabwe. Jehu-Appiah et al. (2014) reported that private ownership negatively affected efficiency of the hospitals in Ghana.

The variety of the results in the preceding studies is attributable to the complexity of how the business environment of hospitals is related to their efficiency. Hence, it is meaningful to analyze how competition and ownership is associated with the efficiency of hospitals in the context of market-oriented policies in Vietnam. However, as far as I know, there are not any studies of Vietnam the results of which are able to be directly compared with those of the preceding studies. Though a few studies, such as Nguyen and Giang (2007) and Uslu and Linh (2008), attempted to explore factors related to efficiency of hospitals in Vietnam, they did not focus on either difference in efficiency between public and private hospitals or the relationship between competition and efficiency. This study is an attempt to fill a gap in the empirical studies of Vietnam regarding that point.

4. Analytical framework

From a viewpoint of methodology, the preceding studies summarized in Section 3 are classified into three groups. The first group directly tests whether statistically significant difference exists in the DEA efficiency scores among hospitals with different types of ownership (Valdmanis

1990; Ozkan, Luke and Haksever 1992; and Masiye 2007). The second group uses a so-called two-stage DEA approach—a combination of DEA and a type of regression analyses of DEA efficiency scores—in order to identify the factors related to efficiency of hospitals (Register and Bruning 1987; Chirikos and Sear 1994; Dalmau-Matarrodona and Puig-Junoy 1998; Maredza 2012; Jehu-Appiah et al. 2014). The third group applies a bootstrapping technique to estimating either robust coefficients of explanatory variables or robust confidence intervals of coefficients of explanatory variables in the second step of the two-stage DEA approach (Tiemann and Schreyogg 2009; Chua, Palangkaraya and Yong 2011).

This study adopts a two-stage DEA approach with bootstrapping as the analytical framework, the same estimation strategy as the third group. The first part estimates efficiency scores of the samples by DEA. Technical efficiency has two different concepts. *Overall* technical efficiency is the maximum of a ratio of weighted outputs to weighted inputs subject to the condition that the similar ratios for every DMU (Decision Making Unit) be less than or equal to unity (Charnes, Cooper and Rhodes 1978). By definition, it assumes constant return-to-scale in the sense that maximum efficiency is attainable at any scale where both a numerator and a denominator which jointly realize the maximum efficiency are multiplied by a positive scale parameter. Another concept is *pure* technical efficiency, which is defined at the given level of operations for each DMU where an efficiency rating of one is assigned to a DMU if and only if the DMU lies on the efficiency production surface, even if it may not be operating at the most efficient scale size. In this case, the maximum average productivity realized at a scale is not necessarily attainable at the other scales (Banker, Charnes and Cooper 1984). In other words, it assumes variable return-to-scale. Because of constraints and regulations associated with hospital management in Vietnam, it is plausible to assume variable return-to-scale. Moreover, the input-oriented approach is more suitable than the output-oriented approach, since health care demand derives from disease or bad health conditions, the occurrence of which is beyond the control of a health care provider. Hence, this study uses a concept of input-oriented pure technical efficiency scores in the analysis. The second part is based on Simar and Wilson (2007), where a truncated regression analysis of those efficiency scores and bootstrapping to estimate confidence intervals of coefficients of explanatory variables are conducted. As they argued, a truncated regression is appropriate because of the property of DEA based on finite samples; and bootstrapping is required to address an estimation bias of coefficients of explanatory variables in the two-stage DEA approach.

More concretely, DEA estimates the input-oriented pure technical efficiency score for each of the samples by solving the following linear programming problem:

$$\theta_k = \min\left\{ \theta |\, \theta > 0, y_k \leq \sum_{i=1}^{n} \gamma_i y_i \,, \theta x_k \geq \sum_{i=1}^{n} \gamma_i x_i \,, \sum_{i=1}^{n} \gamma_i = 1, \gamma_i \geq 0 (1 \leq \forall i \leq n) \right\}$$

where n is the number of samples; θ_k is the efficiency score of sample k, $x_j \in \mathbb{R}_+^p$ $(1 \leq j \leq n)$ is a p-input vector of hospital j, $y_j \in \mathbb{R}_+^q$ $(1 \leq j \leq n)$ is a q -output vector of hospital j, and $\{\gamma_k\}$ is a set of the weights corresponding to θ_k, respectively. The difference in implementation of measurement between pure technical efficiency and overall technical efficiency is that pure technical efficiency requires the weight condition $\sum_{i=1}^{n} \gamma_i = 1$, while overall technical efficiency does not in its calculation of efficiency.

Additionally, the following model is assumed in order to describe the relationship between an efficiency score and explanatory variables:

$$\delta_i = z_i \beta + \varepsilon_i \geq 1$$

where $\delta_i = \frac{1}{\theta_i}$, a reciprocal of the sample i's efficiency score corresponding to θ_i, z_i is a vector of explanatory variables of sample i, and ε_i is an error term of sample i following the normal distribution $\mathrm{N}(0, \sigma^2)$ left-truncated at $(1 - z_i \beta)$, respectively.

The first part is to estimate $\hat{\delta} = \left\{\hat{\delta}^k\right\}_{1 \leq k \leq n} = \left\{\frac{1}{\hat{\theta}^k}\right\}_{1 \leq k \leq n}$ by DEA. In the second part, a truncated regression of $\left\{\hat{\delta}^k\right\}_{k \in M}$on z_k where $\mathrm{M} = \left\{m | \hat{\delta}^{\mathrm{m}} > 1, 1 \leq m < n\right\}$ is conducted first to obtain $\left(\hat{\beta}, \hat{\sigma}^2\right)$. Subsequently, the following step (a) and (b) are repeated L times: (a) draw $\{\tilde{\varepsilon}^k\}$ from $N(0, \hat{\sigma}^2)$ left-truncated at $\left(1 - z_i \hat{\beta}\right)$ to construct $\left\{\hat{\hat{\delta}}^k | \hat{\hat{\delta}}^k = z_k \hat{\beta} + \tilde{\varepsilon}^k\right\}_{k \in M}$; and

(b) conduct a truncated regression of $\left\{\hat{\hat{\delta}}^k\right\}_{k\in M}$ on z_k to obtain $\left(\hat{\hat{\beta}}, \hat{\hat{\sigma}}^2\right)$. It is possible to construct $100 \times (1-\alpha)$ percent confidence interval for $\hat{\beta}^s$, sth element of $\hat{\beta}$, from the bootstrap results $\left\{\hat{\hat{\beta}}_b\right\}_{1\leq b\leq L}$ as $t^s_{\frac{\alpha}{2}} \leq \hat{\hat{\beta}}^s_b - \hat{\beta}^s \leq t^s_{\frac{1-\alpha}{2}}$, or $\hat{\hat{\beta}}^s_{b\left(\frac{1-\alpha}{2}\right)} - t^s_{\frac{1-\alpha}{2}} \leq \hat{\beta}^i \leq \hat{\hat{\beta}}^s_{b\left(\frac{\alpha}{2}\right)} - t^s_{\frac{\alpha}{2}}$, where t^s_α is $(100 \times \alpha)$ percentile point of $\hat{\hat{\beta}}^s_b - \hat{\beta}^s$ and $\hat{\hat{\beta}}^s_{b(\alpha)}$ is the value of $\hat{\hat{\beta}}^s_b$ corresponding to t^s_α. Here $L = 2{,}000$ is chosen for the stability of bootstrap estimation.

5. Survey design for data collection

Though some regional-level data from hospitals in Vietnam are available (Ministry of Health 2010 and Ministry of Health 2013, for instance), it is impossible to measure and analyze the efficiency of each hospital with such aggregated data. In order to overcome the constraints of data availability, this study collected micro-level hospital data as of all estimation periods, *i.e.* 2011, 2012, and 2013, by the original survey. This was conducted using a face-to-face method, with a follow-up by e-mail or telephone in order to address inconsistency of the collected data.

Sample regions. Though the number of private hospitals in Vietnam has been growing, it is still much smaller than that of public hospitals, as described in Section 1. Generally speaking, private hospitals in Vietnam are concentrated in urban areas. Hence, six regions which consist of four municipalities (Hanoi, Da Nang, Ho Chi Minh City, and Can Tho) and two provinces around those municipalities (An Giang and Binh Duong) were chosen as the sample regions so that a sufficient number of private as well as public hospitals would be included in the samples.

Listed hospitals. Since this study focuses on the market of general hospitals, the original survey required a complete list of general hospitals located in the sample regions to conduct the sampling of hospitals. The listed hospitals should include: public hospitals which consist of central, provincial, and district hospitals; public hospitals managed by the ministries other than MOH (*e.g.* Ministry of Defense); and private hospitals. In cooperation with MOH and DOHs of the sample regions, 179 general hospitals that had operated between 2011 and 2013 were identified and listed. The basic information of those hospitals including ownership types and the number of actual beds, inpatient discharges, and outpatient physician visits was obtained from their database as well.

Sample hospitals. Ideally, the sample hospitals should have included all of the hospitals in the list. However, the coverage of hospitals in the original survey was restricted to provincial, district, and private hospitals. Central hospitals were eliminated from the sample hospitals since they were generally incomparable with respect to input of medical resources which may affect the quality of service. Additionally, extremely small private hospitals were also eliminated since they were likely to have difficulty in providing detailed data for the survey. In this regard, the list included several private hospitals with fewer than 50 actual beds, while public hospitals meeting that condition were rare. Hence, all of the provincial and district hospitals, and all of the private hospitals with no fewer than 50 actual beds, were chosen as the sample hospitals from the listed hospitals which operated at the time of the survey. Eventually, the sample hospitals included 128 hospitals (23 provincial, 69 district, and 36 private hospitals), with 114 hospitals (23 provincial, 69 district, and 22 private hospitals) answering the survey questionnaire developed to collect data on the individual business environments as well as input and output.

6. Data and variables

DEA, the first part of the analysis, requires both input and output data to estimate efficiency scores. The indicators of input and output are crucially important, since their choice will have a large impact on the estimation results. Typical preceding studies used the number of health professionals and/or the number of actual beds as input, and the number of inpatient admissions/discharges and/or outpatient physician visits as output in order to estimate efficiency scores.

Basically following those studies, the input of this study has four indicators: three associated with labor input and one with capital input. The former includes the number of medical doctors, assistant doctors, and nurses. All of them are evaluated in terms of a full-time equivalent (FTE). In particular, the input of medical doctors is distinguished from that of assistant doctors, since they are considered to play different roles in medical practices. Regarding the latter, the number of actual beds is used as a proxy of capital input. The basic idea is that it will be closely related to the physical scale of a hospital which is likely to be correlated with capital input. The output indicators consist of the number of inpatient discharges and outpatient physician visits so that inpatient care will be distinguished from outpatient care in terms of output.

DEA is followed by the second part, a truncated regression analysis of the estimated efficiency scores to identify the relationship between explanatory variables and efficiency scores of the samples. The explanatory variables in the model include: average length of stay (ALOS), Harfindahl-Hirschman Index (HHI), the number of competing hospitals, the number of competing private hospitals, ownership type dummies, regional dummies, and time trend dummies. HHI, the number of competing hospitals, the number of competing private hospitals, and regional dummies are common among all of the samples located in the same region, while the other variables except for time trend dummies describe the individual business environment of a sample. Time trend dummies are common among all of the samples. More detailed definitions and explanations of the explanatory variables follow.

Average length of stay (ALOS). Ideally, case-mix adjusted output of both inpatient and outpatient treatment should be used to estimate efficiency scores. One approach is to use the information from DRGs (Diagnosis-Related Groups) or a similar diagnostic classification system in order to obtain either a case-mix index of output or the case-mix weights for each of the outputs. For instance, Ozcan, Luke and Haksever (1992), Chirikos and Sear (1994), and Chua, Palangkaraya and Yong (2011) employed this approach. Another approach is to approximate the case-mix weight for each diagnosis by an alternative indicator, as Dalmau-Matarrodona and Puig-Junoy (1998) did using ALOS by diagnosis. Unfortunately, either approach is impossible in this study due to limited available data.[7] Instead, overall ALOS is used as a proxy of the degree of case-mix complexity of inpatients in the model. ALOS is considered to represent persistent cases which require significant resources (Maretza 2012). The more such cases there are, the longer overall ALOS becomes. Consequently, it is likely to be correlated with the degree of case-mix complexity of inpatients.[8]

On the other hand, the case-mix of outpatients is not explicitly considered in the analysis. In Vietnam, all of the outpatients are consulted first at the outpatient department primarily to determine whether they should be admitted as inpatients. Hence, the degree of case-mix complexity of outpatients will not affect the results of the analysis significantly.

Harfindahl-Hirschman Index (HHI). The motivation to include HHI as an explanatory variable in the model is to capture the relationship between efficiency and the level of competition in the market. HHI is defined as the sum of the squared market share for each hospital. One of the crucial points to calculate HHI is the definition of the market. In order to analyze the market structure of hospitals, the geographic market delineation should be based on the flow of patients among regions.[9] However, the collection of such detailed data was so burdensome for hospitals that it was impossible to carry it out in the original survey. One of the alternatives is to use an administrative area as the geographic market. For instance, Tiemann and Schreyögg (2009) used the area of a county for that purpose. Similarly, it is possible in principle to use a district area in Vietnam. However, such an approach may be inappropriate, since a

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[7] According to Matsushima and Yamada (2013), only two pilot hospitals participated in the Vietnamese DRG system; it was applied to patients with acute pneumonia for adults and children, appendix operation and normal delivery.

[8] For instance, regarding acute inpatients, the data from Medicare in the United States in fiscal year 2014 shows that the correlation coefficient between DRG weights and the corresponding ALOS is 0.844 and statistically significant at 1 percent significance level (Centers for Medicare and Medicaid Services 2014).

[9] Elzinga and Hogarty (1973) and Zwanziger and Melnick (1988) are the examples of methods of

district has basically only one district hospital. It is not plausible to assume that a district hospital has a monopolistic power in the district whenever it is the only hospital located there. Because of the situation above, this study uses the area of a region, *i.e.* a municipality or a province, as the geographic market. In other words, the calculation of HHI defined here assumes that all of the hospitals in a region have the same geographic market as the area of that region.

Another point is the choice of indicators to measure output shares. In this study, the market share of a hospital is calculated in two ways: one is the share of the number of actual beds and the other is the share of the number of inpatient discharges. In both of the cases, it is required to process the samples before calculating HHI so that a change in observability of a hospital during the estimation period, *i.e.* from 2011 to 2013, will not affect the calculation results. In the case of actual-bed-based HHI, the samples that did not have all of data on the number of actual beds during all estimation periods were dropped, unless it was the case that a hospital entered or withdrew from the market during the period. The samples in the case of inpatient-discharge-based HHI were handled in the same way. As a result, the samples used to calculate actual-bed-based HHI and those used to calculate inpatient-discharge based HHI do not coincide.

The number of competing hospitals and the number of competing private hospitals. For each actual-bed-based HHI and inpatient-discharge-based HHI, the number of competing hospitals is calculated as the sum of the number of the hospitals included in the computation of the corresponding (*i.e.* actual-bed-based or inpatient-discharge-based) HHI. As Dalmau-Matarrodona and Puig-Junoy (1998) argued, it is possible to approximate the level of competition by the number of competitors and the degree of concentration. Introducing the number of competing hospitals together with HHI into the model makes it possible to analyze the former and the latter separately. The definition of the number of competing private hospitals

geographic market delineation based on goods or the flow of patients among regions.

is the same as that of the number of competing hospitals, except that the summation is conducted over private hospitals only.

Ownership type dummies. In this study, the samples include three types of ownership: provincial, district, and private. Both provincial and district hospitals are public medical institutions. The ownership type dummies associated with provincial and private ownership are introduced into the model to capture the difference in efficiency among hospitals with different ownership types, where a district hospital is the reference category. According to the original survey, all of the private hospitals among the sample were for-profit.

Regional dummies. Regional dummies are used to identify associations between efficiency and the regional business environment which is not explained by regional explanatory variables, such as HHI, the number of competing hospitals, or the number of competing private hospitals. The concentration of hospitals in Hanoi and Ho Chi Minh City is much more remarkable than that in other regions.[10] This may indicate that they are different from the other regions in some condition affecting efficiency of hospitals. Hence, the dummies for Hanoi and Ho Chi Minh City are included in the model.

Time trend dummies. If there exists a time trend in the technological progress of health care delivery across the sample regions, the efficiency of hospitals may also have a time trend. Time trend dummies for the years 2012 and 2013 are included in the model to control such a trend of change in efficiency from the reference year 2011.

(Table 1 Here)

The list of input, output, and explanatory variables is shown in Table 1. Most of them are taken from the data of the original survey. The calculation of HHI, the number of competing hospitals, and the number of competing private hospitals are based on the basic information from

[10] The share of Hanoi and Ho Chi Minh City with respect to the number of provincial, district and private hospitals was 17 percent (in 2012), 5.6 percent (in 2012), and 43 percent (in 2013), respectively (Ministry of Health 2013).

the listed hospitals as well as the data of the original survey. The descriptive statistics of selected indicators from the listed hospitals are presented in Table 2.

(Table 2 Here)

In order to make a dataset for analysis, this study uses the pooled data from 114 sample hospitals obtained by the original survey. Hence, the number of samples should be 342 in total. However, the data from samples including an entry to or withdrawal from the market in the middle of a year may not represent the true relationship between input and output due to the characteristics of the data.[11] Samples that met that condition were therefore removed from the dataset. Moreover, the samples that did not have all of the data in Table 1 as of all estimation periods as well as the samples which had abnormal data were also eliminated. As a result, 304 samples remain in the dataset for DEA, the first part of the analysis. The descriptive statistics of the data are shown in Table 3.

(Table 3 Here)

7. Estimation results

Table 4 presents the descriptive statistics of the input-oriented pure technical efficiency scores of the samples in the dataset for DEA created in Section 6. The mean of the efficiency scores of provincial, district, and private hospitals are 0.767, 0.793, and 0.774, respectively. It also shows the descriptive statistics of the data from the samples, the estimated efficiency scores of which are less than unity, since only the samples satisfying that condition should be included in the dataset for the truncated regression analysis, as described in Section 4. It contains 242 samples, the descriptive statistics of which are shown in Table 5.

(Table 4 Here)

[11] The input indicators (*e.g*. the number of medical doctors) are as of the end of a year, while the output indicators (*e.g.* the number of inpatient discharges) are the flow realized for a year.

(Table 5 Here)

In the truncated regression analysis, two types of models were estimated. Both include all of the explanatory variables in Table 1, except the number of competing hospitals and the number of competing *private* hospitals. Model 1 includes the number of competing hospitals as well as HHI. It aims to analyze the relationship between efficiency and the competition level decomposed into the number of competitors and the degree of concentration in the market. In Model 2, the number of competing hospitals in Model 1 is replaced with the number of competing private hospitals in order to analyze the relationship between efficiency and the number of private competitors. Those two models were estimated for both the actual-bed-based HHI and the inpatient-discharge-based HHI so that the impact of the difference in assumption of the basis of output share calculation on the result could be observed.

(Table 6 Here)

Table 6 presents the results of bootstrapping which provide the confidence intervals of the coefficients of the explanatory variables in Model 1 and Model 2, as well as the results of the truncated regression analysis. Note that a positive (negative) coefficient of an explanatory variable implies *negative* (*positive*) correlation between efficiency and the explanatory variable.

First of all, let us take a look at the bootstrap result of Model 1 in the case of actual-bed-based HHI. Regarding the control variables, ALOS has a statistically significant (at 5 percent significance level) positive coefficient. The inferred sign of its coefficient is the same as expected. The coefficient of the regional dummies of Hanoi and Ho Chi Minh City are negative and statistically significant (at 10 percent significance level). One of the key results concerns the ownership type dummies. The coefficient of the provincial ownership dummy is negative and statistically significant (at 10 percent significance level), while that of the private ownership dummy is positive and statistically significant (at 5 percent significance level). This shows that the provincial hospitals have significantly higher efficiency than the district hospitals and that the private hospitals have significantly lower efficiency than the district hospitals. Another important result is in relation to the competition level in the market. The number of competing hospitals has a statistically significant positive coefficient (at 10 percent significance level), though HHI does not have a statistically significant coefficient. Hence, what matters about the efficiency of the hospitals is not the degree of concentration in the market but the number of competitors, which is negatively correlated with the efficiency of the hospitals. Almost the same results as above are obtained in the case of inpatient-discharge-based HHI.

The bootstrap results of Model 2 are similar to those of Model 1. In particular, the number of competing private hospitals has a significant and negative correlation with the efficiency of the hospitals, while the degree of concentration in the market does not have a significant correlation with it. Again, the difference in the assumption of the basis of output share calculation has little impact on the bootstrap results of Model 2.

8. Discussion

The results of the empirical analysis in the previous section are twofold. First, the provincial hospitals are significantly more efficient and the private hospitals significantly less so than district hospitals. Second, both the number of competing hospitals and the number of competing private hospitals have a significant negative correlation with the efficiency of the hospitals, while the degree of concentration in the market has no significant correlation with it.

Table 5 shows that provincial hospitals have the largest ALOS and private hospitals have the smallest ALOS among the three ownership types of hospitals. The Welch's t-test indicates a statistically significant difference in the mean of ALOS between any two types of hospitals (at 1 percent significance level). It appears to be consistent with the fact that services offered at private facilities tend to focus on specialties, the services of which are easy to implement as well as attractive to patients (Ministry of Health and Health Partnership Group 2013). This may suggest the possibility that provincial hospitals have the most sophisticated inpatient case-mix while private hospitals have the least sophisticated case-mix among the three ownership types of hospitals. Nevertheless, the efficiency of provincial hospitals is significantly higher than that of district hospitals and private hospitals, which is a point of the first result.

The second result is opposite to Dalmau-Matarrodona and Puig-Junoy (1998) with respect to the number of competing hospitals; however, it is consistent with Chua, Palangkaraya and Yong (2011) with respect to the number of private competing hospitals. One of the possible interpretations is that the increase in the number of competing hospitals and/or the number of competing private hospitals leads to more competition for scarce input, which lowers the efficiency of the hospitals. In particular, medical doctors are likely to be recognized as scarce input by hospitals, since their number will not increase significantly in a short period of time. The situation may be worsened by a mismatch between the demand and the supply of health professionals. According to Ministry of Health and Health Partnership Group (2015), an assessment in Hai Duong Province showed signs that excessive numbers of health workers were being trained, especially at the secondary level. This implies that the demand for skilled medical doctors by hospitals is not sufficiently fulfilled by training institutions which intend to primarily supply secondary-level health professionals. This argument is similar to Palangkaraya and Yong's (2011) interpretation of the results of their empirical analysis. If that is the case, the second result also suggests the possibility that competition for scarce input is more closely related to the number of competitors and private competitors than to the level of concentration in the market. In that sense, an increase in the number of competitors and private competitors may account for a more significant change in the level of competition than the level of concentration in the market, which represents reallocation of the market shares among the hospitals.

As described in Section 2, it is difficult for many district hospitals and CHCs to employ enough medical doctors. This may reflect that competition for medical doctors among hospitals is quite severe all over the country, even in urban areas. Moreover, an overlap of specialties may lead to competition for specialized medical doctors among the hospitals. According to Table 7, the percentage of private hospitals that have a specific specialty is in general between those of the provincial hospitals and the district hospitals, apart from outpatient departments, general internal medicine, general surgery, and emergency departments, which almost all hospitals have regardless of the ownership type. This shows that there exists a considerable overlap of coverage in terms of the specialty among the different ownership types of hospitals, as far as the samples from the original survey are concerned.

Another link between the increase in the competition level and decrease in technical efficiency of the hospitals may lie in misallocation of resources through competition for state funding among public hospitals. The original survey revealed that only one hospital out of 92 public hospitals covered all of the operating costs through its revenues only. If this represents the situation of public hospitals located in urban areas on average, most of the public hospitals in Vietnam are likely to depend on state funding more or less to cover operating costs. Hence, an increase in the level of competition in the market is likely to lead to more competition among public hospitals for state funding, especially in terms of investments to attract more patients. The problem is that the allocation of state funds for health care is generally based on input at the provincial level (Tien et al. 2011). This will provide hospitals competing for state funds with incentives that are incompatible with the efficient use of scarce input. For instance, hospitals have an incentive to increase the number of beds to obtain more funding from the state in the absence of a national hospital plan which defines a target of the number of beds (Tien et al. 2011). Thus, an increase in the level of competition in the market can lower the efficiency of public hospitals though the misallocation of resources associated with competition for state funding.

9. Conclusion

This study analyzed the pure technical efficiency of the hospitals in six regions of Vietnam and provided empirical evidence that provincial hospitals had significantly higher efficiency than district hospitals and private hospitals had significantly lower efficiency than district hospitals. It also showed that both the number of competing hospitals and the number of competing private hospitals had a statistically significant negative correlation with the efficiency of the hospitals. If market-oriented policies to stimulate competition among hospitals lead to a resource allocation problem through competition for scarce input, the latter result may suggest that they work adversely as a result. More detailed data and analyses are required to identify the rationale of a hospital's decision-making behind those findings, especially with respect to competition for scarce input. Nevertheless, I believe that this study is the first attempt to examine using a quantitative approach how competition and ownership are related to the efficiency of hospitals in Vietnam.

Those results imply that the performance of for-profit private hospitals in terms of efficiency is not necessarily better than that of public hospitals and that there exists a negative link between the level of competition in the market and efficiency of the hospitals. In that sense, the market-oriented policies, especially those associated with emerging private hospitals and the extension of public hospital autonomy, may not work as expected under the current framework of health care delivery in Vietnam. Needless to say, however, the results of this study should not be directly connected with practical decision-making on the policy of health care delivery of hospitals, since they depend on several assumptions and the limited availability of data. A greater accumulation of empirical analyses to conduct rigorous and careful evaluation of the policies is required in this regard.

It is possible to extend this study in various directions. One direction is an additional analysis of the other regions in Vietnam using the same approach. By virtue of the methodology, the results of this study rely on the sample hospitals. This additional analysis is not only helpful but also necessary in order to examine to what extent the findings of this study hold true for hospitals in the other regions of Vietnam, especially in rural areas. Another direction is to elaborate on the measurement of the competition in the market. The approach used in this study to calculate HHI and the number of competitors admittedly depends on some strong assumptions. More rigorous delineation of the geographic markets based on the detailed data of the flow of patients among regions will allow for the calculation of HHI and the number of competitors more strictly for each of the hospitals. Moreover, this study solely focuses on the analysis of pure technical efficiency for the reason stated in Section 4. However, comparing the results of overall technical efficiency with those of pure technical efficiency obtained in this study will be of more interest as the deregulation of health care market in Vietnam progresses so that a hospital will have more freedom to choose a scale of production. It is also a challenging but important extension of this study to incorporate service quality into the measurement of efficiency. In this study, central hospitals to which far greater medical resources are generally allocated than to the other hospitals were eliminated from the sample hospitals so that the effects of difference in service quality would be removed from the analysis. Similarly, it may contribute toward that purpose to eliminate private hospitals with fewer than 50 actual beds from the sample hospitals. However, service quality itself is not explicitly treated in the analysis; or equivalently, it is assumed that there exists no difference in the service quality of medical treatment of inpatients and outpatients among all of the analyzed samples. The development of empirical analysis in this regard is important, though evaluation and adjustment of service quality has many difficulties to be addressed in practice. Finally, the relationship between congestion and efficiency is an important viewpoint of analysis of health care delivery in Vietnam. It is said that patients in Vietnam are inclined to concentrate in large hospitals, such as central and provincial hospitals. If that is the case, congestion in those hospitals may result in the decline of their efficiency through conflict among different outputs. Though such an analysis is beyond the scope of this study, more empirical analysis in the local context of Vietnam is required.

References

Banker, R. D., A. Charnes and W. W. Cooper. 1984. “Some models for estimating technical and scale inefficiencies in data envelope analysis.” *Management Science* 30, no .9: 1078-92.

Centers for Medicare and Medicaid Services. 2014.“Historical weight file.”*Files for FY 2014 Final Rule and Correction Notice*. Accessed April 21, 2017. https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Acute-Inpatient-Files-for-Download-Items/FY2014-FinalRule-CorrectionNotice-Files.html.

Charnes, A., W. W. Cooper and E. Rhodes. 1978. “Measuring the efficiency of decision making units.” *European Journal of Operational Research* 2, no.6: 429-44.

Chirikos, T. N. and A. M. Sear. 1994. “Technical efficiency and the competitive behavior of hospitals.” *Socio-Economic Planning Sciences* 28, no. 4: 219-27.

Chua, C. L., A. Palangkaraya and J. Yong. 2011. “Hospital competition, technical efficiency and quality.” *Economic Record* 87, no. 277: 252-68.

Dalmau-Matarrodona, E. and J. Puig-Junoy. 1998. “Market structure and hospital efficiency: Evaluating potential effects of deregulation in a National Health Service.” *Review of Industrial Organization* 13, no. 4: 447-66.

Elzinga, K. G., and T. F. Hogarty. 1973. “The problem of geographic market delineation in antimerger suits.” *Antitrust Bulletin* 18: 45-81.

Hort, K. et al. 2011. “The growth of non-state hospitals in Vietnam: Implications for policy and regulatory options.” *Health Policy and Health Finance Knowldge Hub Working Paper Series*, no. 15.

Lieberman, S. S. and A. Wagstaff. 2009. “Health financing and delivery in Vietnam: Looking forward.” *Health, Nutrition, and Population Series.*Washington, D.C.: World Bank.

Maredza, A.. 2012. “Are for-profit hospitals more efficient than non-profit hospitals? A case study of Zimbabwe using data envelopment analysis and the Tobit model.” *African Journal of Business Management* 6, no. 47: 11670-82.

Masiye, F. 2007. “Investigating health system performance: An application of data envelopment analysis to Zambian hospitals.” *BMC Health Services Research* 7, no. 1: 58-68.

Matsushima, M. and H. Yamada. 2013. “Public health insurance in Vietnam towards universal coverage: Identifying the challenges, issues, and problems in its design and organizational practices.” *OSIPP Discussion Paper*, DP-2013-E-003, Osaka School of International Public Policy.

Ministry of Health. 2010. “Health statistics yearbook 2009.”

———. 2013. “Health statistics yearbook 2012.”

Ministry of Health and Health Partnership Group. 2013. “Joint annual health review 2013.”

———. 2015. “Joint annual health review 2015.”

Nguyen, K. M. and T. L. Giang. 2007. “Non-parametric analysis of efficiency performance for hospitals and medical centers in Vietnam.” In *Technical Efficiency and Productivity Growth in Vietnam: Parametric and Non-parametric Analyses*, edited by K. M. Nguyen and T. L. Giang, 85-99. Hanoi: Publishing House of Social Labour.

Jehu-Appiah, C. et al. 2014. “Ownership and technical efficiency of hospitals: Evidence from Ghana using data envelopment analysis.” *Cost Effectiveness and Resource Allocation* 12, no. 1: 9-21.

Oanh, .T. T. M. et al. 2015. “Public hospital governance in Viet Nam: A case study in two provinces.” In *Public Hospital Governance in Asia and the Pacific*, *Comparative Countries Studies,* edited by D. Huntington and K. Hort, 1, no. 1. World Health Organization.

Oxley, H.. 2009. “ Policies for healthy ageing: An overview.” *OECD Health Working Papers*, no. 42.

Ozcan, Y. A., R. D. Luke and C. Haksever. 1992. “Ownership and organizational performance: A comparison of technical efficiency across hospital types.” *Medical care* 30, no. 9: 781-94.

Register, C. A. and E. R. Bruning. 1987. “Profit incentives and technical efficiency in the production of hospital care.” *Southern Economic Journal* 53, no. 4: 899-914.

Simar, L. and P. W. Wilson. 2007. “Estimation and inference in two-stage, semi-parametric models of production processes.” *Journal of Econometrics* 136, no. 1: 31-64.

Tiemann, O. and J. Schreyögg. 2009. “Effects of ownership on hospital efficiency in Germany.” *BUR-Business Research* 2, no. 2: 115-45.

Tien, T. V. et al. 2011. “ A Health financing review of Viet Nam with a focus on social health insurance: Bottlenecks in institutional design and organizational practice of health financing and options to accelerate progress towards universal coverage.” World Health Organization.

Uslu, P. G. and T. P. Linh. 2008. “Effects of changes in public policy on efficiency and productivity of general hospitals in Vietnam.” *CCP Working Paper*, 08-30, Center for Competition Policy, University of East Anglia.

Valdmanis, V. G. 1990. “ Ownership and technical efficiency of hospitals.” *Medical Care* 28, no. 6: 552-61.

United Nations. 2015. “World population prospects: The 2015 revision.”

World Health Organization. 2017. “Global health expenditure database.” Accessed May 5, 2017. http://apps.who.int/nha/database/Home/Index/en.

Zwanziger, J. and G. A. Melnick. 1988. “The effects of hospital competition and the Medicare PPS program on hospital cost behavior in California.” *Journal of Health Economics* 7, no. 4: 301-20.

Table 1 Input, output and explanatory variables

Category	Description	Data Source
Input	Number of medical doctors (FTE)	OS
	Number of assistant doctors (FTE)	OS
	Number of nurses (FTE)	OS
	Number of actual beds	OS
Output	Number of inpatient discharges	OS
	Number of outpatient physician visits	OS
Explanatory variables	Average length of stay	OS
	Harfindahl-Hirschman Index	MOH/DOHs, OS
	Number of competing hospitals	MOH/DOHs
	Number of competing private hospitals	MOH/DOHs
	Ownership type dummies (provincial, private)	MOH/DOHs, OS
	Regional dummies (Hanoi, Ho Chi Minh City)	OS
	Time trend dummies (2012, 2013)	-

Note: OS denotes the original survey by the author; MOH/DOHs denotes the Ministry of Health or the Department of Health that was in charge of the region where the sample hospitals were located.

Table 2 Descriptive statistics of the data of the listed hospitals

		Number of actual beds			Number of inpatient discharges			Number of outpatient physician visits		
		Mean	SD	N	Mean	SD	N	Mean	SD	N
2011	Central	839.3	600.3	10	43,292.0	41,238.0	10	379,203.4	350,645.0	10
	Provincial	701.4	440.4	25	36,957.6	21,900.6	25	352,252.8	191,899.1	25
	District	151.1	78.9	69	9,319.6	6,382.9	69	235,303.7	198,442.2	69
	Other	301.9	247.6	21	12,453.6	11,055.0	18	132,513.1	177,674.2	18
	Private	108.6	112.1	42	6,684.2	8,312.6	42	84,360.9	86,698.8	42
2012	Central	888.6	691.6	10	45,549.2	42,442.9	10	433,571.3	392,887.1	10
	Provincial	696.6	415.4	25	38,186.8	21,017.3	25	361,051.0	206,140.1	25
	District	162.9	87.3	69	10,522.3	7,365.4	69	250,670.8	208,952.2	69
	Other	332.9	268.2	19	13,374.9	12,378.7	14	177,130.6	222,983.9	14
	Private	112.2	112.9	43	6,850.4	8,356.8	43	90,034.0	92,453.5	43
2013	Central	919.6	728.8	10	48,066.2	44,382.2	9	502,677.6	480,315.4	9
	Provincial	717.2	434.7	25	37,230.0	20,103.5	25	356,863.1	206,691.1	25
	District	175.4	96.5	70	10,932.1	8,147.5	70	257,021.8	222,719.3	70
	Other	336.9	261.4	20	13,326.3	12,683.9	15	186,232.3	216,578.3	15
	Private	115.3	115.2	45	6,579.5	7,955.0	45	102,808.9	113,563.3	45

Source: MOH/DOHs and the original survey by the author.
Note: SD denotes the standard deviation; N denotes the number of hospitals.
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Table 3 Descriptive statistics of the data of the samples for DEA

Description	2011					
	Provincial		District		Private	
	Mean	SD	Mean	SD	Mean	SD
Number of medical doctors (FTE)	158.9	99.2	37.0	31.0	52.0	32.5
Of which, post-graduate medical doctors (FTE)	84.2	58.3	16.5	19.4	28.3	22.8
Number of assistant doctors (FTE)	21.1	31.2	22.0	15.0	4.36	5.59
Number of nurses (FTE)	314.3	223.9	59.8	49.4	81.8	74.5
Of which, bachleor's degree or higher (FTE)	17.3	14.3	2.81	6.21	4.67	8.57
Number of actual beds	670.5	426.4	154.4	78.2	146.5	110.1
Number of inpatient discharges	35,172.9	19,990.7	9,464.6	5,974.0	9,335.9	8,806.8
Number of outpatient physician visits	371,888.0	203,118.4	225,044.4	179,118.4	122,021.5	88,078.3
Average length of stay	7.06	1.77	5.19	1.49	4.12	1.14
Harfindahl-Hirschman Index, actual-bed-based	615.7	411.7	1,007.4	660.8	1,025.0	711.1
Number of competing hospitals, actual-bed-based	46.4	13.7	35.6	19.0	35.8	19.4
Number of competing private hospitals, actual-bed-based	12.0	4.20	9.29	5.55	9.28	5.79
Harfindahl-Hirschman Index, inpatient-discharge-based	666.1	490.9	1,114.3	792.8	1,122.8	840.2
Number of competing hospitals, inpatient-discharge-based	45.1	13.2	34.6	18.2	34.8	18.7
Number of competing private hospitals, inpatient-discharge-based	12.0	4.20	9.29	5.55	9.28	5.79
Number of samples	20		62		18	

Description	2012					
	Provincial		District		Private	
	Mean	SD	Mean	SD	Mean	SD
Number of medical doctors (FTE)	166.1	101.4	39.6	33.2	57.5	32.2
Of which, post-graduate medical doctors (FTE)	90.4	59.5	17.9	20.4	33.4	23.1
Number of assistant doctors (FTE)	20.1	29.7	22.0	16.8	7.67	12.3
Number of nurses (FTE)	320.7	227.7	63.6	51.8	94.8	73.4
Of which, bachleor's degree or higher (FTE)	21.7	16.3	3.16	6.45	5.56	8.56
Number of actual beds	666.6	397.3	162.3	82.9	146.7	110.3
Number of inpatient discharges	37,229.4	21,741.6	10,459.1	6,880.9	10,432.1	8,734.9
Number of outpatient physician visits	381,189.5	220,037.5	239,685.0	191,249.2	140,073.6	91,586.3
Average length of stay	7.02	1.94	5.23	1.31	4.03	1.28
Harfindahl-Hirschman Index, actual-bed-based	604.2	390.7	989.8	610.7	985.5	652.7
Number of competing hospitals, actual-bed-based	46.5	13.4	35.0	18.8	35.8	19.2
Number of competing private hospitals, actual-bed-based	12.1	3.69	9.15	5.26	9.22	5.46
Harfindahl-Hirschman Index, inpatient-discharge-based	653.3	455.8	1,036.9	640.2	1,006.1	645.3
Number of competing hospitals, inpatient-discharge-based	45.2	12.9	34.1	18.1	34.8	18.5
Number of competing private hospitals, inpatient-discharge-based	12.1	3.69	9.15	5.26	9.22	5.46
Number of samples	20		62		18	

Description	2013					
	Provincial		District		Private	
	Mean	SD	Mean	SD	Mean	SD
Number of medical doctors (FTE)	173.3	102.0	43.8	38.1	62.1	35.8
Of which, post-graduate medical doctors (FTE)	97.5	64.5	20.4	23.6	36.5	24.5
Number of assistant doctors (FTE)	20.2	27.3	23.0	18.3	8.60	16.6
Number of nurses (FTE)	327.5	223.2	70.1	61.5	109.8	80.0
Of which, bachleor's degree or higher (FTE)	27.6	19.7	4.69	8.95	11.2	19.1
Number of actual beds	679.2	402.9	172.4	90.0	153.8	113.2
Number of inpatient discharges	36,018.0	20,444.0	10,574.0	7,184.6	9,460.9	7,894.7
Number of outpatient physician visits	374,899.5	223,604.4	242,393.5	204,431.8	132,664.4	94,635.9
Average length of stay	6.83	1.95	5.13	1.37	3.95	1.32
Harfindahl-Hirschman Index, actual-bed-based	594.7	392.0	974.6	597.2	903.6	606.6
Number of competing hospitals, actual-bed-based	46.5	13.3	35.2	18.5	37.7	18.5
Number of competing private hospitals, actual-bed-based	12.1	3.63	9.28	5.11	9.8	5.21
Harfindahl-Hirschman Index, inpatient-discharge-based	639.3	447.6	1,010.3	630.7	919.7	611.6
Number of competing hospitals, inpatient-discharge-based	45.2	12.8	34.3	17.8	36.6	17.8
Number of competing private hospitals, inpatient-discharge-based	12.1	3.63	9.28	5.11	9.8	5.21
Number of samples	20		64		20	

Source: MOH/DOHs and the original survey by the author.
Note: SD denotes the standard deviation.

Table 4 Estimation results of input-oriented pure technical efficiency

	All samples				
	Mean	SD	Min	Max	N
Provincial	0.767	0.191	0.292	1.000	60
District	0.793	0.178	0.235	1.000	188
Private	0.774	0.200	0.321	1.000	56

	Samples with efficiency < 1				
	Mean	SD	Min	Max	N
Provincial	0.731	0.180	0.292	0.998	52
District	0.737	0.160	0.235	0.999	148
Private	0.699	0.175	0.321	0.988	42

Source: Author's estimation.
Note: SD denotes the standard deviation; N denotes the number of samples.

Table 5 Descriptive statistics of the data of the samples for the truncated regression

Description	2011					
	Provincial		District		Private	
	Mean	SD	Mean	SD	Mean	SD
Number of medical doctors (FTE)	151.2	100.0	36.9	33.0	56.0	30.6
Of which, post-graduate medical doctors (FTE)	81.9	60.2	16.6	21.13	32.2	23.0
Number of assistant doctors (FTE)	23.4	32.1	22.9	15.0	4.81	6.05
Number of nurses (FTE)	304.3	224.7	60.9	53.2	96.5	79.8
Of which, bachleor's degree or higher (FTE)	17.7	15.0	3.11	6.79	6.38	9.61
Number of actual beds	634.2	399.4	156.3	79.8	154.5	120.7
Number of inpatient discharges	33,657.9	19,705.6	8,929.2	5,749.5	9,299.2	9,467.2
Number of outpatient physician visits	340,553.6	178,333.0	193,509.7	151,883.5	115,135.9	78,810.2
Average length of stay	7.02	1.79	5.38	1.37	4.22	1.15
Harfindahl-Hirschman Index, actual-bed-based	566.5	348.1	1,060.8	678.3	933.6	675.8
Number of competing hospitals, actual-bed-based	47.6	12.0	34.0	18.9	38.2	19.3
Number of competing private hospitals, actual-bed-based	12.2	3.73	8.80	5.42	9.85	5.97
Harfindahl-Hirschman Index, inpatient-discharge-based	619.4	448.4	1,186.1	823.7	989.0	758.2
Number of competing hospitals, inpatient-discharge-based	46.3	11.5	33.1	18.2	37.1	18.6
Number of competing private hospitals, inpatient-discharge-based	12.2	3.73	8.80	5.42	9.85	5.97
Number of samples	18		51		13	

Description	2012					
	Provincial		District		Private	
	Mean	SD	Mean	SD	Mean	SD
Number of medical doctors (FTE)	171.5	106.0	37.1	17.5	59.1	33.3
Of which, post-graduate medical doctors (FTE)	89.3	62.4	16.2	10.84	36.5	24.5
Number of assistant doctors (FTE)	23.3	32.4	24.2	17.5	9.83	14.3
Number of nurses (FTE)	328.7	242.5	59.7	33.8	99.5	82.0
Of which, bachleor's degree or higher (FTE)	22.0	16.7	3.48	7.05	6.67	9.86
Number of actual beds	638.8	375.1	160.9	66.6	161.0	123.9
Number of inpatient discharges	33,963.7	20,374.1	9,748.2	4,984.0	9,610.6	9,437.0
Number of outpatient physician visits	370,404.5	178,671.8	210,832.3	157,552.7	135,897.7	86,715.5
Average length of stay	7.24	1.99	5.47	1.18	4.27	1.09
Harfindahl-Hirschman Index, actual-bed-based	586.9	369.6	1,011.4	630.0	1,029.5	641.1
Number of competing hospitals, actual-bed-based	47.3	13.0	34.5	18.8	33.6	19.3
Number of competing private hospitals, actual-bed-based	12.2	4.00	9.06	5.13	8.58	5.37
Harfindahl-Hirschman Index, inpatient-discharge-based	607.0	364.1	1,071.3	665.6	1,071.4	654.7
Number of competing hospitals, inpatient-discharge-based	45.9	12.6	33.6	18.0	32.7	18.7
Number of competing private hospitals, inpatient-discharge-based	12.2	4.00	9.06	5.13	8.58	5.37
Number of samples	15		48		12	

Description	2013					
	Provincial		District		Private	
	Mean	SD	Mean	SD	Mean	SD
Number of medical doctors (FTE)	171.3	104.3	39.5	24.1	58.0	37.3
Of which, post-graduate medical doctors (FTE)	97.7	66.2	17.9	15.71	33.6	25.1
Number of assistant doctors (FTE)	21.2	27.6	26.6	19.1	10.1	17.7
Number of nurses (FTE)	331.8	228.4	63.5	47.0	100.9	81.5
Of which, bachleor's degree or higher (FTE)	27.7	20.2	5.06	9.99	11.88	20.2
Number of actual beds	686.9	412.4	165.1	68.3	160.0	122.1
Number of inpatient discharges	36,193.8	20,988.7	8,983.0	4,778.2	9,008.9	8,337.3
Number of outpatient physician visits	366,506.5	226,471.9	206,894.1	172,165.2	115,981.8	91,758.1
Average length of stay	6.89	1.98	5.42	1.26	4.15	1.31
Harfindahl-Hirschman Index, actual-bed-based	544.5	330.3	972.8	601.7	984.4	624.9
Number of competing hospitals, actual-bed-based	48.2	11.3	35.2	18.3	35.0	18.9
Number of competing private hospitals, actual-bed-based	12.6	3.01	9.35	4.94	9.06	5.29
Harfindahl-Hirschman Index, inpatient-discharge-based	595.4	413.1	1,029.7	652.8	1,002.5	628.9
Number of competing hospitals, inpatient-discharge-based	46.8	10.8	34.3	17.6	34.1	18.2
Number of competing private hospitals, inpatient-discharge-based	12.6	3.01	9.35	4.94	9.06	5.29
Number of samples	19		49		17	

Source: MOH/DOHs and the original survey by the author.
Note: SD denotes the standard deviation.

Table 6 Estimation results of the models

Model 1

Description	Actual-bed-based HHI								Inpatient-discharge-based HHI							
	Truncated regression		Bootstrap						Truncated regression		Bootstrap					
	Coefficient	SE	99% CI		95% CI		90% CI		Coefficient	SE	99% CI		95% CI		90% CI	
			LB	UB	LB	UB	LB	UB			LB	UB	LB	UB	LB	UB
Average length of stay	0.718	0.245	-0.163	1.148	0.194	1.090	0.334	1.064	0.694	0.241	-0.140	1.104	0.185	1.056	0.323	1.022
Harfindahl-Hirschman Index (HHI)	0.000	0.001	-0.003	0.004	-0.002	0.002	-0.002	0.002	0.000	0.001	-0.002	0.002	-0.001	0.002	-0.001	0.002
Number of competing hospitals	0.532	0.338	-0.389	1.293	-0.100	1.126	0.049	1.062	0.539	0.269	-0.359	1.100	0.007	0.963	0.131	0.910
Ownership (provincial)	-1.245	0.643	-2.426	1.055	-2.233	0.247	-2.145	-0.288	-1.162	0.631	-2.305	1.111	-2.125	0.291	-2.010	-0.159
Ownership (private)	1.416	0.601	-0.722	2.606	0.297	2.398	0.621	2.276	1.449	0.618	-0.578	2.624	0.146	2.452	0.510	2.324
Region (Hanoi)	-18.63	10.83	-43.42	11.95	-37.58	1.659	-35.27	-3.498	-17.59	8.756	-35.60	11.74	-31.40	0.602	-29.80	-4.494
Region (Ho Chi Minh City)	-21.33	12.46	-49.92	14.28	-43.11	1.990	-40.67	-3.792	-19.81	9.77	-39.84	12.57	-35.16	0.002	-33.42	-5.146
Time trend 2012	-0.036	0.421	-1.279	1.257	-0.858	0.835	-0.700	0.632	0.005	0.430	-1.340	1.368	-0.867	0.870	-0.705	0.681
Time trend 2013	0.489	0.414	-1.060	1.356	-0.420	1.193	-0.186	1.109	0.521	0.427	-0.934	1.544	-0.387	1.284	-0.200	1.138
Sigma	0.997	0.206	0.355	1.402	0.645	1.356	0.740	1.323	1.006	0.211	0.359	1.419	0.597	1.355	0.720	1.326
Number of samples	242								242							
Log-likelihood	-35.40								-35.56							

Model 2

Description	Actual-bed-based HHI								Inpatient-discharge-based HHI							
	Truncated regression		Bootstrap						Truncated regression		Bootstrap					
	Coefficient	SE	99% CI		95% CI		90% CI		Coefficient	SE	99% CI		95% CI		90% CI	
			LB	UB	LB	UB	LB	UB			LB	UB	LB	UB	LB	UB
Average length of stay	0.715	0.241	-0.099	1.137	0.228	1.083	0.361	1.046	0.706	0.245	-0.165	1.149	0.205	1.098	0.361	1.053
Harfindahl-Hirschman Index (HHI)	-0.002	0.001	-0.004	0.002	-0.003	0.000	-0.003	0.000	-0.001	0.001	-0.003	0.002	-0.003	0.001	-0.002	0.001
Number of competing private hospitals	0.262	0.144	-0.224	0.605	-0.006	0.523	0.050	0.479	0.391	0.194	-0.361	0.776	-0.036	0.703	0.090	0.672
Ownership (provincial)	-1.224	0.627	-2.373	0.848	-2.192	0.071	-2.077	-0.260	-1.191	0.638	-2.402	1.205	-2.176	0.267	-2.083	-0.146
Ownership (private)	1.457	0.603	-0.579	2.758	0.209	2.476	0.584	2.373	1.442	0.618	-0.552	2.727	0.285	2.474	0.557	2.360
Region (Hanoi)	-4.119	1.917	-8.091	2.815	-7.262	-0.284	-6.901	-1.307	-4.523	2.475	-9.370	4.583	-8.327	1.334	-7.916	-0.409
Region (Ho Chi Minh City)	-5.247	2.336	-10.31	3.055	-9.16	-0.575	-8.704	-1.841	-6.265	3.201	-12.22	6.807	-11.16	1.258	-10.57	-1.096
Time trend 2012	-0.067	0.413	-1.093	1.233	-0.838	0.736	-0.704	0.593	-0.126	0.434	-1.265	1.088	-0.898	0.724	-0.781	0.513
Time trend 2013	0.521	0.405	-0.896	1.446	-0.270	1.230	-0.092	1.115	0.460	0.424	-0.832	1.414	-0.424	1.215	-0.206	1.087
Sigma	0.988	0.202	0.321	1.378	0.615	1.329	0.736	1.298	1.006	0.211	0.338	1.429	0.639	1.382	0.749	1.345
Number of samples	242								242							
Log-likelihood	-34.73								-35.52							

Source: Author’s estimation.

Note: SE denotes the standard deviation; CI denotes the confidence interval; LB and UB denote the lower bound and the upper bound of the confidence interval, respectively. The shadowed CI indicates that the coefficient of the explanatory variable is statistically significant at the corresponding level of significance.

Table 7 Share of hospitals with a specific specialty by ownership type [percent]

	Provincial	District	Private
Outpatient department (OPD)	100.0	100.0	100.0
General internal medicine	95.7	97.1	90.9
General surgery	100.0	94.2	95.5
Emergency	91.3	91.3	86.4
Intensive Care Unit (ICU)	87.0	30.4	59.1
Anesthesiology	100.0	58.0	90.9
Blood transfusion and Hematology	47.8	17.4	40.9
Cardiovascular	100.0	29.0	59.1
Communicable diseases	78.3	62.3	22.7
Dermatology	52.2	31.9	54.5
Diabetes and endocrinology	78.3	31.9	45.5
Dialysis	60.9	11.6	36.4
Gastroenterology	73.9	21.7	59.1
Gerontology	47.8	21.7	18.2
Maxillo-facial-stomatology	91.3	69.6	81.8
Neoplasm and oncology	43.5	8.7	27.3
Neurology	60.9	11.6	36.4
Obstetrics and Gynecology	78.3	87.0	86.4
Ophthalmology	95.7	63.8	72.7
Orthopedics and trauma	91.3	27.5	59.1
Otorhinolaryngology	95.7	69.6	86.4
Pediatrics	78.3	88.4	81.8
Psychiatry	21.7	7.2	9.1
Renal diseases and Urology	73.9	15.9	59.1
Respiratory	73.9	21.7	45.5
Tuberculosis	30.4	14.5	4.5
Number of sample hospitals	23	69	22

Source: The original survey by the author.
Note: The figures are as of the end of 2013.

Abstract (in Japanese)

要約

本研究では、ベトナムの 6 地域の一般病院に対し独自の調査を行い収集したミクロデータを用いて、公立・私立の別や市場における競争の多寡が病院の純技術効率性にどのように関係しているかについて調べた。その結果、郡立病院と比較すると、省立病院の効率性は有意に高く、私立病院の効率性は有意に低かった。また、競合する総病院数と効率性の間には、有意な負の相関がみられ、競合する私立病院数についても同じ結果が得られた。他方で、市場の集中度と効率性の間には、有意な相関がみられなかった。

このような結果は、ベトナムにおいては、病院間の競争が、それらの間の資源配分に問題を生じさせることを示唆しているかもしれない。

キーワード：技術効率性、所有関係、競争、包絡分析法、ブートストラップ法