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Full Length Research Paper

Has the National Health Insurance Scheme improved hospital efficiency in Taiwan? Identifying factors that affects its efficiency

Li Chang[1]* and Yu-Wen Lan[2]

[1]Department of Business Administration, Shih Hsin University, No. 111, Mu-cha Rd., Sec. 1, Taipei 116, Taiwan, R. O. C., Taiwan.

[2]Department of Finance, Lunghwa University, Taoyuan County 33306, Taiwan, R. O. C., Taiwan.

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Striking a balance between containing costs and improving the quality of healthcare is an important issue. In this paper, we used Data Envelopment Analysis (DEA) with variable returns- to- scale to evaluate improvements in healthcare efficiency in terms of cost (input) and quality (output) in Taipei hospitals from 1989 to 2001. We also adopted Tobit regression analysis to determine which factors were the major determinants of efficiency during the study period. Our findings showed that efficiency did not improve after the implementation of the National Health Insurance (NHI) Program. The factors that affected efficiency included the proportion of elderly patients, competition, average Length of Stay (LOS), the adoption of new technologies and the number of beds (scale). The increase in the number of elderly covered by the NHI scheme compared to previous schemes, the increase in the average LOS and inefficient usage of beds were the major factors responsible for the decline in hospital efficiency. Our primary suggestions are to enhance efficiency and cost-effectiveness for the provided healthcare, and as such: (1) the government should expand health promotion and disease prevention programs for the elderly; and (2) hospital managers should reduce the average length of stay and force to the efficient usage of beds.

Key words: Hospital efficiency, determinants of efficiency, cost, quality.

INTRODUCTION

Cost containment and improving the quality of care are the two major concerns currently highlighted by healthcare providers and policymakers (Anderson et al., 2000). Even though it has been shown that cost and quality are positively related (Younis et al., 2005), all too often policymakers deal with cost and quality issues separately (Jiang et al., 2006). This creates a conflict between cost containment and quality improvement because it is difficult to achieve the goals simultaneously. Therefore, striking a balance between cost containment and quality improvement is an important issue. However, efficiency is defined as the best balance between health expenditures (the input) and final health outcomes (the output) (Palmer and Torgerson, 1999; Schwartz et al., 2002). In this study, we examine the issue from the viewpoint of efficiency (Nixon and Ulmann, 2006) to find the best balance between the two seemingly opposite goals (Martin et al., 2008).

Taiwan's National Health Insurance (NHI) scheme with the Fee-For-Service (FFS) system was launched in March, 1995 (Cheng, 2003). The NHI was designed to encourage free competition and use centralized monitoring to achieve cost containment and quality improvement. Since 1995, three notable events have affected the realization of these goals. First, the Bureau of National Health Insurance (BNHI) was established. It is responsible for allocating resources and monitoring costs. Second, legislation was introduced that allowed the market to open up and new contractual hospitals to emerge; as a result,

*Corresponding author. E-mail: scottlic@cc.shu.edu.tw. Tel: +886-2-2236-8225, Ext 63929. Fax: +886-2-2236-8669.

the proportion of contractual hospitals rose from 41% in 1989 to 92% in 2001. Third, after the implementation of the NHI, the percentage of the population covered by insurance increased dramatically, from 49% in 1989 to 96% in 2001. The dual pressures of more thorough monitoring by the BNHI and market competition have forced hospitals to improve efficiency, both in terms of cost containment and quality of care (Lu and Hsiao, 2003).

Although, a positive relationship between cost and quality has been documented (Siegrist and Kane, 2003), researchers still tend to focus on either quality or cost; few have examined both simultaneously. Moreover, relatively few works in the literature consider cost and quality issues from both the micro (individual hospital) and macro (NHI) perspective. At the same time, relevant administrative policies place the primary emphasis on governing at the country level rather than at the individual hospital level. The purposes of this study are: (1) to examine whether the NHI has improved hospital efficiency in terms of cost containment and quality of care; (2) to identify the key factors that affected efficiency before and after the implementation of the NHI; (3) to find the relationship between efficiency and its factors; and (4) to improve efficiency. The findings may also be useful to overseas healthcare organizations that are interested in entering the Taiwan healthcare market, which has been opened in compliance with provisions of the World Trade Organization's (WTO) bilateral trade agreements (Hung and Chang, 2008).

BACKGROUND AND LITERATURE REVIEW

The national health insurance system

Political pressure and the pace of social welfare reform led to the introduction of the NHI scheme in 1995 (Chiang, 1997). Before this scheme, approximately 50% of Taiwanese citizens were covered by three major public health insurance programs: Government employee insurance, farmer's health insurance, or labor insurance (Chang, 1998). However, these programs ran at a loss (Cheng, 2003). As a result, the government integrated all healthcare programs into the universal NHI scheme. The major objectives of the NHI scheme are: (1) to control healthcare expenditures through centralized monitoring; (2) to improve healthcare quality through augmented competition (Chang et al., 2004).

However, after the introduction of universal healthcare, costs continued to increase and quality improvement remained slow (Cheng, 2003). Finding ways to improve quality while maintaining reasonable healthcare expenditures has become the NHI body's mission. Therefore, in this study, we adopt a maximized efficiency perspective, rather than simply undertaking a unilateral discussion of either cost or quality like many previous studies.

Improving cost containment and quality simultaneously is a major challenge (Litvak and Long, 2000). The paradox lies in the fact that, to improve healthcare, it is necessary to hire more skilled professionals, buy more up-to-date equipment, and implement advanced technical innovations, all of which are costly (Shen, 2003). It seems that, despite its best efforts, the NHI cannot control costs effectively and improve the quality of care. The efficient allocation of healthcare resources between cost and quality has not proven very successful. Indeed, hospitals have recklessly expanded their budgets under the guise of improving quality (Lu and Hsiao, 2003). The NHI has posted financial deficits every year since 1997 as a consequence. The losses have seriously hampered efforts to introduce healthcare reforms; thus, more efficient allocation of resources has become a priority.

Determinants of hospital efficiency

In the literature, the determinants of hospital efficiency are competition, aging of the population, length of stay, occupancy rate, hospital scale, doctor density, nurse density, new technology, family structure, household income and health policy (Chang, 1998; Carey and Burgess, 1999; Donaldson, 2001; Chang et al., 2004; Chang et al., 2004; Werner and Bradlow, 2006; Deily and McKay, 2006; Jiang et al., 2006; Jha et al., 2007; Werner et al., 2008). Following the classifications of Tennyson and Fottler (2000); McCue et al. (2001), we utilized competition (CP), family structure (FS), household income (FI) and aging of the population (AP) to represent the environmental dimensions. In addition, we adopted size (BED), average length of stay (LOS), occupancy rate (OR), new technology (NT), professional density (DOC), and teaching status (TEA) as the organizational dimensions. Meanwhile, to improve the statistical power of such a small sample, we reduced the number of independent variables (Chang et al., 2004). To do this, we used correlation matrix analysis and stepwise discriminant analysis and retained the following five variables: AP, CP, BED, LOS and NT. We discuss the related hypotheses in more detail as follow. It is generally recognized the elderly people, that is those aged 65 and over (AP) have poorer health than the general population (Sehamani and Gray, 2004). For example, people in that age bracket use 3 times more hospital services than the general population (Goetghebeur et al., 2003). Their high healthcare costs and high mortality rates lead to poor efficiency (Chi and Hsin, 1999).

Patients are also free to choose their own healthcare providers and selective contracting for health plans promotes CP (Hunt and Morgan, 2004). Thus, hospitals are forced to provide high-quality services and contain costs in order to survive in the face of strong competition (Propper et al., 2002).

An important measurement of the operational index is average LOS (Brownell and Roos, 1995). A shorter average

average LOS represents better treatment and means being able to treat more patients (Clarke, 2002). Appropriate treatment should lead to lower costs and better quality which translates into high efficiency (Chang et al., 2005). The use of NT in the healthcare industry increases the capacity for early diagnosis and treatment (Blendon et al., 2004). New technology can also help reduce treatment errors and improve physicians' clinical decisions, leading to better efficiency that is lower costs and higher quality (Chou et al., 2004). Since large hospitals have more resources than small hospitals, they are better able to improve quality and control costs (Aiken et al., 2002). Hence, it is assumed that BED plays a key role in a hospital's efficiency. Based on the above, the following hypotheses are proposed:

H_1: Efficiency is higher after the NHI than before.
H_2: Aging is negatively associated with efficiency.
H_3: Competition is positively related to efficiency.
H_4: Average length of stay is negatively related to efficiency.
H_5: Advanced technology is positively associated with efficiency.
H_6: Scale is positively linked to efficiency.

RESEARCH FRAMEWORK AND METHODS

Research framework

Our study was conducted in two stages. In stage one, we measured hospital efficiency based on the DEA-BCC model with a hospital's input items (costs) and output items (quality). The DEA is a non-parametric linear programming model adopting multiple inputs and multiple outputs for the evaluation of decision-making units (DMUs). It is an extension of Banker et al's. (1984) BCC model which has been widely applied in the healthcare field. Moreover, from the macro (policymaker) viewpoint, two input variables (the ratio of total revenues to the total number of patients (REV), and the ratio of Operational Revenues to the total number of patients in a hospital (OREV), as well as two output variables (the Inverse of the Mortality Rate (IMR) within one month and the Inverse of Infection Rates (IIR) within one month (Ibrahim et al., 2006) were included in the DEA-BCC model. For the micro (hospital manager) viewpoint, the two input variables (the ratio of total costs (including operational and non-operational costs) over total revenues (TC), and the ratio of total operational costs over total revenues (OC), as well as two output variables (the IMR, and the IIR) were also included in DEA-BCC model. Thus, we were able to get hospital efficiency (EFF_{macro}; EFF_{micro}) from both the macro and micro viewpoint.

In stage two, we used Tobit regression to identify the determinants of hospital efficiency (EFF_{macro}; EFF_{micro}) before and after the implementation of the NHI scheme. This is because that efficiency scores computed with the DEA model have a limiting value (the range is from zero to one) and OLS regression will produce biased parameter estimates (Austin et al., 2000). Therefore, adoption of Tobit regression gives more accurate parameter estimates with this empirical model. The empirical model is summarized as follows:

$$EFF\ (macro) = {}_0 + {}_1 AP + {}_2 CP + {}_3 LOS + {}_4 NT + {}_5 BED + {}_6 DB + {}_7 BA + \quad (1)$$

$$EFF\ (micro) = b_0 + b_1 AP + b_2 CP + b_3 LOS + b_4 NT + b_5 BED + b_6 DB + b_7 BA + v \quad (2)$$

Dependent variable

EFF (macro) or EFF (micro) = efficiency index; the efficiency score of a hospital's input (cost) over its output (quality) is computed from the DEA-BCC model.

Independent variables

Market factors

AP = demand index of a market factor (the population aged 65 in a district and over / the total population in a district).
CP = competition index, (1- (individual hospital's patient days / all hospitals' patient days in a district).

Operational factors

NT = new technology, index of scale (new medical equipment / total fixed assets).
LOS = average length of stay, index of hospital operations (the logarithm of the total number of inpatient days over the total number of admissions).
BED = number of beds which represents a hospital's scale (the logarithm of total number of beds in one hospital).

Control variables

DB = debt ratio (total debts / total assets)
BA = dummy variable (years since the implementation of the NHI = 1 (from 1995 to 2001); years before the implementation = 0 (from 1989 to 1994).
and v = unexplained residual variations.

Data and sample

Being the political and economic center of the country, Taipei has more healthcare resources than any other city in Taiwan. Thus, the experience of the city's hospitals in terms of healthcare reform has become a valuable example for other municipalities. We focused primarily on Taipei's public hospitals because the efficiency of public hospitals is generally poorer than that of private hospitals (Chang et al., 2004) hence; finding ways to improve their efficiency is a crucial issue. Such improvements would also benefit government finances. This is especially important for the NHI scheme, which has been running at a loss for several years. We collected our data from the annual statistics information and health information indices published by the Bureau of National health insurance and Taipei health data center. Our investigation covered the period from 1989 to 2001. We sampled market, operational and financial information from the above-mentioned reports for the following 13 public hospitals in Taipei: Jen Ai, Yang Ming, Zhong Xiao, Hoping, Wan Fang, Chung Hsin, Women and Children, Gan Dau, Chronic Diseases, Songde, Traditional Medicine, Venereal Diseases Control and Taipei hospitals. The total data in the sample were 140, and the distribution of hospitals in the sample is presented in Table 1.

ANALYSES AND RESULTS

Efficiency trend analysis

Trend analysis was used to examine changes in hospital

Table 1. The distribution of hospitals in the sample from 1989 to 2001.

Year	Number of hospitals[1]	Percentage of hospitals in sample to total (%)
1989	10	7.14
1990	10	7.14
1991	10	7.14
1992	10	7.14
1993	10	7.14
1994	10	7.14
1995	10	7.14
1996	11	7.85
1997	11	7.85
1998	11	8.58
1999	12	8.58
2000	12	8.58
2001	13	8.58
Total	140	100.00

[1]The Traditional Medicine hospital commenced official operation in 1996, the Wan Fang hospital began official operation in 1999 and the Gan Dau hospital was officially began operation in 2001. Other hospitals were established before 1989.

efficiency between 1989 and 2001. It can be seen in Figure 1 (as below) that the average efficiency at the macro and micro level declined after the implementation of the NHI scheme. This implies that the balance between cost and quality has deteriorated since the scheme was implemented.

Univariate analysis - A comparison of the data between two subgroups

Table 2 lists the univariate test of the efficiency of Taipei's public hospitals before and after the scheme was introduced. The statistics provided evidence of several changes during the study period.

First, the number of elderly, the number of hospital beds, and implementation of new technology showed a significant increased after the NHI. Second, longer LOS and declining occupancy rates indicated waste of healthcare resources after the NHI. Finally, efficiency decreased significantly after the implementation of the NHI. In other words, the NHI scheme has failed to promote hospital efficiency on the macro and micro levels.

Tobit regression analysis - Determinants of hospital efficiency

As shown in Tables 3 and 4 , all the coefficients of BA (the dummy variable) are significantly negative. Clearly, efficiency had declined since the introduction of universal healthcare in 1995. In addition, Tables 3 and 4 show that AP, CP, LOS, NT and BED have had the most influence on efficiency (EFF) on both the macro and micro levels.

Moreover, the relationship between AP and efficiency was significantly negative. Competition had a positive and significant influence on efficiency. The relationship between LOS and efficiency was significantly negative. Also, NT was positively associated with efficiency. Interestingly, scale (BED) was negatively related to efficiency on the macro level. In contrast, scale (BED) was positively correlated with efficiency on the micro level. This implies that large hospitals can claim a larger share of reimbursements under the FFS system, which has increased the NHI's costs without significant improvements in the quality of care.

The test results for the hypotheses

The test results for the hypotheses are shown in Table 5. Overall, our investigation had shown that hospital efficiency did not improve after the NHI, which is inconsistent with hypothesis 1. Also, AP, CP, LOS, NT and BED were the main factors affecting healthcare efficiency during the study period. Moreover, the relationship between the variables (AP, CP, LOS and NT) and efficiency (EFF) was consistent with our hypotheses 2, 3, 4 and 5. Only BED was negatively related to efficiency on the macro level, which is inconsistent with hypothesis 6.

DISCUSSIONS AND CONCLUSIONS

In this study, we have attempted to determine whether healthcare reform in Taiwan has achieved its goals that are better efficiency in terms of cost containment and improving the quality of patient care. Moreover, we find the main factors that have an influence on hospital efficiency, and investigate the relationship between

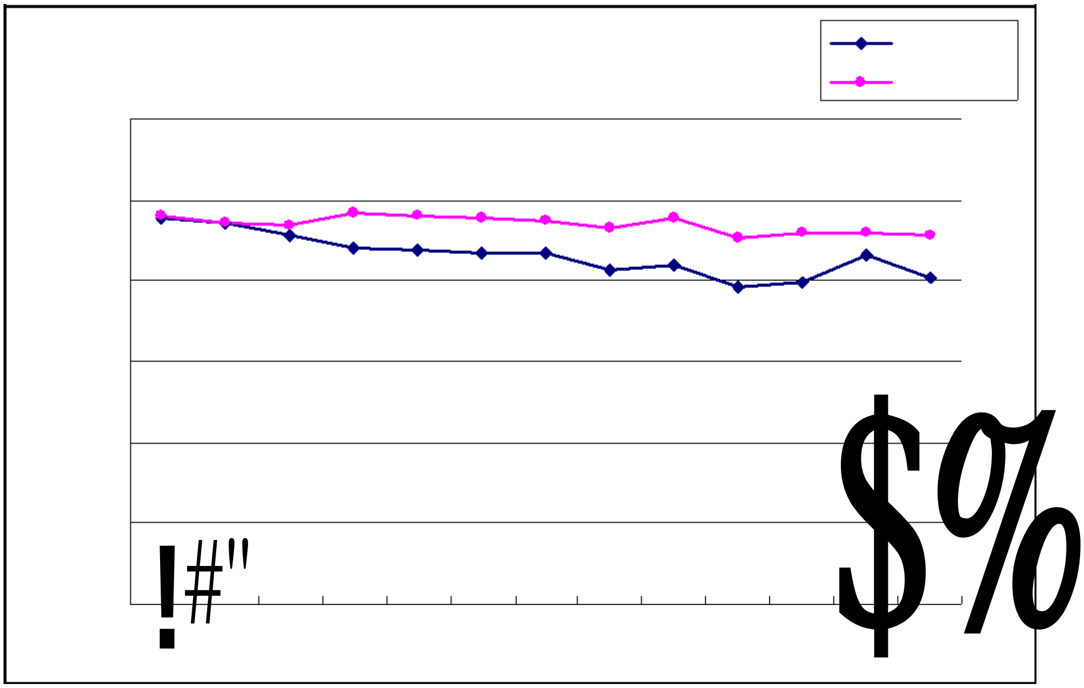

Figure 1. Trend in efficiency from 1989 to 2001 (Source: National health insurance annual statistical information, 2006). Taiwan implemented the NHI scheme in 1995.

Table 2. Univariate analysis before (1989-1994) and after the NHI (1996-2001)[1].

Variable	t-test			
	Mean		Difference (after – before)[2]	
	After the NHI(n = 70)	Before the NHI(n =60)	t-value[3]	p-value (significance)
Dependent variable				
Efficiency-macro	0.7820	08550	-6.9210	0.0000***[5]
Efficiency-micro	0.9104	0.9468	-5.2960	0.0000***
Independent variable				
Market factors				
Competition Index	0.3964	0.3954	1.2560	0.2458
Population aged 65 and over	0.0980	0.0757	38.6650	0.0000***
Household income	6.1493	6.0069	17.9250	0.0000***
Operational factor				
Beds	2.4769	2.3251	5.6880	0.0000***
Occupancy rate	0.6448	0.6524	-0.5340	0.3674
Average length of stay	1.1812	1.1464	0.1620	0.1565
Advanced technology	0.7083	0.4761	10.4140	0.0000***
Financial factor				
Debt structure (%)	0.6532	0.4341	7.5600	0.0000***
N (samples)	70	60		

1. To avoid the confounding effect, we excluded data for 1995 (The NHI implemented in 1995), 2. The difference represents the net amount between variables after and before the NHI. 3. This study used the t- test to obtain the t value. We also adopted the Wilcoxon test (z value) to test for robustness; the results are similar to those from t- test, 4. This study used the Wilcoxon test for the z value, 5. * Significant at the 0.10 level, ** Significant at the 0.05 level, and *** Significant at the 0.01 level.

Table 3. Tobit and OLS regression analysis of efficiency (Macro) between hospital revenues to patients and hospital quality before and after the NHI (from 1989 to 2001). $EFF\ (macro) = {}_0 + {}_1 AP + {}_2 CP + {}_3 LOS + {}_4 NT + {}_5 BED + {}_6 DB + {}_7 BA +$

Dependence Var.: Efficiency-macro	**Macro side**							
Method	**Tobit Regression analysis**							
Independence variables:	**Model (1)**		**Model (2)**		**Model (3)**		**Model (4)**	
Constant	1.1816	0.0000***[4]	0.8793	0.0000***	0.8766	0.0000***	1.2016	0.0000***
AP (Aging people at 65 and over)[2]	-0.0677	0.3521[3]	-0.2205	0.0000***	-0.2327	0.0000***		
CP (Competition)	0.1629	0.000***	0.2467	0.0000***	0.2566	0.0000***	0.1186	0.0000***
LOS (Average length	-0.1246	0.0000***	-0.1088	0.0000***	-0.1128	0.0000***	-0.1196	0.0000***
NT (Adv. technology)	0.3833	0.2341	0.9850	0.0362**	0.6740	0.0826*		
BED (Scale)	-0.1011	0.0000***					-0.1209	0.0000***
BA (Dummy-after before)							-0.3956	0.0000***
DB (Debt ratio)	-0.1164	0.0000***	-0.0642	0.4273				
X^2	87.0807***		53.0541**		50.9827***		78.1446***	
Pseudo R^2	0.4238		0.2582		0.2481		0.3803	
N	140		140		140		140	
Dependence Var.: Efficiency-macro	**Macro side**							
Method	**OLS analysis[1]**							
Independence Variables:	**Model (5)**		**Model (6)**		**Model (7)**		**Model (8)**	
Constant	1.1641	0.000***	0.8766	0.0000***	0.8738	0.0311**	1.1851	0.0000***
AP (Aging people at 65 and over)	-0.0702	0.0273**	-0.2137	0.0000***	-0.2259	0.0000***		
CP (Competition)	0.1615	0.0000***	0.2415	0.0000***	0.2512	0.0000***	0.1136	0.0000***
LOS (Average length	-0.1213	0.0000***	-0.1059	0.0000***	-0.1098	0.0000***	-0.1154	0.0000***
NT (Adv. technology)	0.3777	0.3273	0.9606	0.02837**	0.6840	0.0732*		
BED (Scale)	-0.0953	0.0000***					-0.1541	0.0000***
BA (Dummy-after before)							-0.0388	0.0000***
DB (Debt ratio)	-0.1134	0.0000***	-0.0649	0.5362				
F	21.1757***		13.5372***		16.1701***		27.3012***	
R^2	0.5149		0.3547		0.3474		0.4799	
N	140		140		140		140	

[1.] OLS analysis is used for robustness testing. [2.] EFF(macro) = efficiency of input (cost) to output (quality) on the macro level; AP= population aged 65 and over; CP = competition index; LOS = average length of stay; NT = advanced technology (medical equipment/total fixed assets); BED = total number of beds per hospital; DB = debt ratios; BA = dummy variable (the years after the implementation of the NHI = 1 (from 1995 to 2001); years before = 0 (from 1989 to 1994)). [3.] The p value is reported in Table 3. [4.] *Significant at the 0.10 level; ** Significant at the 0.05 level; *** Significant at the 0.01 level.

efficiency and its drivers. Finally, we will discuss how to improve efficiency. Our findings indicated that efficiency had significantly declined after the NHI. There are several possible explanations for this. First, an inappropriate financial incentive program related to the FFS system induces excessive and inadequate services without providing better quality (Cheng, 2003). Second, the ineffectiveness of the BNHI monitoring systems has led to inefficiency (increased healthcare costs and poor quality) (Fu et al., 2004). Third, fixed salary incentives for public hospital-based physicians have led to inefficient usage of resources and maintenance of the quality of care (Chu et al., 2004).

In addition, we found that the main drivers of hospital efficiency were the increase in the number of elderly, competition, the average length of stay, adoption of new technology and the number of beds. The relationship between efficiency and most factors (the number of elderly, competition, the average length of stay and adoption of new technology) was consistent with our hypotheses. However, the relationship between efficiency on the macro level and number of beds was different than our expectation. How do we improve the efficiency? The first step is to explore which factors leading to the deterioration in efficiency. As shown in Tables 2, 3 and 4, the major causes are (1) the growth in the number of elderly population, (2) the increased average length of stay and (3) the increased number of beds (which are negatively related to efficiency). The second step to improve the factors of deterioration in efficiency is as follows:

First, in relation to factor of the aging population, the government should intensively promote health and exercise

Table 4. Tobit and OLS regression analysis of efficiency (Micro) between hospital costs and hospital quality before and after the NHI (from 1989 to 2001). *EFF(micro)* $= b_0 + b_1\, AP + b_2\, CP + b_3\, LOS + b_4\, NT + b_5\, BED + b_6\, DB + b_7\, BA + v$

Dependence Var.: Efficiency-micro	**Micro side**							
Method	**Tobit regression analysis**							
Independence Variables:	**Model (1)**		**Model (2)**		**Model (3)**		**Model (4)**	
Constant	0.9223	0.000***[4]	0.9885	0.0000***	0.9147	0.0000***	0.9287	0.000***
AP (Aging people at 65 and over)[2]	-0.0886	0.0000***	-0.0480	0.0000***	-0.1077	0.0000***		
CP (Competition)	0.1097	0.0000***	0.0773	0.0000***	0.1249	0.0000***	0.0456	0.09218*
LOS (Average length of stay)	-0.0392	0.0000***	-0.0295	0.0000***	-0.0446	0.0000***	-0.0169	0.2837
NT (Adv. technology)	0.4339	0.0372**	0.1084	0.3281[3]				
BED (Scale)	0.0788	0.0000***			0.0848	0.0000***	0.0181	0.3726
BA (Dummy-after and before)							-0.0335	0.0000***
DB (Debt ratio)	-0.0903	0.0000***	-0.0960	0.0000***				
X^2	66.2931***		47.5152**		45.3428***		25.8907***	
Pseudo R^2	0.3744		0.3279		0.3221		0.2697	
N	140		140		140		140	
Dependence Var.: Efficiency-micro	**Micro side**							
Method	**OLS analysis[1]**							
Independence Variables:	**Model (5)**		**Model (6)**		**Model (7)**		**Model (8)**	
Constant	0.9220	0.0000***	0.9854	0.0000***	0.9118	0.0000***	0.9254	0.0000***
AP (Aging people at 65 and over)	-0.0842	0.0000***	-0.4491	0.0000***	-0.1027	0.0000***		
CP (Competition)	0.1060	0.0000***	0.0753	0.0000***	0.1210	0.0000***	0.0459	0.08272*
LOS (Average length of stay)	-0.0366	0.0000***	-0.0272	0.0000***	-0.0416	0.0000***	-0.0156	0.3827
NT (Adv. technology)	0.4118	0.0283**	0.0954	0.3847				
BED (Scale)	0.0760	0.0000***			0.0817	0.0000***	0.0183	0.2383
BA (Dummy-after and before)							-0.0324	0.0000***
DB (Debt ratio)	-0.0903	0.0000***	-0.0954	0.0000***				
F	15.1173***		12.2619***		13.9157***		7.4632***	
R square	0.4177		0.3516		0.328		0.2075	
N	140		140		140		140	

[1]OLS analysis is used for robustness testing. [2]EFF(micro) = efficiency of input (cost) to output (quality) on the micro level; AP= population aged 65 and over; CP = competition index; LOS = average length of stay; NT = advanced technology (medical equipment/total fixed assets); BED = total number of beds per hospital; DB = debt ratios; BA = dummy variable (the years after the implementation of the NHI = 1 (from 1995 to 2001); years before = 0 (from 1989 to 1994). [3]The p value is reported in Table 4. [4]* Significant at the 0.10 level; ** Significant at the 0.05 level; *** Significant at the 0.01 level.

health and exercise programs to improve the health of the elderly.

Obviously, preventing disease would lead to lower healthcare costs and improved quality. Therefore, the government should provide the long-term health examination programs to the aged and build the effective long-term care policy for the elderly that preventing disease is better than providing medical treatment after they become ill (Campbell and Ikegami, 2000). Second, in relation to the factor of the LOS, the inappropriate FFS system has led to increased LOS, because the FFS allows patients to obtain the provision of maximal care, including excessive and unnecessary services (Eddy, 1997). This implies that a longer LOS, which includes excess services and medical waste, induces inefficient allocation of resources. Therefore, linking efficiency and payment is an effective way to motivate efficiency improvement among all hospitals (Rosenthal et al., 2005). Also, hospitals should enhance efficiency and cost-effectiveness care to improve healthcare allocation and to decrease the LOS. In relation to the factor of the number of beds, the evidence shows that the number of large hospitals has increased and the occupancy rates have decreased. This suggests that the increased number of empty beds lead to inefficient resources allocation. In other word, with the BNHI, large hospitals have greater bargaining power than smaller ones to claim more revenues. In contrast, decreased occupancy rates mean more vacant beds which translate into waste of resources. Greater revenues and more vacant beds lead to inefficiency, especially a problem in large hospitals. Therefore, policymakers should replace the FFS with a

Table 5. Results of hypothesis testing.

Proposed hypotheses		Results
H_1	Efficiency after the NHI is higher than before.	Not supported
H_2	Aging is negatively associated with efficiency.	Supported
H_3	Competition is positively related to efficiency.	Supported
H_4	Average length of stay is negatively related to efficiency.	Supported
H_5	Advanced technology is positively associated with efficiency.	Supported
H_6	Scale is positively linked to efficiency on the macro level.	Not supported
	Scale is positively linked to efficiency on the micro level.	Supported

pay-for-performance system that links payments and efficiency to improve on hospital usage of resources.

This interpretation and generalization of our findings are limited by the following: (1) the size and characteristics of the sample; (2) the difficulty in obtaining complete information about the period before the NHI scheme was introduced; and (3) the difficulty in acquiring relevant data about private hospitals (Chang et al., 2004) . In addition, it is difficult to define and measure the quality of healthcare. Mortality rates are more reliable as an indicator of quality of care than is patient satisfactions (Aiken et al., 2002; Picone et al., 2003; Treurniet et al., 2004) . This is why we have used mortality to represent quality of care (Trinh, and O' Connor, 2000; Cheng et al., 2002). In future, we will extend the scope of this study to include more indices for evaluating quality and a larger sample. In addition, we will incorporate Shimshak and Lenard (2008) modified DEA within two-model approach to enhance the current model (Shimshak et al., 2009).

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