Discussion Papers In Simulation Studies No.8

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January 2015

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7-1-28 Minatojima-Minamimachi, Chuo-ku, Kobe, Hyogo, 650-0047, JAPAN

Financial Evaluation of Public Hospitals: A Factor Analysis Approach

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January 7, 2015

Abstract

Public hospitals in Japan have recently experienced financial difficulties, pushing some into bankruptcy. To tackle the problem, drastic reforms are required. In this study, we employ factor analysis to construct indices to evaluate local public hospitals in terms of financial management, medical services, and cost efficiency.

The eight main outcomes reveal that local hospitals have suffered deteriorating financial circumstances because they have lost profit-earning opportunities owing to a severe shortage of doctors. We also conduct a comparison in terms of stability between the results from factor analysis and data envelopment analysis, a traditional method used to evaluate efficiency in the public sector. This comparison reveals that it is inadvisable to discuss efficiency by either of the two methods because the two results are sometimes irrelevant but the main result is upheld: hospitals experience financial distress because of a shortage of doctors, which leads to further problems in providing medical care and generating income. Therefore, this study concludes that measures to address the doctor shortages in financially distressed hospitals should be taken.

Key words:
public hospitals, management evaluation, factor analysis

JEL cord:
C1, H41, I1, L3

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1. Introduction

Public hospitals in Japan have recently experienced operating difficulties, pushing some into bankruptcy.

Japan introduced a universal health-care insurance system and offers free medical care for all citizens, a policy that makes Japanese citizens enjoy one of the longest average life spans in the world. In addition, Japanese medical spending as the percentage of GDP is maintained at 9.6 percent, similar to the average rate in OECD countries. Japanese medical law has a specific statement for public hospitals, which were expected to support the provision of high-quality medical services as part of ensuring universal access to medical care through a public medical service after the World War II. Therefore, public hospitals now assume an important role in the local secondary and high healthcare fields.

However, some public hospitals are experiencing management crises, and a few have been pushed into bankruptcy (such as the Tadaoka public hospital in Tadaoka city, Osaka, which went bankrupt in 2007; the Choshi public hospital in Choshi city, Chiba, which was closed in 2008; and the Matsubara public hospital in Matubara city, Osaka, which was also closed in 2009). Notably, most Japanese public hospitals are experiencing such management crises and holding large debts; therefore, these hospitals cover their income by a provision from the local government's general accounts. However, local governments themselves are suffering from poor financial circumstances, forcing them to reduce their previously large provision for public hospitals as they find it difficult to continue offering such financial support. In addition, there is the bias of doctor distribution in remote areas or for some diagnostic departments such as obstetrics or surgery. A new clinical training system that was introduced in 2004 allowed trainees to freely select their training hospitals, and most trainees chose hospitals that were not located in remote areas, meaning that many hospitals in remote areas could not obtain sufficient numbers of doctors. As a result, some hospitals have been forced to close their diagnostic departments or wards.

To tackle this problem, drastic operating reforms are required by correctly identifying the causal factors behind hospital financial distress. For this purpose, this paper presents the derivation process of an evaluation index for the financial management of public hospitals. We first attempt to clarify the factors that chronically push public hospitals into financial debt and quantitatively analyze the relationships between the shortage of doctors under the Act on Assurance of Sound Financial Status of Local Governments enacted in 2008 and the actions of hospital management. Several studies have produced estimates for the evaluation of public hospitals. Register and Bruning (1987) headed a quantitative analysis for management inefficiency by data development analysis (DEA). The DEA approach has been used in the analysis of various public entities; studies using data from Japan's national public hospitals are Nakayama (2004) and Nozao (2007). Nozao

(2007), particularly, performed a factor analysis of inefficiency, discussed the factors for more efficient management, and found that the factors of inefficient management exist both with and without subsidies or management evaluations by third-party actors. However, the shortage of doctors assumes a large effect on the management of public hospitals, Nozao (2007) could not clearly justify this point.

Using multiple classification analysis, other studies examine financial conditions more directly than that by Hiramatus (1986) and Suzuki (1999). Atoda et al., (2008) perform financial analysis using multiple classification analysis for local government and focus on management evaluation using original evaluation indices. They discuss the potential applicability of these evaluation indices to other nonprofit entities. The indices are assessed by factor analysis, and each factor is related to financial status, effort to improve financial status, level of service efficiency, and efficiency of service cost and cover 13 major cities in Japan. The DEA approach assumes the input and output in advance and analyzes their relationship, meaning available variables are strictly limited.

Factor analysis approaches, such as that used by Atoda et al., (2008), analyze financial status more directly and from more angles; this means that it can directly discuss the improvement of financial management efforts. As the selection of variables in multiple classification analysis is not necessarily only from the input and output factors, this analysis should also assume the same experimental variables as in DEA. To the best of our knowledge, this method has not been used to date to examine public hospitals' financial data. Multiple classification analysis can also use variables such as the number of or salaries of doctors, nurses, or medical engineers, and it may also analyze the relationship between the shortage of doctors and hospital management. Therefore, the factor analysis model that Atoda et al., (2008) used to evaluate local government financial statements will be used in our evaluation of public hospitals' management. The aim of the analysis is to attempt to derive evaluation indices not only for financial status but also for medical service and medical costs, as well as to examine the factors that deteriorate public hospitals' management.

We will first discuss the analysis techniques, data, and variables we use. Second, using factor analysis, we will examine the significant factors and construct the evaluation indices. Finally, we will examine the robustness of these indices using the DEA efficiency score and compare the results of the factor analysis and DEA approach to clarify the differences between the two approaches. In the final section, we conclude our study and present the remaining issues.

2. Factor analysis and evaluation indices

For derivation indices, factor analysis (principal factor method of SMC) with the Kaiser–Guttman rule (Kaiser 1960, Guttman 1954) and varimax rotation is applied to 289 public hospitals' annual data in 2010, which is obtained from "Chihoukoeikigyo nenkan" published by Japan's Ministry of Internal Affairs and Communications. Because the variables are selected form profit-and-loss statements and balance sheets, 289 public hospitals are available for inclusion in the analysis (Soumusyo Zichizaiseikyoku hen 2012). Variables are basically the same as in Atoda et al., (2008) for the derivation of four index categories, namely, flow finance, stock finance, medical services, and medical costs. For each category, four–seven variables are introduced to estimate each evaluation factor.

Table 1 displays the summary of variables and the factor analysis results. For the flow finance category, TOT/TR and TOT/MR show the highest factor loadings in the first factor. This result implies that the amount of total transfers from other accounts is a common factor; thus, it evaluates financial independence from other accounts ("flow independency"). For the second factor, TR/TE and MR/ME show high factor loadings. These variables explain the degree of daily financial health ("flow health").

Next, for stock finance, we first find that CD/TR and CD/MR, where CD implies cumulative deficit, hold the highest factor loadings of 0.97 and 0.95, respectively. CD is the amount of accumulated current account deficits that strain the asset and liabilities when increasing. By inverting these results, factor loadings would show "stock health." The factor-loading scores for Re/TR (0.97) and Re/MR (0.96) indicate the degree of financial burdens to current revenue; thus, these factors evaluate "stock independence."

In the medical service category, the number of doctors or nurses per patient (ND/TP, NN/TP) shows high factor-loading scores. This factor is used to evaluate "medical staff sufficiency." In the second factor, the number of medical technologists per patient (NMT/TP) and the number of beds per inpatient (NB/IP) get comparatively high factor loadings, which are used effectively to evaluate the performance in terms of "medical facility sufficiency."

Finally, for the medical cost category, total salaries paid to doctors, nurses, or medical technologists per patient (TSD/TP, TSN/TP, TSM/TP) show high score loadings. Comparing these scores enables us to evaluate the degree of effort required to reduce personnel expenses ("wage control"). Salary expenditure, in turn, relates to the investment made in the inputs of medical service.

In the second factor, CRC/TP (construction and renewal costs per patient) and asset shrinkage expenses per patient (ASE/TP) show relatively high score loadings. Using these factor scores, we can compare the degree of control over investment costs ("facility and equipment spending control").

Following the above factor analysis, we observe eight evaluation indices in each category. To test the adequacy of the evaluation index introduced by factor analysis, we examine each index in relation to certain study hospitals. For example, the flow health index is the important determinant factor for bankruptcies. In our factor analysis, the public hospital that receives the lowest factor loadings in the flow health index is Maizurushimin hospital. This hospital partially closed their outpatient department because of a severe shortage of doctors and its difficulty to accept emergency patients (Kyotohu 2012). In addition, the second lowest scoring hospital, Shigarakichuo in Shiga prefecture, could not keep a sufficient number of doctors or nurses; therefore, its revenues are falling. Notably, this hospital's bed utilization rate in 2020 will be under 50%. These hospitals have depended on doctors dispatched from the prefectural government's medical laboratories. However, because the number of doctors in the local government has also decreased, it could not dispatch doctors to local public hospitals (Kougashiritsushigarakichuobyoin 2013).

Table 1 Summary of variables and outcomes of factor analysis

								Factor Analysis		DEA	
	Variables	Equation	Obs	Mean	S.D	Min	Max	Factor1	Factor2	(a)	(b)
1.	Flow finance	(1,000yen, %)									
(1)	TR/TE	Total Revenues/Expenses	289	96.24	5.26	74.80	113.14	0.04	0.42		
(2)	MR/ME	Medical Revenues /Expenses	289	88.18	11.67	47.64	114.50	-0.64	0.48		
(3)	TOT/TR	Total other account transfer/Total Revenues	289	14.87	9.66	1.85	62.39	0.96	-0.06		
(4)	TOT/MR	Total other account transfer /Medical Revenues	289	21.05	18.49	2.30	145.82	0.98	-0.11		
2.	Stock finance	(1,000yen, %)									
(1)	Re/TR	Refund/Total Revenues	289	6.78	4.37	0.13	36.30	0.11	0.97		
(2)	Re/MR	Refund/Medical Revenues	289	9.24	7.05	0.20	61.30	0.15	0.96		
(3)	CD/TR	Cumulative deficit/Total Revenues	289	62.48	49.27	0.03	280.84	0.97	0.11		
(4)	CD/MR	Cumulative deficit/Medical Revenues	289	85.07	76.70	0.04	574.87	0.95	0.17		
(5)	CS/TA	Capital stock/Total assets	289	58.86	44.06	0.58	269.32	0.40	-0.15		
(6)	TL/TA	Total liabilities/Total assets	289	-12.74	19.00	-64.60	184.48	0.42	0.17		
3.	Medical service										
(1)	NB/IP	Number of bed/Inpatients	289	1.49	0.45	1.00	3.96	-0.14	0.34		
(2)	ND/TP	Number of doctors/Total patients	289	0.03	0.01	0.00	0.08	0.86	-0.02		
(3)	NN/TP	Number of nurses/Total patients	289	0.18	0.07	0.02	0.41	0.87	0.19		
(4)	NMT/TP	Number of medical technologists/Total patients	289	0.06	0.02	0.01	0.14	0.36	0.49		
(5)	Nex/100P	Number of examinations/100 patiants	289	314.89	182.93	0.50	796.80	0.55	-0.02		
(6)	Nrad/100P	Number of radiations/100 patiants	289	18.03	8.81	2.00	97.80	0.64	-0.02		
4.	Medical cost										
(1)	TSD/TP	Total saralies of doctor(yen)/Total patients	289	49461.92	17135.01	9476.76	118385.00	0.81	-0.02	*	
(2)	TSN/TP	Total salaries of nurses(yen)/Total patients	289	82070.49	31155.57	8751.95	187826.60	0.86	0.06	*	
(3)	TSM/TP	Total salaries of medical technologists(yen)/Total patients	289	26733.36	7724.63	6548.04	65465.95	0.57	0.05	*	
(4)	MC/TP	Total salaries of medical technologists(yen)/Total patients	289	1172.57	592.04	208.12	4174.37	0.69	-0.03		*
(5)	CRC/TP	Constructio and renewal costs(1,000yen)/Total patients	289	363.23	711.44	5.09	6331.92	0.11	0.39	*	
(6)	DE/TP	Depreciation expenses(1,000yen)/Total patients	289	390.67	238.58	62.03	1618.08	0.57	-0.16	*	
(7)	ASE/TP	Asset shrinkage expenses(1,000yen)/Total patients	289	26.86	172.48	0.00	2596.05	-0.03	0.26	*	
5.	Additional variables for DEA										
(1)	II/TP	Inpatients income(yen)/Inpatients	289	31593.70	12203.83	9082.00	62029.00			*	*
(2)	OI/TP	Outpatients income(yen)/Outpatients	289	9306.23	2898.93	3938.00	18116.00			*	*
(3)	Bed num.	Number of bed	289	73.28	15.17	25.40	98.40				*

Note: * variable for applied to DEA model (a) or (b).

3. Management evaluation

We examine the relationships between the eight indexes as shown by the score loadings calculated from the factor analysis to clarify the factors responsible for management problems in public hospitals. To compare the scores, we convert the factor scores into deviation values.[1] Table 2 shows the Pearson's coefficient correlations and their significance. As shown, once hospital management attempts to ensure the provision of sufficient medical facilities, the investment in facilities increases, thereby imposing strain on the hospital's financial condition. In addition, if these new facilities are not sufficiently used to match the investment made and thus do not generate revenue growth, the flow health will deteriorate. This fact implies that a drop in flow health could directly lead to bankruptcy. However, we also note the investment for facilities is a burden on the financial condition of public hospitals.

Flow independence has a positive relationship with medical staff sufficiency but a negative relationship with the wage control index. This implies that the higher the staff wages, the lower the transfers from other account, and thus, flow independence will increase. This appears to contradict the original assumption; however, it would be explained with the outcomes of flow health index as follows. Although, these public hospitals need to invest in expensive medical equipment, given the severe shortage in the number of doctors, using such medical equipment to earn back the investment cost is difficult. This mean that the necessary facility maintenance costs will be a heavy burden unless the hospital depends on transfers from other accounts.

These facts also imply that the shortage of doctors severely harms a hospital's financial conditions because the facilities are insufficiently used. Once a facility investment is made, adjusting its cost is difficult. In other words, the shortage of doctors critically affects a hospital's financial condition and could lead to bankruptcy.

[1] For the conversion, the scores of flow independency, stock health, stock independency and wage control, facility and equipment spending control are inverted for easy interpretation.

Table 2 Coefficient correlation test

Evaluation Index	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)Flow independency	1							
(2)Flow health	0.09	1						
(3)Stock health	0.02	0.32 **	1					
(4)Stock independency	0.02	0.11	0.01	1				
(5)Medical staff sufficiency	0.50 **	0.09	0.05	-0.05	1			
(6)Medical facility sufficiency	0.11	-0.29 **	-0.11	-0.06	0.12 *	1		
(7)Wage control	-0.45 **	-0.02	-0.05	0.06	-0.96 **	-0.23 **	1	
(8)Facility and equipment spending control	-0.07	0.16 **	-0.11	-0.11	-0.03	-0.18 **	0.01	1

Note: Pearson's correlation is significant at 0.01(**), 0.05(*) level.

4. Robustness of evaluation indices

In this study, we apply factor analysis to evaluate the financial status of public hospitals; however, the DEA approach has previously been applied for the same purpose. Therefore, in this section, we report about the testing of the robustness of our index evaluation from factor analysis using these prior DEA evaluation results.

Nozao (2007) analyzes efficiency scores by DEA under the assumption that three inputs, namely, the number of beds (capital; K), wage per day (labor; L), and material cost per day (cost; C), produce two outputs, namely, inpatient and outpatient incomes per patient for an average in a day. To discuss the robustness of the index evaluation, we compare the more detailed variables (model (a), Table 1) and the factor score deviation values derived by factor analysis with the efficiency scores delivered by DEA, which are obtained from Nozao (2007). If the two approaches yield similar scores, we can conclude that our factor analysis approach is valid. For a further robustness check, we also compare the efficiency score by DEA in the same model as Nozao (2007) using our data as the contrast model (model (b), Table 1).

DEA measures constant return to scale (CRS) and variable return to scale (VRS) between zero and one for each id.[2] For the CRS efficiency score, DEA assumes a constant production-possibility frontier. VRS, on the other hand, assumes an inconsistent return to scale.[3] Thus, they both differ from each other. In this study, we mainly compare results obtained from factor analysis and DEA efficient scores; we do not discuss inefficiency in detail but only analyze both CRS and VRS efficiency scores to compare with the results from Nozao (2007).

[2] Details are available in Charnes, Cooper, and Rhodes (1987) for CRS and in Banker, Charnes, and Cooper (1984) for VRS.

[3] We use an input-oriented model that estimates production activity with the smallest input level as ensuring current level output (Nozao 2007). Nozao (2007) notes both CRS and VRS effective scores should be considered. VRS measurement has a restriction that the total weight of the input should be under one for it to assume that the production possibility frontier is inconstant to scale and would therefore be softer than the effective score by CRS, which assumes a constant return.

Table 3 shows the efficient scores and coefficient correlation with the indices. As shown, models A and B both have a comparatively stronger correlation with the wage control index and a negative relationship with the medical staff sufficiency index. Moreover, they have a negative relationship with flow independence but slight correlations with flow health, stock health, and stock independence index, the index that directly leads to bankruptcy. This indicates that management behavior according to the management measurement indicated by DEA cannot directly ensure the prevention of bankruptcy or assure financial recovery. At least in our model, this finding indicates that a hospital that controls its wages has a higher efficiency score by DEA. However, as the loss of revenue stemming from a shortage of doctors is the primary factor causing financial damage, the DEA approach cannot capture this point.

On the other hand, for VRS, both models A and B have slight correlations with the factor scores. This further indicates that the results from DEA and factor analysis could be independent, meaning that we should discuss the evaluation with reference to both results.

Table 3 Index robustness test vs. DEA

	(A)crste		(A)vrste		(B)crste		(B)vrste	
Flow independency	-0.208	**	-0.3065	**	-0.2234	**	-0.4295	**
Flow health	0.0356		0.006		0.0162		-0.0511	
Stock health	-0.0559		-0.1028		-0.0547		-0.1073	
Stock independency	0.0784		0.0797		0.0132		0.02	
Medical staff sufficiency	-0.5449	**	-0.6181	**	-0.4371	**	-0.56	**
Medical facility sufficiency	-0.1374	*	-0.1929		-0.0926		-0.0989	
Wage control	0.5545		0.6239		0.4515	**	0.5619	**
Medical facility sufficiency	0.0636		0.1001		-0.0041		0.0193	

Note: Pearson's correlation is significant at 0.01(**), 0.05(*) level.

5. Conclusion

In this study, eight indexes are determined by factor analysis to evaluate not only financial status but also medical service provision by public hospitals in Japan. We test the robustness of these indexes by comparing them with historical DEA approach data. Our analysis indicates that a shortage of doctors is the main cause of hospital financial distress because it leads to under-utilization of facilities, as well as renders investment in required equipment and departments into wasted expenditure that cannot be recouped, or otherwise, offloaded. Accordingly, ameliorating the shortage of doctors is the most important step to ensure financial health for financially troubled regional hospitals in Japan. In addition, given that facility costs are a heavy burden, public hospitals should carefully judge their investments in this area.

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