EVALUATING THE IMPACT OF THE LOCAL PUBLIC HOSPITAL REFORM AND MEASURING EFFICIENCY OF THE HEALTH CARE SYSTEM IN JAPAN

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ABSTRACT

The health care system of Japan is considered as one of the best in the world in various aspects such as availability, effectiveness and efficiency. The Japanese population has the longest life expectancy among all OECD countries, while the health care spending as a share of GDP is below the most of developed countries in OECD. The success of Japanese health system is contributed to policy-makers who have been proficient at balancing the demands and supplies with dexterous skills of controlling medical prices under the universal health coverage.

Under the context of private sector dominated health care system, the private hospitals are inclined to pursue "profit" rather than performing public functions. Thus, Local public hospital (LPH) system in Japan is considered as an important countermeasure in maintaining equality of the system. LPHs intensively get involved in securing medical services for local residents by performing "policy-based medical services" (PBMS). During the first decade of 21st century, as one of the largest industries owned by local government, LPH's unfavorable performance worsened financial conditions of local government and threatened the equality of the system. Thus, the Ministry of Internal Affairs and Communications (MIC) launched the LPH reform in late 2007. The results from the reform surveillance data show that the financial performance of LPHs has been greatly improved: the percentage of LPHs operating with surplus increased from 25.5% in 2006 to 52.3% in 2010, and annual deficit sharply decreased from more than 190 billion yen to minus 5.6 billion (surplus) yen during the same period.

The financial performance, however, is only one side of the coin. What were systemic effects of the reform? Could the efficiency-improvement oriented reform be justified? These issues may concern policy-makers more. However, there are few studies addressing the issues. In this research, first we described the characteristics of health care system and basic health policies in Japan; second, we investigate the impact of the LPH reform at different levels, from organizational to local health care system levels; finally, we proposed a way to measure the efficiency of local health care system in Japan, and further exam the relationship between volume and outcome efficiency.

Basic health policies and the LPH status and reform were described in **Chapter 2**. Japan's basic health policy is characterized as a combination of publicly-financed health insurance system and a laissez-faire approach to how services are delivered. The policy leads to private sector dominated health care system in Japan. The local public hospital system is considered as an important measure to guarantee the fair accessibility by implementing PBMS which include high-tech medical care, services for remote areas, emergency services and other non-profitable health care services. The LPH reform launched by MIC in late 2007 included following three major components: first, publicizing and monitoring three key performance indicators; second, reorganizing local health care delivery system and third, initiating organizational reform. The reform aimed not only to enhance the fiscal soundness of the system but also to improve equal access to high quality health care.

Chapter 3 investigated distribution of hospital resources in Japan, and the impact of the LPH reform on equality of health care system and on financial conditions between private and local public hospitals. Our findings reveal that hospital resources

were concentrated on HKD, TKY, OSK and other 6 developed and populated prefectures. Density of hospital resources, however, was higher in those underdeveloped prefectures in southern parts of Japan. The prefectures in northern parts had larger proportion of LPH beds. The results of "gap" analysis indicated that though total number of physicians increased for all prefectures through the research period, the "physician gaps" among prefectures increased. More increased physicians went to developed prefectures. We believe downsizing or even closing LPHs because of local financial pressure aggravated the imbalance in physicians among prefectures. The effect of medical staff training policy and other related health policy could not be neglected, neither. For financial performance, compared with private hospitals, the annual growth rate of medical revenue of LPH substantially increased by 2.3% after the LPH reform, which implies that private hospitals and LPHs adopted different strategies to improve their performances after the reform. Some scholars worried that the reform overstated the importance of the financial soundness and compromised the accessibility of medical services. Combining the fact that distribution of hospital resources had worsened from 2006 to 2011, our findings supports the rising concern about the trade-off between pursuing financial performance and performing public functions.

The impact of the LPH reform on hospital staff and national medical expenditure (NME) was investigated in **Chapter 4**. Many studies have revealed that lack of health professionals and imbalance in doctors had been a problem of health care system in Japan for a long time. Our findings indicate that more medical staff were attracted by prefectures with low proportion of LPH beds after the reform. As the LPHs were considered as financial burden for many prefectures, local government had made great efforts to wipe out the deficit of LPHs by downsizing, merging, privatization and many other measures to improve the efficiency of LPHs. Those policies may lead to less increase of hospital staff in prefectures with large proportion of LPH beds. Results about prefectural NME per capita indicated that the MNE equally increased among prefectures regardless of the proportion of LPH bed. These findings imply two possibilities. On the one hand, hospital staff in prefectures with high proportion of LPH bed may assume more workload than those in low LPH bed prefectures, or in other words, possible reduced health care quality in prefecture with high proportion of LPH bed. On the other hand, more patients in high LPH bed prefectures might seek for health care in prefectures other than those where they live. Because though number of local hospital staff did not increase as many as low LPH bed prefectures, demands (NME per capita) evenly increased among all prefectures. Local governments in Japan might have well controlled the deficit of LPHs but at the expenses of accessibility or health care quality. In order to examine the hypothesis, studies about local provision of medical services and patient flow across prefectures need to be conducted.

In **Chapter 5**, the efficiency of local health care system in Japan was investigated, and the relationship between health care volume efficiency and health outcome efficiency was analyzed using two-stage data envelopment analysis (DEA) approach and correlation analysis. At first stage, the improved slacks-based measure (SBM) DEA model is used to estimate efficiency scores for three DEA models based upon service volume efficiency (SVE), general outcome efficiency (GOE) and outcome efficiency for the senior (OES). At second stage, we apply Tobit model to identify the significant exogenous determinants influencing efficiency scores. Finally, relationship between volume and outcome efficiency is investigated using partial correlation analysis by controlling the factors identified by Tobit model. The results reveal that the correlation coefficient between SVE and GOE under the assumption of constant returns-to-scale (CRS) is statistically significant even after controlling the exogenous factors; while the SVE and GOE scores under variable returns-to-scale (VRS) are not significantly correlated with each other after controlling these factors. The GOE and OES scores are highly correlated. These findings indicate that the high SVE may not be necessarily associated with high health outcome efficiency. The effect of economies of scale plays an important role in volume-outcome efficiency relation. The reason, however, still need to be further investigated. The prefectures with high GOE are capable of producing high OES.

In conclusion, this study indicates a possible compromise of equality of health care system in Japan, though financial performance of LPHs had been significantly improved. The accessibility to health care for residents in prefectures with high proportion of LPH beds might have been undermined during 2005 to 2010. Those consequences might partially result from the LPH reform, but the impacts of other health care policies implemented during the same period could not be neglected, neither. The efficiency analysis shows that high volume efficiency does not always associate with high outcome efficiency. The effect of economies of scale plays an important role in volume-outcome efficiency relationship. Thus, the volume efficiency improvement oriented policy can be hardly justified unless there are evidences supporting that these policies would result in better outcome efficiency for the populations. More comprehensive studies are needed to obtain more convincing policy implications.

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LIST OF ABBREVIATIONS

AAD	Average of Admissions and Discharges
ALOS	Average Length of Stay
AMHI	Association-Managed Health Insurance
CRS	Constant Returns-to-Scale
DEA	Data Envelopment Analysis
DID	Difference in Differences Analysis
DMU	Decision Making Unit
DPC	Diagnosis Procedure Combinations
FEM	Fixed Effects Model
FFS	Fee-For-Service
FY	Fiscal Year
GOE	General Outcome Efficiency
HIS	Health Insurance Societies
HOMAS	Hospital Operation Monitoring Analysis Survey
JHF	Japan Hospital Federation
JHIA	Japan Health Insurance Association
LIAC	Local Independent Administrative Corporation
LPH	Local Public Hospitals
LSDV	Least Squares Dummy Variable
MHLW	Ministry of Health, Labor and Welfare
MIC	Ministry of Internal Affairs and Communications
NHI	National Health Insurance
NME	National Medical Expenditure
OES	Outcome Efficiency for the Senior Population
PBMS	Policy-based Medical Service
PPS	Prospective Payment System
PRH	Private Hospitals
REM	Random Effects Model
SBM	Slacks-based Measure
SMHI	Society-Managed Health Insurance
SVE	Service Volume Efficiency
THE	Total Health Expenditure
VRS	Variable Returns-to-Scale

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TABLE OF PREFECTURE NAMES IN JAPAN

No.	Prefecture	Abbr.	No.	Prefecture	Abbr.
1	Hokkaido	HKD	25	Shiga	SIG
2	Aomori	AOM	26	Kyoto	KYT
3	Iwate	IWT	27	Osaka	OSK
4	Miyagi	MYG	28	Hyogo	HYG
5	Akita	AKT	29	Nara	NAR
6	Yamagata	YGT	30	Wakayama	WKY
7	Fukushima	FKS	31	Tottori	TTR
8	Ibaraki	IBR	32	Shimane	SMN
9	Tochigi	TCG	33	Okayama	OKY
10	Gumma	GNM	34	Hiroshima	HRS
11	Saitama	SIT	35	Yamaguchi	YGC
12	Chiba	CHB	36	Tokushima	TKS
13	Tokyo	TKY	37	Kagawa	KGW
14	Kanagawa	KNG	38	Ehime	EHM
15	Niigata	NGT	39	Kochi	KOC
16	Toyama	TYM	40	Fukuoka	FKO
17	Ishikawa	ISK	41	Saga	SAG
18	Fukui	FKI	42	Nagasaki	NGS
19	Yamanashi	YMN	43	Kumamoto	KMM
20	Nagano	NGN	44	Oita	OIT
21	Gifu	GIF	45	Miyazaki	MIZ
22	Shizuoka	SZO	46	Kagoshima	KGS
23	Aichi	AIC	47	Okinawa	OKN
24	Mie	MIE			

Regions and Prefectures of Japan

Hokkaidō

1. Hokkaidō

Tōhoku

2. Aomori
3. Iwate
4. Miyagi
5. Akita
6. Yamagata
7. Fukushima

Kantō

8. Ibaraki
9. Tochigi
10. Gunma
11. Saitama
12. Chiba
13. Tokyo
14. Kanagawa

Chūbu

15. Niigata
16. Toyama
17. Ishikawa
18. Fukui
19. Yamanashi
20. Nagano
21. Gifu
22. Shizuoka
23. Aichi

Kansai

24. Mie
25. Shiga
26. Kyoto
27. Osaka
28. Hyogo
29. Nara
30. Wakayama

Chūgoku

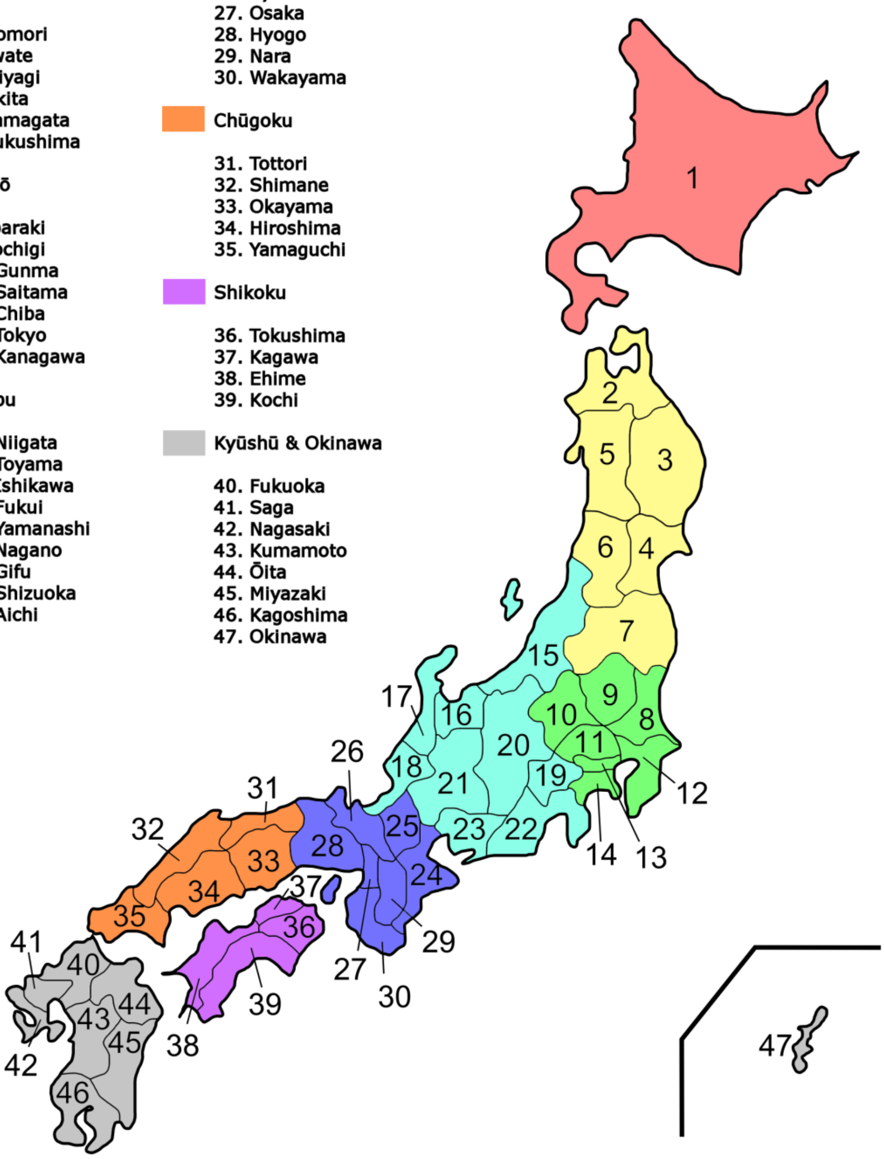
31. Tottori
32. Shimane
33. Okayama
34. Hiroshima
35. Yamaguchi

Shikoku

36. Tokushima
37. Kagawa
38. Ehime
39. Kochi

Kyūshū & Okinawa

40. Fukuoka
41. Saga
42. Nagasaki
43. Kumamoto
44. Ōita
45. Miyazaki
46. Kagoshima
47. Okinawa



1. INTRODUCTION

The health care system of Japan is considered as one of the best systems in the world in various aspects such as its availability, effectiveness and efficiency. In the past 50 years, Japan has achieved satisfactory demographic health at reasonably low cost (Hamada & Lapalme-Remis, 2008; Hashimoto et al., 2011; Jeong & Hurst, 2001; Jones, 2009). The Japanese population has the longest life expectancy among all OECD countries, while the health care spending as a share of GDP is below the most of developed countries in OECD. The success of Japanese health system is contributed to policy-makers who have been proficient at balancing the demands and supply with dexterous skills of controlling medical prices under the universal health coverage(Hashimoto et al., 2011; Ikegami & Campbell, 2004; Ikegami et al., 2011; Jones, 2009).

Japan established universal covered health insurance system in 1961. It is set as a goal of health care system by Japanese government to provide equitable access to “necessary and adequate” medical services to the entire population at a relatively low cost (Jeong & Hurst, 2001; Jones, 2009). To realize the goal, two key issues have been paid substantial attention on. First, the capability of population to pursue necessary and adequate health services, it related to how the health care services are financed. The well-established health insurance system has ensured medical services affordable to every citizen, though it faces increasing financial challenges. Second, accessibility to health care services, it related to how these services are delivered, which, however, has not been well solved yet and faces increasing challenges.

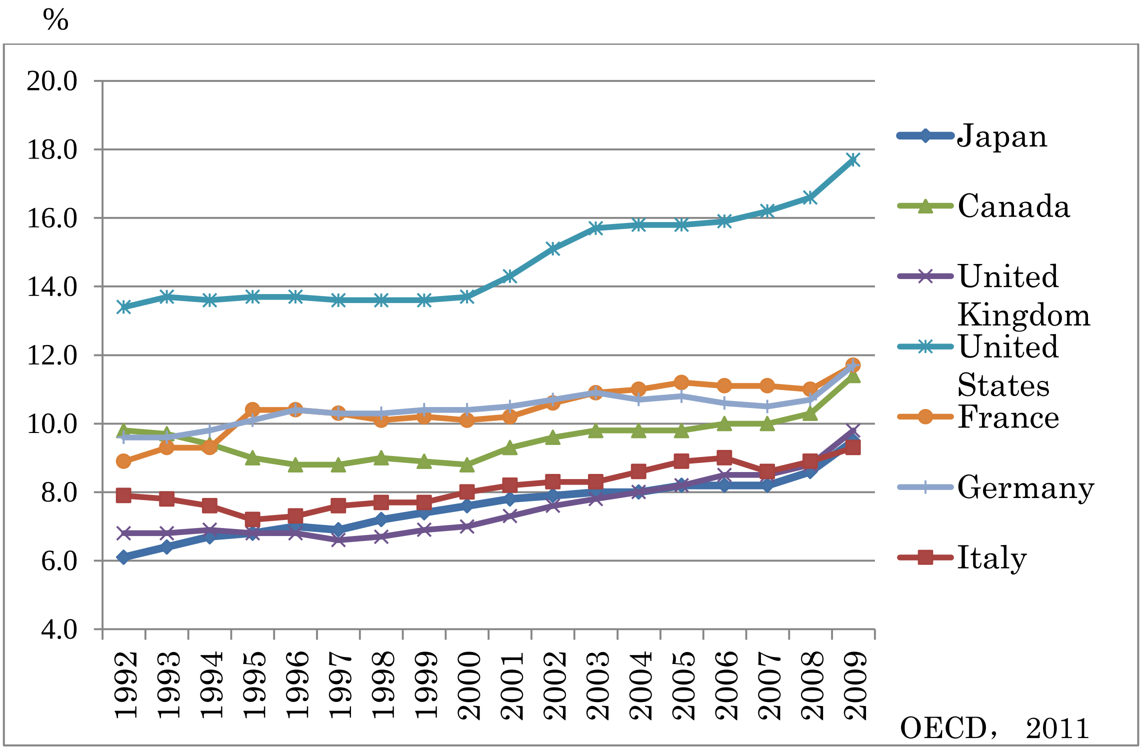
The basic health policy of Japan is characterized as a combination of tight control of payment system and a laissez-faire approach to how services are delivered. For the payment system, the supply-side cost control is imposed by a uniform fee schedule at national level, most providers, no matter private or public sharing the same prices for their medicines, devices and services under this nationwide fee schedule. For the health care system, a laissez-faire approach is adopted by the administration. The health care market is open to all domestic participants equally. The basic health policy has led to three consequences: first, the private sector has dominated the health care system, around 80% hospitals and 70% hospital beds are operated by private sector in 2011 (MHLW, 2011); the second, redundant hospital beds. In 2011, the hospital beds in Japan was more than twice as OECD average, despite a significant drop since 1996(OECD, 2011), and the third, well-controlled health expenditure as shown in **Figure 1-1**.

Although the abundant health resources would have enhanced the accessibility to health care services to some extent, the nature of private medical facilities potentially threaten equality of the system, because the priority of private medical facilities focuses more on "profit" over public functions. The health resources controlled by private sector might follow "cash" rather than needs. Thus, it is possible that insufficient medical resources provide on-profitable services. In order to maintain equity of health care system, the public hospitals are considered as one of important countermeasures, out of which local public hospitals (LPHs) have play an important role in securing medical services for local residents. The LPHs are hospitals owned by local governments. The main functions of LPHs focus more on implementing the so-called "policy-based medical services (PBMS)", which include providing high-tech care for complicated diseases, providing medical care for non-profitable diseases, serving remote areas, getting involved in disaster relief and other public functions.

During the first decade of 21st century, increased health care demands caused by population ageing and deteriorating national financial situation made the health policy at the center of controversy among policy-makers both local and national level, as well as the general public. As one of the largest industries owned by local government, LPH's unfavorable performance worsened local financial conditions, which had suffered from expanding outlays and huge debts. Thus, LPH reform was conducted by the Ministry of Internal Affairs and Communications (MIC) in late 2007. Comprehensive measures were included in the reform guideline aiming at not only enhancing the fiscal soundness but also improving the efficiency and accountability of LPHs. The local governments were required to make a five-year plan according to the guideline. The results of the reform surveillance data show that the percentage of LPHs operating with surplus increased from 25.5% in 2006 to 52.3% in 2010, and annual deficit sharply decreased from more than 190 billion yen to minus 5.6 billion (surplus) yen during the same period (see **Figure 1-2**).

The financial performance of LPHs, however, is only one side of the coin. What were systemic effects of the reform? Could the efficiency-improvement oriented reform be justified? These questions may concern policy-makers more. However, To the best knowledge of the author, there are few studies to investigate these important issues.

This paper is structured as the flow chart in **Figure 1-3**. The basic health policy and the Local Public Hospital reform in Japan are reviewed in **Chapter 2**; impact of the reform on health care system is evaluated in **Chapter 3** and **Chapter 4**; In **Chapter 5**, a two-stage data envelopment analysis (DEA) method is applied to measure the volume efficiency and health outcome efficiency of local health care system in Japan, the relationship between volume and outcome efficiencies is further analyzed in this chapter; and the policy implications and conclusions are presented in the **Chapter 6**.



[a] The health expenditure is used by OECD to compare the health related expenditures among different OECD countries.

[b] National Medical Expenditure(NME)is about 80% as large as health expenditure calculated by the OECD, as it excludes maternity and childbirth expenses, preventative health care and non-prescription drugs(Jones, 2009).

Figure 1-1 Health expenditure and its ratio to GDP

Source: OECD, 2011

Billion Yen %

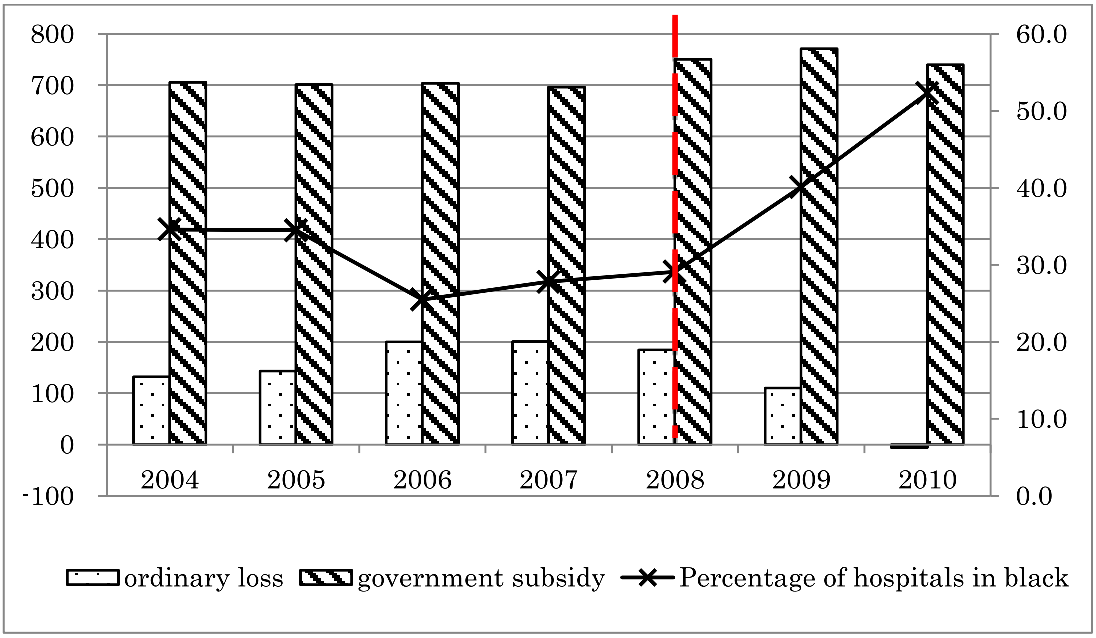


Figure 1-2 The financial situation change of LPHs

Source: Yearbook of Local Public Enterprises, MIC 2011

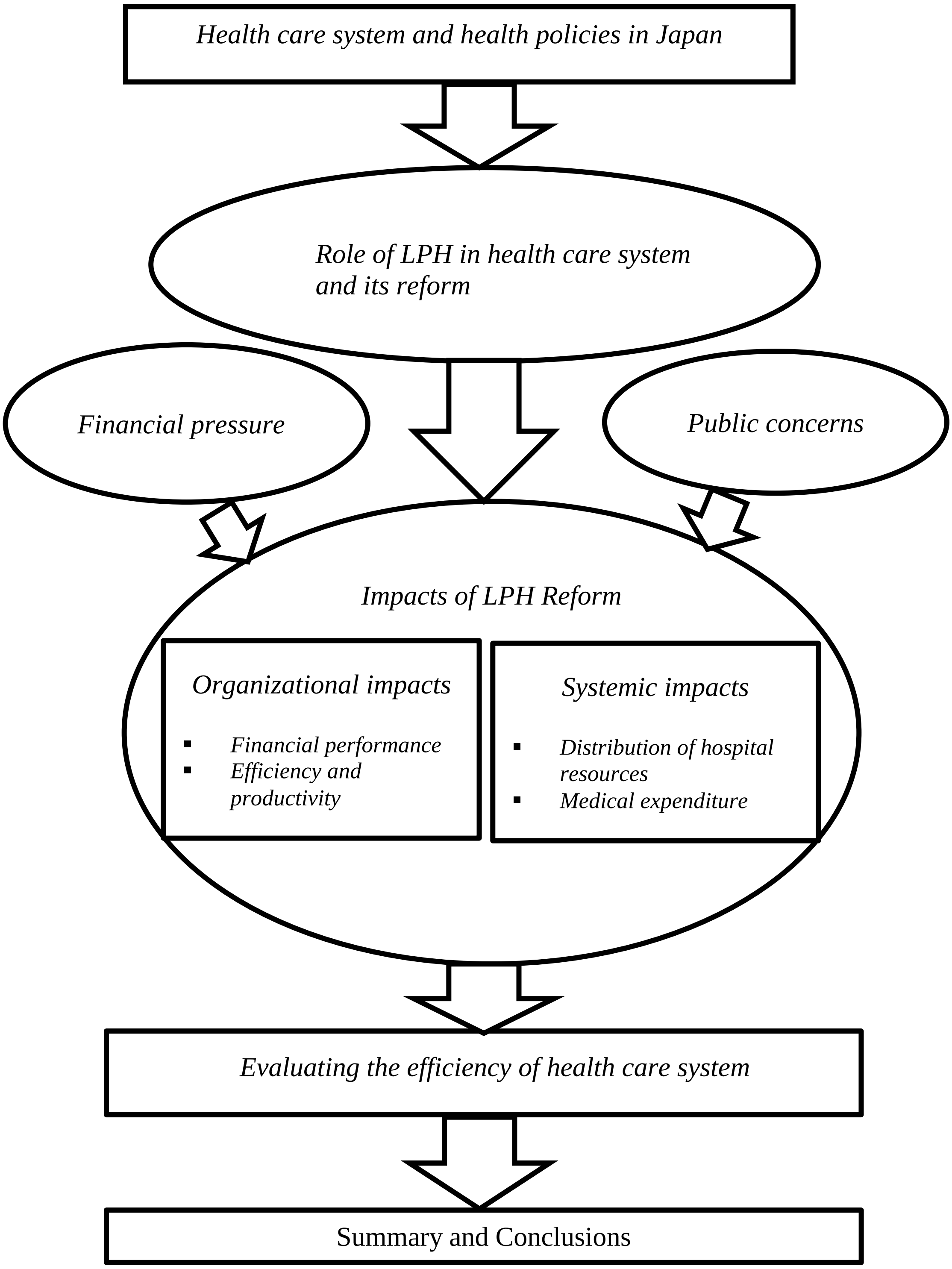


Figure 1-3 Research framework

2. REVIEWING HEALTH CARE SYSTEM AND THE LOCAL PUBLIC HOSPITAL REFORM IN JAPAN

The health care system in Japan is composed of three parties, the population, the providers and the third party insurers. The whole population is covered by 5 major health insurance schemes **Figure 2-1**. People pay for health care in four ways: health insurance contributions; co-payment for insured health services; health insurance taxes; and out-of-pocket payments (for non-covered health services and drugs). The providers include hospitals (with 20 or more beds), most of which are non-profit in that they cannot distribute financial surplus even for those private ones; clinics (with less than 20 beds) that are usually managed by private doctors in independent practice under the fee-for-service basis; health centers which provide public health services; and pharmacies. The third-party insurers are responsible for collecting contributions from the population and employers, and pay the providers directly for the services delivered. In 2011, there were approximately 3500 insurers. Most of them are the quasi-autonomous, non-government bodies charged with the compulsory national health insurance scheme. The insurers are regulated by both central and local governments because of their carrying out of certain public functions. Thus there is little or no competition among them even though they are numerous.

How health care are financed and delivered are two essential aspects of the basic health policy. The first aspect relates to who pays for the health care services, is there any publicly financed health insurance plan share medical burden? The second refers to who provides the health care services, private or public sector? These two aspects have great impact on health status and health spending of a nation.

2.1. Health care system

Japan's basic health policy is characterized as a combination of publicly-financed health insurance system and a laissez-faire approach to how services are delivered (Hashimoto et al., 2011; Hiroi & Kojima, 2004).

The current health insurance system is a complex arrangement because of the way application was expanded in stages. Many health insurance schemes, different financial resources and cross-subsidies among the schemes fabricate a huge and complicated net. There are 4 types of health insurance schemes and one system for advanced elderly people covering almost all population **Figure 2-1**.

Whichever the type of coverage, co-payment structure is unified across nation, which are 20% for those before attendance of compulsory education (before 6 years old), 30% for these after attendance for compulsory education to 69, and 10% for those older than 70(for those age 70 or older but younger than 75, co-payment remains 10% in the period between April 2008 and March 2013 and then rose to 20% gradually. For those age 70 and over with high income [the same level as active workers], co-payment rate is 30%) (MHLW, 2013).

Under the universal covered health insurance system, a tight supply-side cost control is imposed by a uniform fee schedule at national level. The fee schedule controls the money flowing from all insurance plans to almost all providers. The structure makes all 3500 insurers share the same payment system across nation (Ikegami et al., 2011). And most hospitals, no matter private or public, have the same prices for their medicines, devices and services under this nationwide fee schedule. The fee schedule is revised at both the global and the item-by-item basis biennially. At first, the Cabinet decides on the global revision rate for all prices based on the evaluation of nation political and economic situation. And then, the prices of medicines, devices and services are revised on an item-by-item basis under the frame of global revision rate. The effect of revision for each item is volume weighted, which is estimated from the national claims data survey. Official organization named Central Social Insurance Medical Council (CSIMC) which is composed of representatives of stakeholders decides on the price revision for each item. In reality, however, due to the complexity of the process to determine the price for each item, the negotiations are made between providers and officials from Ministry of Health, Labor and Welfare (MHLW). The attitude of MHLW usually substantially influences the result of fee revision. In order to contain the health spending, the influence sometimes links to discourage excessive use of advanced services or even exclude them from the fee schedule, while favor primary health care (Jeong & Hurst, 2001; Jones, 2009).

The coverage of Japan's health care system is shown in **Figure 2-2**. The advanced medical care is just partially covered by health insurance. The depth of Japanese public insurance coverage appears to be relatively low to other developed countries. It reimburses only medical treatments while excludes preventative health care. The National Medical Expenditure (NME), the gray area in **Figure 2-2**, published annually by MHLW covers the insurance payments, co-payments and out-of-pocket payment for traffic accidents but excludes the benefit in cash of childbirth expenses, accident and sickness.

In order to contain the health expenditure, prices of drugs and equipment and fees for physicians and hospitals have been cut repeatedly. Especially after 2002, the government decreased the global rate of fee schedule in four consecutive revisions (see **Figure 2-3**). But this policy might not last anymore. First, the health care demand has significantly increased because of ageing population. Second, the strategy of continuously cutting the fees and the prices cannot continue forever. Prices can fall only so far before products become unavailable and the quality of care suffers. Some scholars argued the point had been reached (Henke, Kadonaga, & Kanzler, 2009). Third, the economy of Japan has been stagnant since late 1980's, and the government debt has been increased as twice as her GDP. It is hard for the government to make any decision to expand the outlays. Thus improve the efficiency of the system seems the effective option to solve the paradox that increases supply while controls expenditure.

For the supply side, a laissez-faire approach is adopted in health care system administration. According to Medical Service Law, establishment of hospitals should be approved by the government, while running a clinic, the owners just need to notify relevant authority. Low entry barrier combined with cultural tradition contributes to large a number of hospitals and hospital beds. It was reported that the number of acute-care hospital bed was as twice as OECD average in 2005 despite a significant drop since 1996 (Jones, 2009). The private sector dominates the health care system, which operates more than 80% hospitals and 70% of beds nationwide. The competition among hospitals is intensive. In recent years, deteriorating national financial situation further enhanced the dominance of private sector in health care system which is considered as more efficient than public one.

Different from other goods, the competition does not always lead to improvement of efficiency in health care market. In Japan, most of medical services are provided on the fee-for-service basis. This payment system links the revenue of health care providers to the volume of services they provide, and may cause overuse of medical services. The health insurers in Japan hardly control the volume of health care consumption which is mainly determined between health care providers and patients. The providers are inclined to maximize their revenue by treating more patients and providing more services, though patients have financial incentive to economize, but asymmetric information between physicians and patients makes it hardly to check physicians' behavior. The long average length of hospital stay (18.5 days in 2009, which is more than twice as the OECD average level) and large share of pharmaceutical expenditure back the possible induced demands in Japanese health care system to some extent.

In order to crowd out the induced medical demands, a prospective payment system (PPS), diagnosis procedure combinations (DPC), was introduced in 2003 by MHLW on the basis of the diagnosis-related groups (DRG) developed by the Yale University Center for Health Studies. The DRGs classify patients into a restricted number of medically justified groups with a statistically stable distribution of resource consumption in each group. The payment for a patient in a given DRG is fixed. If the expenses of treatment for the patient exceed the price of this DRG, the hospital loses money. By 2012, there were 1648 hospitals adopted the DPC system in Japan. However, the studies (Besstremyannaya, 2012; Okamura, Kobayashi, & Sakamaki, 2005; Wang et al., 2010) shown that introduction of PPS resulted in only a limited efficiency gain, which might be related to inadequate incentives by two-part PPS tariff.

The other shortcoming of the laissez-faire health care market is lack of "gate keeper" system. In Japan, patients are almost free to access to any type of hospitals, while in order to achieve financial soundness, hospitals, even tertiary hospitals, are inclined to provide primary health care services which usually are performed by primary health care facilities (Thai, Wimberley, & McManus, 2002). Large share of outpatient care in hospitals would occupy the time that hospital physicians should devote to inpatient care. This may lead to misallocation of the health resources, which probably decreases the efficiency of health care system.

2.2. Local Public Hospital and its reform

The public and private medical facilities receive the same payments according to the uniform fee schedule in Japan. Many public hospitals are compensated for their loss by budget allocations from national or local governments because they have to undertake the PBMS. National public hospitals focus more on highly advanced medical treatment, clinical research for designing health policies, and education and training of health workers, while LPHs concentrate more on the local needs, for example serving remote area, providing emergency services, infectious diseases treatment and control, and other non-profitable health care services.

LPHs are owned by local governments, operating in the form of Local Public Enterprises (LPE) which are established for the purpose of promoting the welfare of local residents. Local Public Enterprise Law (LPEL) is automatically applied to the LPHs. The LPEL stipulates the basic management criteria on organization, finance and personnel administration of LPEs. Local governments could decide on whether the LPHs subject to all articles (full Law-application) or only the financial articles (partial

Law-application) of the LPEL. Theoretically, the LPHs with full Law-application tend to be less intervened by local governments, for their autonomy is guaranteed by the LPEL to some extent. However, the autonomy authorized by local government is limited to deal with affairs related to daily operations as the LPHs do not enjoy independent corporation status. Several fundamental rights, like budgeting, middle and long term planning formulation and other important administrative powers are reserved by local governments.

In 2008, first 22 LPHs were transferred from local governments to Local Independent Administrative Corporations (LIAC). Different from LPHs operated by local governments, LIACs have a legal status which makes them more independent (Tanaka, 2010).

The role of LPHs is even substantial within the context of LPEs. Hospital is one of the most important industries run by LPEs. The LPH was the second largest industry (the LPEs are classified as water supply, transportation, and electricity industries, etc. according to their function) in terms of the expenditure, which was 4.4 trillion yen, 25% of total expenditure, and was the largest industry in terms of revenue which was 3.2 trillion yen, 35.8% of total revenue.

The proportion of LPHs is not quite large in health care system in Japan. According to the data from MHLW, at the end of 2011, there are 836 LPHs, operating 180 thousand beds, hiring 271 thousands staff, accounting for around 11% of hospitals, 13% of hospital beds and 14% of hospital staff. But as shows in **Figure *2-4***, LPHs intensively get involved in performing different PBMSs, Around 68% designated hospitals for serving remote area, 40% emergency centers, 39% regional cancer hospitals, 67% infectious diseases beds, 23% emergency beds and 30% tuberculosis beds were operated by LPHs.

Chronic deficits of LPHs had been a long-standing problem in Japan. Substantial nature of LPHs however made the reform politically difficult. Just before the new policy was proposed for local governments that they had to publish the financial indicators in 2008 based on accounting data with local public enterprises, the MIC timely launched the LPH Reform as a measure to spur local governments to improve the efficiency of the LPHs. Due to the large amount of deficits in LPHs, some local governments had to face financial failure and also might have needed the direct control by the MIC. Financial incentives were introduced to encourage local governments to be fully engaged in the reform. The central government introduced subsidies as well as gave permission of issuing bonds to local governments for restructuring LPHs and developing network of other public health care facilities. Besides improving financial condition, improving the efficiency and accountability of LPHs and developing efficient local health care system were set as other major objectives.

Before the LPH reform, LPHs faced the following major challenges: First, substantial government subsidies, huge debts and high operating costs raised obstacles for the LPHs. Before 2007, the annual government subsidy for LPHs was the second largest in the local public industries, as high as roughly 700 billion yen. Annual issuance of corporate bonds was approximately 300 billion yen, which accumulated to over 4 trillion yen by 2007. Moreover, average operating costs of LPHs were higher than other hospitals under various ownership structures, especially under the category of labor cost. According to the survey from the Japan Hospital Federation in 2012(JHF, 2012), remuneration cost per 100 beds of LPHs was approximately 10 million yen higher than that of private hospitals.

Second, the ambiguity of functions caused problems for LPHs. One of the main functions of an LPH is to undertake PBMS, which are financed by government subsidies. However, on the one hand, other nonpublic hospitals also assumed some public functions, and on the other hand, the LPHs were incapable of providing sufficient PBMS because of their fiscal constraints and common brain drain especially in some remote areas. Furthermore, as there is no gatekeeper system in Japan, a large portion of primary health care services and ambulatory consultations has been performed by LPHs, in direct competition with primary health care facilities. The ambiguous functions of LPHs created misallocation of health care resources.

Third, the unsatisfactory governance structure and lack of autonomy challenged LPHs. The governance structure of LPHs was complicated. The medical chief, who was responsible for medical-related affairs, was dispatched by medical universities, whereas the administrative chief, who was responsible for administrative affairs, was appointed by the local government. This type of so-called “Two Head” structure (Taylor, 2000) impeded the efficiency, accountability and responsiveness of the LPHs. Furthermore, the administrative chief and the medical chief were only authorized to manage daily operations; several important rights were reserved by the local governments. Bureaucratic regulations usually lead to weak responsiveness by LPHs in the competitive health care market in Japan(Hashimoto et al., 2011).

To respond to the challenges mentioned above, especially the financial challenges, a reform was implemented by the MIC in late 2007. Local governments were required to formulate a five-year performance improvement plan, starting in FY2008, according to their practices (MIC, 2007), and in which the following three parts should be included: first, three key performance indicators should be monitored and published, including the ratio of ordinary revenue to ordinary expenditures, the ratio of remuneration expenditures to medical revenue, and the occupancy rate; second, the local health care system should be reorganized by concentrating beds in well-functioning “magnet hospitals” and by building “satellite clinics” to ensure sufficient health care services in rural areas, supported by nearby magnet hospitals; third, organizational reform should be initiated on the basis of reviewing the management of the LPHs. Several measures, including outsourcing daily management, introducing the designated manager system, and corporatization or privatization, were adopted by local authorities. The guidelines also stipulated that the LPHs operating over capacity should cut number of their beds or be replaced by clinics (MIC, 2007).

In March, 2012, a survey was conducted by the MIC in order to evaluate the implementation of the LPHs reform. Percentage of LPHs running black increased from 27.8% in 2007 to 52.2% in 2010, although around 30% of LPHs did not achieve any one of the target performance indicators. Also we find that the ratio of ordinary revenue to expenditure increased from 95.2% to 100.1% in 2010; the occupancy rate decreased from 77.5% to 74.8% and the ratio of remuneration to expenditure deceased from 55.3% to 53.3% during the same period.

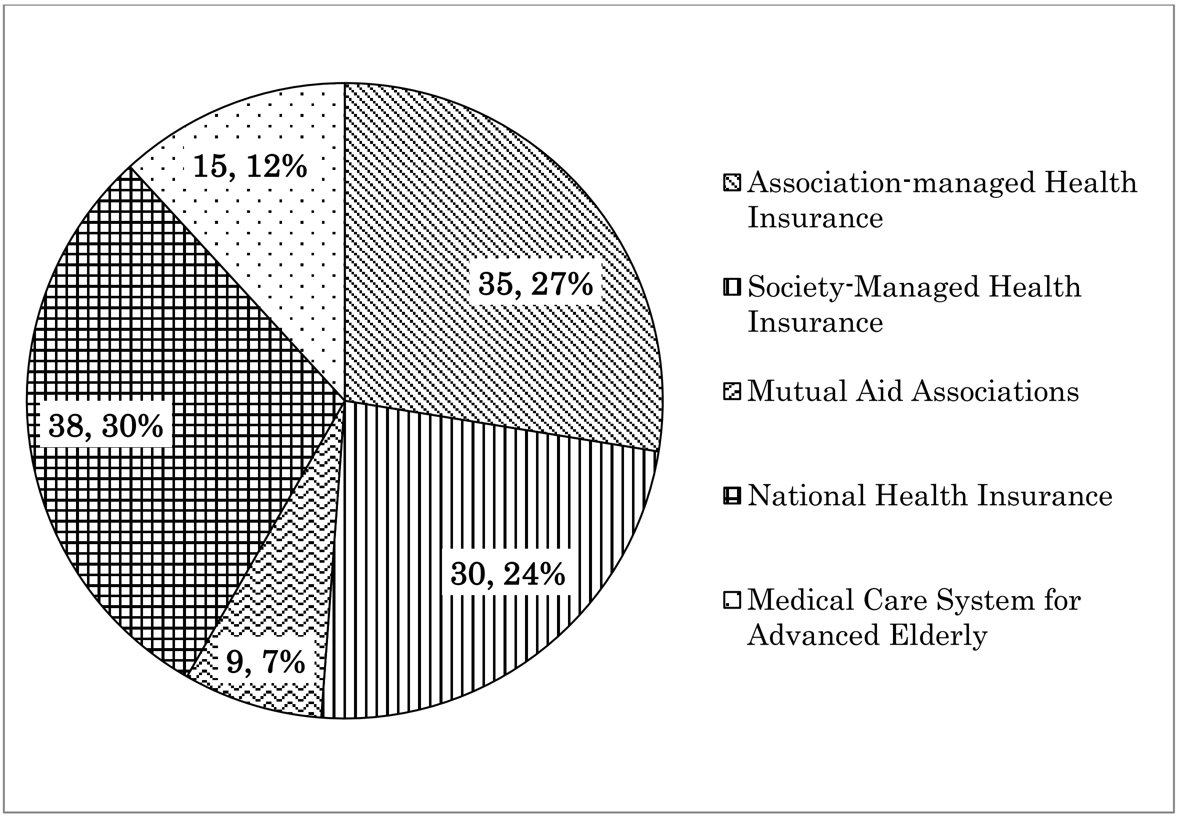


Figure 2-1 Health insurance schemes in Japan in 2011

Source: MHLW White Paper, MHLW

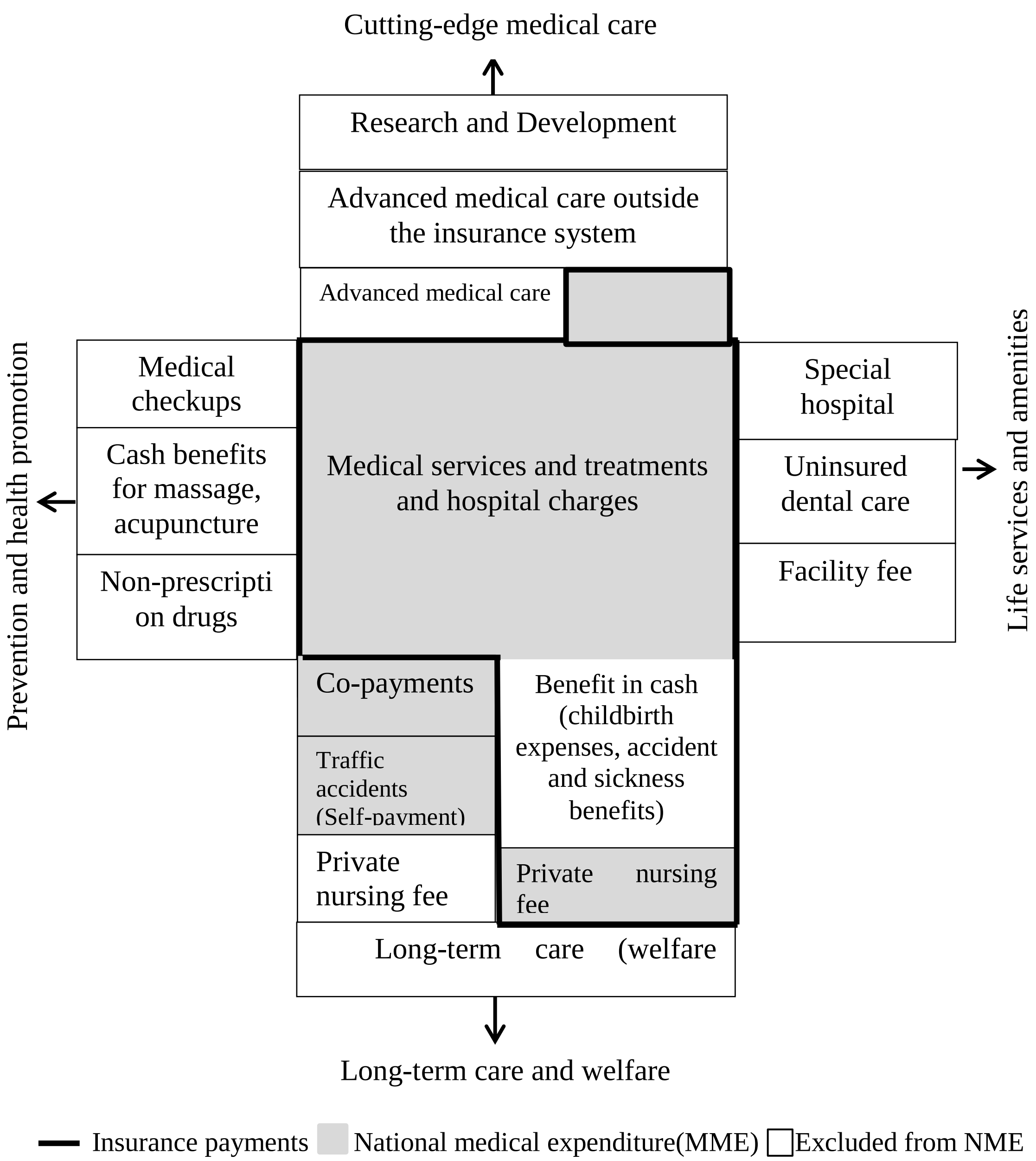


Figure 2-2 The coverage of Japan's health care system

Source: Jones (2009)

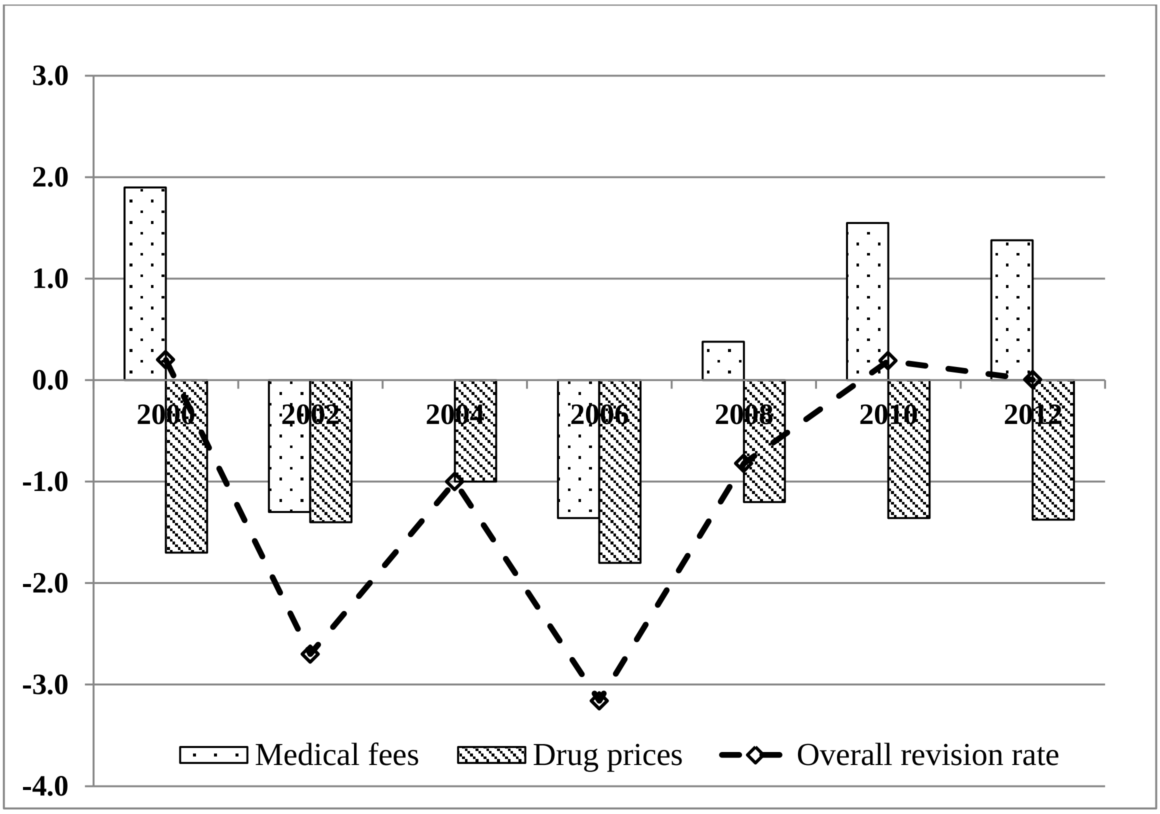


Figure 2-3 Changing global rates of the fee schedule

Source: MHLW White Paper, MHLW

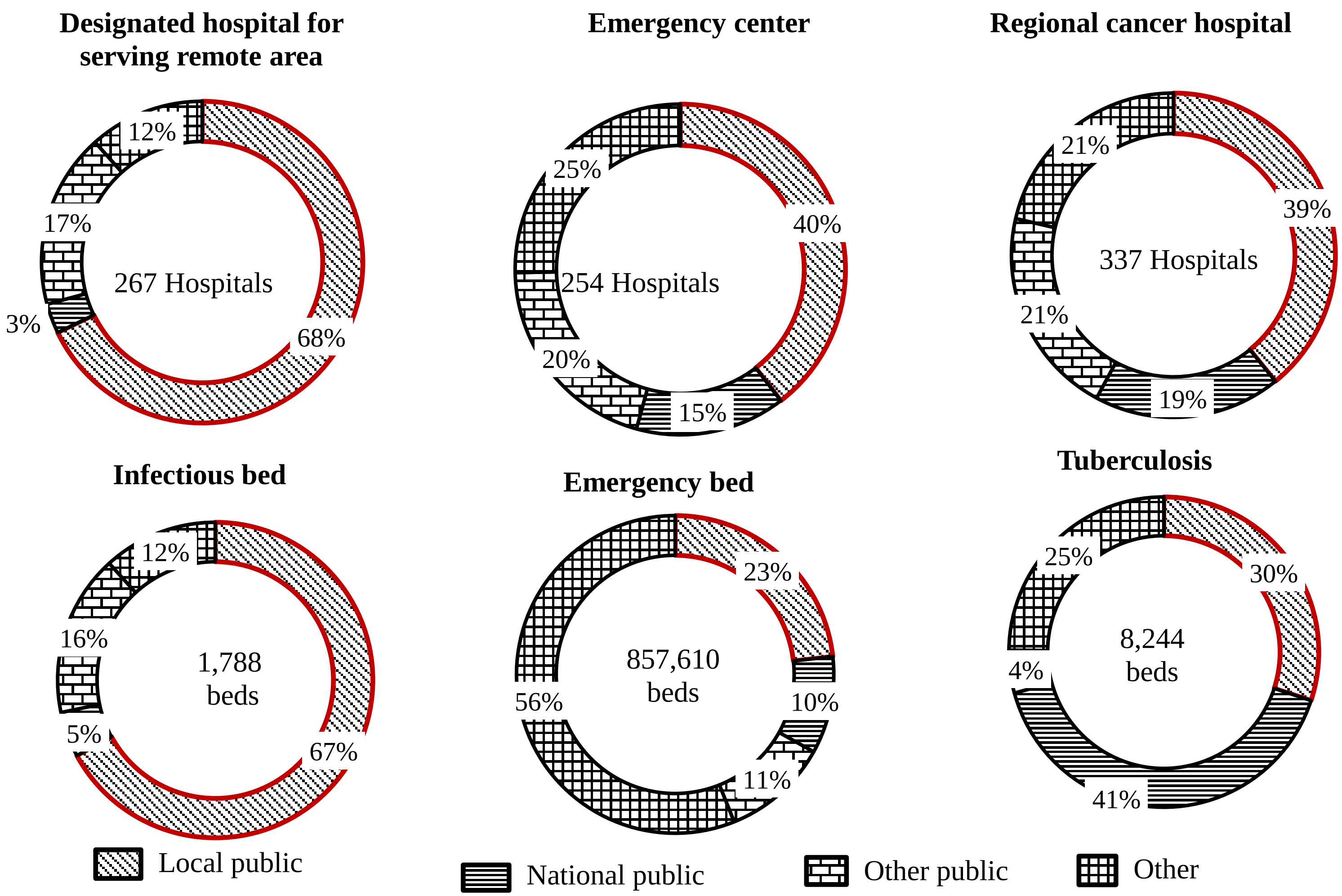


Figure 2-4 Public functions of LPH

Source: Shimazaki, MHLW, 2009,2010

3. INVESTIGATING IMPACT OF THE LOCAL PUBLIC HOSPITAL REFORM IN JAPAN

3.1. The hospital resources and their regional distribution

Hospitals are major and most important health care resources in Japan. **Figure 3-1-A** shows the number of hospitals by ownership such as individual, corporate, social security, local public, national public, and others from 2002 to 2013[1]. Regarding as the total number of hospitals in Japan, we see a slight decrease from 9,187 in 2002 to 8540 in 2013, a 6.8% decrease within 12 years. All types of hospitals have shown decreases except the largest group medical corporation owned hospitals which have shown an increase from 5,533 in 2002 to 5,722 in 2013, a 3.4% increase in 12 years. We also find that individual hospitals showed a largest sharp decrease from 954 in 2002 to 320 in 2013, by a more than 65% decrease.

Figure 3-1-B shows numbers of beds by ownership during the same period. The total number of beds slightly decreased in the last decade, from 1,642.6 thousand in 2002 to 1,573.8 thousand in 2013. This decrease mainly results from a 63.7% drop of the individual hospitals. The share of LPH beds decreased from 15.6% in 2002 to 14.6% in 2013, while share of medical corporation hospital beds increased from 49.4% to 54.3% during the same period.

[1] We follow the classification of MHLW by ownership structure. However, as major interest of this paper is the Local Public Hospital, which is included in public organization owned hospital category, we separate hospitals owned by prefectures, municipalities and Local Independent Administrative Corporation from public organization owned hospital, and create a new category, local public, and combine the rest types of hospitals in this category with social security organization owned hospitals as the category social security and other public.

In order to better analyze the composition and distribution of hospitals, we further combine ownership categories into three groups, which are local public hospitals (LPH), other public hospitals (OPH) and private hospitals (PRH), respectively. The LPHs are those operated by prefectures, municipalities and LIACs[2]; other public hospitals (OPH) include national hospitals and social security organizations owned hospitals; private hospitals (PRH) are hospitals operated by medical corporations, individuals and others.

Table 3-1 shows numbers of hospitals, beds and staff for each type of hospitals of LPH, OPH and PRH, respectively, in Japan in 2011. From **Table 3-1** we see that PRH dominates all categories of hospital, bed and staff with large shares 80.8%, 69.6% and 64.5%, respectively. For LPHs we see all shares for hospitals, beds and staff range between around 11% and 17% and for OPHs the share of hospital is 8.0% while the share of staff is 19.0%. This implies that national hospitals employ more staff compared with other types of hospitals. Comparing the range of three types of shares for hospitals, beds and staff, we find that the hospital shares' range is the largest from around 8.0% to 80.8%, beds' shares' range is the second largest as from 14.7% to 69.6%, and staff shares' range is the smallest as 16.4% to 64.6%. The total number of hospital beds has been decreasing since 2005. It deceased from 1,631 thousands in 2005 to 1,583 thousands in 2011 by around 3.0%. The share of LPH beds decreased from 15.4% in 2005 to 14.7% in 2011 while the share of private hospital beds increased from 68.5% to 69.6% during the same period. The percentage of other public beds decreased from 16.1% to 15.7%.

[2] The LPHs owned by local government are established on the basis of Local Public Enterprise Law while those owned by based LIACs are based on Local Independent Administrative Corporations Law. The LIACs were introduced to management of LPHs after LPH reform as a measure to improve the efficiency.

Figures at the bottom in the second and the third column give the number of beds and staff per corresponding hospital for LPH, OPH and PRH, respectively. From these figures we find that OPH has the largest scale in both number of beds and number of staff per hospital as 363.1 and 529.2, respectively. On the other hand, PRH shows the smallest scale in both number of beds and number of staff per hospital compared with LPH and OPH. LPH data stays in the middle between OPH and PRH, much nearer to the PRH rather than OPH. Thus, we find that hospitals belonging to OPH, e.g. national public hospitals and social security owned hospital with large-scale facilities, are focusing more on advanced and comprehensive medical services while the hospitals in PRH provide more primary and basic medical services. The functions of LPH are in the middle of these two types.

Figure 3-2 is a triangular graph showing all shares of hospitals, beds and staff for LPH, OPH and PRH, respectively. Private hospitals had the largest number of hospital beds 1,101 thousands in 2011 accounting for about 69.6% of total hospital beds while LPHs and OPHs accounted for about 14.7% and 15.7%, respectively. Also private hospitals had the largest number of hospital staff 1,233 thousands in 2011 accounting for about 64.6% of total hospital staff while LPHs and OPHs accounted for about 16.4% and 19.0%, respectively. This indicates that the OPHs tend to have more hospital beds and more staff per hospital in 2011. From **Figure 3-2** we find that for each type of LPH, OPH and PRH, the order between largest and smallest shares among hospitals, beds and staff changes. Namely, LPH and OPH have the largest share 16.4% and 19.0% in staff, then bed shares 14.7% and 15.7%, respectively. Then hospital shares 11.2% and 8.0% are the smallest. On the other hand, PRH has the largest share 80.8% in hospital, then

69.6% in bed and staff share 64.6% is the smallest. This fact implies that PRHs are rather widely distributed with relatively smaller number of beds and staff while public hospitals LPH and OPH are more “concentrated” with relatively large scale with more beds and more staff in order to provide wide range of and various types of advanced medical services. Thus we can say that PRH and LPH-OPH play a “complementary” role, namely they are mutually complementary, in providing medical services. From **Figure 3-2** we find that LPH and OPH are located closer each other and they are far from PRH.

Table 3-2 shows the numbers of hospitals, beds, staff and doctors for each prefecture in Japan in 2006 and 2011, respectively. From this table we find that for hospitals and beds most prefectures have similar values in both years 2006 and 2011. However, for number of staff and doctors we find that in most prefectures values in 2011 are larger than those in 2006, which implies that most prefectures hired more doctors without increasing hospitals and beds.

We apply cluster analysis technique in order to classify all 47 prefectures into several groups based upon three kinds of data given by numbers of hospitals, beds and doctors. Our cluster analysis technique is based on the hierarchical one aiming at integrating nearly located data into each group at each stage. Results for classifying into four groups are given in **Table 3-3**. Detailed data for each cluster is given with basic statistics data in **Table 3-4**. From **Table 3-4** we find that prefectures belonging to each cluster in I, II, III and IV have significantly different “mean” values. Namely, average values for all three indices, i.e., number of hospitals, beds and staff, are getting smaller from cluster I to II, III, and IV. This means that four clusters from I to IV are ordered from largest to smallest with respect to all these indices. Incidentally, we add that the same clustering is obtained for all cases of separate data for 2006 and 2011. We also find that those prefectures having much larger number of hospitals, beds and staff are clustered into the I and II group, including HKD, TKY, OSK, FKO, SIT, CHB, KNG, AIC, and HYG, most urbanized and populated prefectures in Japan with major large cities such as Sapporo, Tokyo, Osaka, Fukuoka, Saitama, Chiba, Yokohama, Nagoya, and Kobe, respectively, in metropolitan and designated populated urban areas. Those less developed prefectures such as OKN, SAG, TTR, SMN, and FKI etc. having fewer hospital resources are clustered into IV group.

We first try to investigate the relation among number of hospitals (*HSP*), number of beds (*BED*), number of staff (*STF*), and number of doctors (*DOC*) by applying regression model analysis techniques. Regression results for each type of function form between two factors are shown in **Table 3-5**. Firstly we see that those three factors *HSP*, *BED* and *STF* are mutually highly correlated each other. Regarding the relation between *BED* and *HSP* for all prefectures for years 2006 and 2011 in Japan, we find that they are proportionally related each other. Their proportional coefficients corresponding to the actual average values for the number of beds per hospital are not significantly different between years 2006 and 2011 as measured 181.9 and 184.0, respectively. Thus as for the relation between *BED* and *HSP*, combining the data for 2006 and 2011 and applying the single variable linear function passing the origin, we obtain the estimate for the "slope" of the linear regression model given by 185.5 as shown in **Table 3-5.**

On the relation between *STF* and *BED* we find there is a significant difference between years 2006 and 2011, so the estimate for the slope is given as 1.042 and 1.234

as in **Table 3-5**, almost 20% increase during the 5 year period. Actual average number of staff per bed is 1.049 and 1.206 in 2006 and 2011, respectively. Regarding the relation between *DOC* and *BED*, we find that those 9 populated prefectures mentioned above are remarkably higher from others with respect to their numbers while other 38 prefectures excluding these 9 prefectures are all located in the densely distributed areas in the lower numbers area. Also we find that *DOC* increases higher than proportional as *BED* increases, namely their relation can be expressed by the convex (quadratic) function as shown in **Table 3-5**. These relations indicate that comparing to 2006, the number of hospitals and hospital beds decreased while hospital staff increased in 2011.

The health care resources in Japan are concentrated in these rather "profitable areas" while they are not so in remote areas. Considering that location of these health care resources is generally and largely determined by the population, we try to investigate the relation between the distribution of health resources and population density for all prefectures. To measure the "equality" of health resources objectively, we take density of health resources into account. From the relation between hospital density (*DHS*) and beds density (*DBD*) given by indices such as the number of hospitals per 100 thousands population and the number of beds per 1000 population for all prefectures, we find that *DHS* is much higher in those underdeveloped prefectures located in southern part of Japan such as KOC, KGS, TKS and so on while those populated prefectures like KNG, SIT and CHB had lower density of hospitals, hospital beds and staff also. Comparing to 2006, we find that the density of hospital staff significantly increased in 2011. From the relation between beds density (*DBD*) and staff density (*DST*) given by indices such as number of beds per 1000 population and number of staff per 1000 population for all prefectures, we see no significant differences between years 2006 and 2011 while they are highly and almost linearly correlated each other. We find that their trend is almost similar to the above case of hospital density and beds density in the sense that they are highly and almost linearly correlated each other.

Relation between *DBD* and *DHS* indicates that the concave function with parameter estimate 0.629 and 0.639, which is less than 1.0, for 2006 and 2011, respectively, can approximate the actual data better. This parameter implies that the percentage increase of *DBD* corresponding to a unit percentage increase of *DHS*, interpreted as *DBD* elasticity with respect to *DHS*, becomes less as the latter factor *DHS* density increases. Also we find the relation between *DST* and *DBD* is linear with the slope larger than 1.0 for both years 2006 and 2011, in which that for 2011 is almost 15% larger than 2006 estimate. This implies more staff per bed were needed recently even with respect to the density per capita. Thus, the same trend is found in hospital resources measured by density, namely, hospital per 1000 population tends to have more beds, and bed per 1000 population tend to have more staff in 2011 compared with 2006. The prefectures with high hospital resource density are usually less developed ones with more geographic barriers and lower population density which prevent local governments from providing medical services within fewer large hospitals. The results reflect the impacts of health policy during this period: the number of hospital and bed decreased and beds were concentrated in large hospitals. The average density of hospital staff had increased among prefectures because of the policy promoting the number of medical staff, but substantial number of increased medical staff was absorbed by more developed prefectures like TKY, OSK, KNG, and so on.

Figure 3-3 further shows the geographic distribution of hospital resources density in 2011. Distributions of *DHS, DBD* and *DST* were consistent that they were much higher in those underdeveloped prefectures located in southern part of Japan such as KOC, KGS, TKS and so on while those populated prefectures like KNG, SIT and CHB had lower density of hospital, bed and staff. The density of hospital resources in northern underdeveloped prefectures, like YGT, MYG, NGT and so on, were relatively lower than their southern counterparts, though densities of hospital resources in these prefectures are higher than some of the major nine developed prefectures mentioned above.

All those results indicate that these underdeveloped prefectures actually do not always have lower health resources density than those developed prefectures while for those underdeveloped prefectures in the northern part of Japan, although their densities are higher than some of the above major nine developed prefectures, their health resources are much lower than their counterparts in the south. The difference among those underdeveloped prefectures may be caused by the health policy in Japan influenced by the factors coming from geographic or climate differences between southern and northern parts of the country. The public hospital system also plays an important role in maintaining the equality of the health care system. Namely, public hospitals are considered as one of the most important countermeasures to secure non-profitable medical services. We introduce the function and distribution of public hospitals in following section.

3.2. Local Public Hospitals and their distribution

Regarding the distribution of LPH resources among prefectures in 2011, we find that the average number of LPHs in a prefecture is 20.6. OIT has the least number of LPHs which is only 5 while HKD has 98. The average number of LPH beds was 4956.0, lowest 1,140 in SAG, highest 15,531 LPH beds in HKD. The average number of LPH staff in a prefecture is 6675.5. OIT has the least hospital staff 1952.2 while HKD has the highest 19006.5. The average percentage of LPH in a prefecture is 14.1%; OIT has the lowest percentage of LPHs while YMG had highest percentage, which was 3.1% and 36.8% respectively. The average percentage of bed owned by LPHs was 17.3%, the lowest percentage is 5.0% in FKO, and the highest percentage is 39.0% in YMG. The average percentage LPH staff was 19.3%, lowest 5.4% in FKO, highest 43.8% in YMG.

Total number of LPHs and LPH beds dramatically decreased 7.6% from 1,047 to 968 and 5.3% from 246,036 to 232,943, respectively. The average percentage of LPH beds decreased from 17.7% to 17.4%. The percentage of LPH beds for some prefectures such as IWT, FKS, AOM, MYG and so on, decreased by more than 2% in 2011, while the percentage of LPH beds in WKY and TTR increased by more than 2%.

The developed prefectures like HKD, AIC, HYG, and OSK had more LPH resources, while those underdeveloped prefectures in northern parts of Japan like YGT, AOM, and IWT had higher proportion of LPH bed. It is noticed that there was big difference between underdeveloped prefectures in northern and southern parts of Japan in terms of LPH beds percentage. Those southern underdeveloped prefectures which possessed high density of hospital resources, had comparatively low proportion of LPH bed, for some prefectures it was even lower than that of developed ones. The disparities reflect different philosophy of local governments to secure the medical services for residents.

Regarding the changes of the number of hospitals and the number of beds for PRH and LPH, respectively, during the period from 2005 to 2011, number of PRHs decreased from 7,241 in 2005 to 6,952 in 2011. The number of PRH beds increased from 1,117 thousands in 2005 to 1,122 thousands in 2007, and then decreased drastically to 1,101 thousands in 2011. The decrease of PRH beds might be due to the implementation of the Health care Reform Act in 2006 which aimed at reduction of long-term care beds in hospitals. Numbers of LPHs and LPH beds have constantly decreased from 1,060 hospitals and 251 thousand beds in 2005 to 968 hospitals and 233 thousand beds in 2011. Annual decrease rates were 1.24% and 0.86% for numbers of LPHs and LPH beds before the reform (before 2008), respectively, while they increased to 1.76% and 1.55% after the reform, respectively.

3.3. Measuring the impact on regional distribution of hospital resources

Equality regarding as the health care system and the allocation of health care resources has been great concerns for many researchers (Matsumoto, Inoue, Bowman, & Kajii, 2010; Nomura, Inoue, & Yano, 2009; Toyabe, 2009). We believe that collecting cross-sectional data and trying to analyze effects of time is very important for policy-makers. In this paper, “gap” analysis technique is applied to investigate the distribution of health care resources.

We denote the set of hospital resources and the set of prefectures by $M = \{\text{bed}, \text{doctor}\}$ and $N = \{1, \dots, 47(= n)\}$, respectively. Then let a_j and p_j indicate the area and the population, respectively, for each prefecture j, $j \in N = \{1, \dots, n\}$. We denote the amount of health care delivery resource i, $i \in M$ for each prefecture j, $j \in N$ by x_{ij}. Assuming that the health care resources would be allocated proportionally to the area and population, we let y_{ij}^A and y_{ij}^P be the expected "proportional" allocation of health resource i in prefecture j based upon the area share and the population share, respectively.

$$y_{ij}^A = \frac{a_j}{A} \sum_j x_{ij}, \quad y_{ij}^P = \frac{p_j}{P} \sum_j x_{ij}$$

where $A = \sum_j a_j$ and $P = \sum_j p_j$.

The expected proportional allocation of doctor could be obtained by equations above, because we used full-time equivalent doctor in this study which can be fraction. As the hospital bed cannot be divided into fraction, the Hamilton method (largest fraction method) is further applied to solve this problem.

Hamilton method first gives integral value equal to the largest integer not exceeding y_{ij}^A and y_{ij}^P to each prefecture. Then calculating the descending order data based upon the remainders given by the difference between y_{ij}^A or y_{ij}^P and nearest (equal or less than respective value) integer, we give additional resource to all possible prefectures with largest remainder until the total number of resources is allocated.

Denoting the expected proportional allocation of doctors and beds as $[y_{ij}^A]$ and $[y_{ij}^P]$, respectively, we can calculate the "gap" of allocation of hospital resource i in prefecture j as $x_{ij}^A - [y_{ij}^A]$ and $x_{ij}^P - [y_{ij}^P]$, respectively, by taking the difference between current distribution and proportional allocation for each resource.

We find that only 7 most urbanized and populated prefectures in Japan of TKY, OSK, KNG, SIT, FKO, CHB and AIC are located far from other 40 prefectures. Namely, regarding the bed-gap only FKO has large positive values for both population and area gaps while TKY, KNG, SIT, CHB and AIC have positive values for area gap and negative population gap, and OSK has positive value for area gap and no population gap. Especially, both TKY and OSK have large positive values for area gap. Regarding the doctor-gap TKY, OSK and FKO have large positive values for both population and area gaps while KNG, SIT, CHB and AIC have positive values for area gap and negative population gap. Especially, TKY has very large positive values for both area and population gaps.

Regarding the bed-gap among other 40 prefectures, prefectures in southern part of Japan, like KMM, YGC and NGS have positive values for both population and area gaps while these prefectures with large shares of LPH such as IWT, AKT, FKS and AOM have positive values for population gap and negative area gap. Prefectures including MYG, YMG, TCG, GNM and so on have negative values for both population and area gaps. We also find that the mean of absolute values of bed gap decreased from 51,165 in 2006 to 50,357 in 2011 by area; and slightly increased from12,170 to 12,415 by population. Regarding the doctor gap among other 40 prefectures, as a general trend, we can say that several prefectures shifted from negative population quadrant to the positive population quadrant, which indicates more doctors had been attracted in those two metropolises. Also the mean of absolute value of doctor gap increased from 6,749 in 2006 to 7,553 in 2011 by area and increased from 1,145 to 1,209 by population. This indicates the distribution of doctors was becoming imbalanced in Japan between 2006 and 2011.

We apply cluster analysis technique to the “gap” data. The following three kinds of data set are inputs to the cluster analysis; (i)“Bed” gap data (by area, by population), (ii) “Doctor” gap data (by area, by population), (iii)“Bed and Doctor” aggregated gap data. Computational results of cluster analysis are given in **Table 3-6**. From **Table 3-6** we find that HKD (Hokkaido) is always “exceptional” as it constitutes a cluster by itself. This is due to the fact that HKD’s allocation of beds and doctors “by area” is exceptionally far smaller than other prefectures as it has an extremely large area. We also find that Doctor only and Bed-Doctor aggregate cases give the same clustering result while Bed only case give a little different result for clusters II and III. Cluster II and III contain most populated urban prefectures such as TKY, OSK, FKO, CHB, KNG and AIC for all cases. Cluster II for Doctor and Bed-Doctor aggregate cases consist of TKY, OSK and FKO only, which means that all these prefectures have large positive gaps for both by area and by population. Cluster III for these cases consists of SIT, CHB, KNG and AIC, which correspond to the fact that these prefectures have large positive gap for by area and large negative gap for by population.

3.4. Evaluating the impact on financial performance

The Hospital Operation Monitoring Analysis Survey (HOMAS) provides the opportunity to observe the financial situation of hospitals under different ownership. The HOMAS is conducted by Japan Hospital Federation (JHF) annually, aiming at monitoring operation of his member hospitals, providing the basic information such as profit, cost, and staff salary for improving management system as well as the payment system. What has to be noticed is that the HOMAS is not a follow-up survey, which means the subjects vary year by year.

As shown in **Table 3-7**, there were around 590 LPHs and 290 private hospitals included in the survey from 2005 to 2011. The financial performance of private hospitals was much better than that of LPHs. The percentage of hospitals running surplus was around 10% among LPHs while it was 55% among private hospitals. The yearly percentage of hospital running surplus shows V-shape in two groups, the percentages in 2008 were the bottom, which was 6.7% in LPHs and 45.5% in private hospitals. The financial performance was substantially influenced by the fee schedule. The revision rate of medical service had increased in 2008 for the first time after three consecutive decrease of revision rate since 2002. The improvement of financial performance is probably related to the increased revision rate[3].

According to the HOMAS, revenue of a hospital includes medical revenue, non-medical revenue and special revenue; and expenditure includes medical expenditure, non-medical expenditure and special loss. **Figure 3-4** shows the revenues and expenditures per 100 beds for LPHs and PRHs during the period from 2005 to 2011. The average revenues have always been higher than expenditure for PRHs except in 2008 while the average expenditures have always been larger than revenues for LPHs. Situation for the LPH had been getting worse from 2005 to 2008 as the expenditure expanded during the above period while the revenue decreased even slightly. The

[3] What should be noticed is that the change of revenue is closely related to the revision of fee schedule. The revisions in 2010 and 2012 favored the larger hospitals. However, because of lacking information about the scale of private and local public hospitals included in HOMAS, it is difficult to differentiate the effect of fee schedule revision from that of operational strategy change on financial conditions for LPHs and PRHs. Thus the results need to be explained with caution

situation started to get improved since 2008 for both LPHs and PRHs. For LPHs, we can see a rapid increase of its revenue and expenditure after 2008.

We denote the average revenue and expenditure of LPH in period t by LR_t and LE_t;, respectively, while PR_t and PE_t stand for revenue and expenditure for PRH in period t, respectively. Then we define the differences regarding as revenue and expenditure for PRH and LPH as follows.

$$\Delta R_t = PR_t - LR_t,\ \Delta E_t = PE_t - LE_t$$

The differences regarding as revenue and expenditure for PRH and LPH are shown in **Figure 3-5**. The value of ΔR_t drastically increased between 2005 and 2007, then decreased in 2008. The value of ΔR_t started to increase again after 2008. While ΔE_t was substantially increased among negative values during the period from 2005 to 2007, ΔE_t increased later during the corresponding period from 2008 to 2011.

We divide the whole period from 2005 to 2011 into two sub periods: period I (2005-2008) and period II (2008-2011), respectively. During the period I LPH decreased their revenue by 2.97% while their expenditure increased by 0.91%. On the other hand, PRH increased their revenue by around 4.83% while their expenditure increased by 7.34%. Neither expenditure nor revenue changed in a large scale for LPH during the period I. They just showed that revenue decreased while expenditure increased slightly. This made the financial situation of LPH worse. Regarding to the period II, we find increases in both expenditure and revenue for both LPH and PRH. For LPH, revenue increased 17.2% during the period II while expenditure increased 10.1%. In the case of

PRH, revenue increased 18.5% during the period II, higher than LPH, while expenditure increased 14.7%, which was also larger than LPH.

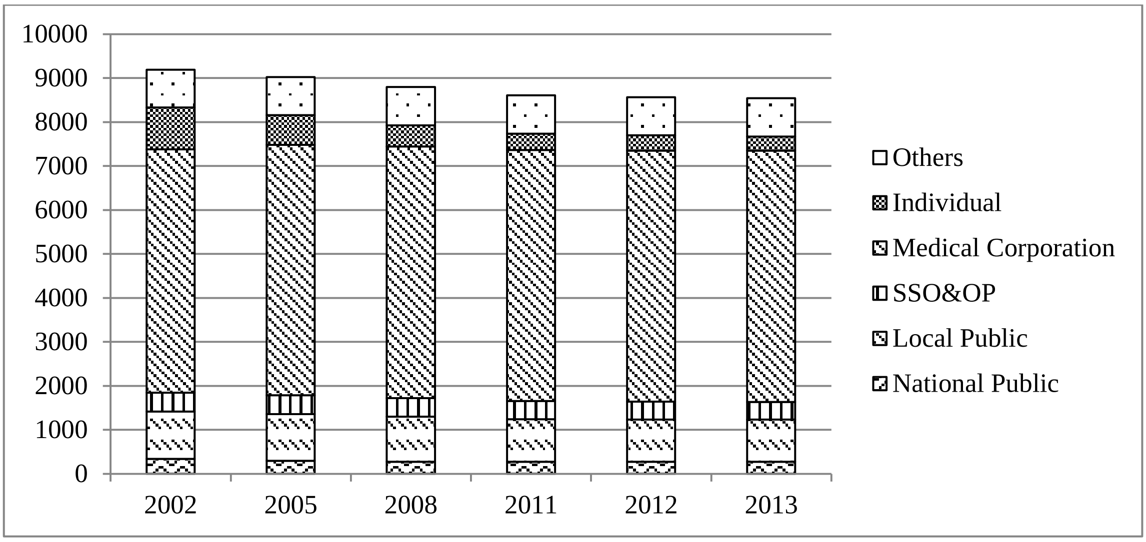
We further investigate the medical revenue and expenditure of PRHs and LPHs (see **Table 3-8**), because these two indicators are more closely related to the management of hospitals. For LPHs, medical expenditure increased from 145.9 million in 2005 to 165.3 million in 2011 by 13.3%, for period I 1.3%, period II 11.8%; while medical revenue increased from 128.8 million to 151.2 million by 17.4 during the same period, for period I it decreased 3.0%, for period II with an increase of 21.0%. For PRHs, medical expenditure increased from 124.9 million in 2005 to 158.6 million in 2011 by 26.9%, period I for 7.8%, period II 17.7%; while medical revenue increased from 127.1 million to 164.8 million by 29.7% during the same period, period I for 5.5%, period II for 22.9%. The remuneration and inpatient revenue contributed the major increases to medical expenditure and revenue for both LPH and PRH, respectively.

We apply a difference in differences (DID) approach to analyze the effect of the LPH reform on its financial performance. The principle of DID is to calculates the effect of a treatment on an outcome by comparing the change over time in the outcome variable for the treatment group to the change over time for the control group. DID requires a parallel trend assumption, which means treatment and control groups share the common trend. Thus, the treatment effects could be measured by subtracting the difference in period I from the difference in period II. In our case, the treatment is LPH reform. We compare the average annual growth rates of medical expenditure and revenue for LPHs (treatment group) and PRHs (control group) in period I and II (before and after the reform). As showed in **Table 3-9**, comparing to the average annual medical expenditure growth rates of PRHs, those of LPHs were 2.2% and 2.0% lower in period I and II, respectively; while the changes of the rate between period I and II were 3.5% and 3.3% for LPHs and PRHs, respectively. For the average annual medical revenue growth rates, they were 2.8% and 0.6% lower in LPHs than in PRHs for period I and II, respectively; while they were 8.0% and 5.8% higher in period II than in period I for LPHs and PRHs, respectively. The results indicate that the reform only led to a slight increase (0.2%) in annual medical expenditure growth rate but a substantial increase in annual medical revenue growth rate for LPHs (2.3%) compared with PRHs. In other words, comparing to PRHs, the LPH reform probably resulted in no difference in controlling their medical expenditure, but it significantly motivated LPHs to increase their revenue.

Figure 3-6 shows the differences of expenditure and revenue between PRH and LPH in more specific categories from 2005 to 2011. During the period I, decreased medical expenditure ΔE_t was majorly due to those decreasing differences of both remuneration and material costs (see **Figure 3-6-A**). During the second period II, difference of remuneration continued to decrease and that of material cost dropped in a large scale. Differences of utility fee and others, which have rather small shares, were almost stable during the whole period. Decreases of remuneration in ΔE_t resulted from rapid increase of remuneration in PRH while LPH's remuneration had been rather stable during the period I and slightly increased in the period II.

Regarding the trend of medical revenue difference ΔR_t between PRHs and LPHs (see **Figure 3-6-B**), it increased drastically during the first period I, which was majorly due to the difference of inpatient revenues which contributed to the major difference from less than 1 million in 2005 to 9.6 million in 2011. Enlarging difference of inpatient revenue in the first period resulted from PRH's substantial inpatient revenue increase. The difference of inpatient revenue did not increase much during the second period II, it was rather stable at around 10 million yen. The outpatient revenue of LPH was more than that of PRHs; however the difference of outpatient revenue decreased from 5.9 million yen in 2005 to 0.8 million yen in 2011. The difference of other revenues remained almost constant.

A: Number of hospitals by ownership



B: Number of hospital beds by ownership

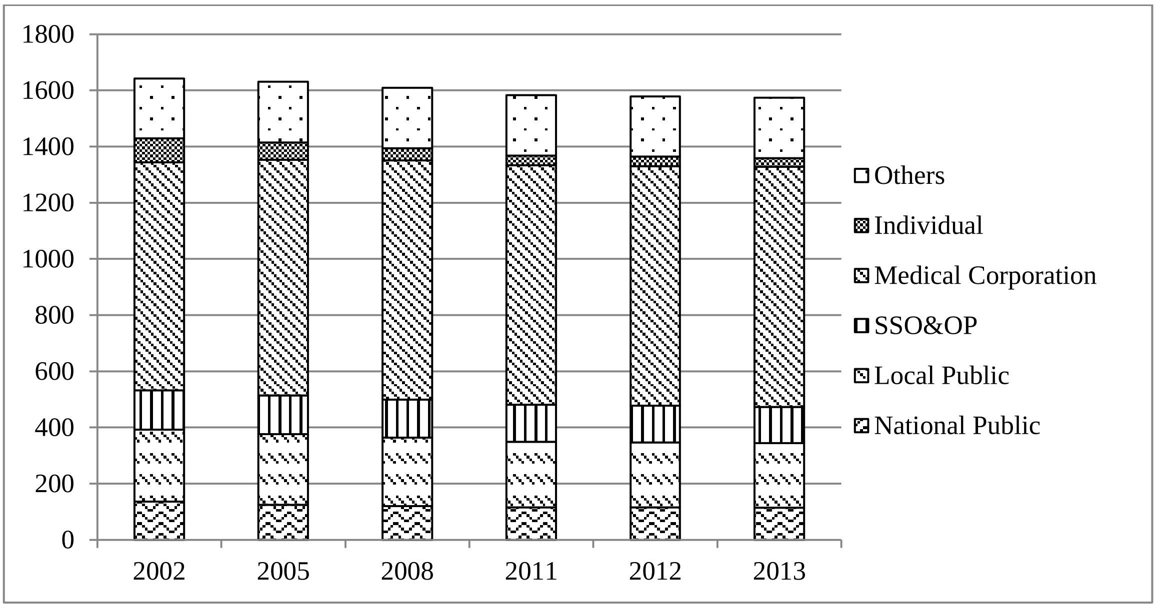


Figure 3-1 Number of hospitals and beds by ownership

SSO&OP: Social security organizations and other public organization

Source: Survey of Medical Institutions, MHLW,2002-2013

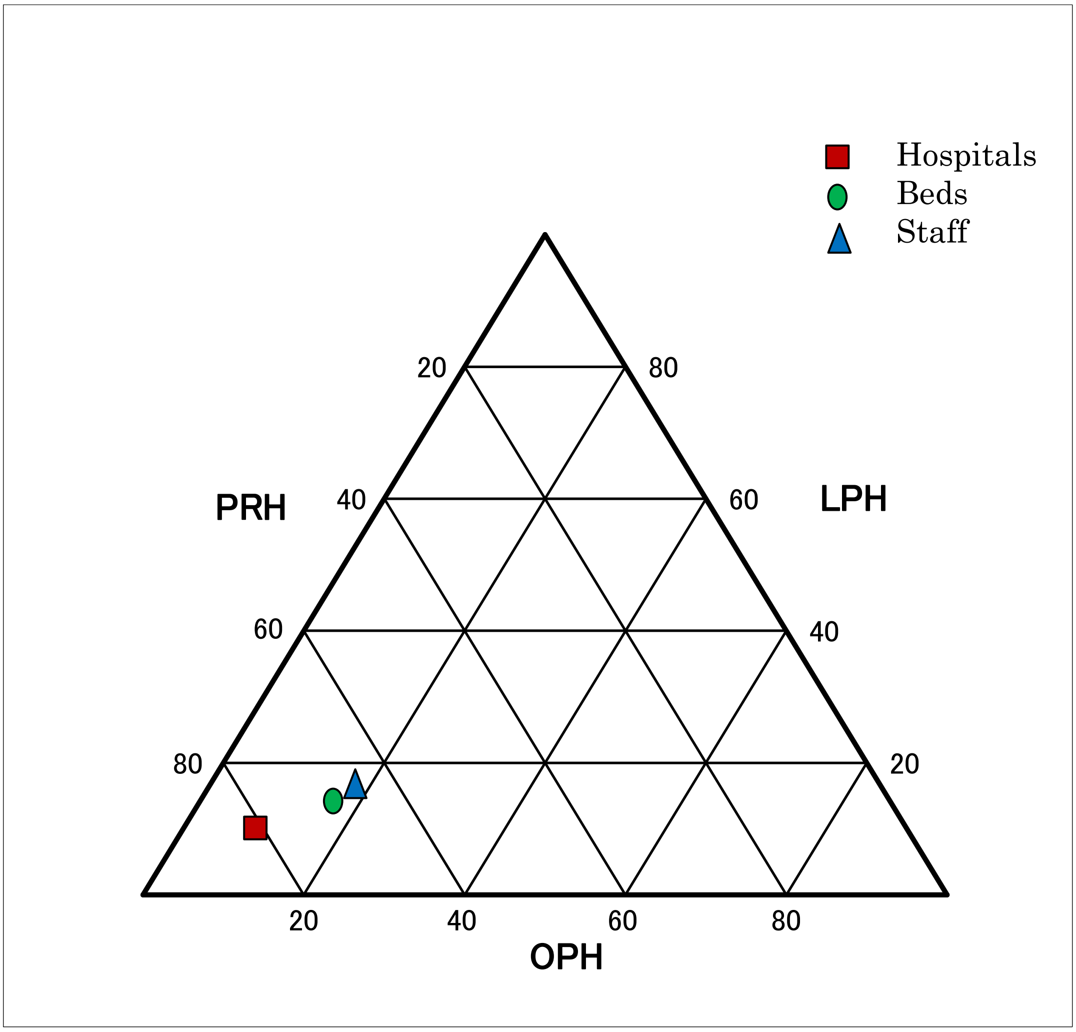
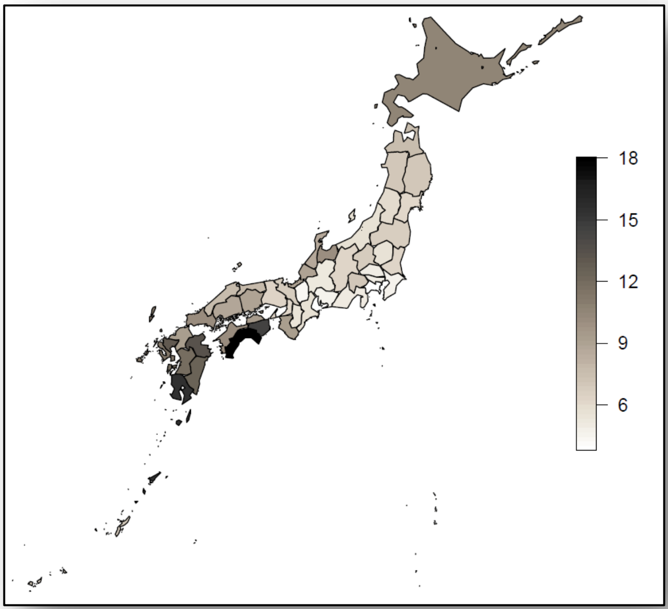


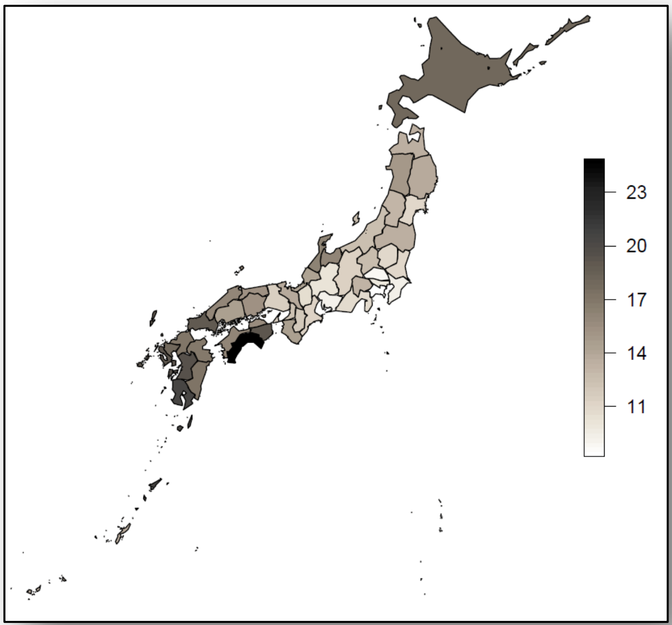
Figure 3-2 Shares of hospitals, beds and staff for LPH, OPH and PRH

Source: Survey of Medical Institutions, MHLW, 2011

A: Hospital density (No. of hospital per 100 thousand population)



B: Bed density(no. of bed per 1000 population)



C: Hospital staff density(no. of hospital staff per 1000 population)

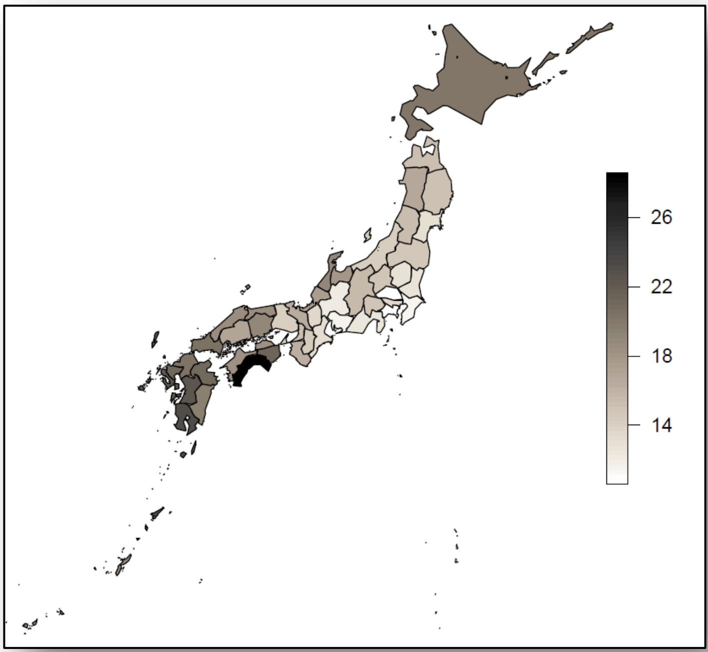


Figure 3-3 Geographic distribution of hospital resources density in 2011

Source: Survey of Medical Institutions, MHLW,2011

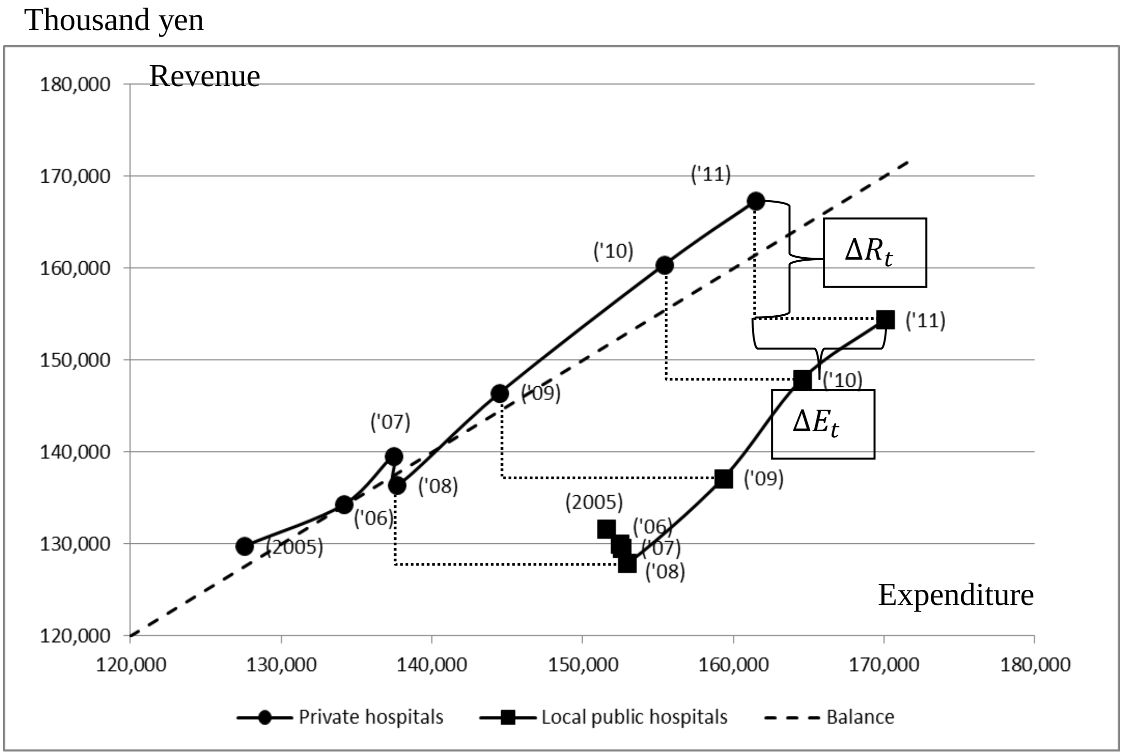


Figure 3-4 Revenue and expenditure per 100 beds by ownership

Source: HOMAS Report, Japan Hospital Federation, 2005-2011

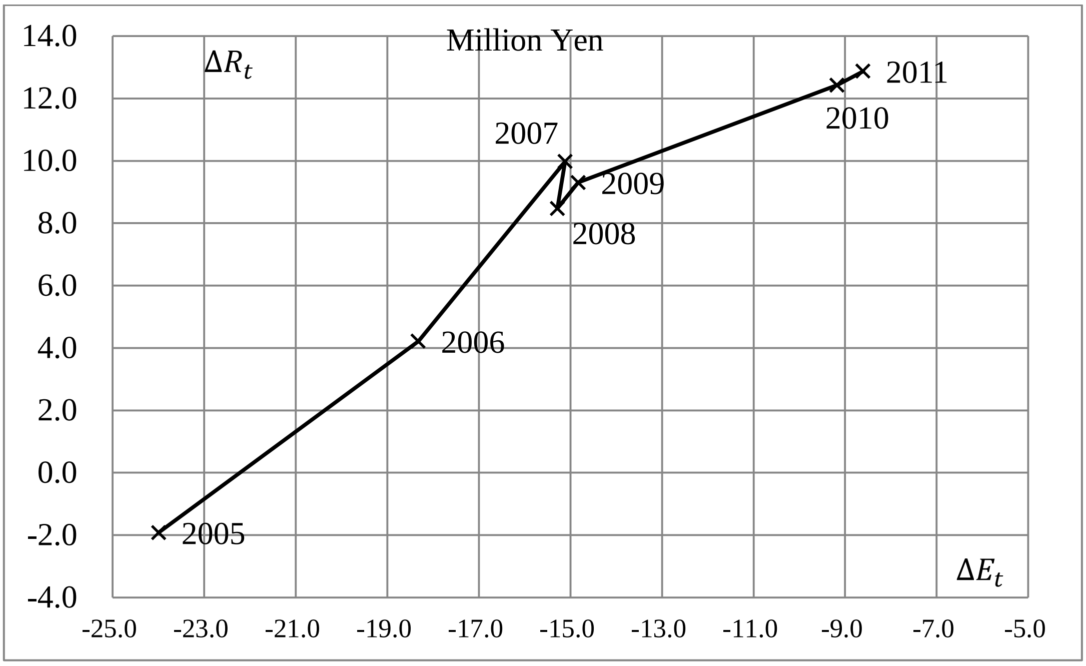
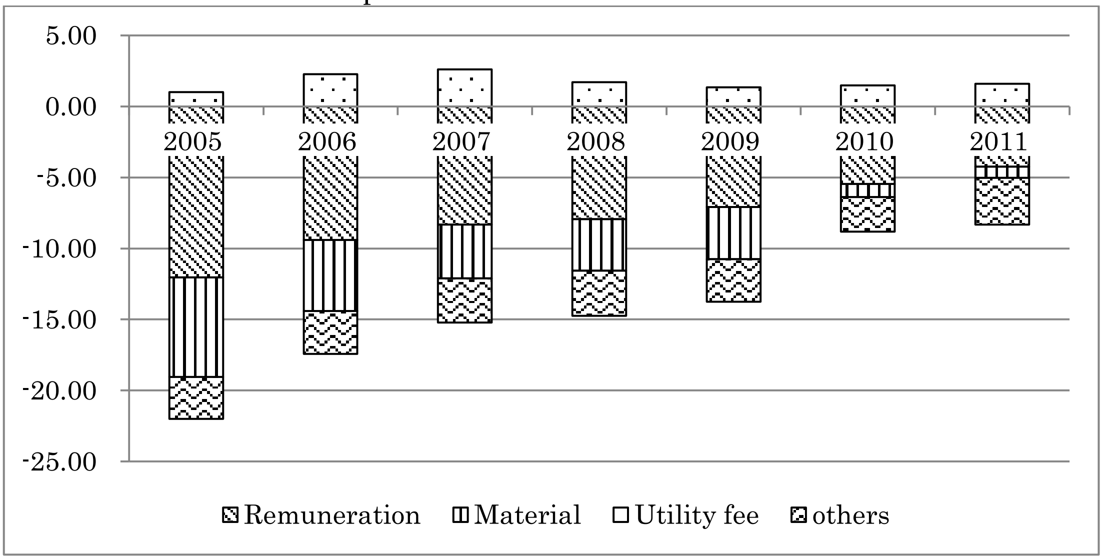


Figure 3-5 Difference of revenue and expenditure per 100 beds by ownership

Source: HOMAS Report, Japan Hospital Federation,2005-2011

A: Difference of medical expenditure



B: Difference of medical revenue

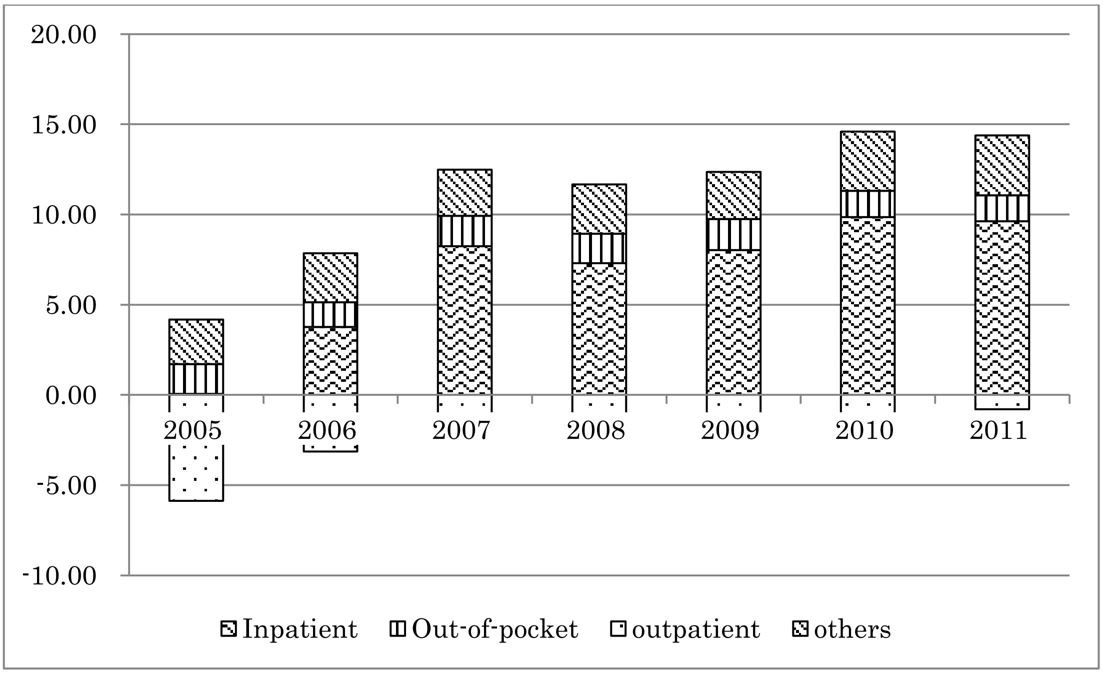


Figure 3-6 Difference of medical expenditure and revenue per 100 bed between PRHs and LPHs

Source: HOMAS Report, Japan Hospital Federation, 2005-2011

Table 3-1 Hospitals, beds and staff in Japan (2011)

	Hospitals	Beds	Staff
LPH	968(11.2)	232,934(14.7)[a] 262.2	313,747(16.4) 324.1
OPH	685(8.0)	248,717(15.7) 363.1	362,531(19.0) 529.2
PRH	6,952(80.8)	1,101,422(69.6) 158.4	1,233,460(64.6) 177.4
Total	8,605(100.0)	1,583,073(100.0)	1,958,018(100.0)

[a] *Figures in ( ) indicate percentages to the total.*

Source: Survey of Medical Institutions, MHLW, 2011

Table 3-2 Number of hospitals, beds and staff for each prefecture (2006, 2011)

Pref.	Hospital		Bed		Staff (Doctor)			
	2006	2011	2006	2011	2006		2011	
HKD	613	579	103,712	98,526	103,396.3	(8568.5)	110,659.6	(9110.7)
AOM	109	102	19,292	18,300	18,639.4	(1637.9)	20,568.7	(1754.0)
IWT	103	92	19,757	17,965	18,879.7	(1859.3)	19,702.7	(1913.9)
MYG	149	141	26,885	25,251	26,779.8	(2920.9)	30,105.6	(3174.2)
AKT	78	75	16,959	16,012	16,185.3	(1562.5)	17,997.5	(1651.1)
YGT	70	68	15,328	15,115	16,013.6	(1531.5)	17,720.4	(1678.4)
FKS	147	130	29,742	26,621	28,372.7	(2441.4)	28,965.3	(2472.7)
IBR	201	183	33,441	32,376	32,860.8	(3383.7)	36,855.9	(3648.8)
TCG	115	109	22,576	21,694	23,136.8	(2803.3)	25,391.0	(3098.3)
GNM	141	133	25,314	24,959	26,557.3	(2591.0)	29,422.7	(2834.6)
SIT	359	346	62,751	62,475	65,633.2	(6801.5)	76,229.9	(7840.1)
CHB	286	279	56,284	56,909	59,543.1	(6578.8)	70,027.8	(7534.5)
TKY	658	643	129,939	127,380	143,637.5	(23103.0)	174,952.2	(25913.3)
KNG	351	344	75,256	73,834	82,473.6	(10637.5)	96,662.4	(12272.3)
NGT	140	130	31,033	29,329	30,829.3	(2804.8)	33,331.7	(2907.1)
TYM	116	110	18,255	17,493	17,823.8	(1713.1)	19,485.7	(1830.5)
ISK	106	101	19,770	19,060	20,224.0	(2065.3)	22,014.6	(2228.5)
FKI	83	72	11,861	11,381	12,907.0	(1316.1)	14,009.6	(1424.1)
YMN	61	60	11,484	11,215	11,793.3	(1217.7)	12,603.9	(1285.5)
NGN	138	133	25,282	24,147	27,711.0	(2845.3)	33,210.2	(3179.6)
GIF	108	104	20,892	20,760	21,044.8	(2358.6)	24,846.8	(2570.6)
SZO	188	186	41,248	39,782	42,592.9	(4224.5)	46,654.1	(4612.4)
AIC	347	327	69,296	67,811	72,447.0	(8965.1)	84,775.6	(9897.5)
MIE	112	102	21,386	20,624	20,905.2	(2124.5)	23,981.5	(2258.7)
SIG	60	60	14,564	14,805	16,263.1	(1898.7)	18,886.1	(2128.2)
KYT	177	175	36,624	36,187	38,396.0	(4715.1)	43,280.3	(5203.4)
OSK	549	534	110,589	108,584	115,477.9	(13887.5)	134,610.9	(15561.7)
HYG	353	348	64,972	63,890	67,376.1	(7203.4)	77,936.2	(8314.9)
NAR	78	75	16,759	16,489	17,359.8	(2007.3)	20,005.7	(2230.5)
WKY	94	92	14,620	14,296	14,258.6	(1626.3)	16,074.2	(1669.7)
TTR	46	45	9,396	8,936	8,965.2	(1057.2)	10,818.6	(1088.2)
SMN	60	54	12,099	11,408	11,955.4	(1284.6)	13,188.1	(1282.8)
OKY	182	174	30,830	29,776	32,221.5	(3372.1)	36,756.1	(3819.0)
HRS	254	249	41,981	41,108	42,352.4	(4035.1)	48,244.4	(4385.6)
YGC	150	147	27,986	27,400	26,005.5	(2184.0)	29,527.9	(2318.1)
TKS	122	114	15,506	15,029	15,005.0	(1466.7)	16,705.7	(1575.2)
KGW	99	93	16,489	15,465	16,584.0	(1690.3)	18,119.1	(1776.2)

EHM	148	144	23,452	22,952	24,146.4	(2213.6)	26,062.2	(2327.8)
KOC	140	137	19,164	18,879	19,846.5	(1669.9)	21,682.9	(1676.4)
FKO	475	467	88,409	86,985	89,261.6	(9208.4)	103,786.9	(10107.4)
SAG	111	110	15,534	15,220	15,022.4	(1399.2)	17,924.5	(1554.3)
NGS	166	160	27,844	27,322	27,964.5	(2500.4)	31,938.7	(2684.3)
KMM	219	216	36,108	35,610	36,040.0	(3058.7)	40,849.4	(3322.9)
OIT	165	160	20,983	20,177	21,800.1	(1969.5)	25,141.2	(2207.1)
MIZ	145	142	19,762	19,507	19,637.3	(1657.8)	22,018.6	(1758.6)
KGS	277	265	35,486	35,032	34,923.3	(2855.0)	39,657.6	(3003.2)
OKN	94	95	19,689	18,997	21,902.9	(2174.2)	26,346.2	(2412.3)

Source: Survey of Medical Institutions, MHLW,2006-2011

Table 3-3 Results of cluster analysis

Cluster	Prefectures
I	HKD, TKY, OSK, FKO
II	SIT, CHB, KNG, AIC, HYG
III	MYG, FKS, IBR, GNM, NGT, NGN, SZO, KYT, OKY, HRS, YGC, EHM, KOC, NGS, KMM, OIT, MIZ, KGS
IV	AOM, IWT, AKT, YGT, TCG, TYM, ISK, FKI, YMN, GIF, MIE, SIG, NAR, WKY, TTR, SMN, TKS, KGW, SAG, OKN

Table 3-4 Basic statistics for each cluster

Cluster	Year	Hospital		Bed		Doctor	
		mean	SD	Mean	SD	mean	SD
I	2006	573.8	79.6	108,162.3	17,225.1	13,691.9	6,707.2
	2010	555.8	74.2	105,368.8	17,123.3	15,173.3	7,701.0
II	2006	339.2	30.1	65,711.8	7,108.7	8,037.3	1,730.0
	2010	328.8	29.1	64,983.8	6,305.0	9,171.9	1,957.6
III	2006	173.7	40.8	29,620.3	6,866.2	2,857.9	846.2
	2010	166.9	40.4	28,689.7	6,760.2	3,085.3	962.7
IV	2006	91.3	22.7	16,610.8	3,624.1	1,739.7	428.3
	2010	86.7	21.2	16,013.2	3,468.6	1,870.6	492.2

Table 3-5 Relationship among hospital, bed and hospital staff

Dependent variable		*BED*	*STF*	*DOC*	*DBD*	*DST*
Independent variable		*HSP*	*BED*	*BED*	*DHS*	*DBD*
Model		$y = ax$	$y = ax$	$y = ax^2 + bx$	$y = ax^b$	$y = ax$
Parameter estimate	a	185.5***	1.042***(2006) 1.234***(2011)	0.00052***(2006) 0.00065***(2011)	4.241***(2006)[a] 4.270***(2011)	1.025***(2006) 1.170***(2011)
	b	-	-	0.0794***(2006) 0.0870***(2011)	0.629***(2006) 0.639***(2011)	-
R^2		0.9875	0.9982(2006) 0.9952(2011)	0.958(2006) 0.957(2011)	0.878(2006) 0.897(2011)	0.998(2006) 0.997(2011)

BED : number of beds; *HSP* : number of hospitals; *STF* : number of staff; *DHS* : density of hospitals (number of hospitals per 1,000 population), *DBD* : density of beds (number of beds per 1,000 population), *DST* : density of staff (number of staff per 1,000 population)

[a] Ln(a)

*** p<0.01;

Table 3-6 Results of cluster analysis of gap data

Bed	
Cluster	Prefectures
I	HKD
II	SIT, CHB, TKY, KNG, AIC
III	TYM, ISK, KYT, OSK, OKY, HRS, YGC, TKS, KGW, EHM, KOC, FKO, SAG, NGS, KMM, OIT, MIZ, KGS, OKN
IV	AOM, IWT, MYG, AKT, YGT, FKS, IBR, TCG, GNM, NGT, FKI, YMN, NGN, GIF, SZO, MIE, SIG, HYG, NAR, WKY, TTR, SMN
Doctor	
Cluster	Prefectures
I	HKD
II	TKY, OSK, FKO
III	SIT, CHB, KNG, AIC
IV	AOM, IWT, MYG, AKT, YGT, FKS, IBR, TCG, GNM, NGT, TYM, ISK, FKI, YMN, NGN, GIF, SZO, MIE, SIG, KYT, HYG, NAR, WKY, TTR, SMN, OKY, HRS, YGC, TKS, KGW, EHM, KOC, SAG, NGS, KMM, OIT, MIZ, KGS, OKN
Bed-Doctor	
Cluster	Prefectures
I	HKD
II	TKY, OSK, FKO
III	SIT, CHB, KNG, AIC
IV	AOM, IWT, MYG, AKT, YGT, FKS, IBR, TCG, GNM, NGT, TYM, ISK, FKI, YMN, NGN, GIF, SZO, MIE, SIG. KYT, HYG, NAR, WKY, TTR, SMN, OKY, HRS, YGC, TKS, KGW, EHM, KOC, SAG, NGS, KMM, OIT, MIZ, KGS, OKN

Table 3-7 Number and composition of surplus and deficit hospitals by ownership

Year	LPH					PRH				
	Total	S-H		D-H		Total	S-H		D-H	
2005	631	72	(11.4)	559	(88.6)	317	180	(56.8)	137	(43.2)
2006	599	56	(9.3)	543	(90.7)	279	147	(52.7)	132	(47.3)
2007	594	44	(7.4)	550	(92.6)	307	161	(52.4)	146	(47.6)
2008	599	40	(6.7)	559	(93.3)	319	145	(45.5)	174	(54.5)
2009	584	50	(8.6)	534	(91.4)	323	178	(55.1)	145	(44.9)
2010	579	87	(15.0)	492	(85.0)	307	193	(62.9)	114	(37.1)
2011	553	85	(15.4)	468	(84.6)	188	122	(64.9)	66	(35.1)

S-H:Surplus hospital, D-H:Deficit hospital

Source: HOMAS Report, Japan Hospital Federation

Table 3-8 Medical expenditure and medical revenue for PRHs and LPHs

	Local Public Hospital (LPH)						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Medical Expend.	145,922	146,751	146,924	147,798	154,106	159,761	165,288
Remuneration	76,540	77,309	78,515	78,797	82,579	85,947	88,014
Material	36,828	36,749	35,385	34,209	36,390	37,404	38,924
Utility fee	21,472	21,352	21,493	22,862	23,496	24,535	25,607
Others	11,082	11,341	11,531	11,930	11,640	11,875	12,741
Medical Revenue	128,775	127,362	126,722	124,949	133,781	144,877	151,192
Inpatient	85,160	84,790	84,582	84,475	90,105	98,997	103,001
Out-of-pocket	1,270	1,287	1,335	1,352	1,427	1,442	1,484
Outpatient	40,705	39,371	38,786	37,208	40,334	42,114	44,478
Others	1,641	1,915	2,018	1,914	1,916	2,323	2,229
	Private Hospital (PRH)						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Medical Expend.	124,941	131,612	134,330	134,745	141,704	152,436	158,566
Remuneration	64,494	67,902	70,201	70,855	75,503	80,498	83,778
Material	29,829	31,754	31,596	30,589	32,707	36,472	38,118
Utility fee	22,483	23,629	24,108	24,557	24,851	26,025	27,200
Others	8,136	8,326	8,425	8,744	8,642	9,442	9,470
Medical Revenue	127,080	132,083	136,756	134,089	144,008	158,005	164,784
Inpatient	85,224	88,565	92,819	91,772	98,138	108,852	112,623
Out-of-pocket	2,919	2,646	3,032	2,993	3,138	2,908	2,920
Outpatient	34,826	36,231	36,327	34,682	38,194	40,642	43,691
Others	4,111	4,641	4,578	4,642	4,537	5,603	4,641

(Thousand Yen)

Source: HOMAS Report, Japan Hospital Federation, 2005-2011

Table 3-9 DID table of average annual growth rate of medical expenditure and revenue

	LPH	PRH	Difference
Average annual medical expenditure growth rate			
Period 1	0.4	2.6	-2.1 [a]
Period 2	3.8	5.6	-1.8
Change	3.4	3.0	0.4[a]
Average annual medical revenue growth rate			
Period 1	-1.0	1.8	-2.8
Period 2	6.6	7.1	-0.6
Change	7.6	5.3	2.3[a]

[a] *the value may be different when taking difference by row or column because of round*

4. MEASURING IMPACT OF THE REFORM ON HOSPITAL STAFF AND NATIONAL MEDICAL EXPENDITURE

Many scholars contributed the success of health system in Japan to its basic health policy, which is characterized as a combination of control of the condition of payment but a laissez-faire approach to how services are delivered, and the equality has been set as one of most important goal of this system(Hashimoto et al., 2011; Ikegami et al., 2011; Shibuya et al., 2011). For the payment system, universal covered health insurance system has been established since 1961. Under the universal coverage system, four major health insurance schemes and the Medical care System for the Elderly aged 75 and over cover almost whole population. Whichever the type of health insurance scheme, co-payments are unified across nation (Ikegami et al., 2011; MHLW, 2013). All providers, no matter private or public, share the same prices for their medicines, devices and medical care services under a nationwide fee schedule. The fee schedule is revised biennially according to the economic and political factors and estimation of utilization of medical service (Hashimoto et al., 2011; Jones, 2009). The revision rate of fee schedule has a great impact on National Medical Expenditure (NME).

The difference of the scopes between estimated NME and coverage of health insurance is showed in **Figure 2-2**. The estimated NME includes medical services and treatments and hospital charges covered by health insurance, copayment of patients and other public financed health care services. Settled NME further includes out-of-pocket medical expenses besides copayment, some nursing fee, transportation fee and others. Expenses of normal delivery, health promotion, disease prevention and control, vaccine injection and so on are not included in NME. Recent years, Japan has experienced great pressure of increase health expenditure. The annual growth rate of NME was more than 3.0% from 2009 to 2011. The proportion of NME in GDP increased from 6.5% in 2006 to 8.2% in 2011. As society getting older, Japan faced greater challenges of containing health expenditure.

For the health care system that is crucial to guarantee the equal accessibility to medical services, the government adopts quite neutral policy, which is equally open to all domestic players. The private sector dominates the health care system, operating more than 80% hospitals and 70% of beds nationwide. The nature of private medical facilities, however, is to pursue “profit” rather than performing public functions. The health resources controlled by a private sector might follow “cash” rather than “needs”. Thus, there is a potential threat of insufficient medical resources in those “non-profitable” services, for example emergency, infectious diseases treatment, serving the remote areas and so on. The Local Public Hospitals considered as one of the most important countermeasures have been played essential role in maintaining equality of local health care system in Japan. However, there are quite few articles reviewing LPH policy and its impacts on local health care system in Japan.

Though the fairness of health care system in Japan was ranked among the best in the world, as shown in **Table 4-1** internal differences of estimated NME and medical resources were substantial among prefectures in 2010. NME per capita and hospital staff per 1000 population in KOC prefecture are 1.7 and 2.7 times greater than these in SIT prefecture, respectively. And the table also reveals that the prefectures with higher proportion of LPH beds tend to have less NME per capita and less hospital staff per 1000 population.

4.1. Determinants of hospital personnel and health expenditure

Researches about distribution of medical resources in Japan mainly focused equality between urban and rural areas. A large number of studies have investigated the distribution of human resource, which revealed that the inequality of physician existed among urban and rural areas. Although the total number of physician increased, Koike et al. (2009) using the data of Surveys of Physicians, Dentists, and Pharmacists from 1972 to 2004, found that the inequality of physicians among urban and rural had not been improved, because the growth rate of physicians for urban and rural areas remained similar. The research from Nomura et al. (2009) showed that inequality of pediatrician workforce got even worse distributed in the rural areas. Toyabe (2009) analyze the time trends in number and distribution of physicians from 1996 to 2006, which revealed that the number of physicians working at hospitals had significantly increased in highly populated urban areas but not in the prefectures with low population densities. The research also found that the distribution of physicians worsened after 2004, especially for the distribution of physicians working at hospitals, which may result from the residency system reform launched in 2004. And many studies also revealed not only geographic inequality of human resource but also maldistribution in specialties and hospital-clinics (Ide, Koike, Kodama, Yasunaga, & Imamura, 2009; Matsumoto, Inoue, & Kajii, 2010; Sasaki, Otsubo, & Imanaka, 2013; Toyokawa & Kobayashi, 2010; Yasunaga, 2008)

These studies, however, faced following challenges. First, most of these researches applied concentration curve and index, like Gini index (Matsumoto, Inoue, Bowman, et al., 2010; Nomura et al., 2009), Atkinson index and Theil index (Toyabe, 2009). These indexes were originally proposed as a measure representing the income distribution of a nation's residents. However, when it is borrowed to describe the distribution of medical resources, it has many problems (Fleurbaey & Schokkaert, 2012; Gravelle, 2003; Harper et al., 2010), because not all health inequalities are inequitable. Rather than neutrally describing the inequality of health resources among population, we move a step further to take account of other environmental factors to justify these differences. Second, most studies had only analyzed distribution of physicians. Quality medical services are provided by different types of medical staff in hospital who are concerted by close collaboration. Number of physicians may not well present human resources in hospital. Third, none of these researches measured the effects of LPHs on distribution of medical human resources. Most of these studies used the data before 2006. As the LPHs reform was launched in 2007, these studies were not able to evaluate the impact of the reform.

Shinjo and Aramaki (2012) used the data in 2008 at secondary health care service areas (SHSA) level to analyze the factors that influence the distribution of health resources in Japan by multiple regress analysis. The research found that health care services were significantly scarcer in outflow groups after control of demographical and socioeconomic factors. And provision of health care services was also imbalanced among different inpatient flow groups. Authors suggested a need to reconstitute the geographical distribution of the health care resources in Japan. However, this study just collected cross-sectional data, thus fail to analyze longitudinal change, which is also very important for policy-makers.

In recent years, rising health expenditure had made studies about determinants of health expenditure a hot topic in many countries. Panel data were commonly applied in these researches, for it has advantage of larger sample size, can test more variables, and apply more robust longitudinal methods to get more consistent estimates. Previous researches have revealed that health expenditure is primarily driven by following factors.

Income is major concern of in health expenditure studies, because income elasticities could help to identify the characteristic of health care services, whether it is normal or inferior goods, or necessity or luxuries. Many studies used data across nations (Clemente, Marcuello, & Montañés, 2008; Newhouse, 1977; Rivera & Currais, 1999), while others focused more within a country (Acemoglu, Finkelstein, & Notowidigdo, 2013; Ang, 2010; Bilgel & Tran, 2013; Pan & Liu, 2012). The results indicated that health care was more likely a luxury at cross-national level, while a necessity within one country.

Many social factors have also been proved related to the health expenditure. Age is one of important factors, either proportion of younger (under 15 years old) or senior population is related to the health expenditure (Ang, 2010; Di Matteo & Di Matteo, 1998; López-Casasnovas & Saez, 2007; Pan & Liu, 2012). Gender is another factor that influence the health expenditure (E. Sato & Fushimi, 2009), not only because of different life expectancy, but also the social and political status and their reaction to the medical needs (Månsdotter, Lindholm, & Öhman, 2004). Many research studies (Costa-Font & Pons-Novell, 2007; Pan & Liu, 2012; Prieto & Lago-Peñas, 2012) had taken the institutional conditions, like beds, doctors, as a factor that influences the health expenditure. It is reasonable, on one hand people purchase health care from facilities where they located, on the other hand substantial presence of induced medical demand under the FFS payment system would boost health expenditure.

There was no research directly exploring the effects of public hospital on health expenditure. However, many researches had revealed difference of performance among hospitals under different ownerships (Barbetta, Turati, & Zago, 2007; Hollingsworth, 2008; Siciliani, Sivey, & Street, 2013). Those differences might reflect on the medical expenditure among regions where proportion of public hospitals varies.

4.2. Data source and definition of variables

We used a sample of panel data covering 47 prefectures in Japan from 2005 to 2010. The data were compiled from reports and surveys of MHLW and MIC. The sources and definitions of data are showed in **Table 4-2**.

The full-time equivalent *STAFF* and *BED* in this study only refer to those owned by hospitals which are defined as the medical facilities with 20 or more beds. We use estimated *NME* to measure the prefectural medical expenditure and all monetary variables, *NME* and *INCOME* are deflated by consumer price index taking 2010 as 100(see **Figure 4-1**).

4.3. Fixed effects and random effects panel regression models

An econometric model for medical resources can be set as follows:

$$y_{it} = \beta_0 + \beta x_{it} + u_i + v_{it} \qquad (4.1)$$

Where i stands for the prefecture, and t denotes time. health careit stands for STAFF or NME of the prefecture i at time t. x_{it} is the vector of determining variables; u_i is unobserved characteristics; and $v_{it}$is the idiosyncratic error term. The equation 4.1 can be estimated using pooled OLS and panel regression techniques where parameters can be estimated by the fixed effects model (FEM) and random effects model (REM). We need to determine which method is the most preferable to our data. The major difference of these methods is related to the assumption of the composite error term, $\varepsilon_{it} = u_i + v_{it}$ (Jeffrey, 2009; Park, 2005). If the composite error term is uncorrelated with x_{it} where u_i is considered as zero, OLS can be used to consistently estimate β. Thus, pooled OLS is preferable in this situation. However, pooled OLS is biased and inconsistent if u_i and x_{it} are correlated, even though the idiosyncratic error v_{it} is uncorrelated with x. In this situation, panel regression techniques are preferable. The core difference between FEM and REM lies in the assumption of u_i. For the FEM, u_i is considered as a part of the intercept, and is allowed to be correlated to other regressors. The least squares dummy variable (LSDV) and within effect estimation methods can be applied to FEM.

For REM, by the contrast, u_i is considered as a part of errors and to be independent with other regressors. Because u_i is in the composite error in each time period, the ε_{it} might be serially correlated across time, and because usual pooled OLS standard errors ignore this correlation, the estimates will be inconsistent. In this case, the REM is better. The generalized least squares (GLS) can be used to solve the serial correlation problem when variance structure among groups is known; while the feasible generalized least squares (FGLS) method can be applied, when it is unknown. Using the incremental F test and the Breusch and Pagan Lagrange multiplier test (BP-LM test)(Breusch & Pagan, 1980), we can test whether FEM or REM is more favorable than pooled model. And the Hausman test (Hausman, 1978) can be used to test whether FEM or REM is more favorable.

In order to exam the impacts of LPH on *STAFF* and *NME* across time periods, the interactions of *LPHBED* with year dummies are included in our regression model [see eq.(4.2)]. The coefficients of interaction term represent the difference of slopes between the year and basic year 2005. The model can be further specified as follows:

$$healthcare_{it} = \beta_0 + \beta x_{it} + u_i + v_{it} + D06 * LPHBED + \cdots + D10 * LPHBED$$

for i=1, …,47; t=2005, …, 2011 (4.2)

For the regression models about *NME*, we assumed a logarithmic functional form between *NME* and *INCOME* while others linear.

4.4. The effect on distribution of hospital staff

As show in **Table 4-3**, the *STAFF* went up year by year since 2005, and had increased from 14.48 to 16.22 by 12.0% in 2010 compared with 2005. The *BED* slightly decreased, from 14.34 in 2005 to 14.17 in 2010. The percentage of LPH beds slightly decreased from 18.09% in 2005 to 17.53% in 2010 during the study period, which might reflect the impacts of the policy adopted by prefectural government to enhance the financial situation by containing burden of LPHs. The *NME* increased form 263.1

thousands yen in 2005 to 297.9 thousands in 2010, increased by around 13.2% within 6 years.

For demographic factors, the *POPDEN* kept around 1372 during study period. The large standard deviation implied huge differences among prefectures. The highest populated prefecture, Tokyo, had 9479 person per square kilometer, while the lowest one, Hokkaido, only had 247 people per square kilometer in 2011. The proportion of population aged 65 and over rapidly increased while that of population under 15 shrunk, reflecting the severe ageing issue. The *SEX* and *MARRIAGE* slightly decreased from 93.30 and 5.22 in 2005 to 92.99 and 5.06, respectively.

The *DEATH* increased as the society getting old, from 9.30 per 1000 population in 2005 to 10.31 in 2010. The *INCOME* was greatly impacted by the financial crisis in 2008, which experienced a sharp drop in 2008 and 2009 and then slightly increased to 2.68 million yen per year in 2010.

For the *STAFF*, static and pooled regression models were established (see **Appendix 4-1**), the incremental F test and BP-LM test, however, reject null hypothesis and indicate panel regress technique is favorable[4]. We further applied the Hausman test to exam the null hypothesis that the explanatory variables and prefectural-specific error terms are uncorrelated. The result rejects the null hypothesis, indicating u_i is correlated with vector of determining variables x_{it}. Thus the FEM is favorable over the REM.

As the results shown in **Table 4-4**, estimated coefficients of *MARRIAGE* and

[4] Incremental F test: $F(46, 217)=452.48$, $p<0.01$; BP-LM test: $X^2(1)=652.07$, $p<0.01$

DEATH are positive; *POPDEN*, *RAT65* and *SEX* are negative; all of these coefficients are statistically different from zero at 5% significance level except that of *SEX* which is at 10% significance level. In addition, the model explains 92.7% within group variation of *STAFF*.

The year dummies show continuous annual increases of *STAFF*. The intercept reached 3.01 in 2010 which indicate a general increase of the *STAFF* at 3.01 in 2010 compared with that in 2005. Although the coefficient of *LPHBED* does not significantly associated with the *STAFF*, the coefficients of interaction terms of *LPHBED* with year dummy become significantly negative since 2007, and the number of decreased *STAFF* per *LPHBED* increased year by year from 0.005 in 2007 to 0.030 in 2010. For example, though the *STAFF* significantly increased in 2010 compared with that in 2005 in the both prefectures with lowest *LPHBED* (Fukuoka, 5.22%) and the prefecture with highest *LPHBED* (Yamagata, 39.60%), the increased *STAFF* in Fukuoka [2.86=3.01+5.22%*(0.002-0.030)] was 0.96 more than that in Yamagata [1.90=3.01+39.6%*(0.002-0.030)] in 2010.

For the demographic factors, *STAFF* significantly decreases as *POPDEN* goes up. This may be due to highly populated prefectures that usually have less geographic barriers. The medical care providers thus are able to provide medical service in a more efficient way. For the proportions of young and senior population, *RAT15* becomes insignificant in panel regression model, and *RAT65* has significant negative effects on *STAFF* at 1% significance level. *MARRIAGE* significantly increases hospital staff by 0.619. For the coefficient of the *DEATH*, it is positive at 1% significance level. It is reasonable in that policy maker would allocate more *STAFF* to the prefectures with high

DEATH. The *INCOME* was positively associated with *STAFF*, but the coefficient was not significantly different from zero. This positive relationship may result from two possible reasons: high *INCOME* may boost larger medical service demands, and thus increase the hospital staff and prefectures with high salary might be more attractive to hospital staff.

4.5. The effect on national medical expenditure

For the *NME* model, we preform both static and pooled regress analysis, too (see **Appendix 4-2**). The incremental *F* test and *BP-LM* test shows that panel regress technique is more proper for the data[5]. **Table 4-5** shows the results of panel regression. *Hausman* test indicates that the REM is favorable than fixed effects model. The key determinants of *NME* among prefectures are *POPDEN, SEX, RAT65, BED, DEATH* and *INCOME*. And the model explains 91.25% overall variation of the *NME*.

The coefficients of interaction terms for *LPHBED* with year dummies are not significantly different from zero, except that of *D10*LPHBED* ($p<0.05$). For the coefficients of year dummies, except a slight decrease in 2006 by 0.71%, the *NME* significantly increases after 2007. In 2010, the *NME* increased by 13.07% compared with 2005[0.1307=*exp* (0.1228)-1]. The results indicate that changes of *NME* were series of parallel shifts of intercept from 2006 to 2009 when holding other factors fixed. *LPHBED* did not significantly impact the *NME* in these years. The growth rate of *NME* among prefectures was the same regardless of LPH bed percentage ceteris paribus. The results indicate greater *NME* increase after 2008, which corresponded to the data from

[5] Incremental F test: $F(46, 216)=180.09$, $p<0.01$; BP-LM test: $X^2(1)=594.15$, $P<0.01$.

MHLW which showed annual NME growth rate reached above 3.0% after 2009. And this may be due to the increases of revision rates for the fee schedule since 2008.

For the determinants of *NME* model, the *POPDEN* and *RAT65* are positively associated with ln*NME*, which indicate 0.96% and 0.82% increases of *NME* with a unit increase of *POPDEN* and *RAT65*, respectively; while the coefficients of *SEX* and *DEATH* are negative at 1% and 10% significance level, respectively. In *NME* model, we further include the *BED* as explanatory variable. The coefficient of *BED* was significantly positive at 1% level. Many researches have revealed that the hospital resources not only reflected the demand, they created medical demands. We also perform regression models without *BED* (see **Appendix 4-3**). Compared with the model without *BED*, we find that the overall R^2 becomes higher (0.9125 vs. 0.8043) and the REM becomes favorable over FEM ($\chi^2(19)=11.97$ $p>0.10$ vs. $\chi^2(18)=99.55$ $P<0.01$). We find very low income elasticity which is 0.0466 at 10% significance level. A 10% increase of *INCOME* would only lead to a 0.47% increase of prefectural *NME*.

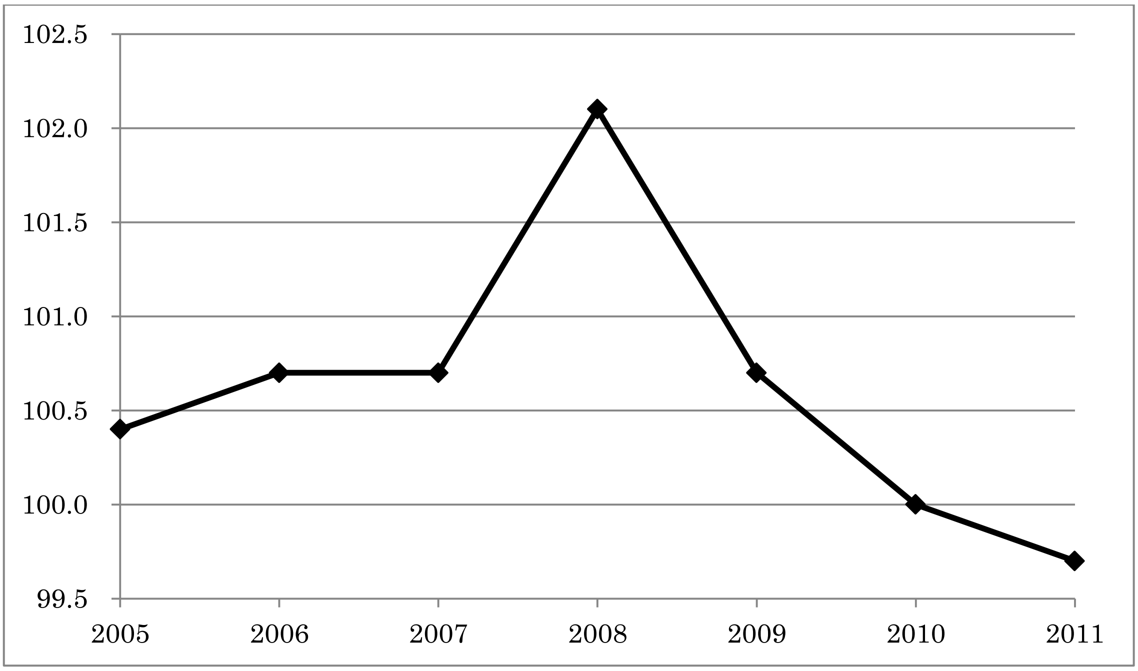


Figure 4-1 Changes of CPI taking 2010's as 100

Table 4-1 Prefectural health resources distribution and health expenditure of 2010

Pref.	*NME*[a]	*NME* rank	*STAFF*[b]	*STAFF* rank	LPH bed %	LPH bed % rank	Population %	GPP share %
KOC	378.5	1	27.8	1	11.20	34	0.60	0.44
NGS	352.0	2	22.0	3	14.24	29	1.11	0.88
HKD	347.2	3	19.7	10	16.20	25	4.30	3.67
OIT	345.9	4	20.5	7	5.96	46	0.93	0.86
KGS	345.7	5	23.0	2	8.34	40	1.33	1.10
TKS	343.2	6	21.2	5	10.57	36	0.61	0.58
FKO	342.2	7	19.9	9	5.22	47	3.96	3.60
YGC	339.7	8	20.0	8	11.11	35	1.13	1.15
KMM	338.9	9	22.0	4	9.49	38	1.42	1.11
HRS	330.4	10	16.5	21	12.57	32	2.23	2.15
KGW	329.7	11	17.9	16	21.41	14	0.78	0.73
SAG	328.8	12	20.5	6	8.14	41	0.66	0.56
OKY	321.8	13	18.4	13	8.46	39	1.52	1.42
EHM	321.4	14	18.0	15	16.84	24	1.12	0.99
MIZ	320.9	15	19.1	11	12.43	33	0.89	0.70
TTR	320.6	16	17.1	20	20.19	18	0.46	0.36
WKY	319.1	17	15.8	24	29.52	4	0.78	0.70
AKT	318.5	18	16.3	22	19.73	21	0.85	0.70
SMN	316.4	19	17.9	17	26.52	6	0.56	0.48
OSK	313.7	20	14.8	28	10.36	37	6.92	7.34
ISK	312.5	21	18.4	12	22.96	11	0.91	0.86
AOM	296.9	22	14.7	29	33.90	3	1.07	0.89
FKI	294.6	23	17.2	19	22.35	12	0.63	0.66
KYT	294.6	24	16.1	23	12.75	31	2.06	1.96
YGT	292.0	25	14.9	26	39.60	1	0.91	0.74
TYM	287.3	26	17.6	18	24.93	10	0.85	0.87
HYG	285.8	27	13.4	35	19.85	20	4.36	3.73
TKY	285.7	28	13.0	37	7.78	42	10.28	18.42
FKS	280.6	29	14.8	27	15.18	27	1.58	1.41
IWT	279.8	30	14.6	30	35.45	2	1.04	0.84
NAR	277.3	31	13.8	34	21.40	15	1.09	0.72
GNM	276.1	32	14.3	31	16.85	23	1.57	1.52
OKN	275.9	33	18.2	14	15.20	26	1.09	0.76
NGT	275.8	34	13.9	33	19.93	19	1.85	1.74
NGN	272.5	35	15.0	25	21.00	16	1.68	1.63
YMN	271.7	36	14.3	32	25.69	8	0.67	0.64
GIF	269.0	37	11.6	43	26.36	7	1.63	1.43
MYG	267.0	38	12.7	38	22.34	13	1.83	1.58
TCG	265.4	39	12.4	40	6.75	45	1.57	1.60
MIE	262.1	40	12.6	39	20.83	17	1.45	1.48
SZO	261.0	41	12.1	42	25.23	9	2.94	3.13
AIC	258.6	42	11.2	44	19.02	22	5.79	6.39

SIG	248.8	43	13.1	36	27.97	5	1.10	1.20
IBR	244.2	44	12.1	41	7.38	43	2.32	2.27
KNG	240.4	45	10.4	46	14.34	28	7.07	6.11
CHB	231.2	46	10.9	45	13.61	30	4.85	3.84
SIT	221.5	47	10.3	47	6.94	44	5.62	4.07

[a] *NMEis estimated national medical expenditure per capita*

[b] *STAFF stands for hospital staff*

Source: Estimates of National Medical Expenditure (2011), Survey of Medical Institutions (2011), Hospital Report (2011).

Table 4-2 Data source and definition

Variable name	Definition
NME[a,d]	Estimated national medical expenditure per capita (1000 yen)
STAFF[b]	No. of hospital staff per 1000 population (full-time equivalent)
BED[b]	No. of hospital beds per 1000 population
LPHBED[b]	Percentage of LPH bed to total hospital beds
POPDEN[c]	1000 people per 1 km^2 of inhabitable area
SEX[c]	100*male/female
RAT15[c]	Percentage of population under 15 year old
RAT65[c]	Percentage of population aged 65 years and over
MARRIAGE[c]	Rate of marriages (per 1 000 population)
UEM[c]	Unemployment rate %
DEATH[c]	Crude death rate (per 1000 persons)
INCOME[c,d]	Annual income per capita(million yen)

[a] Estimates of National Medical Expenditure, MHLW, 2005-2010
[b] Survey of Medical Institutions, MHLW, 2005-2010
[c] Social and Demographic Statistics, MIC, 2005-2010
[d] Variables are CPI standardized

Table 4-3 Descriptive statistics (N=282)

	2005		2006		2007		2008		2009		2010	
Variables	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
STAFF	14.48	3.30	14.77	3.36	15.05	3.47	15.41	3.61	15.85	3.71	16.22	3.79
BED	14.34	3.51	14.34	3.50	14.33	3.52	14.29	3.56	14.26	3.59	14.17	3.58
LPHBED	18.09	8.53	17.73	8.28	17.39	8.26	17.77	8.18	17.62	8.19	17.53	8.29
NME	263.1	32.6	262.6	32.2	271.0	33.4	272.2	33.5	285.9	34.9	297.9	36.4
POPDEN	1.372	1.678	1.372	1.685	1.373	1.695	1.372	1.703	1.370	1.707	1.374	1.738
RAT15	14.00	1.00	13.85	0.96	13.67	0.94	13.53	0.95	13.37	0.96	13.39	0.97
RAT65	21.79	2.81	22.45	2.74	23.08	2.69	23.62	2.63	24.21	2.57	24.39	2.64
SEX	93.30	3.91	93.23	3.97	93.13	4.03	93.05	4.07	92.96	4.06	92.99	3.83
MARRIAGE	5.22	0.53	5.30	0.57	5.22	0.57	5.26	0.59	5.12	0.59	5.06	0.56
UEM	4.16	0.99	3.89	1.01	3.68	0.97	3.90	0.87	4.80	0.82	4.76	0.83
DEATH	9.30	1.31	9.31	1.33	9.53	1.38	9.85	1.43	9.87	1.44	10.31	1.49
INCOME*	2.81	0.49	2.83	0.49	2.85	0.49	2.63	0.43	2.58	0.37	2.68	0.37

* Variables are CPI standardized

Table 4-4 Panel regression results about hospital staff

	STAFF			
	FEM		REM	
	Coefficient	**Robust S.E**	**Coefficient**	**Robust S.E**
POPDEN	-2.401***	0.677	-0.766***	0.178
SEX	-0.163*	0.093	-0.334***	0.088
RAT15	-0.032	0.154	-0.033	0.128
RAT65	-0.432***	0.090	-0.321***	0.093
MARRIAGE	0.619**	0.299	0.768***	0.282
DEATH	0.440***	0.133	0.675***	0.161
INCOME	0.236	0.213	0.405*	0.238
LPHBED	0.002	0.016	-0.031*	0.019
D06	0.579***	0.117	0.465	0.099
D07	1.212***	0.167	0.954	0.145
D08	1.799***	0.242	1.440	0.212
D09	2.734***	0.298	2.328	0.265
D10	3.010***	0.333	2.439	0.308
D06*LPHBED[6]	-0.005	0.004	-0.005	0.004
D07*LPHBED	-0.013**	0.005	-0.013***	0.005
D08*LPHBED	-0.020***	0.007	-0.020***	0.007
D09*LPHBED	-0.031***	0.009	-0.031***	0.009
D10*LPHBED	-0.030***	0.009	-0.030***	0.010
CONSTANT	34.813***	8.919	43.273***	8.816
Observation	282		282	
Hausman Test	$\chi^2(18)=97.29$ $P<0.01$			
R^2: Within	0.927		0.918	
Between	0.142		0.556	
Overall	0.155		0.563	

**** P<0.01, ** P<0.05, * P<0.10*

[6] We also test the effect of LPH bed percentage in a separate fixed effects model which did not include interaction terms while kept other variables the same. The coefficient of *LPHBED* is-0.0004, robust standard error is 0.0006, p>0.10.

Table 4-5 Panel regression results about national medical expenditure

	lnNME			
	FEM		REM	
	Coefficient	Robust S.E.	Coefficient	Robust S.E.
POPDEN	-0.0269	0.0268	0.0096**	0.0043
SEX	-0.0063**	0.0031	-0.0100***	0.0029
RAT15	0.0038	0.0052	0.0030	0.0042
RAT65	0.0061*	0.0034	0.0082***	0.0029
MARRIAGE	0.0013	0.0073	0.0057	0.0076
BED	0.0154**	0.0062	0.0219***	0.0031
DEATH	-0.0106**	0.0047	-0.0068*	0.0038
lnINCOME	0.0403	0.0258	0.0466*	0.0254
LPHBED	-0.0003	0.0006	-0.0003	0.0005
D06	-0.0048	0.0029	-0.0071*	0.0029
D07	0.0271***	0.0057	0.0227***	0.0052
D08	0.0350***	0.0088	0.0280***	0.0072
D09	0.0838***	0.0108	0.0762***	0.0087
D10	0.1321***	0.0118	0.1228***	0.0095
D06*LPHBED	0.00005	0.0001	0.00004	0.0001
D07*LPHBED	-0.0002	0.0001	-0.0002	0.0001
D08*LPHBED	-0.0001	0.0002	-0.0001	0.0001
D09*LPHBED	-0.0002	0.0002	-0.0002	0.0002
D10*LPHBED	-0.0004**	0.0002	-0.0004**	0.0002
CONSTANT	5.5593***	0.3903	5.6147***	0.3672
Observation	282		282	
Hausman Test	$\chi^2(19)=11.97$ p>0.10			
R^2: Within	0.9862		0.9852	
Between	0.6273		0.9034	
Overall	0.6706		0.9125	

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Appendix 4-1 Static regression results about hospital staff

	STAFF							
Year	2005		2008		2010		Pooled	
POPDEN	-0.301	0.308	-0.155	0.295	-0.059	0.335	-0.147	0.116
SEX	-0.563***	0.128	-0.493***	0.121	-0.573***	0.137	-0.501***	0.044
RAT15	0.175	0.433	0.715	0.477	0.849	0.512	0.569***	0.176
RAT65	0.400	0.485	0.499	0.512	0.157	0.508	0.384**	0.147
MARRIAGE	2.943**	1.428	2.757**	1.317	1.580	1.448	2.283***	0.484
DEATH	0.332	1.058	0.801	0.900	1.032	0.788	0.758**	0.298
INCOME	-0.369	0.962	-0.507	1.179	-0.076	1.309	-0.372	0.380
LPHBED	-0.123***	0.037	-0.142***	0.038	-0.163***	0.042	-0.146***	0.015
CONSTANT	41.1**	16.7	21.5	19.0	38.8*	22.2	29.8***	6.5
No. of cases	47		47		47		282	
R^2	0.744		0.794		0.768		0.763	

*** p<0.01, ** p<0.05, * p<0.1

Appendix 4-2 Static regression results about national medical expenditure

Year	ln*NME*							
	2005		2008		2010		Pooled	
POPDEN	-0.0021	0.0084	-0.0004	0.0076	0.0008	0.0084	0.0046	0.0037
SEX	-0.0296***	0.0036	-0.0246***	0.0032	-0.0254***	0.0035	-0.0216***	0.0014
RAT15	-0.0109	0.0120	-0.0025	0.0124	0.0068	0.0129	0.0002	0.0056
RAT65	-0.0010	0.0134	0.0030	0.0135	0.0004	0.0129	0.0127***	0.0047
MARRIAGE	0.1298***	0.0388	0.1191***	0.0335	0.0903	0.0361	0.1057***	0.0153
DEATH	0.0481	0.0292	0.0473*	0.0237	0.0426**	0.0200	0.0381***	0.0095
INCOME	0.0460	0.0801	0.0414	0.0841	0.0778	0.0919	-0.0078	0.0353
LPHBED	-0.0020*	0.0010	-0.0022**	0.0010	-0.0027**	0.0011	-0.0029***	0.0005
CONSTANT	7.05***	0.73	6.47***	0.72	6.49***	0.79	6.5073***	0.3309
No. of cases	47		47		47		282	
R^2	0.867		0.882		0.861		0.824	

*Note: We assumed a logarithmic functional form between NME and household income while others linear; *** P<0.01, ** P<0.05, * P<0.1*

Appendix 4-3 Supplemental models about national medical expenditure

	ln*NME*			
	FEM		REM	
	Coeff.	Robust S.E.	Coeff.	Robust S.E.
POPDEN	-0.0464*	0.0234	-0.0029	0.0055
SEX	-0.0076**	0.0032	-0.0160***	0.0028
RAT15	0.0022	0.0053	0.0020	0.0047
RAT65	0.0064*	0.0033	0.0097***	0.0034
MARRIAGE	0.0026	0.0077	0.0104	0.0087
DEATH	-0.0081	0.0049	0.0007	0.0048
lnINCOME	0.0463*	0.0263	0.0511*	0.0304
LPHBED	-0.0003	0.0006	-0.0013**	0.0006
D06	-0.0057*	0.0030	-0.0096***	0.0034
D07	0.0250***	0.0056	0.0166**	0.0065
D08	0.0321***	0.0083	0.0191**	0.0086
D09	0.0807***	0.0100	0.0664***	0.0102
D10	0.1255***	0.0116	0.1057***	0.0124
D06*LPHBED	0.0000	0.0001	0.0000	0.0001
D07*LPHBED	-0.0002	0.0001	-0.0002	0.0002
D08*LPHBED	-0.0002	0.0002	-0.0002	0.0002
D09*LPHBED	-0.0003	0.0003	-0.0004	0.0003
D10*LPHBED	-0.0004	0.0003	-0.0004	0.0003
CONSTANT	5.8670***	0.3683	6.3750***	0.3809
Observation	282		282	
Hausman Test			$\chi^2(18)=99.55$ $P<0.01$	
R^2: Within	0.9847		0.9821	
Between	0.2394		0.7985	
Overall	0.3180		0.8043	

**** P<0.01, ** P<0.05, * P<0.1*

5. EVALUATING EFFICIENCY OF THE HEALTH CARE SYSTEM IN JAPAN

How to measure the efficiency among health care providers objectively has been a popular research topic for many years. It is the first step in effectively controlling rocketing health care expenditures, which could possibly result in increases in out-of-pocket expenditure, the erosion of governmental financial soundness, and strains on the fiscal solvency of health insurance programs. The definition of efficiency generally pertains to producing a given level of outputs that meets an acceptable standard of quality using the minimum combination of resources, or alternatively producing the maximum amount of output from a given amount of input (Farrell, 1957; Hollingsworth, 2008; Ozcan, 2008; Worthington, 2004). Compared with studies in other industries whose outputs are either straightforward or could be reflected in their price, the complexity of outputs in health care has created a great barrier to efficiency research in this field. There are two key questions in measuring the efficiency of health care. The first is what the outputs of health care are, and the second is how to measure them. Different from a production-line type technology where a set of clearly identified inputs are used to produce standardized output, major health care services are tailor-made to the specific needs of the individual recipient and delivered over multiple time periods(Jacobs, Smith, & Street, 2006). This means that the production process is much less clearly defined, outputs may be difficult to capture, and quality may vary greatly from case to case.

There are two types of outputs in health care: services and outcome. Health care services, however, cannot be considered the real outputs for patients because the demand for health care services derives from the belief that these services would make a beneficial contribution to health status. Thus, health outcomes would be more appropriate outputs. The practical difficulties to measure health outcomes which result from the nature of health care services, delivered by a continuous process beyond the boundaries among health organizations and time limitations with ubiquitous uncertainty, have led to few studies being done to measure the outcomes and further compare the outcome efficiency with peers. Instead, most efficiency studies have used health care services as outputs. In fact, even these research studies usually fail to take into account quality issues. A systematic review of health care efficiency measures from 1990 to 2008 conducted by Hussey et al. (2009) pointed out that among 273 studies about efficiency measures, “almost all of the measures did not explicitly consider the quality of care”. Moreover, the exogenous factors which are beyond the control of policy-makers or indirectly related to the health care system, such as environmental, socioeconomic, and genetic factors, make the problem even more perplexing.

Michael E Porter and Teisberg (2006) proposed the idea of "value" in health care, which is defined as the health outcomes achieved per dollar spent. They argued that the "value" in health care should be "measured by the outcomes achieved, not the volume of services delivered, and shifting focus from volume to value is a central challenge". Furthermore, M. E. Porter (2010) states, "Cost reduction without regard to the outcomes achieved is dangerous and self-defeating, and leads to false savings and potentially limiting effective care." This argument is based on the assumption that the value measured by health outcomes achieved per dollar spent is not associated with the value measured by the volume of services delivered, in other words, volume efficiency does not necessarily lead to outcome efficiency. There is little empirical evidence to support this assumption. In contrast, many research studies have investigated the volume-outcome relationships and revealed that high volume is associated with better outcomes across a wide range of procedures and conditions (Borowski et al., 2010; Gaynor, Seider, & Vogt, 2005; Halm, Lee, & Chassin, 2002; Urbach, Croxford, MacCallum, & Stukel, 2005). However, the results of these studies are hardly justified under the context of health spending containment which is confronted by policy makers from different nations, because they fail to take into account of the costs of these services. Thus, different from evaluating the volume-outcome relationships, this paper estimates the volume and outcome efficiencies of local health care systems in Japan and investigates the relationship between the two efficiencies by taking costs into consideration.

The determinants of volume and outcome efficiency are investigated by applying the two-stage data envelopment analysis (DEA) approach. The basic idea of the two-stage DEA approach is to obtain the efficiency score for decision making units (DMUs) at the first stage and then examine the effect on the efficiency of DMUs of factors that are beyond the control of the decision maker (exogenous variables). Often a regression model is estimated for DEA scores at the second stage(Avkiran, 2009; Hoff, 2007; McDonald, 2009; Ramalho, Ramalho, & Henriques, 2010). The DEA approach has been widely used and proven to be an effective tool for efficiency measurement in health care systems (Hollingsworth, 2003, 2008; O'Neill, Rauner, Heidenberger, & Kraus, 2008; Worthington, 2004). Under the framework of DEA, multiple inputs and outputs are allowed to be included in a linear programming model, identifying the frontier of production, and then developing a single score for each DMU by calculating its distance referring to the frontier. In the second stage, the Tobit regression model is estimated to relate the DEA efficiency scores with the exogenous factors, a method which has been widely applied to many research studies (Kirjavainen & Loikkanent, 1998; Kooreman, 1994; Marschall & Flessa, 2011; Yoshida & Fujimoto, 2004).

5.1. Data source and Definition of Variables

This study utilizes prefectural level data in Japan in 2005 and 2010. As shown in **Table 5-1**, the data are compiled from reports and surveys of the Ministry of Health, Labor and Welfare (MHLW) and the Ministry of Internal Affairs and Communications (MIC), and is categorized into three groups: inputs, outputs, and exogenous factors. It is important to distinguish the endogenous variables, which are included in the DEA model as inputs and outputs, from the exogenous variables, which are included in the Tobit model and taken as factors explaining efficiency differences. To better serve the research objectives, we define the endogenous variables as those that are more easily controlled by policy-makers and more directly related to the health care system, while those outside the decision making power of local governments, such as genetic and environmental factors, population density and lifestyle factors, and employment and education, are defined as exogenous variables by following the rule of thumb of selecting inputs and outputs for the DEA model and exogenous variables for the regression model(Avkiran, 2009; Cook, Tone, & Zhu, 2014; Fried, Schmidt, & Yaisawarng, 1999; Ozcan, 2008).

From **Table 5-1**, it should be noted that *EDU* and the lifestyle risk factors (*VEG*, *OBESITY* and *SMOKE*) are only available in 2010. However, we believe that these factors are crucial to the efficiency of the local health care system, so we run both the cross-sectional Tobit model with those variables and the panel model and without them. As the obesity and smoke rates are very low for females, and their variation is large among prefectures(MHLW, 2010), we only use data for males as proxy variables for lifestyle factors.

All the input and output variables are significantly different between 2005 and 2010(the paired sample *t*-test $p<0.05$). *PHS* and *BED* experienced a significant drop in 2010, from 50.50 and 1434 in 2005 to 46.9 and 1412.4 in 2010, respectively. However, *HOSSTA* increased from 1447.9 in 2005 to 1628.7 in 2010. *OUTPAT* decreased while *DISCHA* increased. Life expectancy has significantly improved in 2010 compared with 2005. All the exogenous factors significantly changed in 2010 except *POPDEN*. *SENIOR* and *UEM* increased from 21.79% and 4.16% in 2005 to 24.39% and 4.76% in

2010, respectively. *INCOME* and *MARRIAGE* decreased from 2.82 million and 5.22‰ in 2005 to 2.68 million and 5.06‰ in 2010, respectively.

Table 5-2 shows the input and output variables for all prefectures in Japan in 2010. The internal differences of some variables were large among prefectures. For instance, *KOC* had the highest *BED* at *2491*, which is 3 times greater than that in the lowest prefecture *KNG*; *TTR* had the highest *PHS* at 71.1 staff per 100 thousand population, while *MYG* only had 15.9. The difference is more than 4 times. Generally speaking, prefectures located in the southern parts of Japan, such as *KOC*, *KGS*, and *KMM*, tended to have more *HOSSTA* and *BED* resources, while those more developed and populated prefectures in the northern parts of Japan, such as *SIT*, *KNG*, *CHB*, possessed fewer resources per 100 thousand population . The life expectancy is generally high in Japan. The average life expectancy at birth for males and females was 79.51 and 86.39 years respectively in 2010. The male and female residents in *NGN* enjoyed the longest life expectancies at birth at 80.88 and 87.18 years respectively, while *AOM* had relatively shorter life expectancy for their male and female residents, which are 77.28 and 85.34 years. The variation of health outcome measures in terms of life expectancy is relatively small, which reflects the good equality of the health care system in Japan.

5.2. Evaluating the efficiency of the local health care system in Japan

5.2.1. The structure of the Quasi-max SBM DEA model

The first DEA model was developed by Charnes, Cooper, and Rhodes (1978), and is known as the CCR model, which assumes a constant returns-to-scale relationship between inputs and outputs. Based on the CCR model, Banker, Charnes, and Cooper (1984) further developed the BCC model with a variable returns-to-scale assumption. These two models, however, assume the proportional change of input or output and usually ignore the remaining slacks. Tone (2001) proposed a slacks-based measure of efficiency in the DEA model, which can deal with inputs or outputs individually and integrate slacks into an efficiency measure.

We define sets of DMUs, inputs and outputs by $N = \{1, \dots, n\}, M = \{1, \dots, m\}\ and\ S = \{1, \dots, s\}$, respectively. Assuming DMU $j (j \in N)$ has *i* input $x_{ij} (i \in M)$ and *r* output $y_{rj} (r \in S)$. λ_j is a non-negative element on DMU j. s_i^- and s_r^+ indicate the input excess and output shortfall, respectively. Subscript *o* indicates the objective DMU. The original non-oriented SBM efficiency score θ_o^{min} can be computed by following model:

$$\theta_o^{min} = \min \frac{1 - \frac{1}{m}\left(\sum_{i \in M} {s_i^-}/{x_{io}}\right)}{1 + \frac{1}{s}\left(\sum_{r \in S} {s_r^+}/{y_{ro}}\right)} \qquad (5.1)$$

subject to

$$x_{io} = \sum_{j \in N} x_{ij} \lambda_j + s_i^- \qquad i \in M$$

$$y_{ro} = \sum_{j \in N} y_{rj} \lambda_j - s_r^+ \qquad r \in S$$

$$\lambda_j \geq 0, j \in N, s_i^- \geq 0, i \in M \text{ and } s_r^+ \geq 0, r \in S \qquad (5.2)$$

However, this original SBM DEA model evaluates the efficiency of DMUs referring to the furthest point on the frontier within a range, which leads to the hardest score and an inappropriate reference for the objective DMU. In this paper, we applied the improved SBM DEA model developed in Tone (2010)'s original paper (Variation I), which evaluates each DMU by the nearest point on the same frontier as the original SBM DEA found and thus improves the measures of efficiency. The efficiency score of the improved SBM DEA model, however, is not really maximized because Variation I actually does not necessarily find the real shortest distance by exhaustively exploring the distances from the DMUs to all possible production frontiers,; thus, we name it the quasi-max SBM model (Tone, 2010). We improve the original SBM model as follows. Let the reference-set R_o for the objective DMU (x_o,y_o) be defined as the set of DMUs corresponding to λ_j^* in the solution of program (5.2) above.

$$R_o = \{j|\lambda_j^* > 0, j \in N\} \quad (5.3)$$

$$\theta_o^{max} = \max \frac{1 - \frac{1}{m}\left(\sum_{i \in M} {s_i^-}/{x_{io}}\right)}{1 + \frac{1}{s}\left(\sum_{r \in S} {s_r^+}/{y_{ro}}\right)} \qquad (5.4)$$

subject to

$$x_{io} = \sum_{j \in R_o} x_{ij}\,\lambda_j + s_i^- \qquad i \in M$$

$$y_{ro} = \sum_{j \in R_o} y_{rj}\,\lambda_j - s_r^+ \qquad r \in S$$

$$\lambda_j \geq 0, j \in N, s_i^- \geq 0, i \in M \text{ and } s_r^+ \geq 0, r \in S \qquad (5.5)$$

Since we deal with the same facet as the original SBM model, we have the relationship:

$$\theta_o^{max} \geq \theta_o^{min} \qquad (5.6)$$

The relation of constant returns-to-scale (CRS) is assumed in the program above. In order to observe the impact of variable returns-to-scale (VRS), the following convexity constraint is added to the model:

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad (5.7)$$

The efficiency of the health care system may have many determinants, however, given the size of the sample, and thus the number of inputs and outputs needs to be limited in order to better differentiate the efficiency among prefectures because the number of inputs and outputs greatly impacts the efficiency score. The more variables are included, the higher the efficiency score. To allow the efficiency scores to be comparable, we keep the number of input and output variables the same for all three DEA models. Three input variables measuring the cost of medical and preventive care are common among all these three models. Only the output variables differ among the three models to measure the efficiency from different aspects (see **Table 5-3**).

Service volume efficiency (SVE) model: In this model, we use *OUTPAT* and *DISCHA* as outputs. These two indicators are used to measure the volume of health care services provided by different prefectures.

General outcome efficiency (GOE) model: The life expectancy at birth for males and females is included in the GOE model. The estimate in this model is to measure one of the most important health outcome efficiencies, life expectancy at birth. As we further use the life expectancy at 65 as an output in the third DEA model, we name the measure in this model general outcome efficiency (GOE).

Outcome efficiency for the senior population (OES) model: This model measures the health outcome efficiency for the senior population, which takes the life expectancy for males and females at 65 years old as output variables. As Japan is facing a severe aging problem, it would be meaningful to pay extra attention to the efficiency for the senior population.

5.2.2. Numerical results

The results of the health volume and outcome efficiency calculated from the quasi-max SBM DEA models are shown in **Table 5-4.** The SVE score is relatively higher than the other two outcome efficiency scores. The medians are 0.765 and 0.840, and the ranges are 0.435 and 0.346 under CRS and VRS in 2010, respectively. The medians are 0.611 and 0.765 for GOE, and 0.618 and 0.814 for OES under CRS and VRS, respectively in 2010. The Wilcoxon Matched-Pairs Signed-Rank Test shows a significant change of efficiency scores in 2010 compared to those in 2005 except for the OES score under VRS. As shown in **Table 5-4,** the medians of SVE decreased from 0.822 and 0.868 in 2005 to 0.765 and 0.840 in 2010 for CRS and VRS, respectively, while the medians of OES increased from 0.609 and 0.807 to 0.618 and 0.814 during the same period for CRS and VRS respectively.

The population density (*POPDEN*) and the proportion of senior population (*SENIOR*) are considered as two of the most important factors which may influence the volume and outcome efficiency of local health care systems. Many research studies have revealed that a higher proportion of senior population is related to larger health expenditure (Ang, 2010; Di Matteo & Di Matteo, 1998; López-Casasnovas & Saez, 2007; Pan & Liu, 2012), which means more inputs and outputs for a health care system. As shown in Figure 1, *SENIOR* is negatively correlated with *POPDEN* (Pearson correlation coefficient is -0.531, $p<0.01$), indicating that prefectures with high *SENIOR* tend to have low *POPDEN*. We further apply the *k*-means clustering method to classify the 47 prefectures into 3 groups according to *SENIOR* and *POPDEN*. The distribution of the prefectures in the three groups is shown in Figure 1. Group I includes the three most developed prefectures in Japan, whose average *POPDEN* is highest and average *SENIOR* is lowest; while group III includes those least developed prefectures that usually have some geographic disadvantages, which have the lowest *POPDEN* and the highest *SENIOR*. The *SENIOR* and *POPDEN* of prefectures in Group II are between these two groups.

The population density (*POPDEN*) and proportion of senior population (*SENIOR*) are considered as two of most important factors which may influence the volume and outcome efficiency of local health care system. Many researches have revealed that the higher proportion of senior population is related to a larger health expenditure, which means more inputs and outputs for a health care system. As showed in **Figure 5-1**, the *SENIOR* is negatively correlated with *POPDEN* (Pearson correlation coefficient is -0.531, p<0.01), indicating that prefectures with high *SENIOR* tend to have low *POPDEN*. We further apply *k*-means clustering method to classify 47 prefectures into 3 groups according to *SENIOR* and *POPDEN*. The distribution of the prefectures in three groups is show in **Figure 5-1**. Group I includes three most developed prefectures in Japan, whose average *POPDEN* is highest and the average *SENIOR* lowest; while group III includes those least developed prefectures and usually have some geographic disadvantages, which have lowest *POPDEN* and highest *SENIOR*. The *SENIOR* and *POPDEN* of prefectures in Group II are between these two groups.

Table 5-5 shows the efficiency scores among the three clustering groups. All three efficiency scores, SVE, GOE and OES, are highest in group I, while they are lowest in group III. The non-parametric test shows that the medians are significantly different among the three groups. The results of Table 5 indicate that exogenous variables, like *POPDEN* and *SENIOR*, do have significant effects on efficiency scores among prefectures. Thus, the impacts of exogenous variables, including demographic factors and socio-economic and lifestyle factors, on prefectural efficiency scores are further analyzed in the second stage, the Tobit regression.

5.3. Identifying the exogenous variables of efficiency by Tobit models

5.3.1. Tobit models

In the second stage, a variety of regression techniques have been used in previous studies (Avkiran, 2009; Hoff, 2007; McDonald, 2009; Ramalho et al., 2010; Simar & Wilson, 2007). In this paper, we select the Tobit regression model. In a standard Tobit model, the independent variable is either 0 or some positive values (Maddala, 1986; Wooldridge, 2012), but the DEA efficiency scores are restricted to a range between (0,1], and there are always more observations at the upper limit, so we transform the efficiency score to an inefficiency score based on the following function (Yoshida & Fujimoto, 2004):

-ln(θ_o^{max})

Tobit models actually explain the source of inefficiency.

The cross-sectional Tobit model can be written as

$$y_i^* = \beta x_i + u_i \quad i \in N \qquad (5.8)$$

where the observed variables is:

$$y_i = \begin{cases} y_i^* & if\ y_i^* > 0 \\ 0 & otherwise \end{cases} \quad i \in N \quad (5.9)$$

where i stands for the prefecture $i \in N$, y_i is a latent variable which can be treated as a threshold beyond which the explanatory variables must affect in order for y_i to "jump" from 0 to some positive value. In our case, the prefectural inefficiency score can be viewed as a continuous variable limited to a minimum value of zero. The error term $u_i \sim NID(0, \sigma^2)$. x_i is the explanatory variables, and β is a vector of parameters to be estimated.

The panel data Tobit model with random effects further splits the error term u_{it} $i \in N, t \in T,$ where T is a set of time periods, into a time-invariant individual random effect v_i and a time-varying idiosyncratic random error ε_{it} with assumptions that the idiosyncratic error ε_{it} is serially uncorrelated; the individual effects v_i are uncorrelated across individuals; i.e., $v_i|x_i \sim NID(0, \sigma_v^2)$. The model is written as follows:

$$y_{it}^* = \beta x_{it} + v_i + \varepsilon_{it} \quad i \in N \quad t \in T \quad (5.10)$$

where the observed variables are:

$$y_{it} = \begin{cases} y_{it}^* & \text{if } y_{it}^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad i \in N \quad t \in T \quad (5.11)$$

The approach with the Tobit model as the secondary stage after deriving the efficiency scores by DEA has been used in many research studies in different fields (Kirjavainen & Loikkanent, 1998; Kooreman, 1994; Luoma, Jarvio, Suoniemi, & Hjerppe, 1996; Marschall & Flessa, 2011; Ray, 1991; Yoshida & Fujimoto, 2004). We find that the efficiency scores are significantly different between 2010 and 2005 by applying the Wilcoxon Matched-Pairs Signed-Rank Test. Thus, the panel Tobit regression is applied in order to investigate the impacts of unobserved exogenous factors.

In this study, we simply want to identify the exogenous variables which have explanatory power for the efficiency differences, then we control them in the correlation analysis performed in the next section. We do not use the results to calibrate the efficiency scores.

5.3.2. Numerical Results

Table 5-6 shows the results of the cross-sectional Tobit models in 2010. The likelihood ratio test indicates that the coefficients for all the models are significantly different from zero (p<0.05). As expected, POPDEN has a significant positive effect on efficiency scores under CRS among different models. For the SVE score, it remains significant even after taking into account the effect of variable returns-to-scale (p=0.023). This indicates that POPDEN might have more direct impacts on the volume of health care services in a health care system than on the life expectancy of population. It is reasonable for *POPDEN* to influence the way that health care services are delivered. Health care services could be provided in a more efficient way as the population is more concentrated, while prefectures with low *POPDEN* are usually less developed with certain geographic disadvantages which make it impossible to provide health care services with fewer health facilities. Furthermore, greater concerns about equality may also lead to more investment per capita for those prefectures. Not surprisingly, the proportion of senior population has a significant negative effect on prefectural efficiency scores. A higher proportion of senior people may require more health inputs, thus leading to lower efficiency scores for those prefectures. The significance of *SENIOR* disappears in the SVE Tobit model under VRS, but it holds significant in two outcome Tobit models, even taking the assumption of VRS into consideration. This indicates that the proportion of senior people may have a greater effect on life expectancy than the utilization of health care services.

As many research studies have revealed, unemployment has many adverse effects on life expectancy and health status (Milner, Page, & LaMontagne, 2014; Roelfs, Shor, Davidson, & Schwartz, 2011). Our results also show that *UEM* has a significant deleterious effect on efficiency scores across all Tobit models (see **Table 5-6**). The effect of marriage on health is complicated (Robles, Slatcher, Trombello, & McGinn, 2014). Our study shows that *MARRIAGE* significantly decreases the efficiency scores under CRS. The reason needs to be further investigated. Many lifestyle factors have been proven to significantly influence health status (Mizoue, Reijula, & Andersson, 2001; Okuda et al., 2015; K. Sato & Tamashiro, 2008; Zhang et al., 2009). Our models reveal that *VEG*, *OBESITY*, and *SMOKE* do not significantly influence the volume efficiency, but *VEG* significantly increases the GOE and OES efficiency.

As shown in **Table 5-7**, the panel Tobit model explains around 60-90% of the variation of efficiency scores among the 6 models (see *rho* value in **Table 5-7**). The values of the Wald $Chi^2(6)$ indicate that the coefficients are significantly different from zero for all the models. The results of the panel Tobit models support the cross-sectional findings. *POPDEN* is positively associated with all efficiency scores, while *SENIOR*, *MARRIAGE*, and *UEM* are negatively correlated with the efficiency scores. What should be noticed is that the year dummy shows a significant increase of efficiency in 2010 in the health outcome models, and this might be because of the increased life expectancy caused by the progress of technology.

As identified in the Tobit models, we control the following determining factors in the partial correlation models: *POPDEN*, *SENIOR*, *MARRIAGE*, *UEM*, *VEG*. As shown in **Table 5-8**, the Spearman correlation coefficient between the SVE and GOE efficiency scores is 0.820 and 0.429 ($p<0.01$) under CRS and VRS, respectively. The correlation coefficients are much higher for the CRS score than for the VRS score. After controlling the determining factors, the coefficient for the CRS efficiency scores drops to 0.591 ($p<0.01$), and that for the VRS scores drops to 0.203, and there is no statistical significance ($p>0.05$). This result indicates that high volume efficiency may not necessarily be associated with the great health outcome efficiency of a health care system. It is meaningful for the policy-makers to reflect on the health policy in Japan, where the nation is facing the great financial pressure of rocketing health expenditure and the problem of the possible overutilization of medical services (Hashimoto et al., 2011; Ikegami et al., 2011). The correlation coefficients between the GOE and OES efficiency scores are very high, which are 0.997 and 0.839 for CRS and VRS scores (p<0.01), respectively. Even after controlling these exogenous factors, the coefficients are 0.998 and 0.675 (p<0.01) for the CRS and VRS efficiency scores, respectively. This indicates the fact that the prefectures with high general health outcome efficiency are usually capable of achieving sound health outcome efficiency for the senior population.

5.4. Relationship between volume and outcome efficiencies

In this paper, we estimate the volume and outcome efficiency scores of prefectures in Japan, then explore the exogenous factors of these efficiency scores, and finally investigate the relationship between the volume and outcome efficiency scores. Three DEA models, SVE, GOE and OES models, are created to measure the volume efficiency, general health outcome efficiency, and outcome efficiency for the senior population. The SVE scores of prefectures are general higher than the outcome efficiency scores. Compared to the efficiency estimates in 2005, SVE experienced a significant drop, while GOE experienced a significant increase.

By applying the Tobit regression analysis, we find that *POPDEN* and *VEG* have significant beneficial effects on efficiency scores, while *SENIOR*, *UEM*, and *MARRIAGE* significantly decrease the efficiency score. We investigate the relationship between the volume and outcome efficiency in a correlation analysis. The Spearman correlation coefficient of the SVE and GOE scores has a significant decrease after controlling the exogenous factors identified by the Tobit models. The coefficient of these two models under CRS remains significant even after controlling the exogenous factors, while the coefficient of the VRS scores becomes insignificant after adjusting for the exogenous factors. This result indicates the fact that the result of pursuing volume efficiency does not always result in good health outcome efficiency. The volume efficiency reflects the interest in the short run. Improvement of service efficiency means "producing" more health services with a given input level, or in other words, "producing" a given volume of health services with less input. Its impact on health outcomes, however, is unclear in the long run. For example, increasing inputs in primary and preventive care may decrease the volume efficiency of a health care system, but it may increase the health outcome efficiency in the long run because those services could help to prevent people from contracting some severe diseases. What is more important, such services contribute to increasing the life expectancy with good quality of life. Thus, this needs to be further investigated.

Life expectancy is not a perfect health outcome indicator for it fails to include information about the quality of life. The Tobit model may not be the best option for the regression analysis because the DEA scores probably do not perfectly match the assumption of the Tobit model regarding the dependent variable. The DEA efficiency scores in this research study, however, are transformed into inefficiency scores, which might mitigate the problem of misspecification. Thus, further research needs to be conducted to investigate the effects of the scale of production in health care systems and the determinants of health outcome efficiency by more reasonable outcome indicators and more reliable regression models.

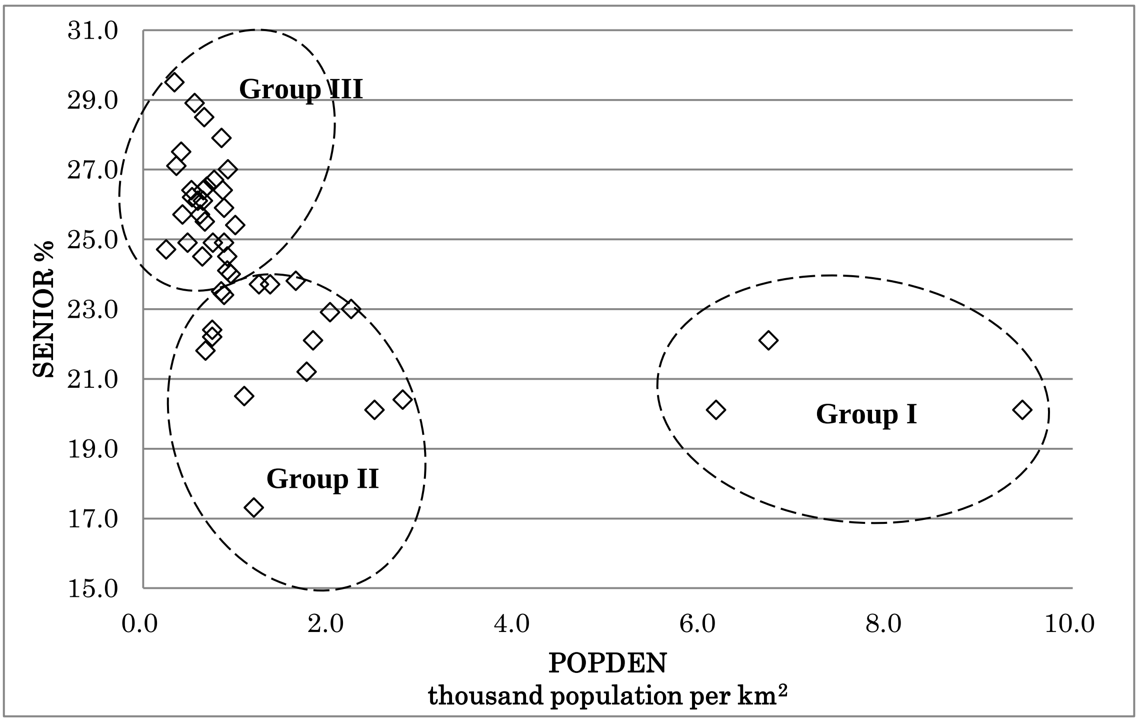


Figure 5-1 Scatter diagram for *SENIOR* and *POPDEN* in 2010

Table 5-1 Data source and definition

Category	Variable name	Description
Inputs	HOSSTA[a]	Hospital staff per 100 thousand population
	BED[b]	Hospital bed per 100 thousand population
	PHS[c]	Permanent public health staff per 100 thousand population
Outputs	OUTPAT[b]	Number of outpatients per day per 100 thousand population
	DISCHA[b]	Number of discharges per day per 100 thousand population
	MLE0[e]	Life expectancy for male at birth
	FLE0[e]	Life expectancy for female at birth
	MLE65[e]	Life expectancy for male at 65
	FLE65[e]	Life expectancy for female at 65
Exogenous factors	SENIOR[f]	Proportion of senior population(age≥65)
	POPDEN[f]	1000 population per km^2 of inhabitable area
	INCOME[f]	Annual personal income, million Yen per year
	MARRIAGE[f]	Marriage rate, ‰
	UEM[f]	Unemployment rate, %
	EDU[f,h]	Proportion of population with college or higher degree, %
	VEG[g,h]	Intake of vegetable for male, gram per day
	OBESITY[g,h]	Obesity(BMI≥25.0) rate for male, %
	SMOKE[g,h]	Smoking rate for male, %

[a] Hospital Report, MHLW, 2005, 2010

[b] Survey of Medical Institutions, MHLW, 2005 and 2010

[c] Report on Regional Public Health Services, MHLW, 2005 and 2010

[e] 20th and 21th Life Tables, MHLW, 2005 and 2010

[f] Social and Demographic Statistics, MIC, 2005 and 2010

[g] National Health and Nutrition Survey, MHLW, 2010

[h] Data only available in 2010

Table 5-2 Input and output variables among prefectures in 2010

	Inputs			Outputs					
Prefecture	**HOSSTA**	**BED**	**PHS**	**OUT**	**DIS**	**MLE0**	**FLE0**	**MLE65**	**MLE65**
HKD	1982	1796	61.0	1484	39.4	79.17	86.30	18.75	24.05
AOM	1476	1343	46.4	1144	31.6	77.28	85.34	17.59	23.28
IWT	1477	1367	59.9	1044	31.5	78.53	85.86	18.46	23.69
MYG	1284	1085	15.9	946	32.0	79.65	86.39	18.81	23.70
AKT	1651	1489	56.4	1379	36.1	78.22	85.93	18.10	23.64
YGT	1496	1302	56.8	1083	36.7	79.97	86.28	18.82	23.98
FKS	1513	1338	46.4	1062	32.0	78.84	86.05	18.45	23.57
IBR	1217	1095	34.4	1049	26.7	79.09	85.83	18.58	23.44
TCG	1244	1085	35.4	998	26.6	79.06	85.66	18.30	23.22
GNM	1434	1247	36.5	1002	32.9	79.40	85.91	18.77	23.47
SIT	1031	867	26.6	889	21.7	79.62	85.88	18.71	23.42
CHB	1094	916	35.0	945	25.0	79.88	86.20	18.97	23.63
TKY	1300	965	32.7	1114	31.1	79.82	86.39	18.82	23.85
KNG	1037	815	36.9	882	26.2	80.25	86.63	19.06	24.03
NGT	1393	1242	53.3	1128	30.9	79.47	86.96	18.87	24.28
TYM	1764	1608	45.7	1326	36.2	79.71	86.75	18.86	24.26
ISK	1848	1635	43.0	1350	37.6	79.71	86.75	18.91	24.23
FKI	1722	1417	56.0	1433	37.2	80.47	86.94	19.19	24.29
YMN	1438	1309	57.3	1136	30.4	79.54	86.65	18.90	24.09
NGN	1504	1127	53.4	1196	35.7	80.88	87.18	19.71	24.36
GIF	1166	1002	43.7	1046	29.2	79.92	86.26	19.03	23.67
SZO	1215	1061	39.7	832	27.3	79.95	86.22	18.91	23.71
AIC	1115	914	35.8	959	27.6	79.71	86.22	18.60	23.54
MIE	1265	1117	37.9	952	27.6	79.68	86.25	18.74	23.61
SIG	1305	1047	42.4	1005	29.5	80.58	86.69	19.18	23.95
KYT	1617	1375	43.4	1254	34.0	80.21	86.65	19.20	23.98
OSK	1483	1225	35.2	1121	34.0	78.99	85.93	18.31	23.47
HYG	1346	1145	35.4	1035	31.5	79.59	86.14	18.71	23.62
NAR	1387	1181	37.9	1135	31.0	80.14	86.60	18.88	23.86
WKY	1592	1437	63.5	1234	34.0	79.07	85.69	18.35	23.52
TTR	1722	1528	71.1	1241	39.2	79.01	86.08	18.47	24.27
SMN	1805	1602	68.5	1073	38.7	79.51	87.07	18.98	24.51

OKY	1845	1534	51.0	1353	38.0	79.77	86.93	18.96	24.17
HRS	1655	1440	38.5	1209	34.7	79.91	86.94	19.10	24.31
YGC	2015	1900	49.7	1170	36.6	79.03	86.07	18.37	23.83
TKS	2138	1927	48.1	1487	35.2	79.44	86.21	18.75	23.77
KGW	1800	1559	41.4	1571	39.8	79.73	86.34	19.06	23.89
EHM	1809	1613	55.6	1413	35.3	79.13	86.54	18.73	24.06
KOC	2806	2491	69.1	1791	40.5	78.91	86.47	18.69	24.04
FKO	1985	1713	45.3	1159	37.0	79.30	86.48	18.58	23.95
SAG	2059	1797	51.1	1285	33.0	79.28	86.58	18.56	24.15
NGS	2216	1928	55.5	1303	39.0	78.88	86.30	18.74	24.06
KMM	2203	1964	54.6	1241	38.1	80.29	86.98	19.46	24.57
OIT	2061	1694	48.2	1322	40.8	80.06	86.91	19.17	24.23
MIZ	1918	1725	49.4	1145	34.3	79.70	86.61	18.97	24.13
KGS	2305	2062	58.8	1310	36.6	79.21	86.28	18.76	23.96
OKN	1810	1356	44.6	1030	36.0	79.40	87.02	19.50	24.89
Mean	1629	1412	46.9	1176	33.5	79.51	86.39	18.80	23.92
SD[a]	382	360	11.5	197	4.6	0.63	0.42	0.37	0.36

[a] *Standard Deviation*

Table 5-3 DEA input and output table

Categories	**Variables**	**SVE model**	**GOE model**	**OES model**
Inputs	HOSSTA	X	X	X
	BED	X	X	X
	PHS	X	X	X
Outputs	OUTPAT	X		
	DISCHA	X		
	MLE0		X	
	FLE0		X	
	MLE65			X
	FLE65			X

Table 5-4 Efficiency scores between 2005 and 2010

		2005			**2010**		
		Median	**Min**	**Efficient DMUs No.(%)**	**Median**	**Min**	**Efficient DMUs No.(%)**
SVE	θ_{CRS}**	0.822	0.609	5(10.6)	0.765	0.565	5(10.6)
	θ_{VRS}*	0.868	0.692	16(34.0)	0.840	0.654	12(25.5)
GOE	θ_{CRS}*	0.599	0.355	2(4.3)	0.611	0.366	3(6.4)
	θ_{VRS}*	0.805	0.380	4(8.5)	0.765	0.406	6(12.8)
OES	θ_{CRS}*	0.609	0.363	2(4.3)	0.618	0.371	3(6.4)
	θ_{VRS}	0.807	0.505	5(10.6)	0.814	0.486	5(10.6)

** *p<0.01*; * *p<0.05*

The maximum of all groups is 1.

Table 5-5 Efficiency scores among clustering groups in 2010

		Group I			Group II			Group III		
		Median	**Min**	**Max**	**Median**	**Min**	**Max**	**Median**	**Min**	**Max**
SVE	CRS*	1.000	0.904	1.000	.835	.647	1.000	.722	.565	1.000
Score	VRS*	1.000	0.870	1.000	.870	.748	1.000	.783	.654	1.000
GOE	CRS**	0.839	0.717	1.000	.763	.538	1.000	.541	.366	.661
Score	VRS**	0.909	0.729	1.000	.840	.600	1.000	.614	.406	1.000
OES	CRS**	0.845	0.713	1.000	.767	.542	1.000	.545	.371	.681
Score	VRS**	0.905	0.721	1.000	.841	.596	1.000	.771	.486	1.000

* $p<0.05$, ** $p<0.01$

Table 5-6 Results of static Tobit models in 2010

Dependent	**-ln(θ) in SVE Model**				**-ln(θ)in GOE model**				**-ln(θ)in OES model**			
	CRS		**VRS**		**CRS**		**VRS**		**CRS**		**VRS**	
	Coefficient	SE[a]	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	p-value	Coefficient	p-value
POPDEN	-0.073***	0.025	-0.074**	0.031	-0.070**	0.026	-0.049	0.032	-0.067**	0.025	-0.048	0.027
SENIOR	0.062***	0.016	0.031	0.020	0.108***	0.018	0.088***	0.021	0.105***	0.017	0.066***	0.017
INCOME	0.002	0.098	0.164	0.122	0.000	0.102	0.240	0.125	0.019	0.099	0.316***	0.107
MARRIAGE	0.258***	0.076	0.117	0.093	0.318***	0.084	0.062	0.097	0.293***	0.081	0.004	0.082
UEM	0.082**	0.037	0.102**	0.047	0.100**	0.040	0.105**	0.047	0.099**	0.039	0.166***	0.040
EDU	-0.008	0.007	-0.011	0.008	-0.006	0.008	-0.011	0.009	-0.006	0.007	-0.011	0.007
VEG	-0.001	0.001	-0.001	0.001	-0.002**	0.001	-0.004***	0.001	-0.002**	0.001	-0.002***	0.001
OBESITY	-0.005	0.005	-0.005	0.006	-0.008	0.006	0.005	0.006	-0.007	0.005	-0.008	0.005
SMOKE	-0.005	0.006	-0.007	0.007	-0.005	0.006	-0.003	0.007	-0.004	0.006	-0.006	0.006
CONSTANT	-2.107**	1.032	-0.953	1.266	-3.008**	1.109	-1.620	1.303	-2.896**	1.071	-1.515	1.084
LR Chi^2*(9)*	42.36 (*p*=0.000)		18.55 (*p*=0.029)		60.21 (*p*=0.000)		57.85 (*p*=0.000)		32.89 (*p*=0.000)		47.16 (*p*=0.000)	

[a] SE, standard error,

** *p*<0.05, *** *p*<0.01

Table 5-7 Results of panel Tobit models

Dependent	**-ln(θ) in SVE Model**				**-ln(θ)in GOE model**				**-ln(θ)in OES model**			
	CRS		**VRS**		**CRS**		**VRS**		**CRS**		**VRS**	
	Coefficient	SE[a]	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
POPDEN	-0.051***	0.016	-0.071***	0.023	-0.051***	0.018	-0.028	0.024	-0.048***	0.017	-0.006	0.021
SENIOR	0.032***	0.011	0.019	0.014	0.067***	0.012	0.067***	0.016	0.066***	0.012	0.045***	0.013
INCOME	-0.065	0.065	0.050	0.085	0.026	0.052	0.092	0.085	0.023	0.051	0.058	0.077
MARRIAGE	0.139**	0.055	0.084	0.074	0.138***	0.053	0.031	0.085	0.131**	0.052	-0.070	0.071
UEM	0.032	0.022	0.064**	0.029	0.046***	0.023	0.115***	0.034	0.046**	0.023	0.084***	0.029
YEAR	-0.027	0.031	-0.023	0.040	-0.168***	0.034	-0.188***	0.047	-0.165***	0.033	-0.199***	0.038
CONSTANT	-1.100	0.574	-1.066	0.760	-1.910***	0.555	-2.047**	0.816	-1.870***	0.539	-0.846	0.687
rho	0.671		0. 593		0.869		0.602		0.863		0.633	
Wald $Chi^2(6)$	56.83 (p=0.000)		21.54 (p=0.002)		62.88 (p=0.000)		45.76 (p=0.000)		66.13 (p=0.000)		50.27 (p=0.000)	

[a] SE, standard error,

** p<0.05, *** p<0.01

Table 5-8 Correlation coefficients between efficiency scores in 2010

		SVE Score		GOE Score		OES Score	
		SCC[a]	**PCC**[b]	**SCC**	**PCC**	**SCC**	**PCC**
SVE Score	CRS	1.000	1.000	0.820**	0.591**	0.811**	0.598**
	VRS	1.000	1.000	0.429**	0.203	0.410**	0.222
GOE Score	CRS	0.820**	0.591**	1.000	1.000	0.997**	0.998**
	VRS	0.429**	0.203	1.000	1.000	0.839**	0.675**
OES Score	CRS	0.811**	0.598**	0.997**	0.998**	1.000	1.000
	VRS	0.410**	0.222	0.839**	0.675**	1.000	1.000

[a] *Spearman correlation coefficient*

[b] *Partial correlation coefficient by controlling for POPDEN, SENIOR, MARRIAGE, UEM and VEG; d.f.=40*

** *$p<0.01$*

6. CONCLUSION AND POLICY IMPLICATIONS

6.1. Summary and Conclusion

Our paper reveals that hospital resources were unequally distributed among prefectures in Japan. Hospital resources were concentrated on major nine developed and populated prefectures including HKD, TKY, OSK, FKO, SIT, CHB, KNG, AIC, and HYG. Further analysis indicates density of hospital resources was higher in underdeveloped prefectures in southern parts of Japan. The underdeveloped prefecture in northern parts of Japan which had larger proportion of LPH beds has been facing the shortage of hospital resources in terms of both absolute volume and resource density.

For financial performance, the data from HOMAS suggest that LPHs substantially improved their financial performance by increasing their annual medical revenue compared with the private hospitals after the reform.

The results about the impacts of LPH on local health care system in Japan suggest that LPH reform launched in 2007 might have compromised accessibility to health care services of residents in prefecture with high proportion of LPH beds and the quality of medical services they had received.

For the relationship between volume and outcome efficiencies, our findings show that high health care service volume efficiency may not necessarily be associated with high health outcome efficiency. The effect of the economies of scale played an important role in the volume-outcome efficiency relationship. The prefectures with high general outcome efficiency were capable of producing high outcome efficiency for the senior population.

In conclusion, our research indicates a possible compromise of equality of health care system. The accessibility to health care resources for residents in prefecture with high proportion of LPH beds might be undermined during 2005 to 2011. Policies related to health care service efficiency improvement should be carefully investigated and weigh the impacts on health outcomes of population in long-run before implementations. The LPH reform launched in 2007, might be one of the causes for these results. Other health care policies implemented during this period, however, could not be neglected, neither. More comprehensive research needs to be further conducted to obtain more convincing policy implications.

6.2. Policy implications

Based on the results in **Chapter 3**, we find that compared with private hospitals, the annual growth rate of medical revenue of LPH substantially increased by 2.3% after the LPH reform, which may reflect different strategies adopted by private hospitals and LPHs after the reform. Combining the fact that imbalances in hospital resources had worsened from 2005 to 2011, this finding raises the concern about the trade-off between pursuing financial performance and performing public functions. Some scholars worried that the reform overstated the importance of the financial soundness while compromised the accessibility of medical services. For example, many LPHs in remote areas were closed or downsized, especially for those underdeveloped prefectures in northern parts of Japan. In 2011, the percentage of LPH beds for some prefectures such as IWT, FKS, AOM, MYG and so on, decreased by more than 2% compared with 2005, where the delivery of local health care services heavily rely on LPHs. To maintain the equality of the health care system, we suggest a careful examination of the accessibility of medical services and financial soundness in those prefectures

For the analysis of impacts of the reform on hospital staff and local NME in **Chapter 4,** many research studies have revealed that lack of and imbalance in health professionals had been a problem of health care system in Japan for a long time (Ide et al., 2009; Koike et al., 2009; Sasaki et al., 2013; Teo, 2007). The government adopted series of measures to increase the number of doctors and nurses since 2005 (MHLW, 2008). The hospital staff per 1000 population increased by more than 3 at average regardless of the impact of LPH bed percentage, though the number of hospital beds kept shrinking during the research period. Our results are consistent with findings of previous studies from a different perspective. Widening disparities of hospital staff were observed among prefectures with different proportions of LPH beds. As the LPH reform was adopted as a measure of local financial consolidation, the local governments had made great efforts to wipe out the deficit of LPHs by downsizing, merging, privatization and many other measures to improve the financial conditions of LPHs. Those policies may lead to less increase of hospital staff in these prefectures. The results about the NME indicated the increases of NME among different years tended to be series of upward parallel shifts of intercept, the proportion of LPH beds did not significantly change the NME among prefectures in Japan when holding other factors fixed except in the year 2010.

The findings may imply following situations. On one hand hospital staff in prefectures with high proportion of LPH bed assumed more workload than those in low LPH bed prefectures. On the other hand, patients in prefectures with high LPH bed proportion might seek for more medical services in other prefectures. Because though local supply (hospital staff per 1000 population) did not increased as many as low LPH bed prefectures did, demands (NME per capita) evenly increased among prefectures. The local governments might have well controlled the deficit of LPHs but at the expenses of accessibility and medical services quality. In addition, as previous studies revealed (Matsumoto, Inoue, Bowman, et al., 2010; Nomura et al., 2009), the mismatch between the local demands and specialties of physicians may be another reason that causes the patients in prefectures with high proportion of LPH beds to seek for medical care in other prefectures. As the social demographics in Japan have been dramatically changing, especially ageing and depopulating issues for these remote prefectures, the local health care demands need to be further investigated. To examine the hypotheses, research studies about supplies and demands of local health care system and the patient flow among prefectures need to be conducted.

Our research also finds the potential induced medical demand. As showing in **Table 4-5**, one additional unit of hospital bed per 1000 population led to around a 2.19% NME increase. In Japan, most services were provided on the fee-for-service (FFS) basis. Many studies (Christianson & Conrad, 2011; McClellan, 2011) had revealed that under FFS payment system physicians were inclined to provide more medical services. The long average length of hospital stay (18.5 days in 2009, which was more than twice as the average level of OECD) and large share of pharmaceutical expenditure backed the inference of induced demands in health care system in Japan. Though the diagnostic procedure combination (DPC) system, a Japanese version of prospective payment system (PPS), was introduced in 2003, many studies

(Besstremyannaya, 2012; Okamura et al., 2005; Wang et al., 2010) showed that introduction of prospective payment system resulted in only a limited gain to control the overutilization of medical care services. Besstremyannaya (2012) argued that the major reason was related to inadequate incentives by two-part PPS tariff, in that the FFS component still played a substantial role in the prospective payment system in Japan. Current payment system would make residents in rich medical resources areas get more medical care services, while those in insufficient medical resources area get less, thus widening the disparities.

This study finds small income elasticity of NME, which is only 0.046. Several studies have pointed out that with health insurance, individual income elasticity was typically near zero or even negative, because the purpose of health insurance is to eliminate the individual budget constraint and reduce the influence of cost of health care on patients' and doctors' decisions about how much care to use (Chernew & Newhouse, 2012; Folland, Goodman, & Stano, 2013; Getzen, 2000). Thus if the population is well insured, the personal medical expenditure may more directly relate to their health status. The effects of income on health status were controversial. Kagamimori, Gaina, and Nasermoaddeli (2009) reviewed researches about influence socioeconomic status on health in Japanese population between 1990 and 2007 and they pointed out that the effects of income were not examined sufficiently.

For the relationship between volume and outcome efficiencies in **Chapter 5**, we find that population density and daily intake of vegetables had significant beneficial effects on efficiency scores by applying the Tobit regression analysis, while proportion of senior population, unemployment rate, and marriage rate significantly were negatively associated with the efficiency score. We investigated the relationship between the volume and outcome efficiency in a correlation analysis. The Spearman correlation coefficient of the SVE and GOE scores had a significant decrease after controlling the exogenous factors identified by the Tobit models. The coefficient of these two efficiency scores under CRS remained significant even after controlling the exogenous factors, while the coefficient of the scores under VRS became insignificant after adjusting for the exogenous factors. This result indicated the fact that the result of pursuing high volume efficiency does not always result in good health outcome efficiency.

The volume efficiency reflects the interests in the short run. Improvement of service efficiency means "producing" more health services with a given input level, or in other words, "producing" a given volume of health services with less input. Its impact on health outcomes, however, is unclear in the long run. For example, increasing inputs in primary and preventive care may decrease the volume efficiency of a health care system measured by the model in this paper, but it may increase the health outcome efficiency in the long run because those services could help to prevent people from contracting some severe diseases. What is more important, such services might contribute to increasing the life expectancy with good quality of life. Thus, any policy related to health care service efficiency improvement should be carefully investigated and weigh the impacts on health outcomes of population in long-run.

6.3. Future problems

For the study in **Chapter 3,** there were some shortcomings to compare the annual data from HOMAS between hospitals under different ownership. First, the HOMAS was not a follow-up survey and subjects are different from year to year, therefor the financial perform change may not result from the changing management of hospital but from the selection of different hospitals. Second, under the context of supply side fee control system, the financial performance may be substantially influenced by the fee schedule. The general improvement of financial performance of LPHs and PRHs after 2008 probably resulted from the revision of fee schedule rather than enhanced management. The revision rate of medical service increased in 2008 for the first time after three consecutive decreases since 2002 (See **Figure 2-3**). Third, the estimator of simple DID analysis might be biased, because we fail to control other environmental factors which may influence hospital financial conditions. Those factors are not available in our HOMAS's database. Our analysis does reveal that LPHs have improved their financial performance after the reform, but we cannot neglect their high annual growth rate of medical revenue which may be the main reason of the improvement. This raises the concern about the trade-off between pursuing financial performance and performing public functions. Some scholars worried that the reform overstated the importance of the financial soundness while compromised the accessibility of medical services. Thus, follow-up studies need to be conducted in the future.

For the study in **Chapter 5**, first, we assume a static relationship between the inputs and outputs in outcome efficiency calculation, in which inputs at current stage affect life expectancy of the population at the same stage. This, however, may not stay true in reality. Health outcomes at one stage may be related to the inputs at the same stage as well as those at previous stages. Second, life expectancy is not a perfect health outcome indicator for it fails to include information about the quality of life. The health outcome indicators that include a measure of quality of life, such as quality-adjusted life expectancy and quality-adjusted life year, however, are largely unavailable in administrative databases. Finally, though we find that the economies of scale played important role in the relationship between volume and outcome efficiencies, we are not able to explain how it works on the volume-outcome relationship. Thus, further longitudinal data-based research studies with more reasonable outcome indicators need to be conducted to investigate inputs and outputs related to health outcome efficiency, and to find explanations for the mechanism of economies of scale working in health care systems.

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