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Measuring the impact of Japanese local public hospital reform on national medical expenditure via panel data regression

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ABSTRACT

Local public hospitals (LPH) in Japan were established to secure equal accessibility and to improve quality for the health care system by providing policy-based medical services. Difficulties faced by the LPHs challenged the equal accessibility of the health care system and the improvement of their financial situation. We try to investigate the impact of LPH burden on the health care system and attempt to repair the problems confronting LPHs in order to attain the higher health care quality based upon the technology innovation. Panel data regression is used to analyze the effect of proportion of LPH beds and an indicator of LPH burden on hospital personnel numbers and also on estimated national medical expenditure (ENME) using the data from 2005 to 2010 for 47 prefectures in Japan. Hospital personnel, a major supply-side indicator, increased more in prefectures shouldering smaller burden of LPH beds. Prefectural ENME, an important demand-side indicator composing of medical expenditure based on the location of medical facilities, tends to decrease with increasing prefectural LPH burden. The results indicate that patients in the prefectures carrying more LPH burden tend to seek health care in the prefectures bearing less LPH burden during the research period. These imbalances substantially increase after the LPH reform.

1. Introduction

Finance strategy and delivery system are two major essential aspects for improving the health care quality and its system in Japan. The success of Japanese health care system is considered as a result of an appropriate balance of these two aspects (Hashimoto et al., 2011; Ikegami et al., 2011; Shibuya et al., 2011). Namely, Japanese hospitals have been struggling to deliver qualified care while dealing with financial challenges. On the one hand, the publicly financed universal health coverage has been established since 1961 (Ikegami et al., 2011). In 2011, the whole population was covered by 5 major health insurance schemes and approximately 3500 insurers which share the same co-payment structure (MHLW, 2013). All prices of medicine, devices and medical care services are tightly regulated by the government using a nationwide unified fee schedule. All providers, both private and public, deliver the same services at the same prices under the fee schedule. Furthermore, the high-cost medical care program was established to mitigate the medial cost burden of household when its expenditure exceeds certain limit (KEMPOREN, 2013). This system guarantees all residents have access to necessary and adequate medical services (Jeong and Hurst, 2001; Jones, 2009) Budget constraints for patients are substantially reduced when they look for health care.

On the other hand, the Local Public Hospitals (LPH) were constituted to ensure that health care could be equally delivered to residents in need. In Japan, the private sector dominates the health care system, accounting for >80% of hospitals and 70% of beds nationwide. The nature of the private sector leads private medical facilities to pursue “profit” rather than public functions (Jones, 2009; Zhang and Oyama, 2016). The Japanese government considers LPH system as an important countermeasure against increasing regional disparity in health resources by providing the government subsidized policy-based medical services (PBMS). The PBMS includes high-tech medical care, emergency services, health care in less densely populated and remote areas and other non-profitable medical care services, services which private medical facilities are either unwilling or unable to provide. The LPHs have been playing an important role such as promoting technology innovation and more advanced technologies in order to attain higher health care quality for the system.

During the first decade of the 21st century, the soundness of the Japanese health care system was challenged by the recession of economy (Takeda, 1995) and a number of problems in the LPH system high operating costs, huge debt, unfavorable management and substantial brain drain (Matsuda, 2008). Some local governments had to reorganize, downsize or even close LPHs to reduce their financial burden. This situation aggravated regional imbalances in health care resources and impaired equal access of the health care system. In late 2007, a LPH reform was implemented by the Ministry of Internal Affairs and Communications (MIC). From technological viewpoints we can say

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that the LPH reform has been an LPH innovation. Multiple measures were included in the reform, aiming to tackle not only the management problems of LPHs but also imbalances in health care resources.

Many studies have investigated policy impact on management and efficiency of LPHs (Besstremyannaya, 2011, 2012; Kawaguchi et al., 2014; Matsuda, 2008). The effect of LPH burden on the health care system, however, is largely neglected. This study primarily examines the LPH burden on supply and demand in local health care system in Japan, using proxy variables such as proportion of LPH beds given as an indicator to measure LPH burden for local governments, hospital personnel given as an important supply-side factor of health care systems, and national medical expenditure given as a major demand-side factor, using data from 2005 to 2010 for 47 prefectures of Japan. Administrative divisions of Japan consist of 47 prefectures, in which the national capital Tokyo and two metropolitan prefectures Kyoto and Osaka are included.

2. The LPH system and national medical expenditure in Japan

2.1. The LPH system

LPHs, a type of Local Public Enterprise (LPE) owned by local governments or Local Independent Administrative Corporations (LIAC) (Tanaka, 2010), are established to secure necessary and adequate health care for all residents across the nation. The LIAC was established by local governments to carry out projects related to public benefits based on the Local Independent Administrative Corporations Law. Legal status of the LIAC makes it more independent of local governments. According to the 2011 data from the Ministry of Health, Labour and Welfare (MHLW), only 11% of all hospitals and 13% of all beds nationwide were operated by LPHs that year. The LPHs, however, engaged intensively in different types of PBMS. For example, LPHs accounted for 67.8% of designated hospitals serving remote areas, 40.9% of emergency centers, and 39.6% of regional perinatal medical centers. These PBMSs are usually subsidized by central and local governments.

Local governments faced both a huge deficit from LPHs and a problem persisting for a number of years and worsening since 2000. In 2008, local governments were required to publicize their financial indicators based on consolidated accounting statements with LPEs including LPHs. Some local governments with large deficit from LPHs would face the risk of financial failure, which would necessitate direct control by the MIC. In late 2007, the MIC launched the LPH reform as a measure to deal with problems in LPH management and with increasing regional disparities in health care resources.

To improve the management of LPHs, the guideline of the reform required first, all local governments should monitor and publicize key performance indicators of their LPHs; second, local governments should initiate the organizational reform for LPHs. The daily management of LPHs was outsourced, a designated manager system was introduced and corporatization given by a transfer from LPE-owned to LIAC-owned or privatization of LPHs was performed by some local governments. To secure equal accessibility while retaining the balance of financial burden on local governments, the guideline stipulated that local health care systems should be reorganized by concentrating beds in well-functioned “magnet hospitals” and building “satellite clinics” to improve the quality of care and to secure health care for remote regions. The guideline also stipulated that LPHs whose occupancy rate was <70% in the three most recent years should reduce the number of beds or be downsized to clinics (MIC, 2007).

The number of total beds decreased from about 1,631,000 to 1,593,000 during the period from 2005 to 2010. The percentage of LPH beds is defined to be the percentage of LPH beds to total number of beds in Japanese hospitals and also it can be a quantitative indicator of LPH burden of local governments. The average percentage of LPH beds for all prefectures in Japan decreased from 18.09% to 17.53% during the above period. The percentage of LPHs operating with a surplus increased from 25.5% in 2006 to 52.3% in 2010, and annual deficits sharply decreased from >190 billion yen to minus 5.6 billion yen (surplus) during the same period (MIC, 2010).

Though financial performance and efficiency of LPHs improved after the reform, some scholars argue that the effect of the reform might have been driven by significant government subsidies and that those effects disappeared with the subsequent decrease in government subsidies (Kawaguchi et al., 2014). Concerns also arose about compromised accessibility of health care system after the reform (Matsuda, 2008).

2.2. National medical expenditure in Japan

Prices of medicine, devices and medical care services in Japan are controlled by the government using a national unified fee schedule. The government could adjust national medical expenditure (NME) by weighing economic and political factors and expected demands by means of a biennial revision of the fee schedule (Jones, 2009; Shibuya et al., 2011). As shown in Fig. 1, prices under the fee schedule were reduced in four consecutive revisions since 2000. Subsequently, revision rates started to increase in 2008 (the revision rate for medical service prices was increased this year). The revisions had a great impact on NME. For example, the annual NME growth rate increased to >3.0% in the period from 2009 to 2011 compared to <2% at the beginning of the 2000's. The proportion of NME in the GDP increased from 6.0% in 2000 to 8.2% in 2011 (MHLW, 2013).

When referring to the term NME in the Japanese setting, caution is required, since the statistic Total Health Expenditure (THE) used among OECD countries is often translated as *Kokumin Iryohi*, which means national medical expenditure. However, these two statistics are different. NME refers to total medical payment, including co-payment, for services covered by the health insurance schemes, which are tracked by the unified national payment system, while THE includes not only payments for items covered by the health insurance but also expenditures for items not covered such as OTC drugs, medical check-ups and some dental services.

The difference in scope between NME and health insurance coverage is shown in Fig. 2. The costs in the area inside the bold line are paid by health insurance. Some health costs such as those related to accidents are not covered by health insurance but are still considered part of NME, while maternity and childbirth expenses are covered by health insurance but are not considered part of NME.

The MHLW publishes estimated NME (ENME) and settled NME (SNME) annually. Prefectural ENME is composed of medical expenditure on the basis of medical facility location, while prefectural SNME is medical expenditure based on the patient place of residence and is estimated every three year by the MHLW. There is one further difference between SNME and ENME: SNME includes medical expenditure covered by accident insurance, medical expenditure for some items not covered by health insurance and transportation fees.

3. Panel data regression model analyses for national medical expenditure

3.1. Data and variables

We use a sampling panel data covering 47 prefectures in Japan from 2005 to 2010. The data were compiled from reports and surveys of the MHLW and MIC. The sources and definitions of variables are shown in Table 1 below.

The *STAFF* and *BED* in this study only refer to those in hospitals which are defined as medical facilities with 20 or more beds. We use *ENME* as a proxy variable of prefectural medical expenditure, and deflate the monetary variables, *ENME* and *INCOME*, using the consumer price index with that for 2010 set as 100 (see Fig. 3). In

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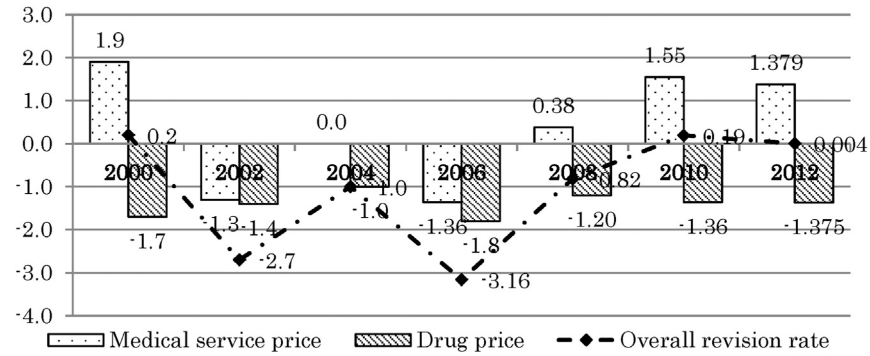

Fig. 1. Fee schedule revision rates, 2000–2012.
Source: MHLW White Paper, MHLW

our numerical experiments we have not included technology related independent variables such as installment of advanced medical instruments e.g. magnetic resonance imaging (MRI), position emission tomography (PET), and application of health information technology which is considered as a useful tool to improve the efficiency and quality (Abraham et al., 2011; Osei-Frimpong et al., 2016; Pai and Huang, 2011). These variables might give us more insights on the impact of the LPH reform or the LPH innovation on the *NME*s.

3.2. Panel data regression models

Let the sets of observations and periods be $N = \{1,\ldots,47\}$ and $T = \{2005,\ldots,2010\}$, respectively. A theoretical econometric model can be characterized as

$$y_{it} = \beta_0 + \beta x_{it} + u_i + v_{it} \quad i \in N, t \in T \tag{1}$$

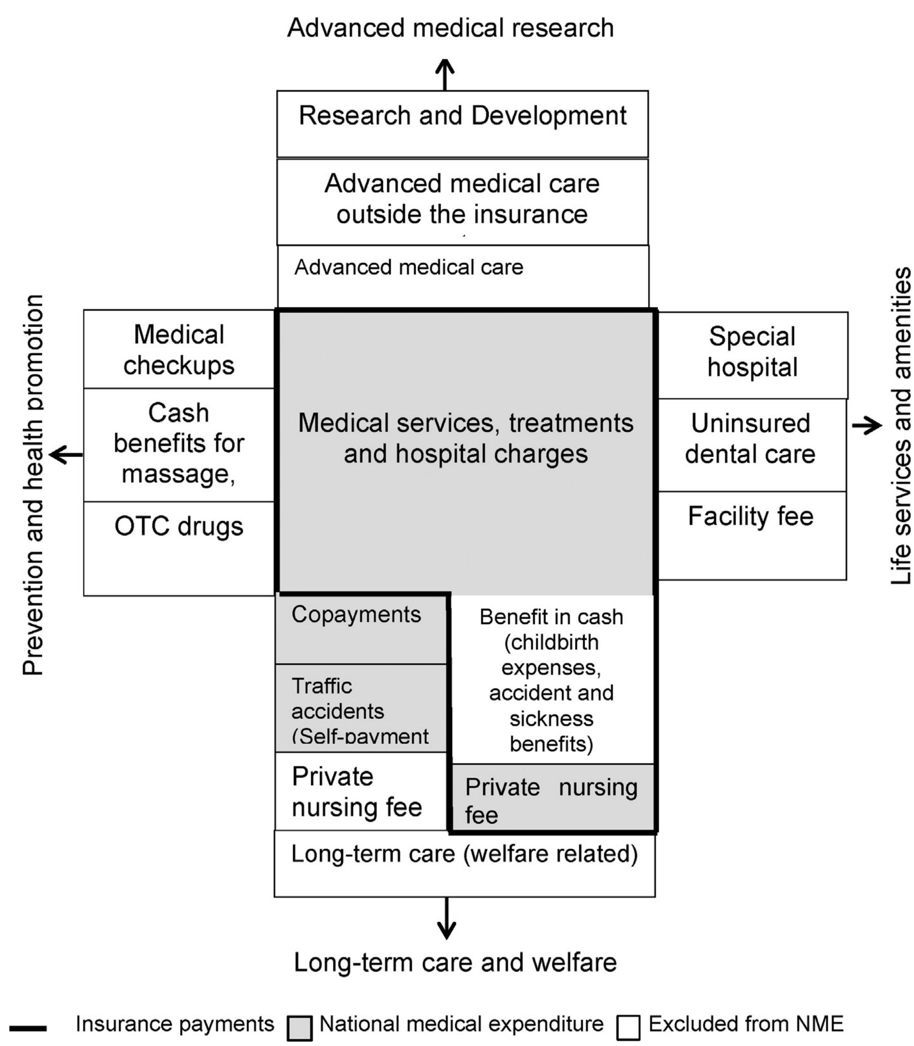

Fig. 2. Coverage of Japan's health care system.
Source: National Institute of Population and Social Security Research, *Social Security in Japan, 2011*

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Table 1
Data source and definition.

Variable name	Definition
ENME[a]	Estimated national medical expenditure per capita (local population where the medical facilities are located, 1000 yen)
SNME[b]	Settled national medical expenditure per capita (local population where the patients live in, 1000 yen)
STAFF[c]	Number of hospital staff per 1000 population (full-time equivalent)
BED[c]	Number of hospital beds per 1000 population
LPHBED[c]	Percentage of LPH beds among total hospital beds
POPDEN[d]	1000 people per 1 km^2 of inhabitable area
SEX[d]	100 ∗ male / female
RAT15[d]	Percentage of population under 15 years old
RAT65[d]	Percentage of population aged 65 years and over
MARRIAGE[d]	Marriage rate (marriages per 1000 population)
UEM[d]	Unemployment rate (% of population currently in the labor force)
DEATH[d]	Crude death rate (per 1000 population)
INCOME[d]	Annual income per capita (million yen)

[a] Survey on the Trend of Medical Care Expenditures, MHLW, 2005–2010.
[b] Estimates of National Medical Care Expenditure, MHLW, 2005, 2008, 2011.
[c] Survey of Medical Institutions, MHLW, 2005–2010.
[d] Social and Demographic Statistics, MIC, 2005–2010.

where x_{it} is the vector of independent variables, u_i is unobserved characteristics of prefecture i and v_{it} is idiosyncratic error. Model (1) can be estimated using pooled OLS and panel regression techniques when assumptions about u_i and v_{it} change (Jeffrey, 2009; Park, 2005). The parameters of the panel regression can be estimated using the fixed effects model (FEM) or the random effects model (REM). Using the incremental F test and the Breusch and Pagan Lagrange multiplier test (BP-LM test) (Breusch and Pagan, 1980), we can test whether FEM or REM is favored over the pooled OLS model. The Hausman test (Hausman, 1978) can be used to determine which of FEM and REM is preferable. FEM is estimated using the least squares dummy variable approach, and REM is calculated using the generalized least squares approach.

We assume that the impact of LPH burden on local health care systems is reflected by the share of LPH resources owned by local governments. Thus, we use the share of LPH beds as a proxy variable for the measurement of LPH burden for local governments. The relationship between share of LPH beds and two health resource variables was examined: *STAFF*, which is an important supply-side factor; and NME, which is a significant demand-side factor. The model used here is further characterized as follows:

$$healthcare^{\alpha}_{it} = \beta_0 + \beta x_{it} + u_i + v_{it} + \sum_{t \in T/\{2005\}}^{2010} D_t * LPHBED_{it} \quad i \in N, t \in T \tag{2}$$

where α stands for *STAFF* or *ENME*, and D_t is year dummy. The coefficients of interactions of $LPHBED_{it}$ with year dummies D_t represent the difference in slopes between the year and base year 2005. For the regression models for *ENME*, we assume a logarithmic functional form between *ENME* and *INCOME*, which is linear with respect to other variables.

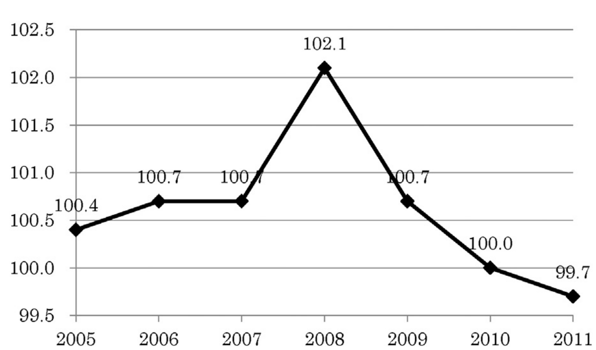

Fig. 3. Changes in CPI (2010 CPI set at 100).

3.3. Regression results

As shown in Table 2, *STAFF* continued to increase, rising from 14.48 to 16.22 by 12.0% between 2005 and 2010. *BED* and *LPHBED* decreased slightly, from 14.34 and 18.09% to 14.17 and 17.53%, respectively, during the same period. The *ENME* increased from about 263,100 yen in 2005 to 297,900 yen in 2010, an increase of approximately 13.2% in a 6 year period.

The *POPDEN* remained steady, at approximately 1370, during the period observed. The large standard deviation implied substantial differences among prefectures. The most populated prefecture, Tokyo, had 9479 persons per square kilometer in 2011, while the least, Hokkaido, had only 247 in the same year. The proportion of the population aged 65 and over rapidly increased while that of the population under 15 shrank during the study period, indicating a severe societal ageing problem. *SEX* and *MARRIAGE* decreased slightly, from 93.30 and 5.22 in 2005 to 92.99 and 5.06 in 2010, respectively. *DEATH* increased as a reflection of the ageing society, from 9.30 to 10.31 per 1000 population during the research period. *INCOME*, greatly influenced by the financial crisis in 2008, dropped sharply in 2008 and 2009 and then increased slightly to 2.68 million yen per year in 2010.

Regarding *STAFF*, the incremental F test ($F(46, 217) = 452.48$, $p < 0.01$) and BP-LM test ($X^2(1) = 652.07$, $p < 0.01$) rejected the null hypothesis and indicated that the panel regress model is favorable. The results of the Hausman test rejected the null hypothesis that the explanatory variables and prefectural-specific error terms are uncorrelated, indicating that u_i correlated strongly with other regressors. Thus FEM was found to be favored over REM.

As shown in the results in Table 3, the model explains 92.7% of the group variation of *STAFF*. The estimated coefficients of *MARRIAGE* and *DEATH* are positive; those for *POPDEN*, *RAT65* and *SEX* are negative; all of these coefficients are significantly different from zero at 5% significance level except that of *SEX*, which is at the 10% significance level.

The year dummies show a continuous increase of *STAFF* year by year. The intercept reached 3.01 in 2010, indicating a general increase in *STAFF* of 3.01 from 2005 to 2010. Although the coefficient of *LPHBED* was not found to be significantly associated with *STAFF*, the coefficients of the interaction terms of *LPHBED* with year dummies 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, increasing more rapidly after the LPH reform. For example, the number of decreased hospital staff per *LPHBED* reached 0.031 in 2009, an increase of 0.011 from 2008. Though the *STAFF* significantly increased in 2010 compared with that for 2005 in the prefecture with lowest *LPHBED* (Fukuoka, 5.22%) and the prefecture with highest (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 (see Table 3).

As for demographic factors (see Table 3), *STAFF* significantly decreased as *POPDEN* increased. This may have been due to the fact that highly populated prefectures usually have fewer geographic barriers, and thus the medical care providers there are able to provide medical service more efficiently. The coefficient of *RAT15* was not significantly different from zero in the panel regression model, and *RAT65* was negatively associated with *STAFF* at 1% significance level. As for *DEATH*, *STAFF* increased by 0.44 with a unit increase of *DEATH* ($p < 0.01$). This appears reasonable, since policy makers would likely deploy more health workers to prefectures with high *DEATH*. *INCOME* was positively associated with *STAFF*, but its coefficient was not significantly different from zero. This positive relationship may have been the result of two factors: high *INCOME* may tend to lead to increased medical service demand and

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Table 2
Descriptive statistics ($N = 282$).

Variables	2005		2006		2007		2008		2009		2010	
	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
ENME	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[a]	2.81	0.49	2.83	0.49	2.85	0.49	2.63	0.43	2.58	0.37	2.68	0.37

[a] Variables are CPI standardized.

thus to increases in hospital staff; and prefectures with high average income might be more attractive to hospital staff.

For the *ENME* model, results of incremental F test ($F(46, 216) = 180.09$, $p < 0.01$) and *BP-LM* test ($X^2(1) = 594.15$, $p < 0.01$) also indicated that panel regress technique was more appropriate for the data. Table 4 shows the results of panel regression. Hausman test results suggested that the REM was favored over FEM. The key determinants of *ENME* among prefectures are *POPDEN*, *SEX*, *RAT65*, *BED*, *DEATH* and *INCOME*. The model explains 91.25% of overall variation of *ENME*.

The coefficients of interaction terms for *LPHBED* with year dummies are negatively associated with *ENME*. A significant decrease is noted in 2010 ($D_{10} * LPHBED = -0.0004$, $p < 0.05$, see Table 4). For the coefficients of year dummies, aside from a slight decrease of 0.71% in 2006, *ENME* increased significantly after 2007. In 2010, *ENME* was 13.07% higher than in 2005 [0.1307 = exp.(0.1228) − 1]. There was a substantial *ENME* increase after 2008, correlated with the revision rate of the fee schedule (see Fig. 1). The increase also reflects fast growth of health care demand. As entire population is covered by health insurance in Japan, *NME* can more accurately reflect medical demand. The low income elasticity also indicates that the *NME* is more directly related to their health status. The results indicate smaller increases in *ENME* in prefectures with higher LPH beds share during the study period, with other factors fixed.

For the determinants of *ENME* model, as revealed in other studies, demographic factors can substantially influence the health expenditure of a health care system (Di Matteo and Di Matteo, 1998; Pan and Liu, 2012; Sato and Fushimi, 2009). The results also show that *POPDEN* and *RAT65* are positively associated with *ENME*: *ENME* rose 0.96% and 0.82% with a unit increase of *POPDEN* and *RAT65*, respectively. The coefficients of *SEX* and *DEATH* are negative at 1% and 10% significance level, respectively. *BED* is significantly associated with *ENME*. ENME increased by approximately 2.2% as a unit increase of *BED*.

4. Analyses on the regression results

Many studies have investigated imbalances in health resources and the determinants of health expenditure in Japan (Hiyoshi et al., 2014;

Table 3
Panel regression results for 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
D_{2006}	0.579***	0.117	0.465***	0.099
D_{2007}	1.212***	0.167	0.954***	0.145
D_{2008}	1.799***	0.242	1.440***	0.212
D_{2009}	2.734***	0.298	2.328***	0.265
D_{2010}	3.010***	0.333	2.439***	0.308
D_{2006}*LPHBED	−0.005	0.004	−0.005	0.004
D_{2007}*LPHBED	−0.013**	0.005	−0.013***	0.005
D_{2008}*LPHBED	−0.020***	0.007	−0.020***	0.007
D_{2009}*LPHBED	−0.031***	0.009	−0.031***	0.009
D_{2010}*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	

*** $p < 0.01$. ** $p < 0.05$. * $p < 0.10$.

Table 4
Panel regression results for estimated national medical expenditure.

	ln*ENME*			
	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
ln*INCOME*	0.0403	0.0258	0.0466*	0.0254
LPHBED	−0.0003	0.0006	−0.0003	0.0005
D_{2006}	−0.0048	0.0029	−0.0071*	0.0029
D_{2007}	0.0271***	0.0057	0.0227***	0.0052
D_{2008}	0.0350***	0.0088	0.0280***	0.0072
D_{2009}	0.0838***	0.0108	0.0762***	0.0087
D_{2010}	0.1321***	0.0118	0.1228***	0.0095
D_{2006}*LPHBED	0.00005	0.0001	0.00004	0.0001
D_{2007}*LPHBED	−0.0002	0.0001	−0.0002	0.0001
D_{2008}*LPHBED	−0.0001	0.0002	−0.0001	0.0001
D_{2009}*LPHBED	−0.0002	0.0002	−0.0002	0.0002
D_{2010}*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	

*** $p < 0.01$. ** $p < 0.05$. * $p < 0.10$.

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Ide et al., 2009; Kinjo et al., 2014; Koike et al., 2009; Sasaki et al., 2013; Tamakoshi and Hamori, 2014; Teo, 2007; Tsugawa et al., 2015). Urban-rural factors, demographic factors and other socioeconomic factors have been shown to significantly affect health expenditure and distribution of physicians. To the best knowledge of the authors, no study has directly investigated the effects of local government LPH burden on these two factors for the case of the health care system in Japan. However, many studies revealed a difference in performance among hospitals with different ownership structures (Barbetta et al., 2007; Hollingsworth, 2008; Siciliani et al., 2013). Further, variation in LPH burden, which depends on heavy public financial support, may affect distribution of hospital resources among prefectures and prefectural medical expenditure.

Consistent with findings of previous studies (Matsumoto et al., 2010; Sasaki et al., 2013), our results further identified an imbalance in hospital personnel among prefectures with different LPH burden. As mentioned before, after the LPH reform in 2007, local governments made efforts to reorganize local health care delivery and at the same time wipe out deficits related to LPHs by seeking innovations such as downsizing, merging, privatization and other measures. It is possible that these measures resulted in smaller increases in hospital staff in prefectures with heavy LPH burden. Further, the introduction of a new internship system in 2004 also tended to aggravate the imbalance in the distribution of physicians, because medical interns are quite free in their selection of their training hospitals, and not surprisingly, hospitals in developed areas are favored (Toyabe, 2009).

The combination of findings of *STAFF* and *ENME* models suggests that patients in prefectures assuming more LPH burden tended to seek better health care quality in other prefectures more often. As mentioned above, prefectural ENME is calculated based on medical facility location. Patients living in a given prefecture can see doctors in other prefectures, but the expenses are billed to the prefecture where the medical facility is located. As shown in Table 4, the negative coefficients of interaction terms indicate increased patient consumption of health care rather than increased local demand in prefectures with smaller LPH bed share. We also investigate the relationship between share of LPH beds and *SNME* using the panel data in 2005, 2008 and 2011, respectively. The results suggest that health care demand increased by the same amount for all prefectures regardless of their LPH burden (see REM in Table 5). This further supports our assumption that the patients in prefectures shouldering heavy LPH burden tended to seek better health care quality in other prefectures during the research period.

Table 5
Panel regression model results on the *ENME*.

ln*SNME*	FEM		REM	
	Coeff.	Robust S.E.	Coeff.	Robust S.E.
POPDEN	−0.0024	0.0028	0.0006	0.0004
SEX	−0.0039	0.0038	−0.0097***	0.0024
RAT15	−0.0030	0.0059	−0.0021	0.0054
RAT65	0.0026	0.0029	0.0062	0.0026
MARRIAGE	−0.0116	0.0099	−0.0071	0.0082
DEATH[7]	−0.0295***	0.0078	−0.0144	0.0067
BED	0.0193***	0.0048	0.0219***	0.0026
lnINCOME	−0.0143	0.0301	−0.0013	0.0257
LPHBED	−0.0003	0.0017	−0.0004	0.0005
D_{2008}	0.0635***	0.0074	0.0484***	0.0062
D_{2011}	0.1791***	0.0114	0.1510***	0.0070
D_{2008}**LPHBED*	−0.0001	0.0002	−0.0001	0.0002
D_{2011}**LPHBED*	0.00004	0.0002	0.00004	0.0002
CONSTANT	6.1530***	0.5303	6.2563	0.3133
No. of cases	141		141	
Hausman test		$\chi^2(13) = 18.36$ $p > 0.01$		
R-sq: within	0.9911		0.9893	
Between	0.6539		0.9177	
Overall	0.7321		0.9343	

Data for *MARRIAGE* and *DEATH* were not available for 2011. The variables were estimated by taking means of the data in 2010 and 2012 in this model.

This assumption is consistent with the conclusion of Shinjo and Aramaki (2012), who used multiple regression analysis using 2008 data to explore the determinants of distribution of health resources in the secondary healthcare service areas (SHSA) in Japan. The results indicate that more patients in SHSAs with scarcer health care resources flowed to other SHSAs for health care. Moreover, the mismatch of demand and supply in the local health care system may be another reason why patients in prefectures with high *LPHBED* seek better medical care quality in other prefectures (Matsumoto et al., 2010; Nomura et al., 2009). For example, local governments may not be able to allocate enough obstetric and pediatric health care resources to remote areas. As the social demographics in Japan have been dramatically changing, especially depopulation and ageing problems in remote prefectures, local health care demands need to be monitored and analyzed regularly, with timely adjustments to geographical distribution of health care resources.

This study also investigates whether there was induced medical demand in the health care system in Japan. A number of studies (Costa-Font and Pons-Novell, 2007; Pan and Liu, 2012; Prieto and Lago-Peñas, 2012) took into account institutional factors such as number of beds and number of doctors as determinants of health expenditure or indicators of induced medical demand. The justification for doing so is that hospital resources have been proven not only to reflect demand but also to create demand (Folland et al., 2013). *BED* was included as an explanatory variable in the *ENME* models. As shown in Table 4, one additional unit of *BED* lead to an approximate increase of 2.19% in *ENME*. We also performed regression models without *BED* (see Table 6). Compared with the model with *BED*, the model without BED had lower overall R^2 (0.8043 vs. 0.9125) and FEM became favored over REM [$\chi^2(18) = 99.55$ $p < 0.01$ vs. $\chi^2(19) = 11.97$ $p > 0.10$]. The estimates between the two models are consistent except for differences in significance level for some coefficients (see REM in Table 4 and FEM in Table 6). The result indicates possible induced medical demand.

In Japan, most services are provided on the fee-for-service (FFS) basis. Many studies (Christianson and Conrad, 2011; McClellan, 2011) revealed that under the FFS payment system, medical providers were inclined to provide more medical services. Long average hospital stay and large share of pharmaceutical expenditure suggest the presence of induced

Table 6
Panel regression results on the *ENME*.

ln*ENME*	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
D_{2006}	−0.0057*	0.0030	−0.0096***	0.0034
D_{2007}	0.0250***	0.0056	0.0166**	0.0065
D_{2008}	0.0321***	0.0083	0.0191**	0.0086
D_{2009}	0.0807***	0.0100	0.0664***	0.0102
D_{2010}	0.1255***	0.0116	0.1057***	0.0124
D_{2006}**LPHBED*	0.0000	0.0001	0.0000	0.0001
D_{2007}**LPHBED*	−0.0002	0.0001	−0.0002	0.0002
D_{2008}**LPHBED*	−0.0002	0.0002	−0.0002	0.0002
D_{2009}**LPHBED*	−0.0003	0.0003	−0.0004	0.0003
D_{2010}**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	

*** $p < 0.01$. ** $p < 0.05$. * $p < 0.10$.

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demand in Japanese health care system (Jones, 2009). Though the diagnostic procedure combination (DPC) system, a Japanese version of the prospective payment system (PPS), was introduced in 2003, previous studies (Besstremyannaya, 2012; Okamura et al., 2005; Wang et al., 2010) suggest that the new system resulted in only a limited increase of control of overutilization of medical care services. Besstremyannaya (2012) argues that the major reason is inadequate incentives, caused by the two-part PPS tariff, where the FFS component actually dominates the payment system in Japan. Induced medical demand widened the disparities among prefectures. The demand for better health care quality from other prefectures cannot be neglected either. However, clarification of the causal relationship between external demand and large supply for a given prefectural is beyond the scope of this study.

The elasticity of *ENME* with respect to *INCOME* is as small as 0.046. Many studies suggest that with health insurance, individual income elasticity is typically near zero or even negative, because the purpose of health insurance is to eliminate individual budget constraint and reduce the influence of cost of health care on patients' and doctors' decisions about extent of care (Chernew and Newhouse, 2012; Folland et al., 2013; Getzen, 2000). Thus if the population is well insured, health expenditure tends to directly reflect actual health care needs. Japan has had a compulsory universal covered health insurance system since 1961. Though premiums vary among health insurance schemes and municipalities, the co-payment structure is unified across the nation (MHLW, 2013). Thus, it is reasonable to assume that low income elasticity reflects the real situation in Japan.

5. Conclusion

Our findings reveal that, first, the number of hospital staff rises as the LPH burden reduces; second, medical-facility-location-based *ENME* increases in prefectures with less LPH burden. The scale of these two increases accelerates after the LPH reform. These findings suggest that the policies related to LPH system after 2005 have tended to compromise accessibility to better medical services quality for residents in prefectures bearing heavy LPH burden. We can say that the relation between accessibility to better medical services quality and the LPH burden to local governments needs to be made clearer and more accurate through various types of researches.

This quantitative approach for measuring the impact of Japanese LPH reform on the *NME*, even though it did not take e.g. clinics, nonprofit hospitals and so on in our analysis, could help improve the quality of the health care system, and furthermore, it could contribute to providing more efficient and reliable health care services policy.

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