How Does the Price Regulation Policy Impact on Patient-Nurse Ratios and the Length of Hospital Stays in Japanese Hospitals?

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Abstract

This study examines how the 2000 and 2006 revisions of the fee-for-service system have affected patient-nurse ratios and the average length of hospital stays in Japan. The empirical results show that hospitals are quite responsive to changes in price policy. The fee revisions have certainly achieved the policy objectives of reducing patient-nurse ratios and the length of hospital stays. As a result, hospitals have responded by greatly increasing the number of expensive beds for acute care. However, this was not exactly predicted by the Japanese government which has aimed to reallocate health care resources such as beds to sub-acute or long-term care.

Key words: price regulation, fee-for-service (FFS) system, patient-nurse ratio, length of hospital stay, natural experiment, kernel propensity score matching difference-in-difference estimation

JEL codes: I11, I18

1. Introduction

The Japanese health care system has seemed to be functioning successfully during the last several decades. This would be implied by the fact that Japan has achieved the highest level of population health in the world at a relatively low cost (WHO, 2000; Hashimoto et al., 2011)[2]. However, some statistics show that the financial stability of the health care system in Japan will be under threat, in particular, from demographic and economic factors in the future (Shibuya *et al.*, 2011). The population aged 65 and older will continue to increase from 33.952 million in 2015 to 36.573 million in 2025 when the baby boomers become 75 years of age and older, and then it will be peak at 38.782 million in 2042 (NIPSSR, 2013). On the other hand, the working-age population (those aged 15-64) which supports the current pay-as-you-go social security system will shrink from 76.818 million in 2015 to 70.845 million in 2025, and then to 55.985 million in 2042 (NIPSSR, 2013). Among the OECD countries, the recent rate of increase in total health expenditure as a percentage of gross domestic product (GDP) was the largest in Japan, an increase of 2 percentage points from 8 % in 2005 to 10% in the 2010s (OECD, 2014)[3]. Further, the outstanding stock of Japanese national debt mainly caused by the growth of social security expenditure was 10.46 trillion US dollars in 2013, which is more than double the size of GDP (about 4.9 trillion US dollars), and it is the biggest public financial burden in the world (Schwartz, 2013). In order to make the universal health care system financially

[2] Japan's global health indices, such as life expectancy at birth (79.9 years for males and 86.4 years for females), infant mortality (2.2 deaths per 1,000 live births) and perinatal mortality (2.9 deaths per 1,000 live births), are among the best in the world, while its total health expenditure as a percentage of gross domestic product (GDP) was 10% in 2011, ranking 23th among the OECD countries where data are available in 2011-2013 (OECD, 2014; MHLW, 2010).

[3] During the same period, total health expenditures as a percentage of GDP increased by approximately 1.7 percentage points in Korea, the United States, and New Zealand, 1.3 percentage points in Canada, 1.2 percentage points in Spain and Ireland; and 1.1 percentage points in Denmark, the United Kingdom, and the Netherlands.

sustainable given the drastic changes in population structure and severe budget constraints, health care reform which moves towards a more efficient reallocation of both physical and human resources is urgently required.

Economic theory explains how an equilibrium price is achieved through the market mechanism, which makes the distribution of resources efficient, yet does not necessarily lead to equity in the society. However, in Japan, medical care is reimbursed under a nation-wide uniform single payment system mainly based on a fee-for-service (FFS) system completely controlled by the government. FFS is paid equally, regardless of the types of insurance[4] and facility[5]. It is worth noting that Japan's FFS is not adjusted to take account of regional cost differences (Ikegami & Anderson, 2012). After an overall revision rate for medical care services as a whole is determined by negotiations between the Ministry of Health, Labour and Welfare (MHLW) and the Ministry of Finance[6], the FFS is officially revised on an item-by-item basis every other year through discussions among the representatives of various interest groups (for example, physicians,

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[4] Since the Japanese public health insurance became a compulsory system in 1961, people are forced to be enrolled into one of five types of public health insurance: (1) the "National Health Insurance (NHI)" for farmers, self-employed, and retired persons under the employee's health insurance; (2) health insurance for the employees of large firms and managed by health insurance societies; and for the employees of small firms and managed by the Japan Health Insurance Association (*Zenkoku Kenko Hoken Kyokai*); (3) health insurance for the employees of national and local governments, and teachers or the staff of private schools and managed by mutual aid associations; (4) seamen's insurance; and (5) the medical care system for people aged 75 and older.

[5] The Japanese Medical Service Law defines two types of medical facilities, hospitals and clinics. A "hospital" is a medical facility with 20 or more beds, while a "clinic" has less than 20 beds or no beds at all.

[6] The overall revision rates for the FFS set in these negotiations have apparently been influenced by changes in political power. Under Prime Minister Junichiro Koizumi, the overall revision rates were set at 0 or negative levels, such as -1.30% in 2002, 0.00% in 2004, and -1.36% in 2006, because the Liberal Demographic Party (LDP) regarded achieving positive primary balance by 2011 as the first priority of fiscal policy and, therefore, the LDP attempted to suppress social security spending. After the Democratic Party of Japan (DPJ) won the election in 2009, the overall revision rates have turned positive, for example, 1.55% in 2010 and 1.38% in 2012, which reflected the DPJ's policy of enhancing social security services rather than suppressing the financial deficit. The latest revision rate of 0.63% is slightly positive and will be offset by an increase in the consumption tax rate from 5% to 8% implemented at the same time of the revision in April 2014, after the LDP regained government.

pharmacists, dentists, psychiatrists from the supply-side, insurers, and patients from the demand-side, and public interest groups as a third party) at the Central Social Insurance Medical Council appointed by the MHLW[7]. Price regulation of medical care services imposed by the government would influence the economic welfare in society, through the effects of the revisions of the FFS on medical care providers' treatment choices and, consequently, the allocation of medical care resources. Hence, it is important for policy makers to evaluate the impacts of a change in price policy on supply-side behavior (Tokita, 2004).

Some researchers emphasize the primary contribution of the reimbursement system described earlier as being cost containment and, therefore, the efficiency in providing medical care up to now (Ikegami & Campbell, 2004; Wagstaff, 2005; Ikegami et al. 2011; Ikegami & Anderson, 2012). These points are also indicated in a report by the MHLW as being important characteristics of the current health care system[8]. In contrast, other empirical studies in the economics field using micro-based individual data have reached different conclusions. First, the supply of medical care would often be inefficient because supplier-induced demand (SID) might deliver unnecessary care for improving patient outcomes, due to the asymmetric information among patients, insurers, and medical care providers (Evans, 1974; Fuchs, 1978; Pauly, 1980; McGuire, 2000). As has been found in the United States, some earlier studies have found the presence of SID in Japanese medical care (Kawai & Maruyama, 2000; Tokita, 2004; Suzuki, 2005; Shigeoka & Fushimi, 2014). These studies deal with either the introduction of the Diagnosis

[7] For details of the process of revising the FFS, see Hashimoto et al. (2011), Ikegami and Campbell (2004) and MHLW (2012).

[8] In addition to providing high-quality medical care at relatively low cost, MHLW (2015) characterizes the Japanese health care system as follows: compulsory universal coverage as of 1961; free access to medical care without a gatekeeping system; and income-related social insurance subsidized by general taxes.

Procedure Combination (DPC) or the Prospective Payment System (PPS) in 2003 (Kawai & Maruyama, 2000; Shigeoka & Fushimi, 2014), or the revision of the FFS in every other year (Tokita, 2004; Suzuki, 2005) as natural experiments[9] and evaluate the impacts of changes in price policy on medical care providers' treatment choices and/or patterns. In sum, the results show that medical care providers were quite responsive to the DPC/PPS adoption and/or the revision of FFS, in the sense that they might extend the length of hospital stays, increase the frequency of visits to a medical facility, and raise even patient-days, in order to compensate for the decrease in the unit price of medical care[10].

Second and more importantly, the Japanese regulated price policy could lead to a more uneven distribution of medical care resources with respect to geographic regions and clinical departments or specialties. To my knowledge, Iizuka and Watanabe (2014) is the first empirical study to tackle this issue, using the introduction of the New Postgraduate Medical Education Program in Japan in 2004 as a natural experiment, in order to clarify the differences between the short-run and long-run demands for physicians in the labor market. Hospitals in rural areas often have to pay physicians much higher salaries than hospitals in urban areas in order to attract physicians. But, the price-regulation policy does not allow these medical facilities to raise their fees for patients and absorb higher wages, so that they have to exit the market in the long-run. Therefore, Iizuka and Watanabe (2014) conclude that "the demand for physician labor is inelastic in the short-run but more elastic in the long-run". Nevertheless, Iizuka and Watanabe (2014) could

[9] As of 2003, the Japanese government introduced a new-flat-fee payment system called the DPC or PPS, which covers part of inpatient hospital care. For the differences of this Japan's version of the case-mix payments and Diagnosis-Related Groups (DRGs), please see Ikegami and Anderson (2012).

[10] Some researchers argue that SID might not occur or that the size of SID could be small enough to be ignored in Japan, since most physicians are employees so that they might have no incentive to induce demand. In addition, by law there are no private hospitals for-profit in Japan (Kishida, 2001; Kadoya & Kodera, 2014).

not isolate the effect of price regulation on the labor supply of physicians directly, because the price policy, more specifically, the revisions of the FFS, influence all over the medical care market and, therefore, a control group which is not affected by the revisions could not be identified. This is one of the most critical challenges for empirical studies attempting to evaluate the impacts of price policy in Japan.

This study focuses on another key human resource for medical care, nurses, because the patient-nurse ratio (PNR) in a ward has been one of the most significant factors for determining reimbursements under the FFS system in the past few decades. For example, it is internationally well-known that the average length of a hospital stay (LHS) is much longer in Japan than in other OECD countries (OECD, 2014)[11], and that this has been considered to be one of the major causes of rising medical expenditures. Ogata (2003) indicates that the insufficient allocation of medical care professionals such as physicians and nurses in acute care hospitals would make LHS longer in Japan than in other developed countries[12]. Therefore, the FFS system raised the reimbursement rate for hospitals with a PNR less than a certain standard, conditional on shortening LHS. Unfortunately, for the same reason as in Iizuka and Watanabe (2014), so far, no studies have clarified the impact of the revisions of the FFS on the demand and supply in the labor market for nurses without a relevant counterfactual. Hence, the main objective of this study is to examine the effects of price regulation on PNR in a ward and the average LHS, using the FFS revisions as natural experiments. There are five types of inpatient

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[11] The average LHS in Japan for all causes has decreased rapidly from 34.4 days to 17.5 days during the 1994-2012 period. This would be caused by the separation of hospital beds for long-term care from beds for acute care in August, 2008. Even so, LHS in Japan still remains much longer than the OECD average of 7.4 days.

[12] Ogata (2003) also stated that the larger number of hospital beds per 1,000 people compared to other countries and the mixture of inpatients with acute and chronical diseases in the same wards are major causes of the longer LHS in Japan.

beds for (1) psychiatric disease, (2) infectious diseases, (3) tuberculosis, (4) long-term care, and (5) other, called general beds. The reimbursement varies by type of beds[13]. Since the major revisions of FFS have been attempting to the PNR and the average LHS of general beds, this study pays attention to only hospitals that have general beds.

In the next section, I describe some background information for this study. Section 3 explains the data used and the econometric strategy. The empirical results are presented in the Section 4, and the final section contains a conclusion.

2. Background

2.1 Nurse labor market in Japan

The insufficient number of nurses in Japan has often been discussed in the past few decades[14]. In response to an increase in the demand for nursing care in hospitals caused by population aging and the diffusion of high-tech care (MHLW, 2012), the number of universities with schools of nursing and, therefore, the total quota of nursing places at universities have been growing rapidly following the Act on Assurance of Work Forces enacted in 1992 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT)[15]. This has contributed to an increase in the total supply of nurses, such that the

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13 In 2010, the numbers of beds by type of bed are: 346,715 for psychiatric disease, 1,788 for infectious diseases, 8,244 for tuberculosis, 332,986 for long-term care, and 903,621 for other. Accessed 19 January 2015. Available from URL: http://www.mhlw.go.jp/toukei/saikin/hw/iryosd/11/dl/1-2.pdf

14 In accordance with the Economic Partnership Agreements (EPA) that Japan has signed with Indonesia, the Philippines, and Vietnam, the Japanese MHLW has been accepting trainees for nursing and long-term care workers from these countries since 2008. In the seven years from 2008 to 2014, the total number of accepted trainees for nursing was 839. However, of these trainees, only 128 of them passed the National Nursing Examination, which is not enough to influence the entire nurse labor market in Japan, although the percentage of these trainees who pass the exam has increased from 0% in 2008 to 10.6% in 2013. Accessed 19 January 2015. Available URL: http://www.mhlw.go.jp/file/06-Seisakujouhou-11650000-Shokugyouanteikyokuhakenyukiroudoutaisakubu/epa_gaiyou.pdf

15 The number of universities with a school of nursing has increased from 14 in 1992 to 210 in 2013. Accordingly, the quota on the number of nursing places in universities rose greatly from 748 to 17,779

number of registered nurses (RNs) has rapid increased from 308,415 in the mid-1980s to 1,015,744 in 2012, an increase of about 9 percentage on average every year. Accordingly, the total number of nurses has more than doubled from 590,177 in 1984 to 1,373,521 in 2012, although the number of licensed practicing nurses (LPNs) has declined since 2000[16][17]. Thus, as Figure 1 indicates, compared to other OECD countries, the number of practicing nurses per 1,000 population is not so low in Japan. In 2010, the number of practicing nurses per 1,000 Japanese population was about 10, which is higher than the average of 34 OECD countries which was 8.8.

[Figure 1 around here]

Even though the total labor supply of nurses has been growing, on average, the effective job openings to applications ratio has always been more than 1.0, and even this ratio has grown from 1.18 in 2000 to 2.69 in 2013 (MHLW, 2014). This indicates that excess demand still remains. An answer from a macro perspective might be the geographically uneven distribution of nursing labor. The allocation of nurses is biased toward the south-west regions, and urban areas such as Tokyo and Osaka seem to have an insufficient

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during the same period. MEXT. Table for trend of number of universities and quotas with school of nursing and Quota (*in Japanese*). Accessed 19 January 2015. Available from URL: http://www.mext.go.jp/component/a_menu/education/detail/__icsFiles/afieldfile/2014/01/20/1314031_3.pdf

[16] In Japan, RNs are required to have 3,000 or more hours of training in a nursing program in universities, colleges, or professional schools and to pass the National Nursing Examination in order to obtain a license. On the other hand, LPNs should have 1890 or more hours of training in professional schools or 5-years consecutive nursing high-school and pass a qualification exam conducted by any of the 47 prefecture-level governments. According to the current rapid development of medical technology, further sophisticated expertise and higher-tech skills are required to provide nursing care in medical facilities. Hence, the abolition of LPNs has been one of major debates among interest groups, such as Japanese Nursing Association (JNA) and Japan Medical Association (JMA) (JNA, 2009).

[17] The number of physicians also started increasing in the mid-1980s by about 4 percentage on average every year. However, the number of nurses has increased much faster than the number of physicians.

number of nurses, even though this is where acute care hospitals are concentrated and so the demand for nursing care is relatively high.

From a micro perspective, Nakata and Miyazaki (2010) provide another possible reason for this. First, they suspect that the national health reform in 1994 increased the demand for nurses, because supplemental care by family members for inpatients was no longer be allowed in hospitals and nurses' aides were excluded from the nominal head count of nursing staff used in calculating the daily reimbursements as of 1994. Therefore, the reform motivated hospitals to hire more RNs and LPNs in order to maintain the levels of PNR and so, reimbursements, which would lead to a rise in the demand for nurses. Second, Nakata and Miyazaki also discussed that nurses' wages have not increased much, despite the tight labor market, contrary to the standard demand-supply theory. Figure 2 shows the mean hourly wages of nurses and their wages relative to the wages of welfare service workers from 2001-2013. Overall, the mean hourly wage has not changed so much and has even slightly fallen in some periods, while the relative wages of RNs and LPNs compared to welfare worker have been increasing, but not considerably. Thus, it might lessen an individual nurse's incentive to stay in the labor market, due to their low opportunity costs for a heavy workload. Therefore, the policy implications suggested by Nakata and Miyazaki (2010) are: to introduce a reorientation program for nurses who are no longer in the labor market; to restructure the working environment for nurses; and finally, to reassess the current wage system.

[Figure 2 around here]

2.2 **Major revisions of the FFS related to the nurse labor market**

This section describes the major revisions of the FFS for inpatient hospital care which might influence the labor market for nurses in the last three decades, focusing on the PNR for general beds. Figure 3 shows the trend in PNR by hospital size[18] and the timing of major revisions of the FFS.

[Figure 3 around here]

As of 1988, a ward where an employed nurse is assigned to ten inpatients (the so-called 10:1 PNR) and the average LHS is less than 20 days, started to be reimbursed with an additional payment[19]. After 1988, the nurse placement in medium-sized hospitals had been catching up rapidly with that in large hospitals, where a relatively low PNR had already achieved before the revision. Then, the FFS for wards not meeting the legal standard of PNR required by the Medical Care Act, which is twenty patients per employed nurse (20:1 PNR), was abolished in 1992 and hospitals which did not meet this standard could no longer be reimbursed by the FFS system. Further, as discussed in the previous section, the national health reform in 1994 forbid supplemental care by family members for inpatients and, after the reform, nurses' aides have no longer been counted in the PNR for the purpose of calculating the daily reimbursement as of 1994. The major revisions in 1992 and 1994 should have led to a fall in the PNR even in small hospitals speedily. As

[18] Hospitals are categorized into three sizes, small hospitals (the number of general beds is less than 100), medium-sized hospitals (the number of general beds is 100 and more and less than 500), and large hospitals (the number of general beds is 500 and more), and these categories are generally utilized in the surveys conducted by MHLW.

[19] In this study, the PNRs are shown are based on the new standard revised as of 2006. Before 2006, each PNR of "7:1", "10:1", "13:1", "15:1", "18:1", and "20:1" were counted as "1.4:1", "2:1", "2.5:1", "3:1", "3.5:1", and "4:1" (Nagata et al., 2012). Please see footnote 27 for a further explanation.

of 2000, three categories of charges for nursing care, medical supervision and management, and a hospital room were combined into an inpatient hospital fee[20]. Also, as conditions for additional reimbursements, the average LHS for various standards of PNRs were revised to 21 days or less for “10:1”; 26 day or less for “13:1”; 60 days or less for “15:1”; and 90 days or less for “18:1”, respectively (MHLW, 2012). Finally, a new standard for inpatient hospital fees was introduced in 2006. Nagata et al. (2012) provide a good summary for this as follows. Instead of the number of inpatients per employed nurses, the number of inpatients per working nurses per working hour became a new criterion as of 2006[21]. Also, as a new criterion for an additional reimbursement, a PNR of “7:1” conditional on average LHS of 19 days or less (so-called a “7:1” hospital) was introduced by the FFS system.

[Figures 4 & 5 around here]

Figures 4 and 5 summarize the trend of the number and distribution ratio of general beds in 1984-2008, by hospital size and types of hospital based on criteria for an additional reimbursement defined in 2000 and 2006. The total number of general beds which meets the standard of a “7:1” hospital defined by the FFS system in 2006 were 1,354 (9% of total number of general beds), which has been increased to 317,901 in 2008 (43%). The increase could be clarified by increasing the number of general beds of the

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[20] Under the FFS system, dietary therapy expenses started to be evaluated separately from patient inpatient hospital fees as of 2000 (MHLW, 2012).

[21] Nagata et al. (2012) provide an example as follows, “if there were 20 nurses assigned to a ward with 40 patients, according to the previous standard it was calculated that there was one nurse for every 2 patients (=2:1). On the other hand, if there are 20 nurses assigned to a ward, at most only 4 nurses can work at same time because of shift work; therefore, by the new standard it was calculated that 40:4 = 10:1”.

“7:1” type in medium-sized and large hospitals, while the number of beds of the “non-7:1” type in both sized hospitals has been decreasing gradually after 2000 (Figure 4). Also, Figure 5 shows that almost all medium-sized and large hospitals could meet the conditions for additional reimbursements after 2000, but more than 30% of small hospitals have not satisfied with these standards, and they have remained categorized into “other”. Even so, regardless of hospital size, the distribution ratios of general beds which meet the standard of additional reimbursements have been increasing rapidly, in particular, after 2000. In sum, these simple basic statistics indicate how hospitals started to respond especially to the FFS revisions as of 2000. Therefore, among the revisions of the FFS in the past decades, this study focuses on the latest drastic revisions of inpatient hospital fees in 2000 and 2006 as natural experiments when the FFS system begun to clarify new standards based on PNR combined with LHS for an additional reimbursement. The data and econometric strategy are explained in the next section.

3. Data and Econometric Strategy

3.1 Data structure

This study constructs hospital-year-based data by combining data from two nation-wide surveys conducted by the MHLW, the “Hospital Report (HR)”, and the “Survey of Medical Institutions (SMI)”, which contain common hospital identifiers from survey to survey.

Both HR and SMI are population surveys which cover the entire hospital system in Japan. First, the HR contains two questionnaires, one regarding patients and the other relating to employees[22]. Each hospital has to submit the results of the patient

[22] All clinics with inpatient beds have to provide answers only to the questionnaire for patients every month (Accessed 19 January 2015. Available URL: http://www.mhlw.go.jp/toukei/list/80-

questionnaire which includes the total numbers of inpatients and discharged patients every month to the MHLW, while the questionnaire for employees is conducted once a year on the 1st of October and asks about the number of physicians, RNs, LPNs, dentists, pharmacists, and other type of employees.

Unfortunately, in these surveys, the data necessary to calculate the new criteria adopted from 2006, such as working hours and the structure of the shifts of nurses, is not available. Instead, I simply define a PNR for a hospital in year *t* as follows:

$$\mathrm{PNR_t} = \frac{\sum_{j=1}^{12} total\ number\ of\ inpatients\ in\ jth\ month\ of\ year\ t\ /12}{Number\ of\ RNs\ on\ Oct\ 1\ of\ year\ t} \qquad (1)$$

where t=1984, …, 2008.

Second, SMI is conducted once every three years on the 1st of October[23][24]. As with HR, SMI includes questions related to the type and number of inpatient beds and employees, and it has more detailed information on facilities compared to HR, such as the type of owners, the presence of clinical departments, emergency rooms, an intensive care unit (ICU), cardiac ICU (CICU), pediatric ICU (PICU), and teaching/educational systems. Out of these, I use only variables commonly available from 1984 through 2008[25].

1a.html#link01), but clinics with no beds do not need to report answers to the HR. In order to focus on the supply of inpatient care service in hospitals, this study excludes the data for clinics with inpatient beds.

[23] Therefore, the data are available in 1984, 1990, 1993, 1996, 1999, 2002, 2005, and 2008.

[24] There is also a vital survey in the SMI, which is a monthly report related solely to the opening and closing of hospitals/clinics (Accessed 19 January 2015. Available URL:http://www.mhlw.go.jp/toukei/list/79-1b.html#1). This study uses only hospital data in the static survey of SMI.

[25] Details of the number of inpatient beds, the type of owner, the presence of teaching/educational systems, and the population size of municipality where a hospital is located are available for every period. But, details of the type of owners and the presence of teaching/educational systems are included only in SMI, but not in HR. So, for these variables, assuming that they do change over the three year period, I merged HR with SMI.

Finally, HR and SMI are merged by using the common hospital identifier in each survey year. This study excludes hospitals which do not have general beds or which do not meet any criteria of both PNRs and LHS for additional reimbursements as of 2000 described in section 2.2[26]. The average LHS seem to be too long for these hospitals, probably because HR does not clarify the number of inpatients by type of beds so that the average LHS including patients with non-acute diseases might be evaluated.

3.2. Econometric strategy

The econometric strategy used in this study is simple and straightforward. For the primary purpose of this study – evaluating how responsive and sensitive hospitals are to a change in price policy-, we visually want to show a change in PNR and LHS, before and after the revision of the FFS system. I apply a difference-in-difference (DID) estimator on the common support with kernel propensity score matching before/after the revisions of FFS system in 2000 and 2006, respectively. As described in the previous section, the revisions provide distinct criteria for the PNR combined with LHS for an additional reimbursement, so that control and treatment groups can easily be constructed in a DID context. An advantage of the use of a kernel propensity score matching DID estimation method is that we can ignore observable time-invariant effects on PNR and LHS because the model is supposed to extract hospitals which have similar characteristics either in the treatment or the control group[27]. For reference, our final model is as follows.

[26] Hospitals which are categorized into "Other" in Figure 5 are excluded from the regression analyses.
[27] However, endogeneity issues still remain because it is difficult to make adjustments for time-variant unobservable hospital characteristics. I will discuss this in the last section.

$$\hat{\delta} = \frac{1}{N_{\text{after}}} \sum_{i \in I_{\text{after},1}} \left(Y_{\text{after},i}(1) - \sum_{j \in I_{\text{after},0}} W\left(P\left(X_{\text{after},i}\right), P\left(X_{\text{after},j}\right)\right) Y_{\text{after},j}(0) \right) -$$

$$\frac{1}{N_{\text{before}}} \sum_{i \in I_{\text{befpre},1}} \left(Y_{\text{before},i}(1) - \sum_{j \in I_{\text{before},0}} W\left(P\left(X_{\text{before},i}\right), P\left(X_{\text{before},j}\right)\right) Y_{\text{before},j}(0) \right) \tag{2}$$

where [before] and [after] implies post- and pre-revision of the FFS in 2000 and 2006. Then, hospitals which have satisfied the new standard for an additional reimbursement, a PNR of "7:1" conditional on average LHS of 19 days or less before the year of 2000/2006 are defined as "the controlled" (control group) and those which have not achieved "7:1" requirements before 2000/2006 as "the treated" (treatment group). [$\mathrm{I}_{\text{after},1}$,$\mathrm{I}_{\text{before},1}$] and [$\mathrm{I}_{\text{after},0}$,$\mathrm{I}_{\text{before},0}$] are respectively the treatment and control groups before and after 2000 and 2006, respectively, and N_t [t=after, before] is the number of hospitals in the treatment group. Let D_i be a dummy variable indicating the i^{th} hospital's status with $D_i = 1$ indicating a "non-7:1" hospitals and $D_i = 0$ indicating a "7:1" hospital. The variables indicating the i^{th} hospital's PNR and LHS are denoted by $Y_{t,i}(D_i)$ as a function of D_i. $P\left(X_{\mathrm{t},i}\right)$ is the propensity score for the i^{th} hospital at time t. The variables appearing in $X_{\mathrm{t},i}$ are dummy variables relating to the i^{th} hospital's characteristics at time *t*, which are the number of general beds, ownership types (public, private, or other)[28], and the size of the population of municipality where the hospital is

28 While the number of hospital beds per 1,000 population is larger in Japan than in other OECD countries (for example, 2.71 in Sweden, 2.75 in Canada, 2.95 in United Kingdom, 3.05 in United States, 6.37 in France, 8.27 in Germany, and 13.4 in Japan (OECD, 2014)). In Japan, only 3.8% of hospitals are large hospitals, so that most hospital beds are medium-sized or small hospitals. The data in this study also shows that private non-profit hospitals occupy 66% of the medical care market, which is the largest proportion among all hospital types.

located[29]. As results of the balancing test, the difference in the mean values of all $X_{t,i}$ between control and treatment groups are statistically insignificant at the base line of 2000 and 2006[30]. W is the weight derived from the kernel propensity scoring matching between treated and the matched control hospitals. In practice, for each outcome, $\hat{\delta}$ is estimated as a coefficient of an interactive term of year dummy ([before] as 0 and [after] as 1) with D_i. I performed separate regressions for 2000 and 2006, by hospital size.

4. Results

4.1 Distribution of PNR and LHS over time

Figures 6 and 7 show histograms for PNR and LHS by the size of the hospital and the timing of the major revisions of FFS, respectively. These histograms are obtained using kernel density estimates[31]. During the baseline period (1984-1987), the mean/median PNRs are about 3.5/2.3, 6.7/3.3, and 9.6/6.4 with standard deviations of 4.0, 10.7, and 10.1 for large, medium-sized, and small hospitals, respectively, which decline to 1.2/1.1, 1.6/1.3, and 2.4/1.9, with standard deviations of 0.7, 0.8, and 2.1 in the period 2006-2008. Similar to PNR, the mean/median LHS in 1984-1987 are about 31.6/ 30.3, 33.7/28.6, and 41.8/37.8 with standard deviations of 9.3, 16.1, and 21.5 for large, medium-sized, and small hospitals, respectively, which decline to 18.0/16.7, 25.9/ 21.1, and 38.3/ 33.5, with standard deviations of 6.7, 15.0, and 22.7 in the period 2006-2008. However, the standard deviation for large hospitals has been shrinking over time, while the standard deviations

[29] Municipalities are divided into 4 categories depending on the size of their population: a "metropolitan area (MA)" with a population greater than one million; "rural urban center (RUC)" with a population greater than 0.3 million and less than or equal to 1 million; a "local small city (LSC)" with a population greater than 0.1 million and less than or equal to 0.3 million; and an "underpopulated area (UPA)" with a population of less than or equal to 0.1million.

[30] The results of the balancing test can be provided by the author, if it is requested by readers.

[31] In producing the estimates in Figure 6, I have eliminated hospitals where the PNR is more than 10 (about 5% of the sample).

for medium-sized and small hospitals have not changed.

Regardless of the size of the hospital, the distributions of PNR and LHS have been shifting to the left over time. However, the decreases in PNR and LHS seem to be drastic for medium-sized and large hospitals after the period, 1992-1999. Almost half of the large hospitals had already met the requirements for a “7:1” hospital before 2006, and consequently, 78% of the large hospitals attain an additional reimbursement after 2006. Medium-sized hospitals have been steadily catching up with the large hospitals in 2000-2005 and about 43% of medium-sized hospitals obtain the high reimbursement after 2006. For small hospitals, the PNR and LHS had begun to fall slightly in 2000-2005, and 20% of these hospitals have satisfied the new criteria after 2006.

[Figures 6 and 7 around here]

The distributions of PNR and LHS over time imply that large and even some medium-sized hospitals could predict the direction of the price policy change in the near future and make a decision even before the actual revision of the FFS. If that is the case, hospital characteristics would affect how fast a hospital responds to a change in pricing policy. So, balancing these characteristics between the control and treatment groups using a DID estimator on the common support with a kernel propensity score matching would be significant to identify the pure effect of a change in FFS on PNR and LHS.

4.2 Kernel propensity score matching DID estimates

Tables 1 and 2 present the results of estimating equation (2), before and after 2000 and before and after 2006, respectively. DID estimates ($\hat{\delta}$) show that the revision of the FFS system in 2000 significantly decreases PNR by -0.19 and -0.04 (-0.13, in average) (p-value <0.01). However, the effect on PNR is not statistically significant for small hospitals. On the other hand, the revision in 2000 has the largest statistically significant effects on LHS in small hospitals of about -7.1 days, following -4.5 days and -2.9 days in large and medium-sized hospitals, respectively (-5.5 days, in average). Table 2 shows that the revision in 2006 does have statistically significant impacts, such that it would influence the PNR of each large and medium-sized hospitals, by -0.08 (p-value <0.1) and -0.07 (p-value<0.05). As with the effect of the 2000 revision, the PNR of small hospitals is less likely to be influenced by the 2006 revision. In contrast to PNR, regardless of hospital size, LHS is more likely to be affected by the 2006 revision, -6.9 days, -3.7 days, and -1.9 days for small, large, and medium-sized hospitals, respectively (-5.1 days, in average) (p-value <0.01).

[Tables 1 and 2 around here]

Looking at the DID estimates that pick up the impact of the revisions of the FFS in 2000 and 2006, the impacts on PNR for both medium-sized and large hospitals turn out to be statistically significant before and after 2000, rather than around 2006. After the revision in 2006 which introduced an additional reimbursement for “7:1” hospitals, there is a debate that medium-sized and large hospitals succeeded in increasing the number of their nursing staff, but this is not the case for small hospitals, about 80% of which are run by private organizations. Due to the limited number of nurses in the labor market, small hospitals, particularly in rural areas, which could not provide better salary and/or working conditions are at a disadvantage and completely failed to employ new additional nursing staff (Moriyama, 2009). In contrast to that debate, the results here show that the decline in PNR after 2006 does not appear to be statistically significant as much as the one after 2000, probably because the declining trend of the PNR had already begun at an earlier time period just after 2000 when the PNR became significant factors for the revision of the FFS.

Interestingly, in contrast to the trends for PNR, both the 2000 and 2006 revisions seem to decrease LHS significantly, in particular, among small hospitals, where we could not observe statistically significant declines in PNR during the study periods. Although we observe improvements in the average LHS in small hospitals to some extent after the revisions, looking at the mean LHS in the treatment groups for small hospitals, LHS still remains longer than 40 days in the base line periods for both 2000 and 2006.

A decline in PNR could contribute to reducing the average LHS to less than 30 days in each medium-sized and large hospitals, approximately more than 50% and 70% of which are run by public or social insurance interested organizations (SIIO). This might be because public or SIIO hospitals are subsidized by the government more than private hospitals, to provide attractive working conditions including wages to nurses. But, if that is the case, it may not be sustainable. Consequently, the insolvent financial status of public hospitals could be a further fiscal burden for municipalities, particularly in rural areas. Therefore, as Iizuka and Watanabe (2014) pointed out with respect to physicians labor, local government hospitals may have to exit from the market due to the financial burden of hiring many nurses to maintain a relatively high PNR with a shorter LHS.

5. Conclusion

Overall, the empirical results in this study indicate that the revisions of the FFS system in 2000 and 2006 have certainly achieved the policy objectives relating to the working conditions for nurses in medium-sized and large hospitals, but that is not the case in small hospitals. Further, regardless of hospital size, the “7:1” regulation is successful in shortening the average LHS, however it still remains longer than one month particularly in “non-7:1” small hospitals in the baseline periods.

In order to bring the average LHS for acute high-tech care with a PNR of “7:1” close to the mean of OECD countries (7.4 days in 2014) , intermediate facilities and clinics are necessary, where sub-acute, long-term, and home health care are provided. For example, a patient could promptly be treated at an expensive acute high-tech care hospital and, after a short stay at a high-tech hospital, he or she could be transferred to an intermediate care hospital or clinics for rehabilitation to go back to daily life at home. Considering the current increase in the number of old people living alone in the community without informal care givers, the demand for this type of care after acute medical treatments will be rising rapidly. For that purpose, health care resources such as physicians, nurses, and beds should be reallocated to sub-acute, long-term, and home health care, and therefore, the MHLW attempted to reduce the number of hospital beds for acute high-tech care to about 180,000 by 2025 when the baby boomers become 75 and older. A series of revisions of the FSS aim to clarify and differentiate the roles and functions of medical facilities with various characteristics, rather than motivate them all in the same direction to satisfy the high criterion for intensive care along with an additional reimbursement. Unfortunately, hospitals were not discouraged from adopting unsympathetic new standards for high reimbursement. As described in Figures 4 and 5, the number of general beds for acute care which met the requirements for a “7:1” hospital with high reimbursement has increased up to 328,518 in 2010 (MHLW, 2012)[32]. This might be caused by the response of medium-sized and large hospitals a change in price policy in order to pursue higher reimbursement. However, this is not exactly what the MHLW intended. Consequently, the latest revision of the FFS in 2014 turned to decrease drastically the fee for inpatient hospital care provided by "7:1" hospitals, in order to motivate some hospitals to transfer from "7:1" acute care hospitals to "non-7:1" providing other type of care.

A lesson from this example is that constant quantitative evaluation of the impact of a price policy on the supplier's behavior is necessary, in particular, when a free hand choice is allowed for health care providers, to some extent, under a price regulation policy.

Finally, there are a number of limitations of this study. First, the econometric strategy in this study could not identify the effects of FFS revisions completely, since kernel propensity matching score DID could account for observable time-invariant effects, but unobservable influences still might remain within the model. Second, it did not evaluate the impacts of the FFS on patient outcomes and medical costs, where it could be quite challenging to identify pure effects because of the endogeneity problem between policy changes and outcomes. Finally, due to data limitations, the long-run effects of the critical revisions in 2006 have not been examined in this study. So, further research is necessary to clarify the effects of policy-changes on health care in Japan.

[32] Also, MHLW (2012) indicates that there are 248,606 beds in 10:1 hospitals, 33,668 beds in 13:1 hospitals, and 66,822 in 15:1 hospitals in 2010.

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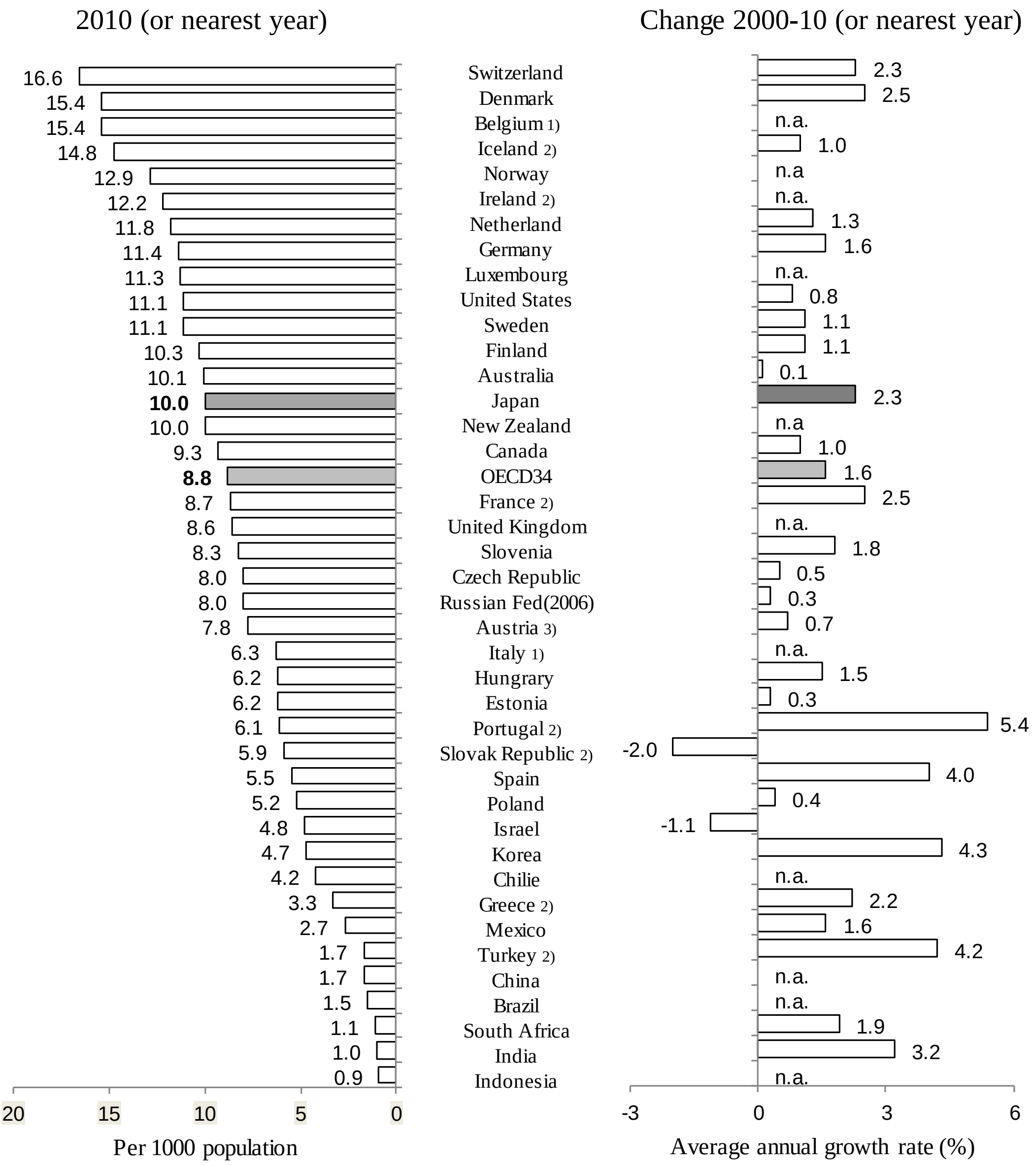
Fig.1 Practising nurses per 1,000 population, 2010 and change between 2000 and 2010



Notes

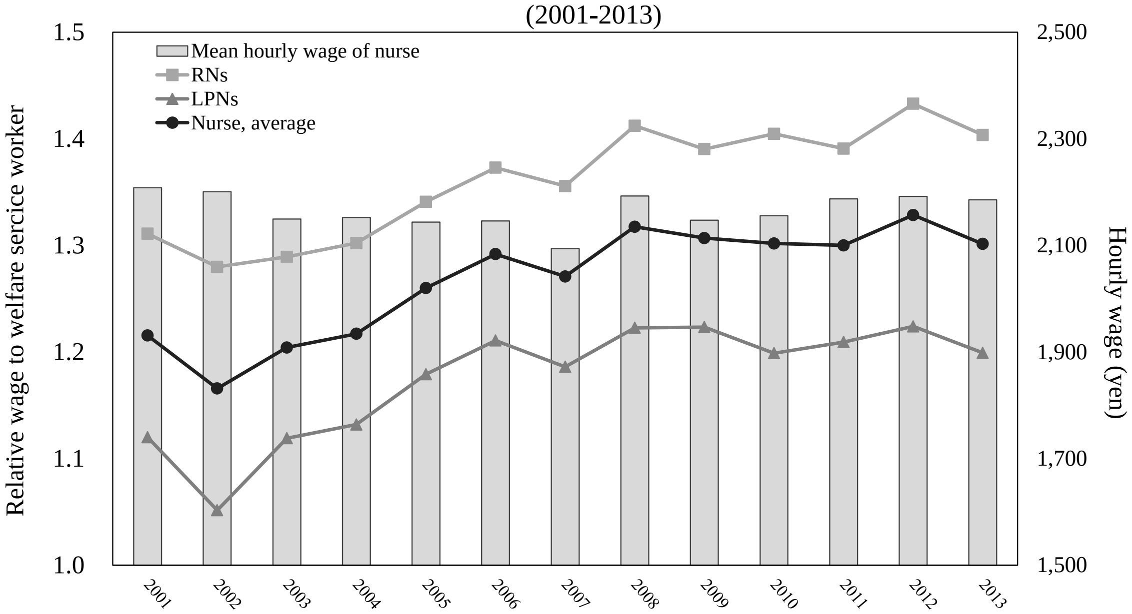
1) Data refer to all nurses who are licensed to practice.

2) Data include not only nurses providing direct care to patients, but also those working in the health sector as managers, educators, researchers, etc.

3) Austria reports only nurses employed in hospitals.

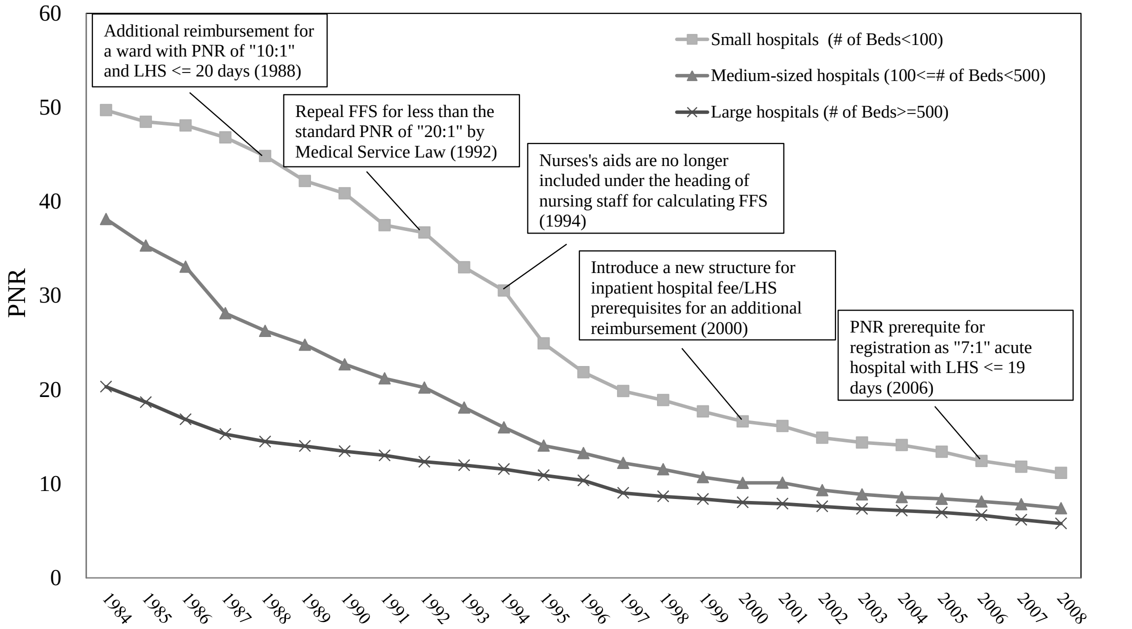
Source: OECD Health Data 2014; Eurostat Statistics Database; WHO European Health For All Database.

Fig2. Mean hourly wages of nurses and relative wage to welfare service worker (2001-2013)



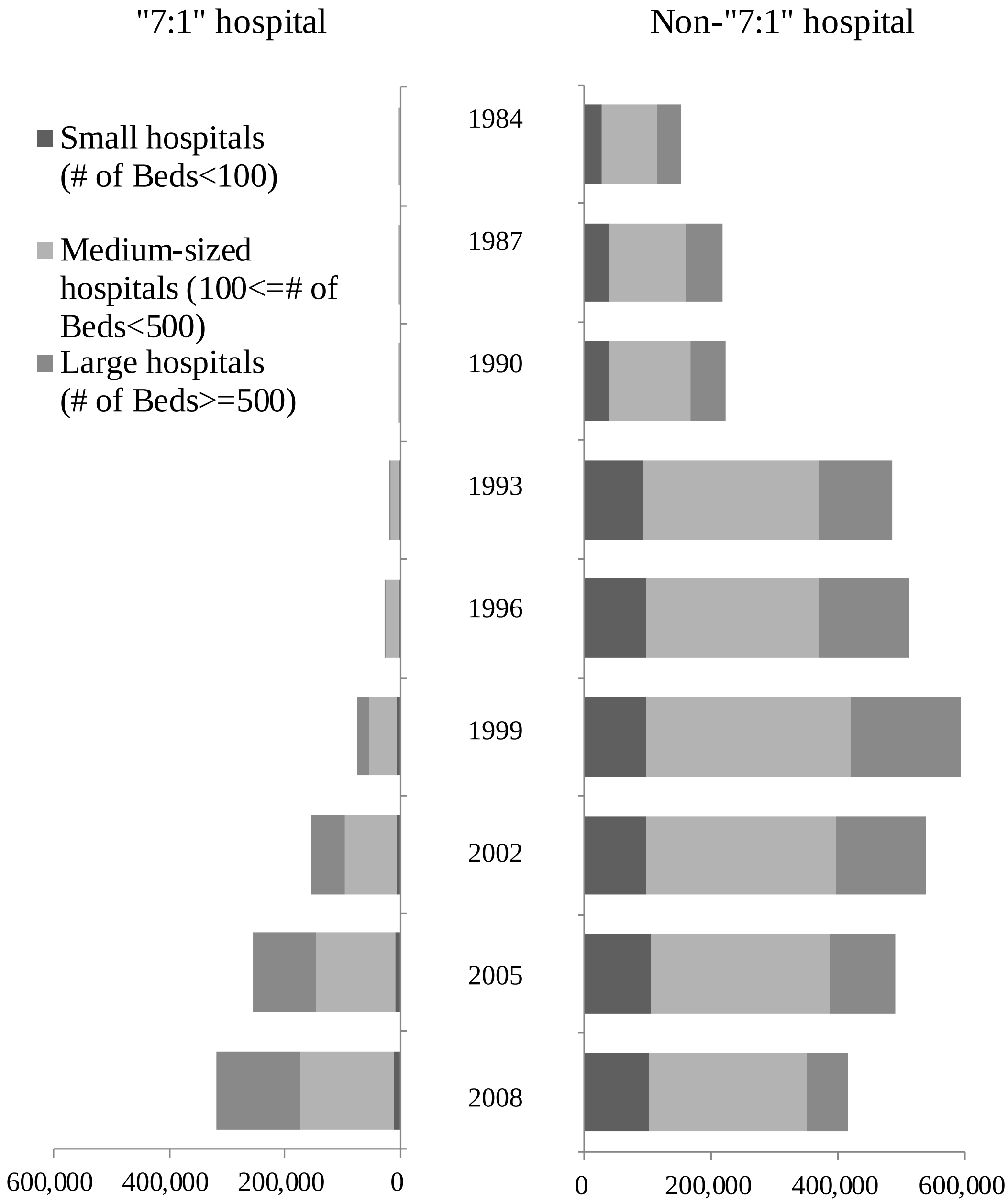
Source: MHLW. " Basic Survey of Wage structure: *Chingin kozo kihon toukei chousa: in Japanese*)"
Note: Mean hourly wage is calculated by annual income (including bonus)/total annual hours of working (including overtime work).
Welfare service worker includes physical/occupational therapists, care managers, care workers, and home helpers.

Fig.3 PNR by hospital size and the timing of major revisions of FFS (1984-2008)



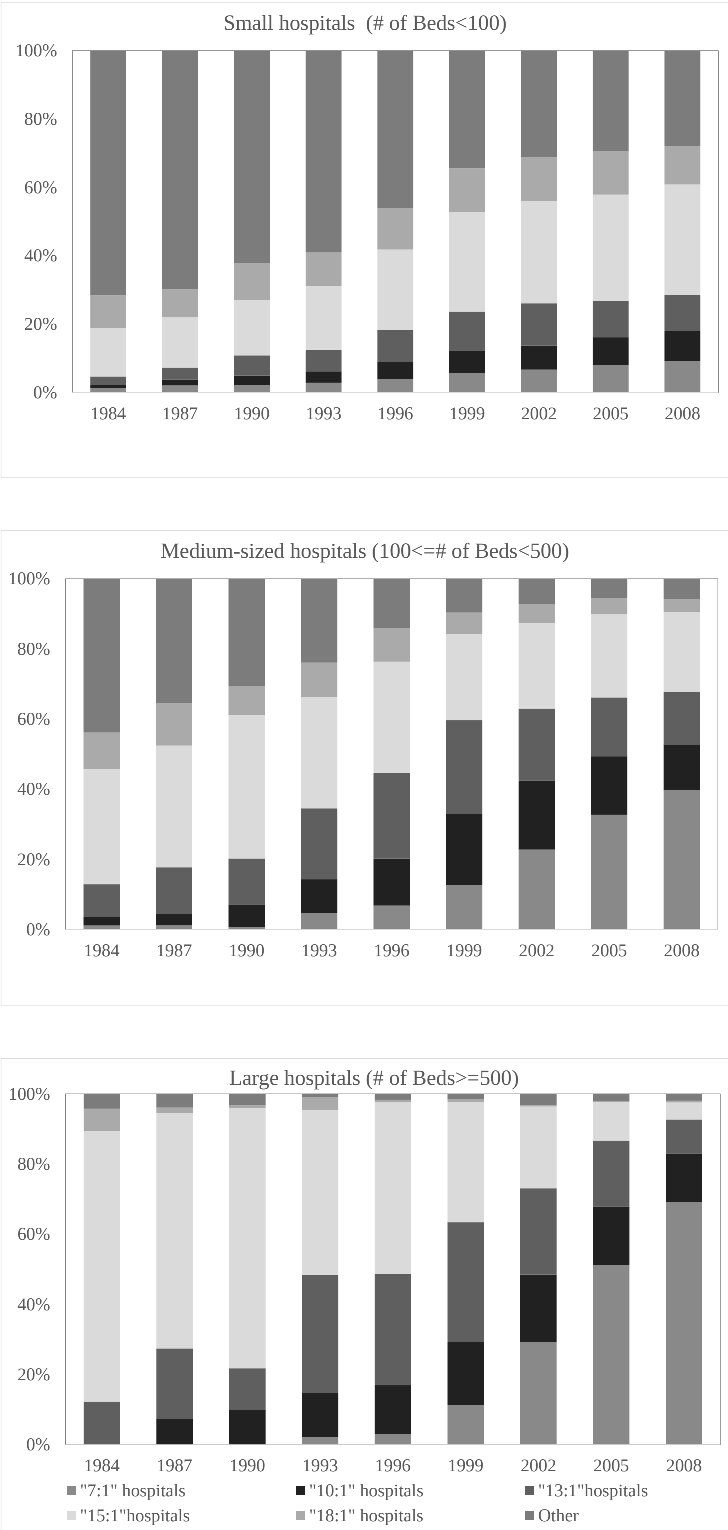
Source: PNRs are calculated by the author, based on "Hospital Report (HR)" and "Survey of Medical Institutions (SMI)" (MHLW).
Note: PRN and LHS stand for "patient-nurse ratio" and "length of hospital stay", respectively. All PRNs in this figure are based on the new standard revised as of 2006. Before 2006, each PNR of "7:1", "10:1", "13:1", "15:1", "18:1", and "20:1" were counted as "1.4:1", "2:1", "2.5:1", "3:1", "3.5:1", and "4:1" .

Fig.4 Number of general beds in hospitals
with PNRs of "7:1" versus more than "7:1", by hospital size



Source: Number of general beds, PNRs, and an average LHS are calculated by the author, based on HR and SMI (MHLW).
Note: "7:1" hospital is defined as a medical facility which satisfies PNR of 7:1 conditional on an average LHS of 19 days, while non-"7:1" hospitals do not meet the criteria.

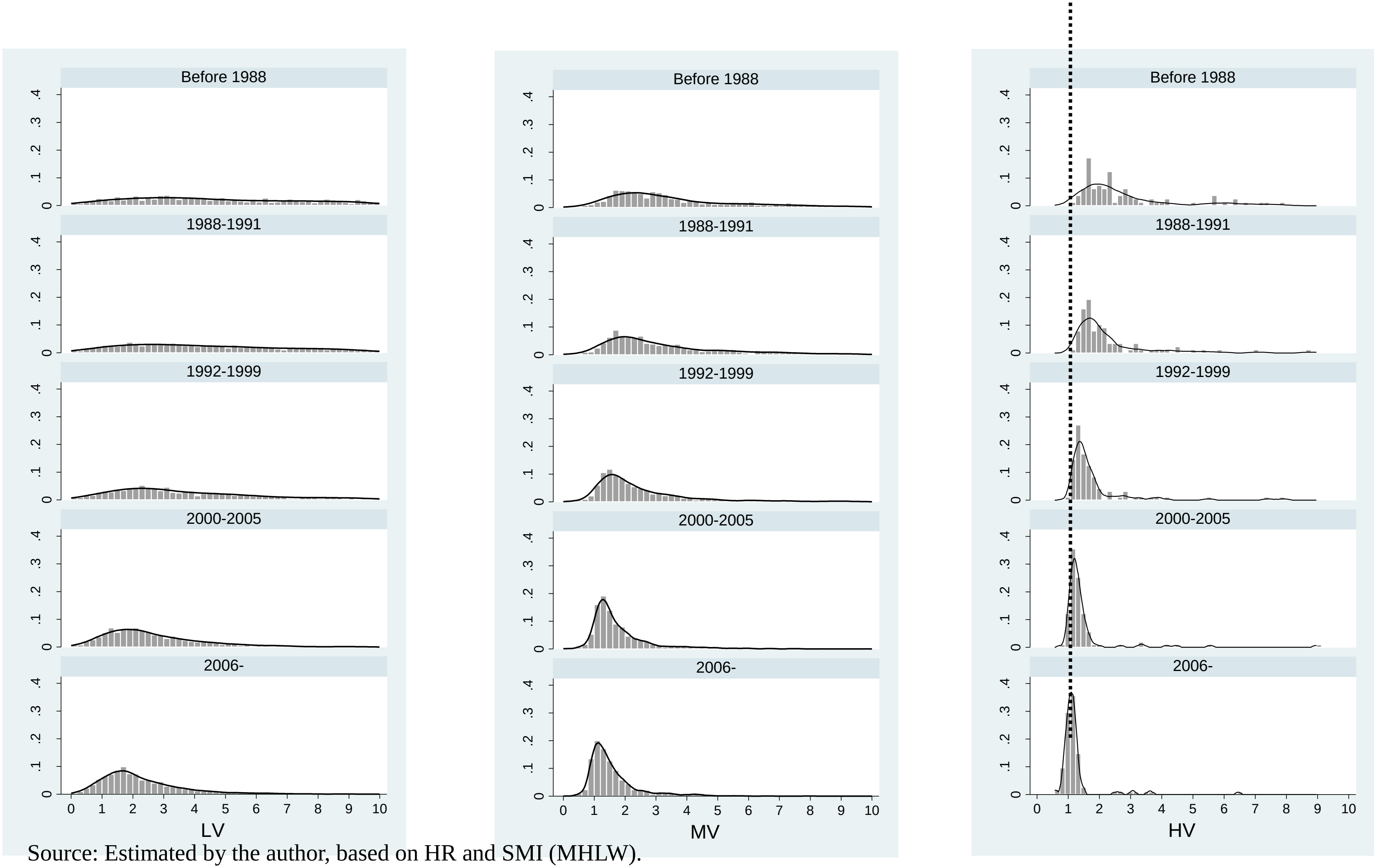
Fig.5 Distribution ratio of number of general beds, by hospital size and types of PNRs based on 2000 and 2006 criteria for additional reimbursements



Source: Distribution ratios are calculated by the author, based on HR and SMI (MHLW).

Note: The definitions of “10:1”, “13:1”, “15:1”, and “18:1” hospitals are based on the FFS revision in 2000 and "7:1" hospital was defined in 2006.

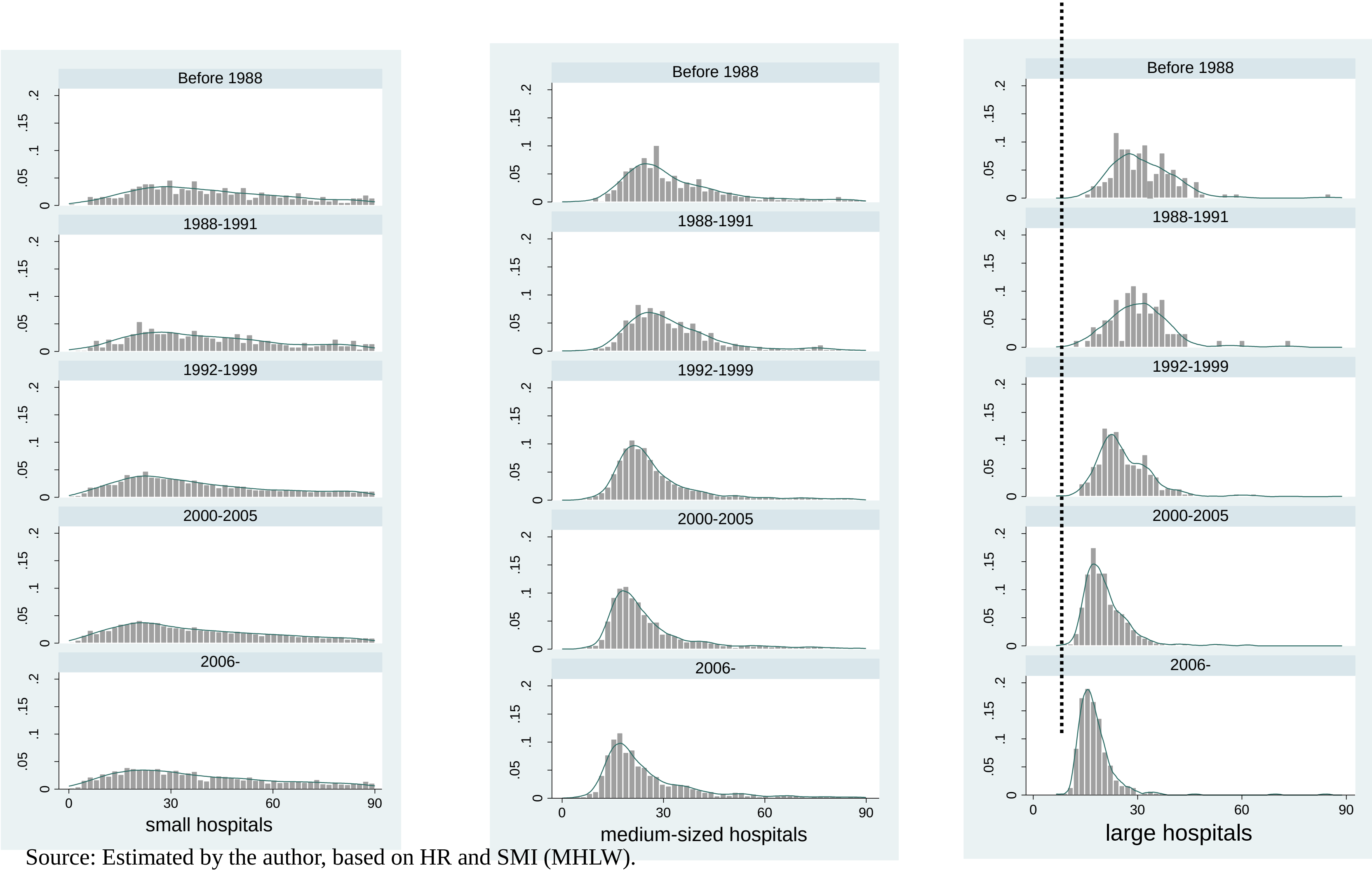
Fig. 6 Histogram of PNR by hospital size and the timing of major revisions of FFS with kernel density estimates



ospitals

Source: Estimated by the author, based on HR and SMI (MHLW).
Note: Broken lines show "a 7:1 hospital".

Fig. 7 Histogram of LHS by hospital size and the timing of major revisions of FFS with kernel density estimates



spitals

Source: Estimated by the author, based on HR and SMI (MHLW).

Table 1 Kernel propensity score matching DID estimates before and after 2000

Outcome variables	Number of observations	Base line before 2000				Follow up after 2000				DID		R-square
		Control	Treated	Difference at base line		Control	Treated	Difference at follow up		DID δ in Eq.(2)		
A. PNR												
A-1. All hospitals	19501	1.042	1.644	0.602	***	0.880	1.352	0.473	***	-0.130	***	0.133
		(0.010)	(0.010)	(0.014)		(0.012)	(0.011)	(0.016)		(0.022)		
A-2. Small hospitals	9708	0.728	1.421	0.693		0.653	1.314	0.660		-0.032		0.127
		(0.016)	(0.016)	(0.022)		(0.022)	(0.020)	(0.030)		(0.038)		
A-3. Medium-sized hospitals	8214	1.357	1.968	0.612	***	1.008	1.429	0.421	***	-0.191	***	0.321
		(0.011)	(0.011)	(0.015)		(0.011)	(0.011)	(0.016)		(0.022)		
A-4. Large hospitals	1403	1.396	1.568	0.172	***	1.024	1.157	0.133	***	-0.040	***	0.338
		(0.016)	(0.016)	(0.022)		(0.016)	(0.016)	(0.023)		(0.032)		
B. LHS												
B-1. All hospitals	19501	20.549	36.849	16.300	***	20.917	31.758	10.841	***	-5.459	***	0.157
		(0.223)	(0.223)	(0.316)		(0.265)	(0.247)	(0.363)		(0.481)		
B-2. Small hospitals	9708	20.710	42.121	21.411	***	24.280	38.602	14.322	***	-7.089	***	0.189
		(0.359)	(0.359)	(0.508)		(0.493)	(0.432)	(0.655)		(0.829)		
B-3. Medium-sized hospitals	8214	19.790	31.080	11.290	***	18.495	26.924	8.429	***	-2.861	***	0.162
		(0.254)	(0.254)	(0.360)		(0.271)	(0.262)	(0.376)		(0.521)		
B-4. Large hospitals	1403	20.461	28.395	7.934	***	17.057	20.456	3.399	***	-4.536	***	0.259
		(0.374)	(0.374)	(0.529)		(0.383)	(0.384)	(0.542)		(0.758)		

Source: Estimated by the author, based on HR and SMI (MHLW).
Note: *** p<0.01; **p<0.05; and *p<0.1.

Table 2 Kernel propensity score matching DID estimates before and after 2006

Outcome variables	Number of observations	Base line before 2006 Control	Treated	Difference at base line		Follow up after 2006 Control	Treated	Difference at follow up		DID δ in Eq.(2)		R-square
A. PNR												
A-1. All hospitals	21964	1.068	1.604	0.536	***	0.871	1.347	0.476	***	-0.060	*	0.100
		(0.009)	(0.009)	(0.012)		(0.021)	(0.020)	(0.029)		(0.031)		
A-2. Small hospitals	11272	0.850	1.442	0.591	***	0.734	1.327	0.594	***	0.002		0.093
		(0.013)	(0.013)	(0.019)		(0.036)	(0.032)	(0.038)		(0.052)		
A-3. Medium-sized hospitals	8859	1.433	1.887	0.454	***	1.014	1.401	0.387	***	-0.066	**	0.199
		(0.009)	(0.009)	(0.013)		(0.021)	(0.020)	(0.029)		(0.032)		
A-4. Large hospitals	1768	1.333	1.494	0.161	***	0.967	1.044	0.077	*	-0.084	*	0.196
		(0.013)	(0.013)	(0.018)		(0.028)	(0.029)	(0.040)		(0.044)		
B. LHS												
B-1. All hospitals	21964	21.514	38.033	16.519	***	22.542	33.958	11.416	***	-5.103	***	0.171
		(0.181)	(0.181)	(0.256)		(0.449)	(0.416)	(0.612)		(0.663)		
B-2. Small hospitals	11272	22.129	42.163	20.035	***	25.753	38.861	13.108	***	-6.927	***	0.193
		(0.282)	(0.282)	(0.398)		(0.772)	(0.680)	(1.029)		(1.103)		
B-3. Medium-sized hospitals	8859	20.532	32.342	11.810	***	18.766	28.706	9.940	***	-1.871	***	0.175
		(0.209)	(0.209)	(0.295)		(0.464)	(0.459)	(0.653)		(0.717)		
B-4. Large hospitals	1768	21.676	29.193	7.518	***	16.406	20.255	3.849	***	-3.669	***	0.241
		(0.289)	(0.289)	(0.409)		(0.637)	(0.654)	(0.913)		(1.000)		

Source: Estimated by the author, based on HR and SMI (MHLW).
Note: *** p<0.01; **p<0.05; and *p<0.1.