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

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

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. $P(X_{\mathrm{t},i})$ 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

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[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.

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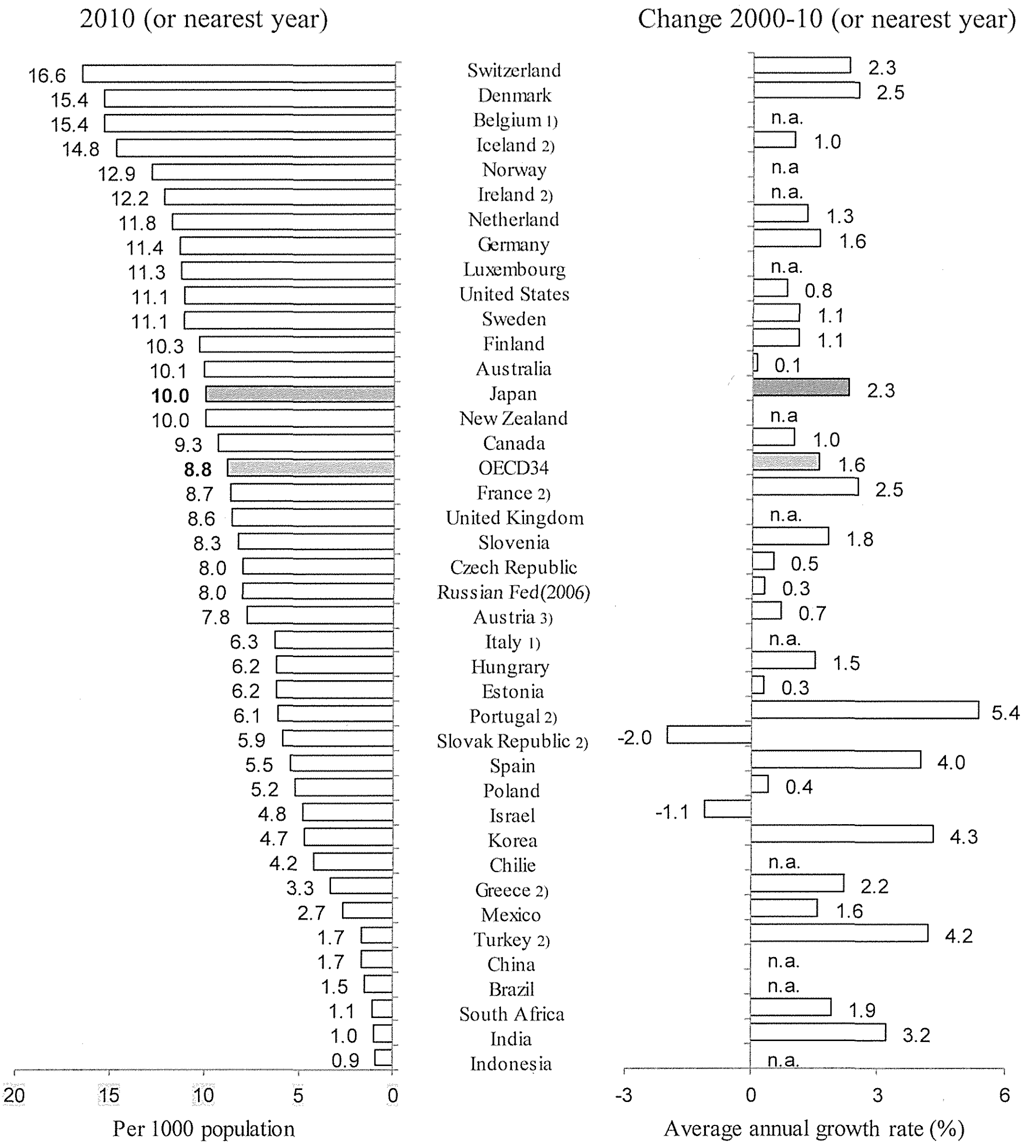
Fig.1 Practising nurses per 1,000 population, 2010 and change between 2000 and 2010



Notes

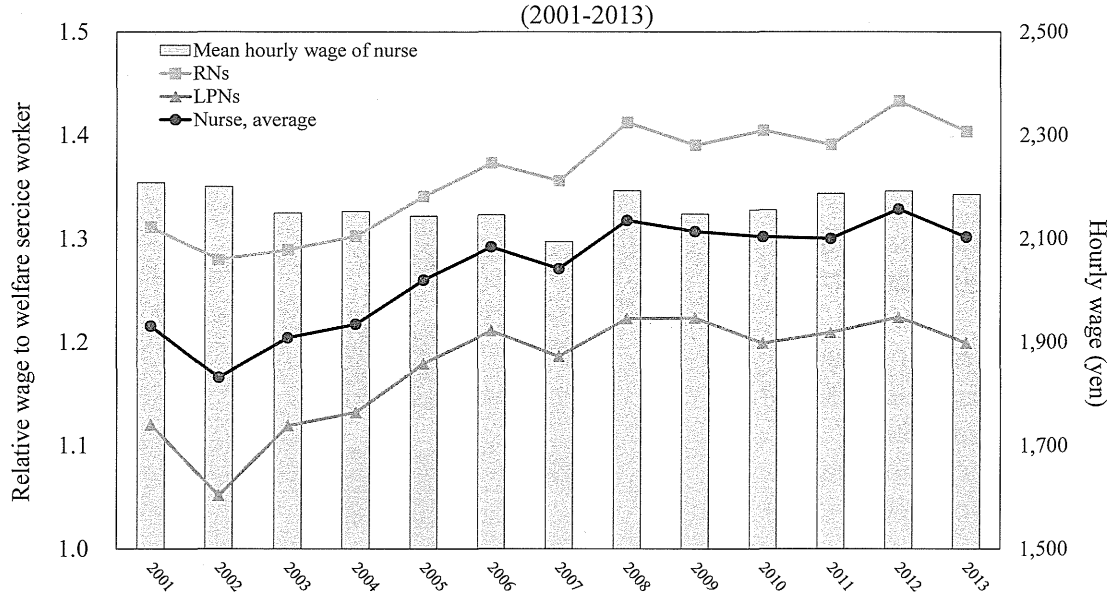
1) Data refer to all nurses who are licensed to practice.

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.

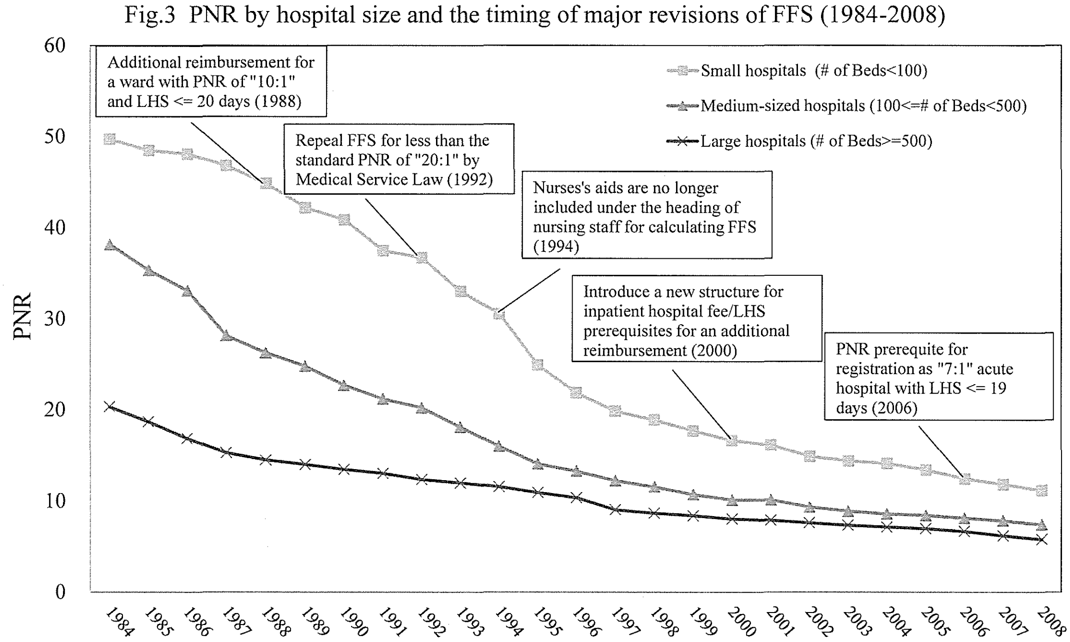
Source: OECD Health Data 2014; Eurostat Statistics Database; WHO European Health For All Database.

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



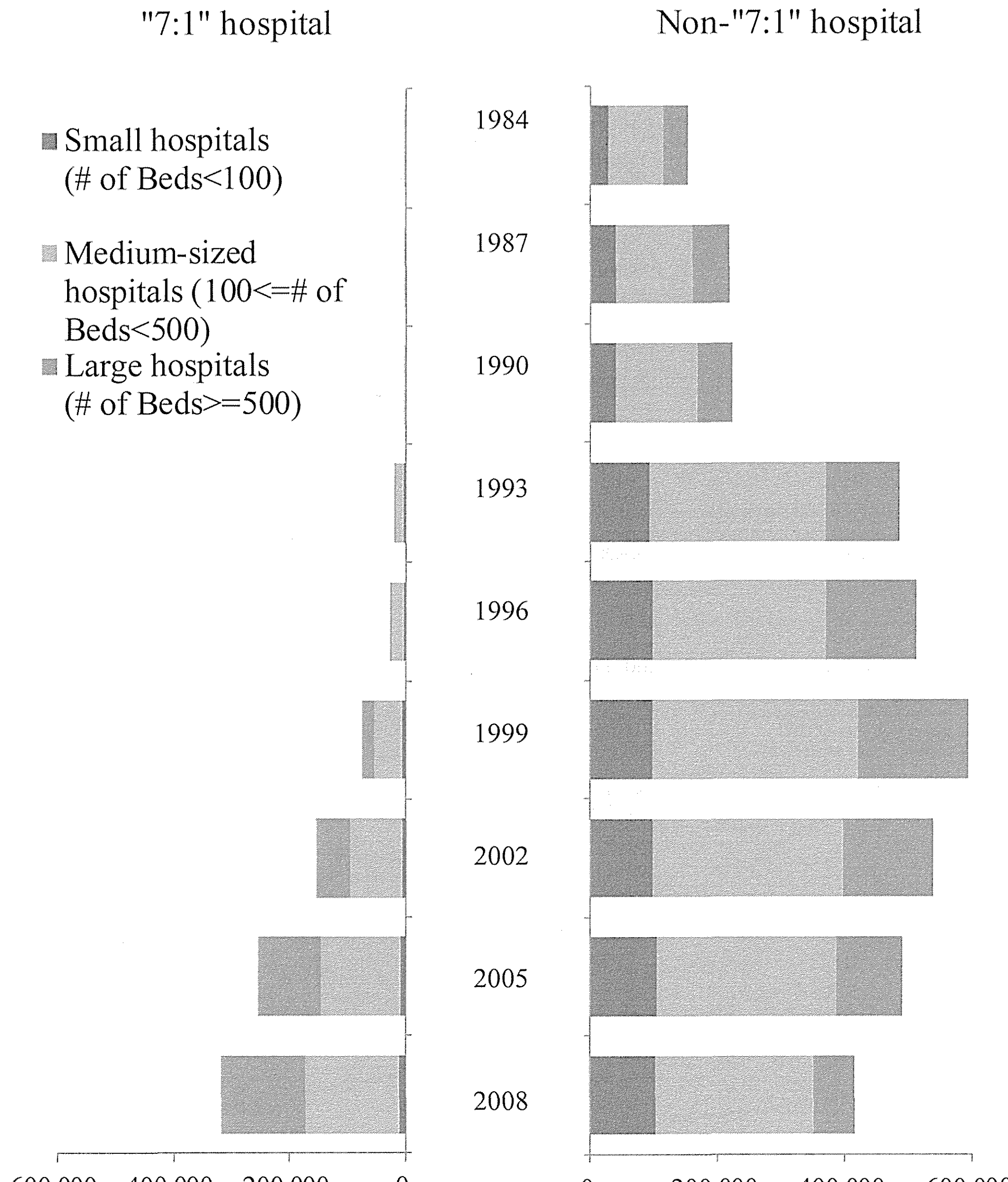
Source: MHLW. " Basic Survey of Wage structure: *Chingin kozo kihon toukei chousa: in Japanese*)"
Note: Mean hourly wage is calculated by annual income (including bonus)/total annual hours of working (including overtime work). Welfare service worker includes physical/occupational therapists, care managers,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

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



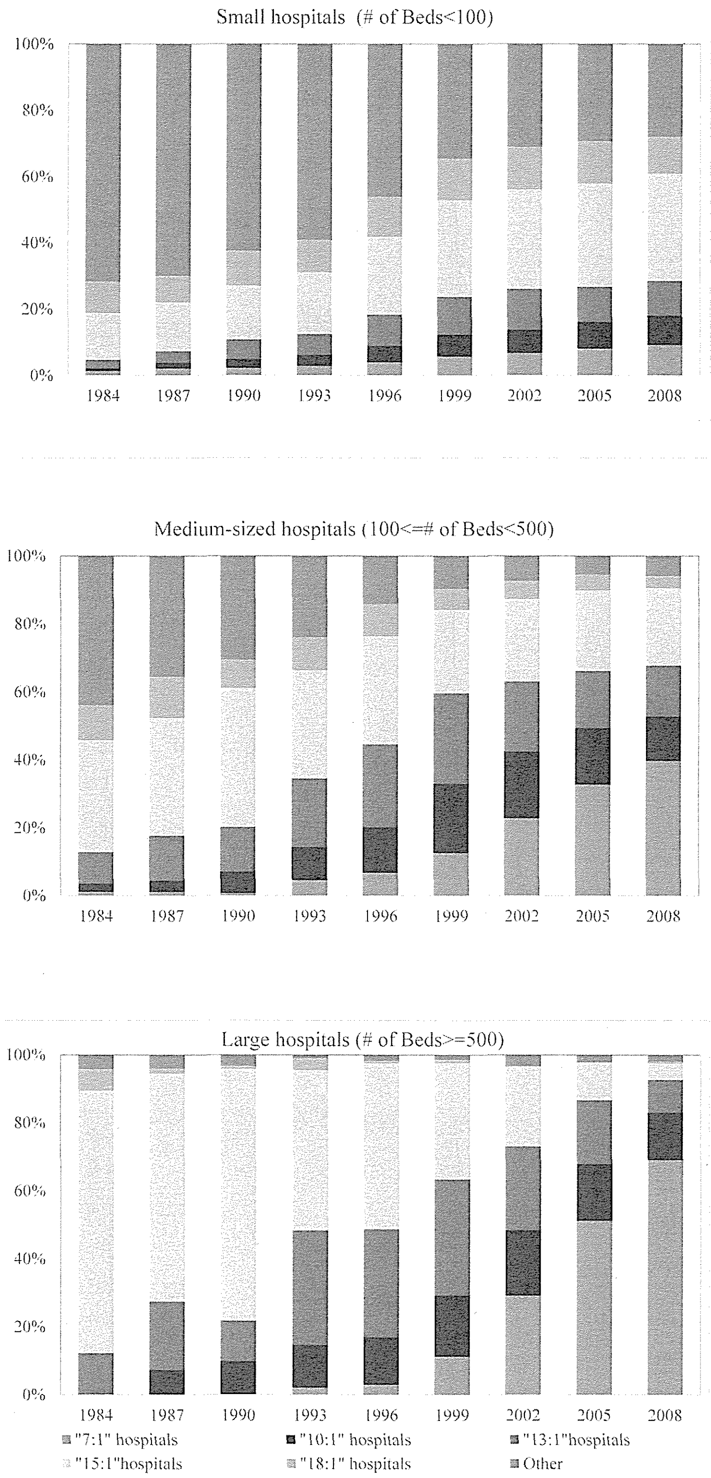
Source: PNRs are calculated by the author, based on "Hospital Report (HR)" and "Survey of Medical Institutions (SMI)" (MHLW).
Note: PRN and LHS stand for "patient-nurse ratio" and "length of hospital stay", respectively. All PRNs in this figure are based on the new standard revised as of 2006. Before 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.

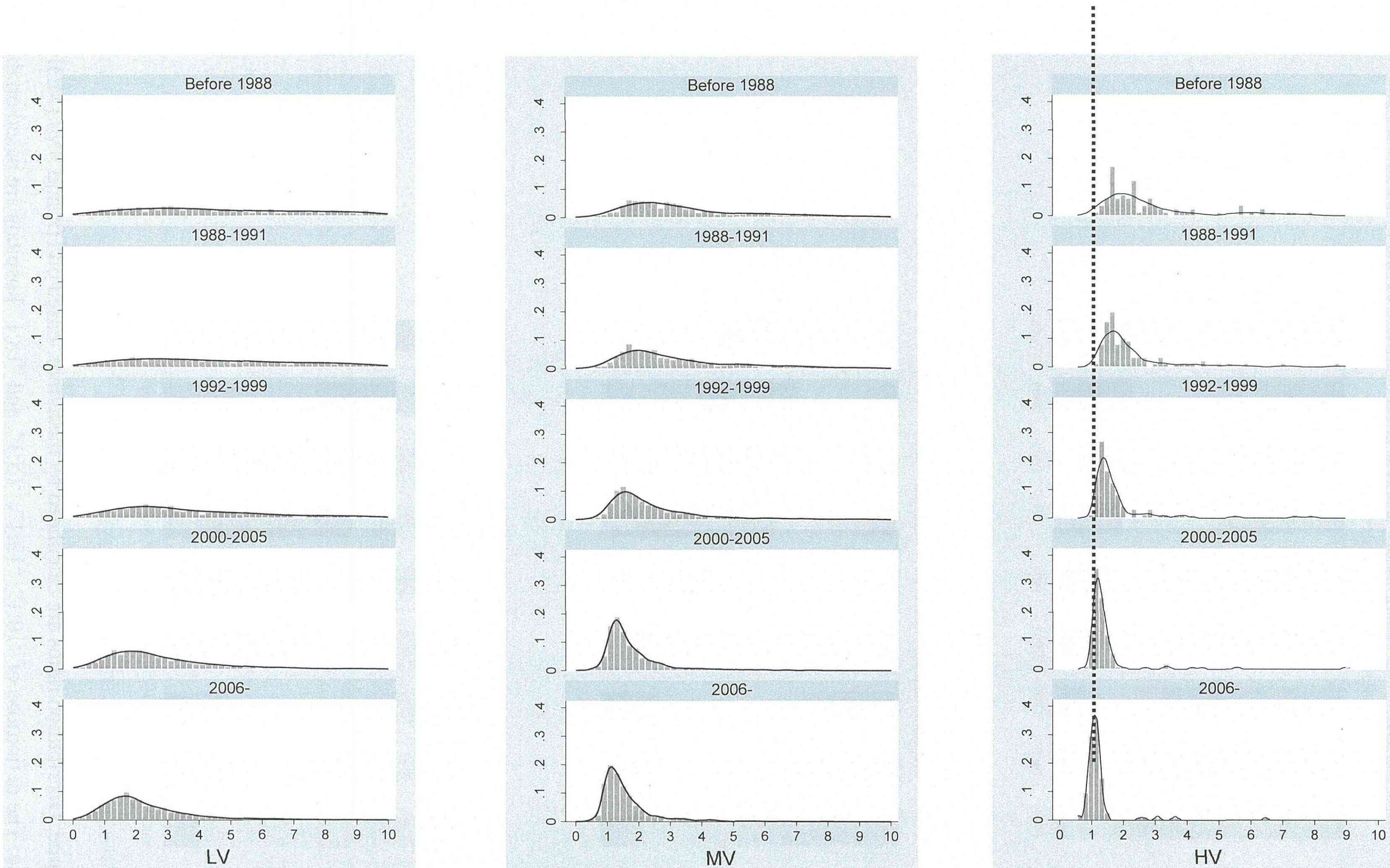
Fig.5 Distribution ratio of number of general beds, by hospital size and types of PNRs based on 2000 and 2006 criteria for additional reimbursements



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

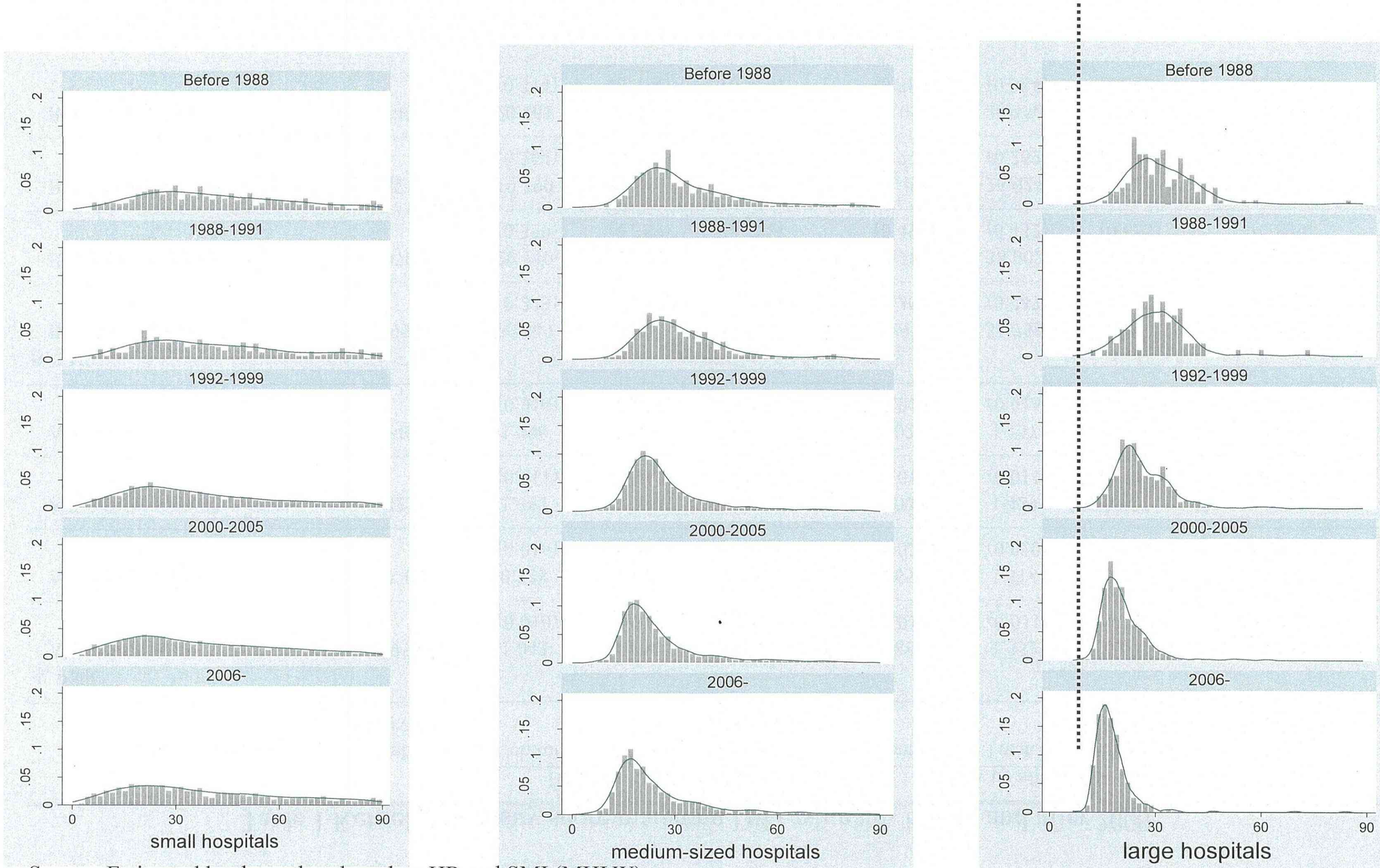
Note: The definitions of "10:1", "13:1", "15:1", and "18:1" hospitals are based on the FFS revision in 2000 and "7:1" hospital was defined in 2006.

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



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



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	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.