Centre for
Economic
and Financial
Research at
New Economic
School

May 2013

Heterogeneous hospital response to a per diem prospective payment system

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Working Paper No 193

CEFIR /NES Working Paper series

The adverse effects of prospective payment system

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May 14, 2013

Abstract

The paper demonstrates the adverse effects of degressive rates, dependent on the percentiles of length of stay, in a prospective payment system with per diem payments. Using the dynamic panel data estimates with a recent nationwide administrative database for major diagnostic categories in 697 Japanese hospitals in July 2007- March 2012, the paper shows that average length of stay significantly increases (decreases) for hospitals in percentiles 0-25 (51-100) of the pre-reform length of stay. The decline of the average length of stay is larger for hospitals in higher percentiles of the length of stay. Hospitals in percentiles 51-100 significantly raise planned early readmission rate. As a remedy to the problem, the paper discusses the applicability of the "best practice" rate-setting.

JEL codes: I10, I18, G22, R22

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1 Introduction

The inpatient prospective payment system (PPS), which involves a fixed payment for an episode of medical care provision to a patient within a given diagnosis group, is a significant example of reimbursement policies, aimed at creating adequate provider incentives for cost containment (Chalkley and Malcomson 2000; Holmstrom and Milgrom 1991; Shleifer 1985). Prospective per case financing creates incentives to increase cost efficiency of hospital operations, since hospitals start to bear the financial burden of excessive medical treatment (Fetter and Freeman 1986; Thompson *et al.* 1979. Yet, a modification of the original version of the PPS allowing *per diem* prospective payments may be adequate for a number of specialized hospitals, where it is sufficient to regulate daily resource use.[2] Per diem PPS may be also favored by countries with high variation of treatment patterns, an emphasis on medical procedures, historical differences in hospital reimbursement, or lack of standardized data on patient cases. Since per diem PPS generally has fewer incentives for cost containment (Busse and Riesberg 2004; Rosko and Broyles 1987), degressive rates might be exploited as a tool to stimulate shorter hospitalizations. However, the way the rates are diminished is a key issue to avoiding the unwanted effects of a per diem PPS (Drummond *et al.* 1997; Monrad Aas 1995).

While some studies pay attention to potential adverse effects of the per diem PPS on hospital's length of stay and quality (Grabowski *et al.* 2011; Sood *et al.* 2008; Gold *et al.* 1993; Coulam and Gaumer 1991; Morrisey *et al.* 1984), only a few papers explore the undesired effects of degressive rates in a per diem PPS. To the best of our knowledge, Nawata and Kawabuchi (2012) is the only paper to suggest that decrease of mean average length of stay (ALOS) owing to a step-down per diem PPS reform might be separated into increase of

[2] E.g., psychiatric hospitals, skilled nursing facilities, hospices.

ALOS at some hospitals and decrease of ALOS at other hospitals.[3] As regards hospital quality, Kondo and Kawabuchi (2012) assume that patients who require long treatment (e.g. rehabilitation after surgery owing to hip fractures) are vulnerable to premature discharges owing to the incentives inherent to the degressive per diem prospective payment.

The novelty of the present paper is the use of a variety of diagnoses and a large sample of the hospitals for empirical estimates of adverse effect of prospective payment system with degressive per diem rates on the length of stay and hospital quality (proxied by planned early readmission rate). The paper exploits the unique nationwide administrative data (2007 -2012) for recent Japanese experience of introducing per diem PPS with length-of-stay dependent step-down rates. The empirical analysis is conducted for each Major Diagnostic Category (MDC) – aggregate groups of diagnoses, constructed in Japan on the basis of the International Classification of Diseases (ICD-10) with minor modifications. The results indicate persuasive evidence supporting the adverse effects of the per diem PPS with degressive rates. The average length of stay significantly increases (decreases) for hospitals in percentiles 0-25 (51-100) of the pre-reform nationwide length of stay. The decline of average length of stay is larger for hospitals in higher percentiles of the pre-reform length of stay. At the same time, the planned readmission rate within 42 days after discharge rises at hospitals in percentiles 51–100. As a remedy to the problem, the paper discusses the applicability of the "best practice" rate-setting.

The remainder of this paper is structured as follows. Section 2 provides a description of the major features of the Japanese inpatient PPS, introduced to replace the fee-for-service (FFS) reimbursement. Section 3 describes the data, and Section 4 gives specifications for the empirical analysis. Section 5 presents the results of the estimations, and the discussion about degressive rates in a per diem PPS is presented in Section 6.

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[3] Similarly, Yasunaga *et al.* (2006) argue that decline in ALOS occurs primarily at large Japanese hospitals, which deal primarily with surgical patients.

2. Per diem prospective payment system in Japan

Cost containment entered the agenda of Japanese health care policy makers in the 1970s, when the rate of health care expenditure growth started to exceed the rate of growth of GDP (Fujii and Reich 1988). The factors causing soaring health care costs are population aging, decrease of the labor force, and the spread of new medical technologies in the environment of physician-induced demand under fee-for-service reimbursement. Consequently, the Japanese social health insurance system became highly subsidized. In 2012, for example, central government financed 25.3% of health care expenditure (MHLW 2012b), which represented 10.2 % of the government budget (Ministry of Finance 2012). By the early 2000s the effectiveness of raising coinsurance rates and lowering of fees in the unified fee schedule had been exhausted as means of containing health care costs (Ikegami 2009). Consequently, the Ministry of Health, Labor, and Welfare (MHLW) decided to introduce an inpatient prospective payment system for acute care hospitals to create incentives for cost containment.

An inpatient PPS was first introduced in Japan in 1990, when inclusive per diem rates (unadjusted for case-mix) were employed in 50% of geriatric hospitals, which satisfied the required staffing criteria (MHLW 2012a; Ikegami 2005; Okamura *et al.* 2005). The per diem PPS led to the reduction of excess material costs and laboratory tests (Ikegami 2005; Okamura *et al.* 2005). Inpatient PPS (ver.1) with per case payments was then tested at 10 acute care hospitals in 1998-2004 (Kondo and Kawabuchi 2012). However, owing to high diversity of medical treatment patterns, the effect of the full PPS was ambiguous and the system was not expanded nationwide (Kondo and Kawabuchi 2012; Okamura *et al.* 2005). Therefore, in 2003 *per diem* PPS was piloted at 82 special-function hospitals, providing high-technology health care. In 2004-2013 there was a steady increase in the number of Japanese public and private hospitals, joining the PPS voluntarily. As of April 2013, 20.0% of acute care (general) hospitals, accounting for 53.4% of hospital beds in Japan, are financed using prospective payment system (MHLW 2013).[4]

For each group of diagnoses – referred to as diagnosis-procedure combination, DPC – the amount of the inclusive per diem payment is a step-down function of the patient's length of stay. The classification of DPCs employed nationwide in 2003 (ver.3.0) consisted of 2552 expertly determined diagnosis groups. The per diem rates were set on the basis of 1860 homogeneous groups, which covered about 90% of admissions (Ikegami 2005). Subsequently, the numbers of diagnoses were adjusted (with slight increases and decreases), and as of 2012/2013 revision of the unified fee schedule, there are 2927 diagnosis groups and 2241 DPCs. Each DPC incorporates diagnosis, algorithm, procedure, and co-morbidity. Diagnoses are coded according to ICD-10 and procedures are classified on the basis of the Japanese Procedure Code, commonly used under fee-for-service reimbursement in Japanese unified fee schedule (Matsuda *et al.* 2008, MHLW 2004).[5]

The Japanese version of inpatient PPS is a mixed system. The two-part tariff is the sum of DPC and fee-for-service components, whose approximate shares are 0.7 and 0.3 respectfully (Okamura *et al.* 2005). The DPC component of the Japanese PPS covers the cost of basic hospital fee, examinations, diagnostic images, pharmaceuticals, injections, and procedures worth less than 10,000 yen. The fee-for-service component reimburses medical teaching, surgical procedures, anaesthesia, endoscopies, radioactive treatment, pharmaceuticals and materials used in operating theatres, as well as procedures costing more than 10,000 yen (MHLW 2012a; Yasunaga *et al.* 2005a). The two-component system may be justified in part by the historically developed variety of practice patterns in Japanese hospitals (Hamada *et al.* 2012; Campbell and Ikegami 1998). Moreover, ICD coding, which is a prerequisite for

[4] Small hospitals seem to be more reluctant to changeover to PPS. Indeed, while the prevalence of PPS in the groups of hospitals with 20-99 beds and 100-199 beds is 5.7% and 14.3% correspondingly, almost half of hospitals with 300-500 beds and two thirds of hospitals with over 500 beds joined the reform by 2013.

unification, had very low prevalence in Japan; it was employed only in 10% of hospitals (Ikegami and Campbell 2004). The Japanese two-part tariff may be regarded analogous to the German PPS in 1996-2003, where the per diem fee was a sum of a department-specific prospective component for medical costs and a hospital-specific retrospective component for nonmedical costs (Busse and Schwartz 1997).

The DPC component is constructed as a per diem step-down rate, related to the hospital's length of stay. For a standard DPC (i.e. a DPC without particularly high or particularly low medical cost at the beginning of the treatment), the amount of the daily inclusive payment is flat over each of the three consecutive periods: period I represents the 25-percentile of ALOS calculated for all hospitals submitting data to MHLW;[6] period II contains percentiles 26-50 of the ALOS; and period III includes two standard deviations from the ALOS (MHLW 2010a, b). After the end of period III, hospitals are reimbursed according to the unified fee schedule. To create incentives for shorter lengths of stay, per diem payment in period I is 15-50% higher than in period II,[7] and in period II – 15% higher than in period III.

[INSERT FIGURE 1 HERE]

The reform immediately resulted in decline of the ALOS nationally (MHLW 2005), which corresponds to the prediction of the models on hospital behavior and empirical evidence in other countries (Suthummanon and Omachonu 2004; Laffont and Tirole 2003; Rosko and Broyles 1988). A number of Japanese hospitals use classic measures to shorten ALOS by raising the efficiency of medical treatment (Borghans *et al.* 2012; Besstremyannaya 2011; Suwabe 2004). Since ALOS reflects optimal resource use and, therefore, is often treated as a proxy for hospital efficiency (Lopes *et al.* 2004; Rapoport *et al.* 2003; Heggestad 2002), a fall in ALOS is arguably associated with increased efficiency (Kuwabara *et al.* 2011). Yet, both

[5] According to Matsuda *et al.* (2008) DPCs are based on the Dutch Diagnose Behandeling Combinatie, with an influence of the pricing systems in Austria, Belgium, France, and the UK.
[6] The initial rates were set according to the claim data on 267,000 patients discharged from 82 targeted hospitals in July-October 2002.

technical and cost efficiency of Japanese hospitals demonstrate only a minor improvement owing to the reform (Besstremyannaya 2012) and the impact on hospital costs is ambiguous (Nishioka 2010; Yasunaga *et al.* 2006; Yasunaga *et al.* 2005a). Moreover, per diem PPS might not have shortened ALOS in a number of cases (Nawata and Kawabuchi 2012; Yasunaga *et al.* 2006).

3. Methodology

3.1 Predictions about the adverse effects

3.1.1. Average length of stay

Ellis and McGuire (1996) is one of a few papers to explicitly compare the effect of the prospective payment system on the changes in length of stay for patients at different percentiles of pre-reform length of stay.[8] The present paper similarly tests for adverse effects of the *per diem* PPS reform, looking at 25-percentiles of average length of stay, which are the units for the length of steps in the degressive PPS schedule.

The highest rate in the Japanese per diem PPS is paid during the period corresponding to the 0-25 percentile of the nationwide ALOS. Therefore, financial incentives within DPC schedule do not apply to hospitals with ALOS below the value of the 25th percentile. In fact, hospitals in percentiles 0-25 might be likely to increase their ALOS till the nationwide threshold value of the 25th percentile. Indeed, given the capability of sustaining high bed occupancy rate (Abe *et al.* 2005), hospitals in percentiles 0-25 are indifferent between admitting a new patient or treating already hospitalized patient longer. As for percentiles 26-50 of ALOS, a part of hospitals which can not decrease their ALOS till the value of the 25th percentile might increase it till the value of the mean nationwide ALOS. However, a part of hospitals would strive to lower their ALOS till the value of the 25th percentile. Consequently, the overall effect for hospitals in percentiles 26-50 is ambiguous. Finally, hospitals in percentiles 51-100 of

[7] The upper cap of 50% for a standard DPC was introduced in 2012.

ALOS will attempt to decrease their ALOS till the value of mean nationwide ALOS. Moreover, the closer the hospital's pre-reform ALOS to the mean nationwide ALOS, the smaller will be the reduction of ALOS.

Accordingly, *Hypothesis I* forecasts that ALOS is likely to *increase* for hospitals in percentiles 0-25 of the empirical nationwide ALOS and is likely to *decrease* for hospitals in percentiles 51-100 ALOS. *Hypothesis II* predicts larger decline of ALOS for hospitals in higher percentiles of nationwide ALOS.[9]

3.1.2 Quality

It is commonly noted that the reverse side of the Japanese PPS is quality deterioration, reflected in the growing prevalence of "remission" reports and decline in the number of "healing (cure)" reports[10] for discharged patients nationally (MHLW 2009) and for certain diagnoses (Kondo and Kawabuchi 2012). The MHLW's data enables the use of early readmission rate as an indicator of hospital quality (Halfon *et al.* 2006; Lopes *et al.* 2004; Weissman *et al.* 1999; Ashton *et al.* 1997). In particular, this paper tests whether the degressive rates result in differential changes in *planned* early readmission rate. Indeed, the rise of the early readmission rate owing to the Japanese PPS reform (Hamada *et al.* 2012; Yasunaga *et al.* 2005a) may be primarily explained by an increase in the prevalence of

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[8] Fig.3 on page 275. A few papers use the division into smaller number of groups according to the values of non-ALOS variables (Sood *et al.* 2008; McKnight 2006).

[9] *Hypothesis II* stems from the findings in Ellis and McGuire (1996) and Nawata and Kawabuchi (2012), who demonstrate larger reduction of ALOS for patients (or at hospitals) with larger pre-reform ALOS. Similarly, the argument about longer length of stay resulting from per diem rates set above marginal costs (Lave 2003; Frank and Lave 1989; Frank and Lave 1986) might offer a theoretical explanation of larger decline of ALOS for hospitals with larger pre-reform ALOS.

[10] According to MHLW (2009), there are the following patient outcomes: 1) healing (*chiyu*): there is no need in outpatient treatment after discharge; 2) improvement (*keikai*): improvement was achieved in the course of treatment. In principle, there is a need for continuous outpatient care after discharge; 3) remission (*kankai*): radical treatment (e.g., as in case of circulatory system diseases) was applied during hospital stay, and there was temporary improvement; but, there is a chance that the disease will reoccur; 4) no change (*fuhen*): no improvement was achieved in the course of the relevant treatment in hospital; 5) worsening (*dzouaku*): worsening was noticed in the course of the relevant treatment in hospital (Author's (2010) translation. Kondo and Kawabuchi (2012) use the terms cured, improved and tentatively improved for outcomes (1), (2) and (3) respectfully).

planned[11] early readmissions (Okamura *et al.* 2005) which, in turn, is caused by step-down of the per diem PPS tariff (Kondo and Kawabuchi 2012).

Arguably, hospitals in the upper percentiles of the empirical distribution of ALOS would seek to adhere to the MHLW's threshold levels (mean ALOS or mean ALOS plus 2 standard deviations) to get reimbursement according to PPS schedule. However, such hospitals might not be able to change their technology within a short period of time. As a result, these hospitals will have to readmit their patients. It should be noted that owing to high degree of trust between doctor and patient in Japan the days of treatment are negotiated (Muramatsu and Liang 1996). Owing to strong personal relation between doctor and patient, the patient would seek continuation of her care at the same hospital.[12] The decision about the planned readmission is commonly made slightly before the discharge, since hospitals can predict only a minor variation in medical costs upon patient's admission (Dranove 1987).

To sum up, *Hypothesis III* predicts that planned readmission rate within 42 days after discharge is likely to increase for Japanese hospitals in percentiles 51-100 of the empirical distribution of nationwide ALOS.

3.2 Dynamic panel data model

Owing to historical links between hospital departments and a certain medical university, and strong hierarchical relations within each department (Campbell and Ikegami 1998), our analysis assumes that a hospital strongly adheres to its practice patterns. Therefore, the value of the average length of stay (planned readmission rate) for each group of diagnoses depends

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[11] MHLW (2005) groups readmissions into planned, anticipated, and unplanned, according to their reasons. Anticipated readmissions happen in the following cases: 1) anticipated worsening of medical condition; 2) anticipated worsening of co-morbidity; 3) temporary discharge to raise patient's quality of life; 4) discharge from previous hospital stay at the patient's request; 5) other. Planned readmissions occur according to the following reasons: 1) operation after preliminary tests; 2) planned operation or procedures; 3)chemotherapy or radiation therapy; 4) planned examinations/tests; 5) examination/operation was stopped during the previous treatment, and the patient was discharged; 6) patient was sent home recuperation before an operation. The reasons for unplanned readmissions are: 1) unanticipated worsening of medical condition; 2) unanticipated worsening of co-morbidity; 3) emergence of other acute medical condition; 4) other.

[12] The phenomenon was the reason for MHLW's prohibition of planned readmissions with the same diagnosis within 3 days after patient's discharge (Nishioka 2010).

on the value of the variable in the previous period. Formally, for each MDC the analysis is based on the AR(1) specification:[13]

$$y_{it} - \mu = \beta_1(y_{i,t-1} - \mu) + \beta_2(y_{i,t-1} - \mu)\, PPS_{it} + \gamma \mathbf{X}_{it} + \nu_i + \varepsilon_{it} \qquad (1)$$

The dependent variable, y_{it}, is average length of stay or planned readmission rate. PPS_{it} is the reform dummy which equals unity if hospital *i* introduced PPS in year *t*, $\mathbf{X}_{it}$ are hospital control variables, ν_i are hospital fixed effects, ε_{it} are i.i.d. with zero mean. When included in (1) time dummies proved insignificant for most MDCs[14], therefore, they are not used in the analysis.

When μ is significant, there exists an "attraction point": the effect of the PPS reform for hospitals with the pre-reform value of y_{it} greater (smaller) than μ monotonically approaches the effect for hospitals with y_{it} equal to μ "from above" ("from below").[15] The identification condition for the AR(1) process is $0< \beta_1<1$. If an additional condition $0< \beta_1+\beta_2<1$ holds, then the "attraction point" is the same in the pre-reform and post-reform periods.

For convenience an equivalent specification is used for estimations:

$$y_{it} = \beta_0 + \beta_1 y_{i,t-1} + \beta_2 y_{i,t-1} PPS_{it} + \beta_3 PPS_{it} + \gamma \mathbf{X}_{it} + \nu_i + \varepsilon_{it} \qquad (2)$$

Here $\beta_0 = \beta_3(\beta_1 - 1)/\beta_2$ and $\mu = -\beta_3/\beta_2$. Equation (2) is estimated using Arellano-Bover (1995)/Blundell-Bond (1998) estimator,[16] with robust variance-covariance matrix (Windmeijer 2005). Since $y_{i,t-1}$ is a factor of the cross-term $y_{i,t-1}PPS_{it}$, the cross-term is treated as a predetermined variable. Owing to the voluntary participation in the PPS reform (Besstremyannaya 2012), hospital is assumed to make a decision about introducing PPS, considering the value of its ALOS in the pre-reform year. Consequently, PPS_{it} must be regarded as a predetermined variable, too. Lagged levels and lagged differences of y_{it}, PPS_{it} and $y_{i,t-1}PPS_{it}$ are used as instruments for the differenced equation. Arellano-Bond (1991) test

[13] The length of time-series does not enable the use of specifications with higher order lags.
[14] Indeed there were no significant reforms in the MHLW's PPS rate-setting in the analyzed period of time.
[15] In case of the specification with ALOS and DPC-level data, the estimated value of μ may be contrasted to the actual values of the thresholds of a piece-wise tariff.

does not reject the hypothesis about the absence of order two serial correlation in the first differenced errors.[17]

3.3 Hypotheses testing

For identification of the cross-term variables and for most consistent estimates of the dynamic panel data model the empirical analysis concentrates on the subsample of 697 hospitals with the longest pre- and post-reform time-series data available (i.e. 5 year data for July 2007-March 2012). Yet, since the rates are set on the basis of the empirical distribution for all hospitals, submitting the data to MHLW, the attribution to each 25-percentile group is conducted using the data for *all* 1648 hospitals in the first analyzed year (2007).

To test hypotheses I-III, the empirical analysis focuses at the changes in the fitted values of the dependent variable (i.e. ALOS or planned early readmission rate) in the *s* post-reform years and the pre-reform year[18] in 25-percentile groups.[19] More precisely, for each s= 1...3 let

$$\delta_{y,i,s} = \sum_{j=1}^{s} \hat{y}_{i,t+j} - \hat{y}_{i,t} \quad (3)$$

where $\hat{y}_{i,t}$ is the fitted value of the corresponding dependent variable, estimated in (2) and t=2008.

3.4 Robustness check

As robustness check of the panel data results, we measure $\delta_{y,i,s}$ by estimating cross-section analogues of equation (2) for each t = 2009 … 2011. The cross-section specifications enable taking into account time-invariant hospital characteristics in $\mathbf{X}_{it}$, which are differenced out in the analysis using dynamic panel data.

[16] More efficient than Arellano-Bond (1991) estimator.
[17] Exception is MDC14 in the estimates with ALOS and MDC6 in the estimates with planned early readmission rate.
[18] Taking the average value of the two pre-reform years (i.e. 2007 and 2008) would be desirable, yet, estimations of dynamic panel involve the first differences and does not enable obtaining the fitted value of the dependent variables in the initial year (i.e. 2007).
[19] The division into larger number of groups would decrease sample size, and albeit desirable, is inappropriate with existing hospital data.

4. Data

The analysis employs an administrative database from Japan's Ministry of Health, Labor, and Welfare (August 21, 2012) on annual hospital-MDC level aggregated information for patients, discharged in July-December 2006-2010 and July 2011-March 2012.[20] The data are voluntarily sent to MHLW by hospitals, which plan to join the PPS reform. Hospitals may join the PPS reform after the trial period (commonly after two years), may postpone the decision and keep submitting the data to the MHLW, or may choose to never join the reform and discontinue sending their data.

The annual files only allow us to retrieve the full two year pre-reform information for hospitals, which joined the PPS in 2009. Merging the MHLW's annual files by hospital name (checking for any change of name due to restructuring, mergers, and closures), we construct an unbalanced panel of 697 hospitals, which have submitted data to MHLW since 2007. Of these institutions 566 employed PPS in 2009, 33 in 2010, and 14 in 2011, while the rest remained in the FFS reimbursement system. It should be noted that 6 FFS hospitals left the database in 2008, 7 discontinued submitting the data in 2009, 14 stopped sending the data in 2010, and 2 in 2011.[21] One hospital which introduced PPS in 2009 does not have any data in subsequent years owing to hospital merger.[22]

As the MHLW's database does not provide the combination of hospital ALOS and quality by each DPC, we conduct the analysis at the level of MDCs (Hayashida *et al.* 2009; Kuwabara *et al.* 2008). It should be noted that 16 MDCs existed in Japan in the pre-2008 period. In 2008 the 16th MDC, which encompassed unclassified diseases, was subdivided into three categories: "Trauma, burns, poison" (new MDC 16); "Mental diseases and disorders'

[20] In 2002 the MHLW decided that survey data on hospital discharges are collected annually for the period from July to October. The length of period was gradually extended: July to December in each fiscal year 2006-2009; July 2010 to March 2011 in fiscal year 2010, and full fiscal year 2011 (April 2011 – March 2012). The released data for the latest rounds of MHLW's survey covers the periods of July – December in each year 2006–2010, and July 2011 – March 2012. The data exclusively for July – December 2011 (which would be a better annual subsample for comparison with the previous rounds) are unavailable.

(new MDC 17), and “Miscellaneous” (new MDC 18). Therefore, since our econometric analysis deals with data for 2007-2011, we use only 15 MDCs. Aggregating/disaggregating of certain diagnoses in Japanese MDCs, relative to ICD-10, is explained in Table I.

The dependent variables in the empirical analysis are average length of stay and prevalence of early planned readmissions (i.e. planned readmissions within 42 days after discharge). While the values of ALOS are available at the MDC level, the database reports prevalence of planned readmissions only at the hospital level. However, the MDC-level data are available for three major reasons of planned readmissions: “Operation after preliminary tests”, “Planned operation or treatment”, and “Chemical and radioactive treatment”, which account for 72-82 percent of all planned readmissions. The total number of planned readmissions is imputed for each MDC assuming that the share of these three reasons for planned readmissions is constant across all MDCs and equals to the hospital-level share.

[INSERT TABLE I HERE]

Hospital characteristics (the number of beds as hospital size and proxy for capital; the number of hospital departments as proxy for diversity; the time-invariant dichotomous variables for rural, emergency, university hospitals; for the presence of MRI or CT scanners) come from the 2011 online version of the Handbook of Hospitals (*Byouin yoran*). The data from the Japan Council for Quality Health Care (2013) enables constructing a time-varying dichotomous variable, which equals unity if the hospital is given accreditation by the beginning of the corresponding financial year.[23] The MHLW (2011a) data are employed to create a time-varying dichotomous variable with unity value for hospitals, which received the status of designated hospital (and hence, subsidy per each admission) by the beginning of the

[21] The distributions of ALOS for FFS hospitals that left the database and remained in the database are similar.
[22] In 2010 *Okaya enrei* hospital in Nagano prefecture merged with *Shiritsu Okaya* hospital.
[23] The third-party accreditation is started in Japan in 1997, and is granted to hospitals that fulfill seven standards: 1) mission, policy, organisation and planning; 2) community needs; 3) medical care and medical care support systems; 4) nursing care; 5) patient satisfaction and safety; 6) administration; 7) specific standard for rehabilitation and psychiatric hospitals (Hirose et al. 2003).

financial year. Since ownership and geographic region are shown to be a significant determinant of length of stay (Kuwabara *et al.* 2011; Kuwabara *et al.* 2006), we construct dichotomous variables for public hospitals[24] and for eight Japanese regions (Table II).

[INSERT TABLE II HERE]

The quality of the available data brings some limitations to our analysis. Firstly, we employ the MDC-level data, implicitly assuming that the composition of DPCs within each MDC is the same in all analyzed hospitals. Secondly, the fact that the Japanese DPC database contains the data only for those fee-for-service hospitals, which plan to employ PPS in the immediate future, as well as our use of a subsample of 697 hospitals (which started submitting the data since 2007) introduce a selection bias in the estimations. To correct for the bias, we employ various types of hospital control variables, which may be regarded as determinants of the length of stay. However, our analysis with percentiles of ALOS implicitly assumes that the bias is the same in each quartile. Finally, the data does not contain variables related to individual patient characteristics.

5. Empirical analysis

Average length of stay

The results of our estimates reveal that the identification condition for dynamic panel data analysis holds for the specification with the average length of stay: β_1 belongs to the interval (0,1) for the average of all MDcs and fourteen MDCs out of fifteen, and is statistically significant thirteen MDCs (in case of the analysis for the average of all MDCs and for MDC 4 the results are reported for dynamic panel with the first differences of ALOS, since the dynamic panel in levels proved to be non-stationary). The sum $\beta_1+\beta_2$ belongs to the interval (0,1) and is statistically significant for the average of all MDCs and ten MDCs. The estimated coefficient β_3 is statistically significant for the average of all MDCs and fourteen MDCs. The

[24] Public hospitals are national (kokuritsu), prefectural (kenritsu, douritsu, furitsu), city (shimin, shiritsu), town

value of the attraction point μ is statistically significant for the average of all MDCs and fourteen MDCs (Table III).

[INSERT TABLE III HERE]

The mean values of δ_{ALOS} (Table IV) are positive in percentiles 0-25 of the nationwide ALOS for eight to eleven MDC in 2009-2011/12 and for the average of all MDCs in 2010-2011/12. The positively significant values are observed for the average of all MDCs in 2010-2011/12 and for eight MDCs in 2009-2011/12. As for percentiles 51-100, the mean values of δ_{ALOS} reveal smaller decline of ALOS in higher percentiles of ALOS. Even when the mean values of δ_{ALOS} are negatively significant in percentiles 0-25, the absolute value of the decrease in ALOS is *smaller* than in percentiles 26-100.

In case of percentiles 51-100 mean values of δ_{ALOS} are negative for the average of all MDCs in 2009-2011/12, fifteen MDCs in 2009, and fourteen MDCs in 2010-2011/12. In case of percentiles 51-75, negatively significant mean δ_{ALOS} are observed for the average of all MDCs, fourteen MDCs in 2009, and thirteen MDCs in 2010-2011/12. As for percentiles 76-100, negatively significant values are found for the average of all MDCs and each MDCs in 2009-2011/12.

To test robustness of the results, we conducted cross-section calculations and discovered slightly better results: the mean values of δ_{ALOS} are positive in percentiles 0-25 ALOS for eleven MDCs in 2009-2011/12.[25] As for percentiles 51-100, δ_{ALOSs} are negative for the average of all MDCs and for fourteen to fifteen MDCs in 2009-2011/12. Overall, the evidence is consistent with *Hypothesis I* (for most MDCs hospitals in percentiles 0-25 increase their ALOS and hospitals in percentiles 51-100 decrease it) and *Hypothesis II* (larger decline of ALOS at hospitals in higher percentiles of ALOS). A failure of *Hypothesis I* for some MDCs may be explained by a large prevalence of surgical patients, for whom material costs are well-

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(chouritsu), village (sonritsu), municipal (kouritsu) hospitals, and hospitals in National Health Insurance system (kokuho) and the system for health care of workers (roudousha kenkou fukushi kikou).

covered within DPC schedule (Yasunaga et al. 2006). MDC2 “Eye system”, where non-surgical patients constitute only 5 percent (Hayashida *et al.* 2009; Kuwabara *et al.* 2008), may provide an example of such case.

[INSERT TABLE IV HERE]

The estimates of (2) with planned early readmission rate as the dependent variable (Table V) indicate that β_1 belongs to the interval (0,1) for the average of all MDCs and fourteen MDCs, and is statistically significant for the average of all MDCs and ten MDCs. The sum $\beta_1+\beta_2$ belongs to the interval (0,1) for the average of all MDCs and eleven MDCs, and is statistically significant for the average of all MDCs and eight MDCs. The attraction point, μ, exists for the average of all MDCs and for eight MDCs.

[INSERT TABLE V HERE]

The mean values of $\delta_{planned\ readmission\ rate}$ are positive in percentiles 51-75 (76-100) of the average ALOS of all MDCs in 2009-2011/12, nine (eleven) MDCs in 2009, ten (eleven) MDCs in 2010-2011/12. Significantly positive values are found for the average of all MDCs in 2009-2011/12; for five (nine) MDCs in 2009, nine (nine) MDCs in 2010, and ten (nine) MDCs in 2011/12 (Table VI). This may be interpreted as the proof of *Hypothesis III*. The results of cross-section estimations similarly indicate that *Hypothesis III* holds for the average of all MDCs and for most MDCs.

[INSERT TABLE VI HERE]

It should be noted that the MDC-level estimations for the planned early readmission rate are based on the assumption that the share of the three reasons for planned early readmission is the same for all MDCs. Justified by the desire to achieve a reasonable approximation in the absence of available data, the assumption is likely to be questionable for MDC3 “Ear, nose, mouth, and throat” and MDC12 “Female reproductive system, abnormal pregnancy” (which

[25] Negatively significant for two MDCs in 2009, three MDCs in 2010, and four MDCs in 2011/12.

would not have many planned readmissions within 42 days after discharge for the reason: "Chemical and radioactive treatment").[26] Overall, since we cannot quantitatively assess the assumption, the MDC-level results for the planned early readmission rate can only be treated as tentative.

6. Discussion

The empirical analysis in this paper confirms the adverse effects of per diem PPS with degressive rate on hospital's ALOS and quality. The hypotheses on the adverse effects are essentially built-in on the fact that there is a certain length of each period to which the degressive rates apply (Monrad Aas 1995). In other words, "the width" of the first step (i.e. period I, corresponding to the 25th percentile of the nationwide ALOS) may be longer than the ALOS at some most efficient hospitals. Therefore, the Japanese inpatient PPS makes hospitals raise their ALOS up to the end of the first period. Our finding is similar to the conclusion of Okamura *et al.* (2005) about a disincentive for a sharp decline in ALOS within the Japanese per diem tariff.

As for the planned readmission rate, the economic theory suggests that it increases when a readmitted patient has a higher revenue-to-cost margin compared with a potential patient who might have been admitted to sustain the same bed occupancy rate (Hockenberry *et al.* 2013; Kondo and Kawabuchi 2012). The estimations in the present paper may be viewed as an empirical confirmation of this assumption.

In this regard, we suggest applying the "best practice" rate-setting: decreasing the length of period I to ALOS at the best performing hospital, and establishing a flat per diem rate for all other days of treatment. Indeed, the marginal benefits of treating a patient in the periods with higher per diem rates are larger than in the potential case with a flat per diem rate. After the development of medical standardization, the measure might be applicable to Japanese

[26] This may explain the fact that the estimations with our data reveal Hypothesis 2 does not hold for MDC3, MDC4, and MDC12.

hospitals in order to alleviate the adverse effects of the reform. It should be noted that MHLW's (2012a) decrease of period I to one day for 22 DPCs with high medical costs may be regarded as a move towards the "best practice" rate-setting.

It should be noted that despite the limitations of per diem rates, a changeover to the full PPS would be a premature measure in Japan. Indeed, the failure of the per case PPS in 10 national hospitals in 1998-2004 was due to the underdeveloped standardization, when patients with different conditions were assigned the same diagnosis group (Kondo and Kawabuchi 2012). Therefore, Japan sustains the per diem character of its PPS: introduced in 2003 with the name "inclusive payment system according to diagnosis-procedure combinations", the system was renamed to "diagnosis-procedure combination/per diem payment system", or DPC/PDPS in 2010 (MHLW 2011b).

7. Conclusion

The paper demonstrates the adverse effects of prospective payment system with per diem degressive rates. The analysis with the recent data for each major diagnostic category at 697 hospitals in Japan (July 2007 – March 2012) indicates that the average length of stay significantly increases (decreases) for hospitals in percentiles 0-25 (51-100) of the pre-reform nationwide length of stay. The decline of average length of stay is larger for hospitals in higher percentiles of the pre-reform length of stay. At the same time, the planned readmission rate within 42 days after discharge rises at hospitals in percentiles 51–100 of the nationwide average length of stay. The effect may be explained by the length-of-stay dependent step-down rates in the Japanese per diem PPS.

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FIGURES AND TABLES

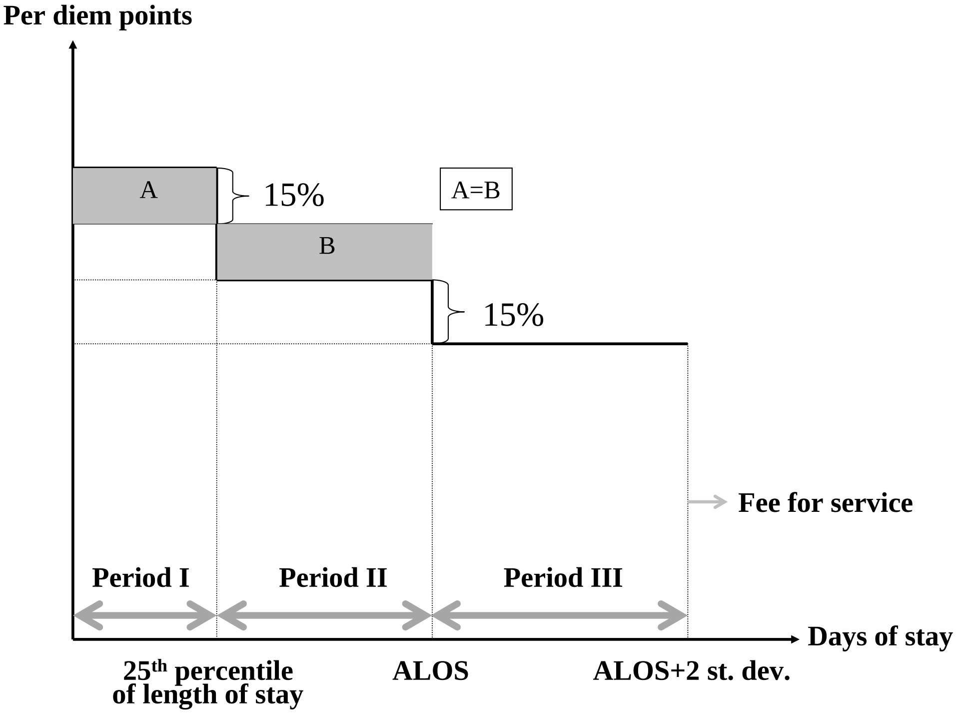

Figure 1. Step-down per diem inclusive rates for a standard DPC (Source: MHLW 2010a,b).

Table I. Average length of stay, planned early readmission rate, and patient cases in each MDC for hospitals, which introduced PPS in 2009

MDC	Definition	Hospitals					Patient cases					Average length of stay					Planned early readmission rate				
		2007	2008	2009	2010	2011/12	2007	2008	2009	2010	2011/12	2007	2008	2009	2010	2011/12	2007	2008	2009	2010	2011/12
1	Nervous system	536	538	537	539	545	80554	81310	83756	85523	128476	21.30	20.73	20.52	21.25	21.47	0.0693	0.0706	0.0733	0.0787	0.0883
2	Eye system	350	349	334	334	340	47409	47820	50548	52583	79791	6.51	6.27	5.55	5.26	5.02	0.1117	0.1117	0.1309	0.0573	0.0345
3	Ear, nose, mouth, and throat system	497	507	489	497	510	48159	47942	44328	47044	66523	8.25	8.19	7.62	7.32	7.37	0.0242	0.0196	0.0164	0.0181	0.0122
4	Respiratory system	543	544	539	547	550	151653	152654	157150	161992	257537	18.28	18.17	17.64	18.08	17.93	0.2047	0.1817	0.1819	0.2153	0.2106
5	Circulatory system	515	524	523	531	538	116850	121448	126555	128625	201674	15.67	15.71	14.79	14.98	15.14	0.1998	0.1917	0.2102	0.2626	0.2639
6	Alimentary, liver, biliary-tree, and pancreas	540	543	542	541	542	284800	301237	307766	311295	457503	15.48	14.98	13.80	13.67	13.25	0.7584	0.7796	0.7793	0.8368	0.8298
7	Musculoskeletal and connective tissue system	526	525	528	518	531	60668	64337	65715	62099	90784	21.51	21.01	19.79	19.98	19.99	0.1413	0.1463	0.1429	0.1580	0.1584
8	Skin and subcutaneous tissue	398	385	369	424	471	13409	13714	13088	18068	26553	12.51	12.55	11.90	13.19	14.03	0.0010	0.0029	0.0029	0.0105	0.0059
9	Breast system	306	306	292	296	328	14221	14342	14468	14421	20494	14.34	12.88	11.63	11.93	11.69	0.1105	0.1198	0.1061	0.1140	0.1033
10	Endocrine, nutritional, and metabolic system	532	537	525	537	542	38555	38199	36919	39978	56995	17.71	17.20	16.52	16.14	16.21	0.0145	0.0163	0.0138	0.0113	0.0119
11	Kidney, urinary tract, and male reproductive system	527	530	532	528	536	92307	94762	95942	99673	145604	15.54	15.60	14.65	14.72	14.61	0.1784	0.1687	0.1598	0.1750	0.1604
12	Female reproductive system and puerperal diseases, abnormal pregnancy, and abnormal labor	290	294	292	291	302	75637	77857	76984	79182	115559	12.35	11.53	10.97	10.96	10.82	0.2949	0.2927	0.2541	0.2708	0.2458
13	Blood and blood forming organs and immunological disorders	399	408	438	444	488	20935	22239	25638	26814	40644	24.61	23.74	23.49	23.26	23.22	0.0853	0.0795	0.0945	0.0980	0.0905
14	Newborn and other neonates, congenital anomalies	246	243	241	247	262	23835	24921	24709	26107	38720	11.43	10.64	10.69	10.39	10.16	0.0179	0.0180	0.0195	0.0215	0.0198
15	Pediatric diseases	498	492	449	475	497	27675	24867	18428	22927	34820	7.79	8.08	8.00	7.68	7.68	0.0010	0.0003	0.0007	0.0007	0.0002
16	Trauma, burns, poison		537	536	542	543		87445	88390	94220	145001		19.25	18.48	18.40	18.88		0.0308	0.0313	0.0386	0.0389
17	Mental diseases and disorders		129	96	81	117		2298	1730	1443	2341		12.76	11.97	10.78	8.64		0.0004	0.0003	0.0001	0.00002
18	Miscellaneous	560	422	447	466	494	109202	18104	20332	22692	34509	18.93	17.60	22.19	22.19	23.29	0.0664	0.0179	0.0185	0.0146	0.0121

Notes: 1) The numbers of Japanese MDCs are given as of 2008. Therefore, MDC18 (“miscellaneous”) in 2007 is equivalent to the sum of MDC16, MDC17 and MDC18 in 2008-2011. 2) The Japanese MDC6 encompasses MDC6 and MDC7 in ICD-10, MDC11 incorporates MDC11 and MDC12 in ICD-10, MDC12 combines MDC13 and MDC14 in ICD-10, MDC13 includes MDC16 and MDC17 in ICD-10. At the same time, MDC9 in ICD-10 is disaggregated into the Japanese MDC8 and MDC9. 3) The data for *Okaya Enrei* hospital are not included for the calculations in Table I. 4) English equivalents of MHLW’s MDCs (2012c) are adopted from Hayashida et al. (2009), Kuwabara *et al.* (2008) and Ishikawa *et al.* (2005). 5) 2007-2010 denote the time period July to December in each year; 2011/12 denotes July 2011 to March 2012.

Table II Descriptive statistics for the unbalanced panel in July 2007- March 2012

Variable	Definition	Obs	Mean	St Dev	Min	Max
Reform indicator						
PPS	=1 if joined inpatient PPS by corresponding financial year	3408	0.52	0.50	0	1
Hospital variables						
beds	total number of beds	3408	292.80	168.96	30	1196
departments	total number of departments	3408	15.31	6.14	1	33
urban	=1 if urban hospital	3408	0.89	0.31	0	1
public	=1 if public hospital	3408	0.28	0.45	0	1
designated	=1 if granted the status of designated local public hospital by corresponding financial year	3408	0.08	0.27	0	1
accredited	=1 if given independent accreditation by Japan Council for Quality Health Care by corresponding financial year	3408	0.62	0.49	0	1
emergency	=1 if emergency hospital	3408	0.84	0.37	0	1
university	=1 if university hospital	3408	0.02	0.13	0	1
mri/ct	=1 if has MRI or CT scanner	3408	0.93	0.25	0	1
Regional variables						
Hokkaido	=1 if Hokkaido prefecture	3408	0.07	0.26	0	1
Tohoku	=1 if Akita, Aomori, Fukushima, Iwate, Miyagi or Yamagata prefecture	3408	0.07	0.26	0	1
Kanto	=1 if Gunma, Tochigi, Ibaraki, Saitama, Tokyo, Chiba or Kanagawa prefecture	3408	0.24	0.43	0	1
Chubu	=1 if Niigata, Toyama, Ishikawa, Fukui, Yamanashi, Nagano, Gifu, Shizuoka, Aichi or Mie prefecture	3408	0.17	0.38	0	1
Kinki	=1 if Shiga, Kyoto, Osaka, Hyogo, Nara or Wakayama prefecture	3408	0.28	0.45	0	1
Chugoku	=1 if Tottori, Shimane, Okayama, Hiroshima or Yamaguchi prefecture	3408	0.07	0.26	0	1
Shikoku	=1 Tokushima, Kagawa, Ehime or Kochi prefecture	3408	0.04	0.21	0	1
Kyushu	=1 if Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, Kagoshima or Okinawa prefecture	3408	0.14	0.35	0	1

Note: Prefecture grants the status of designated hospital and financial support of 10,000 yen per each admission to local public hospital which satisfies the following requirements: 1) has over 200 beds; 2) the share of patients referred from other facilities is over 60%; 3) shares its beds and expensive equipment (e.g. MRI, CT scanner) with other hospitals; 4) educates local health care officials; 5) has emergency status.

Table III. Explaining average length of stay with dynamic panel data model

	Hospitals	β1		β2		$\beta_1 + \beta_2$		β_3		μ	
All MDCs	684	0.030	(0.091)	-0.391***	(0.097)	-0.361***	(0.030)	-1.148***	(0.290)	-2.936***	(1.146)
MDC 1	655	0.548***	(0.103)	-0.422***	(0.100)	0.126***	(0.050)	9.392***	(2.136)	22.240***	(0.589)
MDC 2	404	0.877***	(0.042)	-0.260***	(0.041)	0.617***	(0.034)	1.318***	(0.266)	5.062***	(0.349)
MDC 3	603	0.758***	(0.057)	-0.255***	(0.061)	0.503***	(0.054)	1.699***	(0.501)	6.661***	(0.561)
MDC 4	659	-0.061	(0.134)	-0.377***	(0.137)	-0.438***	(0.025)	-0.992	(0.655)	-2.630	(1.866)
MDC 5	636	0.421***	(0.064)	-0.332***	(0.062)	0.088**	(0.039)	4.826***	(0.969)	14.530***	(0.520)
MDC 6	650	0.892***	(0.060)	-0.513***	(0.060)	0.379***	(0.034)	7.163***	(0.915)	13.950***	(0.283)
MDC 7	636	0.595***	(0.081)	-0.512***	(0.079)	0.083**	(0.049)	10.05***	(1.727)	19.630***	(0.548)
MDC 8	497	0.520***	(0.123)	-0.601***	(0.125)	-0.082	(0.048)	7.510***	(1.551)	12.490***	(0.377)
MDC 9	351	0.335***	(0.075)	-0.528***	(0.080)	-0.192	(0.051)	5.619***	(1.070)	10.650***	(0.591)
MDC 10	652	0.446***	(0.092)	-0.506***	(0.097)	-0.060	(0.056)	8.177***	(1.710)	16.170***	(0.469)
MDC 11	637	0.453***	(0.090)	-0.315***	(0.084)	0.138***	(0.039)	4.086***	(1.329)	12.960***	(0.914)
MDC 12	331	0.488***	(0.085)	-0.286***	(0.088)	0.202***	(0.061)	3.359***	(0.989)	11.720***	(0.560)
MDC 13	511	0.644***	(0.074)	-0.488***	(0.063)	0.156***	(0.039)	11.86***	(1.640)	24.290***	(0.906)
MDC 14	272	0.783***	(0.070)	-0.148***	(0.050)	0.635***	(0.058)	2.096***	(0.523)	14.140***	(1.981)
MDC 15	587	0.139	(0.098)	-0.367***	(0.096)	-0.228	(0.042)	2.748***	(0.762)	7.495***	(0.328

Notes: Robust standard errors (estimated using delta-method for $\beta_1 + \beta_2$ and μ) in parentheses. * p-value <0.1, ** p-value <0.05, *** p-value<0.01

Table IV. Changes in the average length of stay for hospitals which joined PPS in 2009

	δ_1				δ_2				δ_3			
	0-25 percentile	**26-50 percentile**	**51-75 percentile**	**76-100percentile**	**0-25percentile**	**26-50percentile**	**51-75percentile**	**76-100percentile**	**0-25percentile**	**26-50percentile**	**51-75percentile**	**76-100percentile**
All MDCs	-0.169*** (0.055)	-0.387*** (0.049)	-0.783*** (0.039)	-1.123*** (0.068)	0.596*** (0.090)	-0.364*** (0.057)	-0.879*** (0.051)	-1.790*** (0.097)	0.642*** (0.098)	-0.368*** (0.063)	-0.872*** (0.057)	-1.799*** (0.103)
MDC1	0.520*** (0.047)	0.007 (0.049)	-0.218*** (0.053)	-0.902*** (0.056)	0.890*** (0.048)	0.330*** (0.050)	0.061 (0.054)	-0.579*** (0.055)	1.130*** (0.051)	0.513*** (0.053)	0.282*** (0.056)	-0.359*** (0.055)
MDC2	-0.103** (0.051)	-0.509*** (0.071)	-0.708*** (0.063)	-1.430*** (0.107)	-0.051 (0.051)	-0.588*** (0.070)	-0.869*** (0.073)	-1.744*** (0.117)	-0.103** (0.051)	-0.674*** (0.068)	-1.017*** (0.072)	-1.897*** (0.118)
MDC3	0.031 (0.056)	-0.220*** (0.078)	-0.729*** (0.070)	-1.184*** (0.152)	-0.019 (0.052)	-0.404*** (0.058)	-0.772*** (0.059)	-1.318*** (0.161)	-0.057 (0.049)	-0.453*** (0.052)	-0.862*** (0.057)	-1.384*** (0.165)
MDC4	0.021 (0.066)	-0.403*** (0.082)	-0.454*** (0.111)	-1.616*** (0.138)	0.413*** (0.079)	-0.059 (0.077)	-0.377*** (0.101)	-1.374*** (0.127)	0.579*** (0.085)	0.009 (0.077)	-0.403*** (0.100)	-1.333*** (0.125)
MDC5	0.008 (0.050)	-0.336*** (0.032)	-0.791*** (0.051)	-1.689*** (0.063)	0.174*** (0.053)	-0.186*** (0.040)	-0.650*** (0.055)	-1.556*** (0.065)	0.235*** (0.056)	-0.115*** (0.047)	-0.598*** (0.061)	-1.493*** (0.067)
MDC6	-0.400*** (0.060)	-0.971*** (0.037)	-1.269*** (0.040)	-2.000*** (0.067)	-0.481*** (0.057)	-1.061*** (0.034)	-1.382*** (0.035)	-2.176*** (0.065)	-0.571*** (0.059)	-1.185*** (0.033)	-1.526*** (0.035)	-2.369*** (0.066)
MDC7	0.428*** (0.068)	-0.623*** (0.038)	-1.290*** (0.048)	-2.627*** (0.078)	0.429*** (0.070)	-0.606*** (0.045)	-1.300*** (0.049)	-2.611*** (0.080)	0.404*** (0.063)	-0.588*** (0.051)	-1.318*** (0.052)	-2.618*** (0.082)
MDC8	0.506*** (0.062)	-0.107*** (0.044)	-0.795*** (0.062)	-2.012*** (0.112)	1.003*** (0.060)	0.470*** (0.042)	-0.212*** (0.053)	-1.375*** (0.098)	1.502*** (0.062)	0.986*** (0.048)	0.277*** (0.053)	-0.860*** (0.097)
MDC9	0.506*** (0.145)	-0.472*** (0.154)	-1.484*** (0.151)	-3.424*** (0.208)	0.520*** (0.148)	-0.433*** (0.137)	-1.326*** (0.119)	-3.129*** (0.193)	0.296** (0.150)	-0.612*** (0.139)	-1.515*** (0.121)	-3.274*** (0.191)
MDC10	0.068* (0.048)	-0.512*** (0.039)	-0.834*** (0.037)	-1.682*** (0.049)	-0.277*** (0.047)	-0.821*** (0.035)	-1.125*** (0.035)	-1.939*** (0.050)	-0.232*** (0.048)	-0.761*** (0.035)	-1.062*** (0.034)	-1.844*** (0.050)
MDC11	-0.651*** (0.044)	-0.861*** (0.059)	-1.011*** (0.043)	-1.514*** (0.063)	-0.587*** (0.043)	-0.842*** (0.059)	-0.994*** (0.043)	-1.504*** (0.063)	-0.559*** (0.044)	-0.811*** (0.061)	-0.992*** (0.047)	-1.486*** (0.061)
MDC12	-0.024 (0.034)	-0.229*** (0.029)	-0.395*** (0.039)	-0.987*** (0.075)	0.012 (0.030)	-0.230*** (0.025)	-0.420*** (0.033)	-1.025*** (0.071)	-0.084*** (0.029)	-0.320*** (0.024)	-0.525*** (0.034)	-1.138*** (0.071)
MDC13	2.429*** (0.223)	0.487** (0.253)	-1.159*** (0.203)	-3.778*** (0.261)	2.399*** (0.230)	0.450** (0.257)	-1.136*** (0.203)	-4.062*** (0.271)	2.299*** (0.237)	0.416* (0.260)	-1.210*** (0.222)	-4.151*** (0.278)
MDC14	0.567*** (0.105)	0.038 (0.137)	-0.114 (0.231)	-0.598** (0.269)	0.443*** (0.118)	-0.188* (0.115)	-0.195 (0.235)	-0.821*** (0.266)	0.352*** (0.121)	-0.175* (0.128)	-0.259 (0.230)	-0.986*** (0.273)
MDC15	0.073* (0.047)	0.025 (0.047)	-0.058* (0.041)	-0.094* (0.070)	-0.056* (0.034)	-0.153*** (0.046)	-0.172*** (0.036)	-0.273*** (0.057)	-0.121*** (0.034)	-0.184*** (0.040)	-0.185*** (0.035)	-0.300*** (0.055)

Note: Hospitals are sorted according to the value of their average length of stay in 2007. Robust standard errors (estimated in the means test against the value of zero) in parentheses.
* p-value <0.1, ** p-value <0.05, *** p-value<0.01

Table V. Explaining planned readmission rate within 42 days after discharge with dynamic panel data model

	Hospitals	β1		β2		$\beta_1 + \beta_2$		β3		μ	
All MDCs	691	0.878***	(0.051)	-0.250**	(0.099)	0.628***	(0.068)	0.013***	(0.005)	0.051***	(0.004)
MDC 1	632	0.308***	(0.081)	-0.0310	(0.076)	0.277***	(0.077)	0.007	(0.007)	0.241	(0.536)
MDC 2	399	0.301**	(0.120)	-0.280***	(0.101)	0.021	(0.062)	0.032***	(0.012)	0.115***	(0.041)
MDC 3	585	0.275***	(0.089)	-0.417***	(0.093)	-0.142	(0.037)	0.006	(0.004)	0.013**	(0.007)
MDC 4	635	0.069	(0.055)	0.0257	(0.059)	0.095**	(0.053)	-0.003	(0.013)	0.127	(0.372)
MDC 5	613	0.296***	(0.052)	-0.0298	(0.048)	0.266***	(0.056)	0.041***	(0.011)	1.381	(1.433)
MDC 6	627	0.553***	(0.070)	-0.426***	(0.070)	0.127***	(0.047)	0.343***	(0.059)	0.804***	(0.029)
MDC 7	610	0.122**	(0.061)	-0.100	(0.070)	0.022	(0.054)	0.026*	(0.014)	0.260**	(0.124)
MDC 8	486	-0.002	(0.003)	0.196	(0.282)	0.194	(0.283)	0.004*	(0.002)	-0.020	(0.033)
MDC 9	349	0.579***	(0.138)	-0.405***	(0.149)	0.174**	(0.082)	0.036***	(0.014)	0.089***	(0.019)
MDC 10	624	0.003	(0.044)	-0.165*	(0.092)	-0.161	(0.082)	0.002	(0.003)	0.013	(0.015)
MDC 11	617	0.113*	(0.067)	-0.158**	(0.073)	-0.045	(0.045)	0.028**	(0.013)	0.177***	(0.060)
MDC 12	331	0.316***	(0.050)	-0.179***	(0.060)	0.137**	(0.049)	0.018	(0.020)	0.098	(0.091)
MDC 13	505	0.167*	(0.094)	-0.049	(0.100)	0.118*	(0.070)	0.021**	(0.009)	0.435	(0.798)
MDC 14	272	0.097	(0.162)	0.377**	(0.160)	0.474***	(0.100)	-0.012***	(0.004)	0.031**	(0.018)
MDC 15	569	0.005	(0.004)	-0.363***	(0.021)	-0.359	(0.020)	0.001**	(0.0003)	0.002***	(0.001)

Notes: Robust standard errors (estimated using delta-method for $\beta_1 + \beta_2$ and μ) in parentheses. * p-value <0.1, ** p-value <0.05, *** p-value<0.01

Table 6. Changes in the prevalence of planned readmissions within 42-days after discharge for hospitals which joined PPS in 2009

	δ_1							
	0-25 percentile		26-50 percentile		51-75 percentile		76-100percentile	
All MDCs	0.0021**	(0.0013)	0.0029***	(0.0012)	0.0067***	(0.0009)	0.0052***	(0.0012)
MDC1	-0.0031	(0.0042)	-0.0030	(0.0037)	-0.0002***	(0.0036)	-0.0022	(0.0033)
MDC2	0.0109*	(0.0072)	0.0133**	(0.0066)	0.0229***	(0.0062)	0.0286***	(0.0056)
MDC3	-0.0028***	(0.0020)	-0.0034**	(0.0017)	-0.0063***	(0.0018)	-0.0100	(0.0024)
MDC4	-0.0027	(0.0022)	0.0013	(0.0025)	-0.0041***	(0.0022)	-0.0066	(0.0022)
MDC5	0.0281***	(0.0056)	0.0177***	(0.0054)	0.0156***	(0.0058)	0.0106***	(0.0041)
MDC6	0.0095*	(0.0062)	-0.0168***	(0.0039)	0.0053	(0.0049)	0.0023	(0.0047)
MDC7	-0.0084***	(0.0025)	0.0013	(0.0018)	0.0006	(0.0018)	0.0050***	(0.0013)
MDC8	0.0018***	(0.0005)	0.0019***	(0.0004)	0.0016***	(0.0005)	0.0025***	(0.0010)
MDC9	-0.0249**	(0.0115)	-0.0135**	(0.0073)	0.0019	(0.0067)	0.0114*	(0.0076)
MDC10	0.0007	(0.0010)	0.0016***	(0.0006)	-0.0014***	(0.0016)	0.0025***	(0.0005)
MDC11	-0.0155***	(0.0029)	-0.0093***	(0.0028)	-0.0042***	(0.0024)	0.0049***	(0.0019)
MDC12	-0.0450***	(0.0081)	-0.0501***	(0.0064)	-0.0437***	(0.0067)	-0.0366***	(0.0060)
MDC13	0.0185***	(0.0027)	0.0184***	(0.0021)	0.0197***	(0.0025)	0.0191***	(0.0031)
MDC14	-0.0033	(0.0037)	-0.0077***	(0.0013)	0.0111	(0.0101)	0.0030	(0.0057)
MDC15	0.0004***	(0.0001)	0.0003***	(0.0001)	0.0004***	(0.0001)	0.0004***	(0.0001)

	δ_2							
	0-25percentile		26-50percentile		51-75percentile		76-100percentile	
All MDCs	0.0022**	(0.0013)	0.0020**	(0.0012)	0.0060***	(0.0010)	0.0047***	(0.0012)
MDC1	0.0032	(0.0037)	0.0011	(0.0039)	0.0013	(0.0032)	-0.0014	(0.0027)
MDC2	-0.0213***	(0.0074)	-0.0160***	(0.0062)	-0.0110*	(0.0067)	-0.0036	(0.0058)
MDC3	-0.0034**	(0.0019)	-0.0033**	(0.0015)	-0.0071***	(0.0018)	-0.0108***	(0.0021)
MDC4	0.0091***	(0.0021)	0.0140***	(0.0026)	0.0110***	(0.0022)	0.0089***	(0.0023)
MDC5	0.0494***	(0.0051)	0.0439***	(0.0047)	0.0441***	(0.0062)	0.0380***	(0.0045)
MDC6	0.0337***	(0.0062)	0.0075**	(0.0040)	0.0295***	(0.0051)	0.0268***	(0.0050)
MDC7	0.0006	(0.0026)	0.0117***	(0.0018)	0.0106***	(0.0018)	0.0146***	(0.0013)
MDC8	0.0056***	(0.0005)	0.0057***	(0.0004)	0.0052***	(0.0005)	0.0058***	(0.0010)
MDC9	-0.0198*	(0.0129)	-0.0055	(0.0078)	0.0110*	(0.0068)	0.0293***	(0.0059)
MDC10	-0.0028***	(0.0011)	-0.0007	(0.0006)	-0.0029***	(0.0011)	0.0005	(0.0005)
MDC11	-0.0125***	(0.0029)	-0.0061**	(0.0027)	-0.0018	(0.0025)	0.0073***	(0.0018)
MDC12	-0.0421***	(0.0085)	-0.0486**	(0.0065)	-0.0380***	(0.0066)	-0.0308***	(0.0062)
MDC13	0.0212***	(0.0029)	0.0205***	(0.0021)	0.0227***	(0.0024)	0.0224***	(0.0027)
MDC14	-0.0037*	(0.0025)	-0.0065***	(0.0013)	0.0165**	(0.0092)	0.0053	(0.0050)
MDC15	0.0005***	(0.0001)	0.0005***	(0.0001)	0.0004***	(0.0001)	0.0004**	(0.0002)

	δ_3							
	0-25percentile		26-50percentile		51-75percentile		76-100percentile	
All MDCs	0.0022*	(0.0014)	0.0017	(0.0013)	0.0054***	(0.0010)	0.0048***	(0.0012)
MDC1	0.0059*	(0.0036)	0.0063*	(0.0040)	0.0060**	(0.0028)	0.0026	(0.0026)
MDC2	-0.0402***	(0.0074)	-0.0379***	(0.0066)	-0.0307***	(0.0067)	-0.0233***	(0.0058)
MDC3	-0.0046***	(0.0019)	-0.0050***	(0.0015)	-0.0087***	(0.0019)	-0.0125***	(0.0022)
MDC4	0.0111***	(0.0022)	0.0184***	(0.0028)	0.0143***	(0.0024)	0.0117***	(0.0026)
MDC5	0.0603***	(0.0053)	0.0567***	(0.0051)	0.0575***	(0.0061)	0.0499***	(0.0050)
MDC6	0.0366***	(0.0064)	0.0122***	(0.0042)	0.0333***	(0.0052)	0.0306***	(0.0051)
MDC7	0.0040*	(0.0026)	0.0146***	(0.0019)	0.0143***	(0.0018)	0.0185***	(0.0013)
MDC8	0.0070***	(0.0010)	0.0065***	(0.0005)	0.0058***	(0.0008)	0.0052***	(0.0009)
MDC9	-0.0211*	(0.0134)	-0.0073	(0.0080)	0.0094*	(0.0070)	0.0277***	(0.0060)
MDC10	-0.0038***	(0.0011)	-0.0015**	(0.0008)	-0.0027***	(0.0009)	-0.0001	(0.0005)
MDC11	-0.0161***	(0.0030)	-0.0095***	(0.0027)	-0.0047**	(0.0026)	0.0052***	(0.0019)
MDC12	-0.0452***	(0.0089)	-0.0503***	(0.0066)	-0.0378***	(0.0067)	-0.0296***	(0.0060)
MDC13	0.0206***	(0.0028)	0.0202***	(0.0021)	0.0218***	(0.0024)	0.0219***	(0.0027)
MDC14	-0.0054***	(0.0020)	-0.0063***	(0.0015)	0.0227**	(0.0107)	0.0086*	(0.0064)
MDC15	0.0004***	(0.0001)	0.0002	(0.0002)	0.0002**	(0.0001)	0.0002	(0.0002)

Note: Hospitals are sorted according to the value of their average length in 2007. Robust standard errors (estimated for t-test for comparison of mean values with zero) in parentheses. * p-value <0.1, ** p-value <0.05, *** p-value<0.01