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MEDICAL FEE REFORMS, CHANGES IN MEDICAL SUPPLY DENSITIES, AND SUPPLIER-INDUCED DEMAND: EMPIRICAL EVIDENCE FROM JAPAN*

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Abstract

This study empirically investigates whether several negative income shocks to medical suppliers lead them to provide patients with unnecessary and/or excessive treatments. We use a variable that is objectively assessed as representing inducement: the amount of fraudulent and/or incorrect claims detected during the bill inspection processes. The empirical results indicate that medical suppliers increase inducement by 7.5 percent in response to a 1 percent medical fee reduction, but that changes in medical supply densities do not affect it. We also find that medical suppliers in more competitive areas are more sensitive to medical fee reductions and that suppliers in low-density areas tend to provide inducements in response to patient shortages.

Keywords: supplier-induced demand, medical fee reforms, medical supply densities, reviews and checks of claim data, Japanese national health insurance
JEL Classification Codes: C33, C36, I18

I. *Introduction*

Supplier-induced demand (SID), which exists when a medical supplier influences a patient's demand for care against their interpretation of the best interests of the patient [McGuire (2000)], has been one of the most highly debated issues in health economics. Investigating the existence of SID will enable us to obtain vital policy implications for health

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care systems because the health care expenditure and resources used for such treatments, which do not improve patient health, are social losses. SID often occurs when a medical supplier faces negative income shocks, such as increased competition in the area or health care system reform. Many researchers have attempted to examine the existence of SID by estimating the causal effect of negative income shocks to medical suppliers on health care expenditure and medical care provision, although their findings and conclusions remain controversial[1].

However, few studies have examined the effect of those medical treatments on patient health. Labbele et al. (1994) note that seemingly unnecessary and/or excessive treatments that ultimately improve patient health outcomes should not be considered as inducements. Given this distinction, most studies do not examine the existence or effect of SID in a strict sense; rather, they investigate the medical suppliers' financial responses to negative income shocks[2].

In this study, using a variable that is objectively assessed as representing inducement in the Japanese national health insurance (NHI) system, we attempt to empirically investigate whether several negative income shocks to medical suppliers result in treatments that fail to improve patient health. In the health care system in Japan, public third-party payers and insurers assess the validity of the medical treatments that are listed in the bills they receive from medical institutions [All-Japan Federation of National Health Insurance Organizations (2009)] . If they conclude that the bills contain medically unnecessary and/or excessive treatments, the outstanding medical fees are not reimbursed. Therefore, the amount of these fraudulent and/or incorrect claims identified during the public third-party payers' review and insurers' check processes can be considered to correspond to the level of inducement. The advantage of using this variable is that it enables us to directly model and estimate the causal effect of negative income shocks on inducement. In other words, the unique characteristic of this study is that it is premised on the existence of SID, whereas most previous studies have examined the existence of SID that cannot necessarily be confirmed from data. In addition, the most common medical fee scheme in Japan is the fee-for-service reimbursement system, which is revised biennially by the central government. Therefore, it is relatively easy for medical suppliers who experience negative income shocks to provide unnecessary and/or excessive treatments[3] . Over the past dozen years, the Japanese government has implemented several health system reforms to compensate for the natural increase in health care expenditure due to aging of the population. For example, in April 2002 a medical fee reduction was implemented that was unprecedented in the history of Japanese public health insurance. In addition, a new prospective payment system in which per-day inpatient medical fees decrease depending on the length of stay was introduced for acute disorders in April 2003[4]. This system is known as the Diagnosis Procedure Combination/Per-Diem Payment System (DPC-PDPS). Moreover, the

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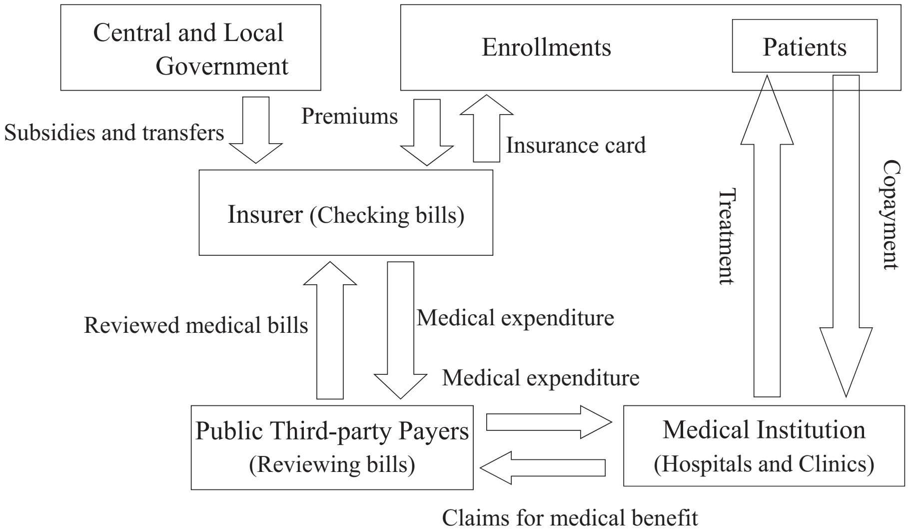
1 These studies have included, more recently, Iversen (2004), Suzuki (2005), Dafny (2005), Nawata et al. (2006), Nassiri and Rochaix (2006), Grytten and Sørensen (2007, 2008), Dumont et al. (2008), Carlsen et al. (2009), and Melichar (2009).

2 One of the reasons for the aforementioned paucity of studies is that there are few datasets that contain detailed information regarding the health status, daily activities, and demand for health care of individual patients.

3 When health care expenditures are mainly reimbursed by an inclusive payment system, medical suppliers would tend not to provide unnecessary and/or excessive treatments to patients because they would gain more profit by underproviding treatments. However, underprovision of treatments will also make the patients' health worse.

4 The number of hospitals that use the DPC-PDPS reimbursement system increased from 82 in April 2003 to 1334 in March 2010.

FIG. 1. OVERVIEW OF THE SETTLEMENT PROCESS OF MEDICAL CARE EXPENDITURE IN THE JAPANESE HEALTH INSURANCE SYSTEM



Source: Compiled by the author from the Ministry of Health, Labour and Welfare (The Ministry of Health, Labour, and Welfare, 2011).

number of hospital beds was decreased following the introduction of public long-term care insurance (LTCI) in April 2000, which addresses social hospitalization. Because these reforms reduce both physicians' incomes and hospitals' revenues, it is possible that physicians and hospitals would provide unnecessary and/or excessive treatments to compensate for the negative income shocks.

The remainder of this paper is organized as follows. Section II briefly presents the settlement process of health care expenditures in the public health insurance system in Japan. Section III presents the econometric models and strategies employed in this study. Section IV describes the dataset used. Section V presents empirical results. Section VI provides our conclusions.

II. *The Settlement Process of Health Care Expenditures in Japan*[5]

Figure 1 summarizes the settlement process of health care expenditures within the Japanese health insurance system[6]. Each time a patient receives medical treatment they pay a copayment

[5] Most of this section is derived from the All-Japan Federation of National Health Insurance Organizations (2009).

[6] The public health insurance system in Japan, which has provided universal coverage since 1961, consists of the following three broad categories for historical reasons: Health Insurance for employees and their dependents; Elderly Health Care Insurance for individuals aged 75 and over; and Japanese NHI, mostly operated by each municipality, for the remaining Japanese population. However, these three categories employ nearly identical settlement processes.

that can range from 10 to 30 percent of the medical fee. Medical institutions subsequently bill the remaining medical fees to the insurers by the 10th day of the following month. The insurers are legally allowed to commission public third-party payers to review a large number of medical bills as the insurers seldom have specialized knowledge of medical care. Each public third-party payer has a review department that includes several physicians, insurer representatives, and academics who are appointed by the prefectural governor. These committees examine the validity of the medical treatments listed in the bills from a medical perspective. The bills deemed "suspicious" are returned to the medical institutions and the "proper" bills are forwarded to the insurers. The insurers also scrutinize each reviewed bill by checking previous claims to confirm that none of the claims are fraudulent or incorrect. Finally, health insurance payments that pass the review and check processes are defrayed by the insurers to the medical institutions through the public third-party payers.

III. *The Model*

1. Theoretical Background

The model used for the empirical estimation is that of Zweifel et al. (2010). In this model, the physician provides medical services to patients who are assumed to be fully insured at the regulated unit price, p, and maximizes utility, $u(y, t, s)$, subject to two time constraints: actual working time (t, $0 \leq t \leq 1$) and working time for providing primary demand per physician and induced demand (h). t is expressed as a fraction of total available time, $t=\min[h(\delta, s), 1]$, and h is defined as $h(\delta, s)=M/\delta + s$. y is the physician's disposable income[7] and s (≥ 0) is induced demand created by each physician[8]. M is the medical demand per inhabitant. δ is physician density in an area defined as $\delta=a/n$, where a and n are the number of identical physicians and inhabitants in the area, respectively. Assuming an interior optimum with $s>0$ and $t<1$, the following induced demand function is derived from first-order conditions:

$$s=s(\delta, p, M) \qquad (1)$$

That is, the volume of induced demand is a function of the exogenous physician density, the medical fee level, and the primary demand per capita.

2. Econometric Model

Based on equation (1), using a fixed effects (FE) regression model, we specify the following induced-demand equation to examine the effects of negative income shocks on medical suppliers that are providing inducements:

$$s_{it}=\alpha_0+\alpha_1 \cdot \delta_{1,it}+\alpha_2 \cdot \delta_{2,it}+\alpha_3 \cdot p_t+\alpha_4 \cdot M_{it}+\mathbf{x}_{\mathbf{it}}'\boldsymbol{\alpha}+e_{1,i}+u_{it} \qquad (2)$$

s is the logarithm of the total amount of inducement per physician in municipal insurer i in year

[7] A physician's disposable income, y, is given as the difference between revenue, pt, and practice expenses and taxes. If practice expenses are a fixed share of revenues and taxes are progressive, y is an increasing and concave function of gross revenue : $y=y(pt)$ with $y'>0$ and $y''<0$.

[8] It is assumed that $u_y>0$, $u_{yy}<0$, $u_t<0$, $u_{tt}\leq 0$, $u_s<0$, $u_{ss}\leq 0$, $u_{yt}\leq 0$, $u_{ys}\leq 0$, and $u_{st}=0$.

t, as adjusted to 2000 prices; it is composed as follows:

$$s_{it}=\exp(s_{1,it}+s_{2,it}) \tag{3}$$

where s_1 and s_2 are the amounts of fraudulent and/or incorrect claims per physician that are found in the first review and the second check processes, respectively.

δ_1 is the physician density, which is defined as the number of physicians per 100,000 inhabitants. If medical suppliers provide unnecessary and/or excessive treatments owing to an income decline caused by more intense competition in the area, α_1 should be positive. δ_2 is the sickbed density, which is defined as the number of sickbeds per 100,000 people. If medical suppliers respond to a decline in medical profit arising from inpatient costs due to a decrease in hospital beds by providing unnecessary and/or excessive inpatient care to patients, α_2 should be negative. p is the increasing rate of medical fees for the average health insurance treatments. If medical suppliers respond to a medical fee reduction to compensate for lost income, α_3 is expected to be negative. M is the proxy for primary demand per capita; it is the consultation rate defined as the monthly average number of claims per insured individual.

$\mathbf{x}$ includes exogenous supply-side factors, fiscal factors, and other local characteristics. Supply-side factors include the employing physician ratios of hospitals and clinics. These are defined as the ratio of the total number of employing physicians to the sum of the numbers of both employing and employed physicians. Employing and employed physicians are considered to have different incentive structures [Grytten and Sørensen (2001)]: employed physicians do not have a financial incentive to induce medical care because they receive a fixed salary that is independent of their output; in contrast, employing physicians have an incentive to compensate for a decrease in income by inducing treatment. Fiscal factors include the three fiscal variables of Japanese NHI public finance: the ratio of the fiscal adjustment subsidy to revenue, the ratio of the transfer from the municipality to revenue, and the premium payment rate. The fiscal adjustment subsidy is obtained from the central government and is designed to correct fiscal disparity among municipal insurers within the Japanese NHI system. The transfer from general accounting of the municipality is used to compensate for the fiscal deficit[9]. The premium payment rate is the ratio of the total amount of collected premiums to the total settled premiums. Municipal insurers with a higher ratio of subsidies or with a lower premium payment rate have fewer independent revenue sources. It is considered that municipalities with fiscal difficulties may tend to check bills more strictly; for example, Hayashi and Kazama (2008) find that municipalities (which are also insurers of the LTCI) with fiscal difficulties tend to conduct care need assessments more strictly to reduce expenses or to alleviate financial burdens. In addition, the three fiscal variables are used to control for variations in screening rigidity among prefectures [Nihon Keizai Shinbun (2010b)]. The other local characteristics are the female population ratio, the locality-specific time trend, and prefectural dummy variables. Because females generally live longer lives than males, the coefficient on the female population ratio is expected to be positive. The prefectural dummy variables capture unobservable local

[9] In recent years, the aging population of enrolled members and the declining premium payment rate haveled to a deterioration of fiscal conditions in the Japanese NHI system. Generally, municipal insurers must raise their premiums to improve the fiscal situation. However, many insurers make transfers from municipal general accounting to the special accounting of the NHI to compensate for the fiscal deficit because residents have rebelled against rapid or excessive premium increases [Nihon Keizai Shinbun (2010a)].

characteristics, such as regional health and medical care plans[10], the border-crossing problem [Dranove and Wehner (1994)], and small area variations. e is the municipal insurer i's fixed effect and u is the disturbance term. Prefectural dummy variables and insurer fixed effects are also important for capturing other causal effects on the amount of inducement. Medical fee reduction revision is implemented to control total health care expenditure, and the Ministry of Health, Labour, and Welfare in Japan (the MHLW) may simultaneously make other revisions. For example, the MHLW may require public third-party payers and insurers to change claim details of the assessment process through the ministry ordinances (*Ryoyo-tanto-kisoku*), legal interpretations (*Gigi-kaisyaku*), or instructions (*Tsutatsu*). If this occurs, these changes will affect the volume of inducement. Because public third-party payers and municipal insurers review or check the medical claims, these effects should be partially captured by prefectural dummy variables and the insurers fixed effects.

However, many empirical studies have noted that medical supply densities are endogenous, as physicians can choose their district of residence based on the potential demand for medical care [e.g., Fuchs (1978) and Cromwell and Mitchell (1986)], and physicians or owners of medical institutions can control the number of beds. Without controlling for these effects, the estimated parameters will be biased. Thus, we specify the following density equations and apply the fixed effect instrumental variables (FEIV) regression model to control for this endogeneity problem:

$$\delta_{1,it}=\beta_0+\beta_1\cdot p_t+\mathbf{z}'_{\mathbf{it}}\boldsymbol{\beta}+e_{2,i}+v_{1,it} \quad (4)$$

$$\delta_{2,it}=\gamma_0+\gamma_1\cdot p_t+\mathbf{z}'_{\mathbf{it}}\boldsymbol{\gamma}+e_{3,i}+v_{2,it} \quad (5)$$

where $\mathbf{z}$ includes the explanatory variables that are contained in $\mathbf{x}$ and the following three instrumental variables: the elderly population (aged 65 and older) ratio, the population density, and the residential land price. In addition, it is assumed that cov $(z_k,v_1)=0$, cov $(z_k,v_2)=0$, and cov $(v_1,v_2)=0$(for $k=1, ..., K$).

IV. *Data and Empirical Strategies*

All of the variables used in this study are yearly panel data from various sources for FY 2000 to FY 2003 at the municipal insurer level. Table 1 summarizes the descriptive statistics of the major variables.

The proxy variable for inducement is obtained from two sources: *Kokuho-rengokai Shinsa Shiharai Gyoumu Toukei* (*Statistics on Medical Fee Reviews and Payment Tasks*), which is compiled by the All-Japan Federation of National Health Insurance Organization[11], and *Kokumin Kenko Hoken Jugyo Joukyo* (*Report on the National Health Insurance Activity*), which is compiled by each prefecture. The statistics from the former source contain the monthly total amount of the bill and the reimbursement, and the statistics from the latter source primarily

[10] Based on the Medical Care Law, the Ministry of Health, Labour, and Welfare in Japan defines several secondary medical zones within one prefecture, which consists of several municipalities, by considering geographical connections and traffic conditions. In each zone, patients can receive most medical treatments including primary care, surgery, and emergency medical services.

[11] These statistics were discontinued in March 2004.

TABLE 1. DESCRIPTIVE STATISTICS

Variables	Source	Mean	SD	Min	Max
Endogenous variables					
Inducement per physician(2)	[1], [2]	299.578	556.034	1.361	11506.290
Physician density	[3](3)	1.334	3.151	0.000	87.884
Bed density	[4]	11.122	27.523	0.000	810.862
Explanatory variables					
Medical fee increasing rate	[5]	2.568	4.210	−1.330	9.221
Consultation rate	[6]	0.586	0.090	0.300	0.928
Employing physician ratio (Hospital)	[3](3)	0.059	0.105	0.000	1.000
Employing physician ratio (Clinic)	[3](3)	0.707	0.294	0.000	1.000
Female population ratio	[7]	0.523	0.056	0.048	1.138
Locality-specific time trend (Total medical expenditure(2))	[6]	2173.289	7544.800	18.920	178110.400
Fiscal variables					
Ratio of fiscal adjustment subsidy to revenue	[6]	0.108	0.053	0.000	0.463
Ratio of transfer from municipality to revenue	[6]	0.069	0.027	0.012	0.253
Premium payment rate	[6]	0.946	0.034	0.776	1.000
Instrumental variables					
Elderly population ratio	[7]	0.260	0.250	0.024	7.933
Population density	[8]	8.436	13.681	0.180	215.826
Residential land price(2)	[9]	38.232	42.392	1.500	287.400
Number of observations		3676			
Number of insurers		919			

Note: (1) Sources are as follows:

[1] *Statistics on Medical Fee Reviews and Payment Tasks* (2000-2003), The All-Japan Federation of National Health Insurance Organization.

[2] *Report on the National Health Insurance Activity* (2000-2003), from each prefecture.

[3] *Survey of Physicians, Dentists and Pharmacists* (2000, 2002, 2004), the Ministry of Health, Labour and Welfare.

[4] *Survey of Medical Institutions* (2000-2003), the Ministry of Health, Labour and Welfare.

[5] *Annual Report on the Consumer Price Index* (1999-2003), the Statistics Bureau, the Ministry of Internal Affairs and Communications.

[6] *Annual Report on the National Health Insurance Activity* (2000-2003), the Ministry of Health, Labour and Welfare.

[7] *Population Directory from the Basic Resident Registers* (2000-2003), the Ministry of Internal Affairs and Communications.

[8] *Land Survey of Prefecture, Shi (city), Machi (town), and Mura (village)* (2000-2003), the Geospatial Information Authority of Japan, the Ministry of Land, Infrastructure, Transport, and Tourism.

[9] *National Land Suevey*(2000-2003), the Ministry of Land, Infrastructure, Transport, and Tourism.

(2) Ten thousand yen (in 2000 price)

(3) Numerical values except for the survey year are calculated by linear interpolation.

contain detailed summaries of the insured, the accounting settlement, and the medical care benefits. In addition, several prefectures release the results of bill inspections for every municipal insurer ($s_{2,it}$) in the latter statistics. Using these two sets of statistics, we calculate the municipal insurer *i*'s total amount of expenditure that is not reimbursed to medical institutions. Note that, because the amount of the first review is only available at the prefectural level, $s_{1,it}$ is calculated by multiplying the prefectural amount of inducement by the ratio of the total health care expenditure of municipal insurer *i* to that of the prefecture. In other words, it is assumed that the amount of inducement of municipal insurer *i* is proportional to its health care expenditure. This calculation will generate a measurement error that biases the estimates. However, given the reasonable assumption that measurement errors are not correlated with other explanatory variables, including fixed effects and disturbance terms, consistent parameters can be obtained by using the usual OLS estimation and other econometric models. Even if they are correlated, only the estimated variance increases, which does not affect the consistency of the estimated parameters [Wooldridge (2010)]. Table 2 shows inducement per physician by year, and we find that the total amount of inducement (s) in 2002 of fee reduction revision increases from the previous year. Moreover, inducement attributed to public third-party payers (s_1) also increases in 2002, whereas inducement attributed to insurers (s_2) has decreased each year.

In our empirical analysis, we not only estimate the effects of negative income shocks on the provision by medical suppliers of inducement across the entire sample, but we also investigate how those effects vary with the degree of market competition. Because inducement will occur more frequently in more competitive areas [Grytten and Sørensen (2001)], we conduct analyses that allow for different effects in high-physician-density and low-physician-density areas. A high-density area is defined as a municipality with a physician density in 2000 that exceeds the median; the remaining municipalities are included in the low-density areas. In addition, our sample includes several doctorless areas. We conduct the same analysis excluding doctorless areas; this robustness check allows for the possibility that there is a large difference in accessibility to health care and medical supply behavior between doctorless areas and other areas. In addition, we estimate clustering robust standard errors at the local secondary medical zone level to control for the correlation of error terms among municipal insurers in the same local secondary medical zone[12].

However, the following caveats should be noted. First, because analyses based on aggregated data for examining SID will give biased results [Grytten and Sørensen (2008)], interpretation of the estimation results should take heed of the potential aggregation problem. Second, owing to data limitations, the expenditure on inducement encompasses inpatient, outpatient, and dental treatments that are provided to Japanese NHI patients, and we cannot separately analyze these distinct types of treatments[13]. Third, we cannot consider other local characteristics of patients, physicians, and medical institutions due to data limitations. Fourth, this study uses a sample comprising only the Japanese NHI; enrollees in the Japanese NHI are generally older and have lower incomes than those with employee insurance. Fifth, insurers included in the sample are the 919 municipal insurers in the 14 prefectures[14] that disclose "The results of the review of medical bills" in *Kokumin Kenko Hoken Jugyo Joukyo*.

[12] See footnote 10.

[13] Factors relating to dental treatments are not considered in this study because their expenditures account for a small fraction of the total health care expenditure.

[14] Specifically, municipal insurers of the following prefectures are included in the sample: Iwate, Tochigi, Ibaraki, Chiba, Kanagawa, Toyama, Nagano, Shiga, Kyoto, Hiroshima, Saga, Nagasaki, Kumamoto, and Kagoshima.

TABLE 2. INDUCEMENT PER PHYSICIAN BY YEAR

Year	s	s_1	s_2
2000	396.450	268.147	128.303
	(687.133)	(487.376)	(285.631)
2001	269.369	142.045	127.325
	(452.899)	(265.418)	(234.332)
2002	271.935	146.831	125.104
	(550.707)	(296.870)	(288.564)
2003	265.552	147.179	118.372
	(495.075)	(240.677)	(331.500)
Total	300.827	176.051	124.776
	(556.073)	(340.954)	(286.989)

Note: (1) Ten thousand yen (in 2000 price):
(2) Standard deviations are shown in parentheses.

V. *Empirical Results*

The estimation results of the induced-demand equation are shown in Table 3[15]. Regardless of the sample, the estimation results are very similar. The results of two test statistics for the validity of the instruments indicate that they are valid: the instruments are not correlated with u_{it} and have sufficient explanatory power for medical supply densities. According to the FEIV estimation results, neither of the two medical supply densities has a significant effect on inducement. In contrast, the medical fee increase rate is found to have a notable negative effect on inducement. Specifically, medical suppliers tend to increase inducement by 7.5 percent in response to a 1 percent reduction in medical fees. The coefficient of the consultation rate is negative and statistically significant in the FE regression model, but it is not significant in the FEIV regression model. Moreover, the employing physician ratios of hospitals have a positive and significant effect on the occurrence of inducement. This result indicates that induced treatments tend to be provided in areas with higher employing physician ratios. As for the other covariates, the female population ratio and locality-specific time trend are positively significant, whereas none of the fiscal variables is significant.

Table 4 shows the results of the same estimation by physician density. The two test statistics for the validity of the instruments show that those used in the sample of the high-density areas are valid, but those used in the low-density areas are not valid. Specifically, in the results for the low-density areas, instruments are not correlated with u_{it} but do not have sufficient explanatory power for medical supply densities because the first-stage F-statistics do not exceed 10 [Stock et al. (2002)] . These results indicate that the estimates are biased; however, some Monte Carlo evidences suggest that the limited maximum likelihood (LIML) estimator performs better than the 2SLS estimators [Stock et al. (2002)]. The LIML estimation results are also shown in the columns entitled FEIV (LIML) in Table 4. If we are willing to

[15] We also estimate induced-demand equations using s_1 and s_2 as dependent variables but the results are not given in this paper because some of the R-squared values are almost zero (i.e., there are no significant coefficients in some models) and because some results of the statistical tests of validity of instruments indicate that they are invalid.

TABLE 3. EFFECT ON INDUCEMENT PER PHYSICIAN

Sample	Full sample				Without doctorless areas			
Estimation method	FE		FEIV		FE		FEIV	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Physician density	−0.026	(0.021)	0.746	(0.514)	−0.016	(0.019)	0.807	(0.530)
Hospital bed density	0.002	(0.002)	−0.084	(0.057)	0.001	(0.002)	−0.090	(0.059)
Medical fee increasing rate	−0.017**	(0.003)	−0.029**	(0.009)	−0.016**	(0.003)	−0.029**	(0.009)
Consultation rate	−1.336*	(0.554)	−1.018	(0.689)	−1.192*	(0.510)	−0.844	(0.661)
Employing physician ratio (Hospital)	0.475*	(0.207)	0.622*	(0.291)	0.492*	(0.206)	0.648*	(0.302)
Employing physician ratio (Clinic)	−0.040	(0.157)	−0.060	(0.186)	0.099	(0.114)	0.083	(0.153)
Female population ratio	1.284**	(0.050)	1.294**	(0.154)	1.289**	(0.053)	1.303**	(0.166)
Ratio of fiscal adjustment subsidy	0.450	(0.515)	0.558	(0.611)	0.537	(0.508)	0.660	(0.630)
Ratio of transfer from municipality	0.873	(0.586)	1.125	(0.707)	0.516	(0.438)	0.729	(0.607)
Premium payment rate	9.321**	(1.299)	4.508	(3.928)	9.542**	(1.236)	4.367	(3.970)
Locality-specific time trend	0.620**	(0.153)	0.520*	(0.231)	0.598**	(0.151)	0.484*	(0.242)
Number of observations	3676		3676		3632		3632	
Number of insurers	919		919		908		908	
Number of clusters	108		108		108		108	
R-squared	0.0857		0.0847		0.0718		0.0745	
Elasticity(3)								
Physician density	−0.034	(0.027)	0.995	(0.686)	−0.022	(0.026)	1.087	(0.715)
Hospital bed density	0.023	(0.025)	−0.929	(0.635)	0.012	(0.024)	−1.015	(0.663)
Medical fee increasing rate	−0.043**	(0.007)	−0.075**	(0.024)	−0.041**	(0.007)	−0.075**	(0.024)
First stage F statistics								
Physician density			F(3,107) = 152.394**				F(3,107) = 153.052**	
Hospital bed density			F(3,107) = 398.948**				F(3,107) = 407.377**	
Sargan's statistics (P-value)			$\chi^2(1)$ = 1.807 (P = 0.179)				$\chi^2(1)$ = 1.781 (P = 0.182)	

Note: (1) ** and * represent statistical significance at the 1 and 5 percent levels, respectively.
(2) Robust standard errors allowing for correlated residuals within secondary medical zones are shown in parentheses.
(3) Elasticities are evaluated at sample mean.

tolerate Wald test distortions of 15 percent and 20 percent based on the LIML estimator, we can reject the null hypothesis of weak instruments because the minimum eigenvalue statistic [Cragg and Donald (1993)] is 4.04, which exceeds the critical value of 3.81, for low-density areas; the minimum eigenvalue statistic of 3.35 also exceeds the critical value of 3.32 for low-density areas excluding doctorless areas [Stock and Yogo (2002)]. In addition, the estimated Anderson-Rubin test statistics for over-identifying restrictions are not rejected; that is, instruments in the LIML estimations are valid.

According to the FEIV regression results, neither of the two medical supply densities has any significant effect on SID in all samples. The medical fee increase rate is also found to have a negative and significant effect on inducement in high-density areas; its elasticity evaluated at the sample mean is -0.094. In low-density areas, the effect is not significant. These results imply that medical suppliers in more competitive areas are more sensitive to medical fee reductions. In addition, the coefficient of the consultation rate is negatively significant in low-density areas, which indicates that medical suppliers in those areas tend to provide inducement in order to compensate for patient shortages. As for the other independent variables, neither of the employing physician ratios has a significant effect on inducement in either sample. With regard to fiscal variables, the ratio of the transfer from municipality has a positive and significant effect on inducement in high-density areas, and the premium payment rate also has a positive and significant effect on inducement in low-density areas. However, the ratio of fiscal adjustment subsidy from the central government does not have any effect. These results imply that the difference in review rigidity depends on specific local financial conditions.

VI. *Conclusions*

In this study, we empirically investigate whether several negative income shocks to medical suppliers lead to treatments that do not improve patient health. We use a variable that is objectively assessed by public third-party payers and municipal insurers in the Japanese NHI system as representing inducement. The empirical results indicate that medical suppliers increase inducement by 7.5 percent in response to a 1 percent medical fee reduction. We also find that medical suppliers in more competitive areas are more sensitive to medical fee reductions (they increase inducement by 9.3 percent in response to a 1 percent medical fee reduction), and medical suppliers in the low-density areas increase inducement in response to patient shortages. These differences in effects by area arise from the existence of the free access system in which patients are free to choose their medical institution; that is, this system will potentially exert pressure on medical suppliers not to provide inducement because patients will not go to a physician or medical institution that has a poor reputation.

According to Labbele et al. (1994), health care expenditure and resources for induced treatments are social losses. Therefore, reducing the occurrence of inducement causes medical resources to be more efficiently utilized, and this outcome will have a positive effect on social welfare. To do this, it is highly desirable to expand the range of application of the inclusive payment system to more medical care services and to encourage more medical institutions to digitize their medical information. These reforms will reduce the occurrence of induced treatments and drive medical resources toward efficient allocation; in turn, this efficiency will contribute to improving the health care financing problem in the rapidly aging Japanese society.

TABLE 4. EFFECT ON INDUCEMENT PER PHYSICIAN BY PHYSICIAN DENSITY

Sample	High density area		Low density area			Low density area without doctorless areas		
Estimation method	FE	FEIV	FE	FEIV	FEIV (LIML)	FE	FEIV	FEIV (LIML)
Physician density	−0.007	0.768	−1.473**	−1.118	−1.164	−1.252**	−0.959	−1.028
	(0.020)	(0.400)	(0.318)	(0.848)	(0.917)	(0.286)	(0.746)	(0.848)
Hospital bed density	0.000	−0.085	−0.009	0.118	0.130	−0.012	0.098	0.118
	(0.002)	(0.044)	(0.007)	(0.106)	(0.122)	(0.008)	(0.098)	(0.123)
Medical fee increasing rate	−0.015**	−0.037**	−0.018**	−0.013*	−0.013	−0.018**	−0.013*	−0.012
	(0.004)	(0.012)	(0.003)	(0.006)	(0.007)	(0.003)	(0.006)	(0.007)
Consultation rate	−1.067	−0.193	−0.899	−1.576*	−1.599*	−0.689	−1.273	−1.315
	(0.626)	(1.009)	(0.753)	(0.782)	(0.790)	(0.653)	(0.684)	(0.704)
Employing physician ratio (Hospital)	0.580*	0.408	0.145	−0.052	−0.086	0.224	0.039	−0.018
	(0.259)	(0.563)	(0.241)	(0.533)	(0.560)	(0.241)	(0.524)	(0.578)
Employing physician ratio (Clinic)	0.170	0.055	−0.259	−0.173	−0.171	−0.065	0.018	0.021
	(0.099)	(0.181)	(0.168)	(0.187)	(0.187)	(0.122)	(0.139)	(0.139)
Female population ratio	1.319**	1.260**	1.787**	0.743	0.682	2.214**	0.767	0.599
	(0.043)	(0.173)	(0.256)	(0.786)	(0.866)	(0.228)	(1.212)	(1.442)
Ratio of fiscal adjustment subsidy	0.025	−0.348	0.588	0.542	0.526	0.864	0.779	0.750
	(0.936)	(1.117)	(0.472)	(0.536)	(0.551)	(0.495)	(0.529)	(0.550)
Ratio of transfer from municipality	2.075**	2.109*	0.031	−0.449	−0.492	−0.695	−1.206	−1.275
	(0.697)	(1.063)	(0.950)	(1.054)	(1.078)	(0.658)	(0.744)	(0.795)
Premium payment rate	12.361**	3.667	7.537**	8.676**	8.834**	7.621**	8.749**	9.007**
	(1.676)	(5.549)	(1.501)	(2.115)	(2.275)	(1.337)	(1.878)	(2.146)
Locality-specific time trend	0.773**	0.582	0.481*	0.568*	0.576*	0.437	0.495*	0.509*
	(0.263)	(0.471)	(0.241)	(0.258)	(0.262)	(0.230)	(0.244)	(0.252)
Number of observations	1836	1836	1840	1840	1840	1796	1796	1796
Number of insurers	459	459	460	460	460	449	449	449
Number of clusters	108	108	97	97	97	97	97	97
R-squared	0.0124	0.0978	0.1942	0.0003	0.0978	0.1888	0.0038	−0.025
Elasticity(3)								
Physician density	−0.014	1.634	−0.797**	−0.605	−0.630	−0.690**	−0.528	−0.566
	(0.043)	(0.852)	(0.172)	(0.459)	(0.496)	(0.157)	(0.411)	(0.467)
Hospital bed density	0.004	−1.574	−0.036	0.455	0.500	−0.048	0.387	0.464
	(0.042)	(0.816)	(0.028)	(0.406)	(0.468)	(0.030)	(0.384)	(0.485)
Medical fee increasing rate	−0.039**	−0.094**	−0.047**	−0.034*	−0.032	−0.045**	−0.033*	−0.030
	(0.009)	(0.032)	(0.008)	(0.016)	(0.017)	(0.008)	(0.015)	(0.017)

First stage F statistics	F(3,107)	F(3,96)		F(3,95)	
Physician density	217.78**	7.15**		6.67**	
Hospital bed density	517.80**	4.16**		4.45**	
ME Statistic(4)			4.043 [15: 3.81]		3.349 [20: 3.32]
Sargan's statistics (P-value)	$\chi^2(1)$ = 1.585 (P = 0.208)	$\chi^2(1)$ = 1.457 (P = 0.228)	$\chi^2(1)$ = 1.431(5) (P = 0.232)	$\chi^2(1)$ = 2.113 (P = 0.146)	$\chi^2(1)$ = 2.050(5) (P = 0.152)

Note: (1) ** and * represent statistical significance at the 1 and 5 percent levels, respectively.
(2) Robust standard errors allowing for correlated residuals within secondary medical zones are shown in parentheses.
(3) Elasticities are evaluated at sample mean.
(4) ME statistic represents "Minimum Eigenvalue Statistic (Cragg and Donald, 1993)". The critical value that tolerates a 15 and 20 relative bias in square blankets (Stock and Yogo, 2002).
(5) Anderson-Rubin likelihood-ratio test.

Finally, we summarize the limitations of this study below. As mentioned in Section IV, the data used in this study contain limited information because they are municipal insurer-level aggregated data. Second, estimates may be upwardly biased due to a sample selection bias; the prefectures that release the results of their reviews of medical bills may examine medical bills more rigorously than other prefectures. Therefore, the amount of inducement in the sample may be larger than the overall average. Third, because expenditure is defined in this study rather broadly, we cannot examine whether outpatient or inpatient treatments are easier to induce. We hope to obtain additional detailed findings that consider these factors; the solutions to these limitations represent important research challenges for future studies.

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