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Abstract:

The maternity ward closures are observing across many countries, yet little known about how the closures affect obstetrician behavior and delivery practices. The unique institutional setting in Japan, exclusion of natural delivery from public health insurance, creates a unique institutional setting for analyzing physician's delivery practices. This study analyzes the effect of hospital-based maternity ward closures on cesarean section practice and health outcomes. Using the Survey of Medical Institutions and Vital Statistics and employing a staggered difference-in-differences, we show that clinics increased the rate of cesarean section regardless of risk-factors of cesarean delivery. Moreover, this result was driven by private clinics. We interpret this result as evidence of overuse of cesarean sections that was caused by physician's profit-maximizing behavior. Our findings imply that the expansion of insurance coverage for delivery care can mitigate this unintended effect.

Keywords: Cesarean delivery, Physician-induced demand, Maternity ward closure

JEL codes: I13, I18, J1

1. Introduction

Maternity ward closures have happened in many developed countries, yet their effects on physician's practice pattern remains under-investigated. Japanese perinatal medical care outcomes are considered among the best in the world. For example, the neonatal mortality rate per 1000 lives was 0.8 in Japan in 2023, it is the third lowest in the world (World Health Organization, n.d.). On the other hand, the total fertility rate was 1.3 in Japan in 2024, the ninth lowest in the world (United Nations Population Fund, n.d.). The Japanese government is considering public health insurance to cover the cost of delivery care as a response to the low fertility rate. However, negative impacts are a concern due to this expanding insurance coverage. Healthcare professionals warn that this policy may affect the financial situation of medical institutions, accelerating the closure of maternity wards. Moreover, it is concerned that the reduction of medical institutions may affect health outcomes for mothers or infants negatively.

This paper examines the effect of hospital-based maternity ward closures on cesarean section outcomes and health outcomes. We use national datasets of medical institutions and birth. We employ staggered difference-in-difference focusing on all hospital-based maternity ward closures.

Key findings of our research are clinics increased cesarean section after the closure. However, the closure did not affect the risk-factors associated with cesarean section. This result implies the overuse of cesarean delivery. Health outcomes were not affected by the closure.

This study contributes to several strands of literature. First, this study contributes to the maternity ward closure study (Avdic, Lundborg, and Vikström 2024; Battaglia 2023; Fischer, Royer, and White 2024; Lorch et al. 2013). The literature shows inconsistent results on health outcomes. Second, this study contributes to C-section research. Several papers discuss the medically necessary cesarean section (Card, Fenizia, and Silver 2023; Currie and MacLeod 2017). These studies use data from limited regions rather than national data. And, hospital closure studies using US data cannot observe the number of cesarean deliveries by each medical institution directly (Battaglia 2023; Fischer, Royer, and White 2024). To the best of our knowledge, this is the first study to show the effect of cesarean section on physician's practice using robust empirical methods and national data.

The rest of this paper is constructed as follows. Section 2 describes the background, maternity ward closure, public health insurance, and perinatal care system. Section 3 describes the data, constructing an analytical sample. Section 4 describes the identification strategy. Section 5 describes the results. Section 6 describes heterogeneity analysis. Section 7 describes robustness checks. Lastly, section 8 is a discussion and conclusion.

2. Background

2.1. Reason for Hospital-based Maternity Ward Closure

Figure 1 shows a decline in the number of medical institutions that provide delivery care in Japan, from 3,991 in 1996 to 2,070 in 2020. This reduction has been attributed to several factors such as the decrease in the number of births and the number of physicians and midwives. The number of births fell by approximately 30 percent, from 1,206,555 in 1996 to 840,835 in 2020 (Ministry of Health, Labour, and Welfare, n.d.). However, the number of full-time physicians per medical institution increased during this period (Japan Association of Obstetricians and Gynecologists, n.d.). This suggests that the closures were mainly driven by declining fertility rates.

[Figure 1 here]

2.2. Public Health Insurance and Cost of Delivery

The Japanese government is considering that public health insurance covers the cost of delivery from April 2026. The cost of natural delivery is not covered by public health insurance in Japan. In contrast, the cost of high-risk delivery, such as cesarean section is already covered by public health insurance.

Public health insurance does not cover natural delivery, but mothers can receive the childbirth lump-sum allowance. The amount of lump-sum allowance is about 3,450 USD (1 USD = 145 JPY). This lump-sum allowance is irrelevant to the delivery type, if mothers experience a cesarean delivery, they can also receive this allowance. However, this allowance is not enough to cover the childbirth costs. For example, the average cost of delivery care is about 4,300 USD in Tokyo in 2023.

2.3. Perinatal Care System

The perinatal care system is determined by each prefecture's medical plan in Japan. The number of medical institutions is based on this medical plan. Prefectural governments decide the number of medical institutions based on the population, access to medical institutions, transportation, and other factors. Medical institutions are categorized into three levels in the perinatal care system under centralization and functional differentiation policy. Tertiary hospitals deal with high-risk pregnant women. This type of hospital has a maternal-fetal intensive care unit and neonatal intensive care units (NICU). Each medical area has one tertiary hospital. Secondary hospitals provide care for intermediate-risk pregnancies. They have NICU beds, and each medical area has several such hospitals. Primary medical institutions deal with low-risk pregnancies. Hospitals, clinics, and midwives are included in primary medical institutions. If pregnant women are diagnosed with high-risk pregnancies, doctors should transfer these patients to higher level hospitals.

Hospitals and clinics provide delivery care in Japan. A hospital is defined as the number of beds of a medical facility over 20, clinic is defined as the number of beds of a medical facility is 20 and under. The number of hospitals that provide delivery care is 963, and the number of clinics that provide delivery care is 1,107 in 2020 (Ministry of Health, Labour, and Welfare, n.d.). Additionally, both private and public medical institutions provide delivery care service in Japan.

3. Data and Sample Selection

3.1. Data

We combine several datasets to generate an analytical sample for this study. Our main datasets are birth and death records, and medical intuitions records. First, we use the "Vital Statistics" which contains all data on birth, death, and stillborn nationwide in Japan. This dataset was provided by the Ministry of Health, Labour, and Welfare from 1984 to current. We use birthweight, weeks gestation, the place of birth, twin birth, mother's birthday, and the city of residence of the child from the birth file. We use the number of stillborns from the stillborn file and the number of infant and neonatal deaths from the death file.

Second, we use the "Survey of Medical Institutions" (SMI) for identifying closure and physician's practice. SMI is conducted by the Ministry of Health, Labour, and Welfare every three years from 1984 to 2020. SMI has a medical institution's name, location, provider, department, number of staff and other related matters. We use the medical institution provides delivery care or not, the number of deliveries, the number of cesarean section (c-section), and the provider type of medical institution.

Third, we utilize the number of populations from Population, Demographic Trends, and Number of Households based on the Resident Registration System, *Jumin Kihon Daicho ni Motozuku Jinko, Jinko Dotai oyobi Setaisu* (PDHRRS). The PDHRRS is published by the

Ministry of Internal Affairs and Communications from 1996 to 2024. Additionally, we use government budget data from the cabinet office.

3.2. Constructing Sample and Identifying Closure

Closure is defined as all hospital-based maternity wards with delivery care closure in a municipality. This definition is similar to Ficher et al. (2024). Figure 2 shows inclusion and exclusion criteria and how to categorize municipalities. We excluded municipalities in the Tohoku region. Those municipalities experienced the Great East Japan Earthquake in 2011. We excluded municipalities that had no hospital-based maternity ward in 1996. We identified 656 municipalities that had one or more hospital-based obstetrics units in 1996. We categorized 656 municipalities into 6 groups, experiencing the opening of hospital-based maternity ware or not, experiencing all loss, some loss or no loss of hospital-based maternity wards. 200 municipalities experienced opening. 110 municipalities experienced some maternity ward closures. We excluded these municipalities. Finally, we identified 195 municipalities as a treatment group, and 151 municipalities as a control group. Figure 3 shows the plotting of treated and untreated municipalities. The period of the analytical sample is from 1996 to 2020.

Municipalities experienced the merger during this survey period. We assigned the municipality code of 2020 to all municipalities (Kondo 2023). Summary statistics for outcomes and covariates is in Table 1. Table 1 shows that there is no difference in share of females from 15 to 44 and fertility rate between the treated (pre-treat) and the untreated.

[Figure 2 here]

[Figure 3 here]

[Table 1 here]

4. Identification Strategy

We apply staggered difference-in-differences (DiD) to examine the effect of obstetrics unit closure. Our model is:

$$Y_{mt} = \beta_0 + \beta_1 Postclosure_{mt} + X'_{mt}\beta_2 + \lambda_m + \lambda_{pt} + \epsilon_{mt}, \quad (1)$$

where Y_{mt} is cesarean delivery and health outcomes in municipality m and survey wave t. Cesarean delivery outcomes are the rate of c-section or non-c-section delivery in municipality m and survey wave t, and the rate of c-section or non-c-section delivery at clinics in municipality m and survey wave t. The rate of c-section is defined as the number of c-section in municipality m divided by the total number of deliveries in municipality m. The rate of non-c-section is defined as the number of c-section in municipality m divided by total number of deliveries in municipality m. The rate of c-section at clinics in municipality m is defined as the number of c-section at clinics divided by the total number of deliveries at clinics in municipality m. Health outcomes are birthweight, low birthweight ratio, very low birthweight ratio, weeks gestation, infant mortality rate, neonatal mortality rate, and stillborn ratio. The birth weight and weeks gestation are the mean of each municipality. The low birthweight is the share of birthweight is less than 2,500g, and the very low birth weight is the share of birthweight is less than 1,500g. The infant mortality rate is the death of under one-year-old per 1000 lives. The neonatal mortality rate is the death of under 28 days per 1000 lives. The stillborn ratio is also per 1000 lives.

$Postclosure_{mt}$ is the variable of interest, one if the municipality m experiences that all hospital-based maternity ward closures in year t, zero if otherwise. X are time-varying covariates, the share of female aged 15 to 44 in municipality m, and per capita municipality's expenditure for health care policy. λ_m is municipality-level fixed effect. We also include λ_{pt}, prefecture-by-year fixed effects.

The concern of our identification strategy is maternity ward closure is not correlated with other unobservable time-varying factors of outcomes. This prefecture-by-year fixed effect can eliminate this concern. This is similar with previous literature (Fischer, Royer, and White 2024).

Given out estimations using a DiD approach, we also implemented an event-study to examine the common trend assumption. To implement an event-study, we estimated the equation (2) with Fixed effects:

$$Y_{mt} = \sum_{k=-5,\ k\neq -1}^{8} \alpha_k Closure_{mt} + X'_{mt}\beta_2 + \lambda_m + \lambda_{pt} + \epsilon_{mt}, \text{(2)}$$

where $\sum_{k=-5,\ k\neq -1}^{8} \alpha_k Closure_{mt}$ is a vector that contains the leads and lags of closure for a municipality *m* at time *t*. The omitted year was one year prior to the closure.

5. Result

We report the procedure outcomes and health outcomes in this section. Our study shows that the effect on the physician's practice is significant and the effect on the health outcomes are insignificant.

5.1. Physician's Practice: Cesarean section outcomes

We show the effect of hospital-based maternity ward closure on the physician's practice outcomes in Table 2. The estimated effect of hospital-based maternity ward closures on cesarean section in treated municipalities was negative, it was 3.2 percentage points. Additionally, the effect of the closures on non-c-section in treated municipalities was positive and 3.2 percentage points. Clinics increased the c-section by 2.1 percentage points and decreased the share of non-c-section by 2.1 percentage points.

We dive the mechanism of the increased c-section by clinics. This heterogeneous analysis shows the existence of physician's induce demand, "creaming" (Ellis 1998). We stratified the share of c-section and non-c-section by provider's type, private or public. The provider of private medical institutions is medical corporations or individuals, the provider of public medical institutions is national government, public medical bodies, or social insurance related organizations. We report the estimate of c-section and non-c-section delivery by private clinic. Private clinics increased the c-section by 2.1 percentage points and decreased the non-c-section by 2.1 percentage points.

Existing literature report that c-section is overused for low-risk mothers. One of reason is c-section is more profitable than other procedures. Noguchi et al. (2025) reveal the cost structure of delivery care in Japan in Table A1. The cost of c-section delivery is almost 3,500 USD and this is more than natural delivery.

[Table 2 here]

5.2. Risk Factor

The necessity of c-section is determined by pregnant women's risk-factors (Currie and MacLeod, n.d.). We checked the municipality level pregnant women's risk factors; first delivery, twin birth, mother's age, and not employed in Table 3. All variables are insignificant or negligible. First delivery increased by 0.1 pp, but this was insignificant. The effect on twin birth was insignificant and magnitude was zero. Mother's age increased by 0.4, but this was also insignificant. Not employed was significant, but magnitude is 0.1 pp. The results mean the increased share of c-section delivery is not lead by these risk-factors.

[Table 3 here]

5.3. Health Outcomes

Table 4 shows that the effect on health outcomes. We cannot observe any significant and negative impacts of closures on health outcomes. The birthweight increased by 1.490g. The rate of low birthweight and very low birthweight was not changed. The weeks gestation increased by 0.5 weeks. The infant mortality rate by 1000 births was increased by 0.032. The neonatal mortality ratio by 1000 births is also increased by 0.292. Stillborn ratio is not changed. These outcomes were statistically insignificant. Therefore, all hospital-based maternity ward closures did not affect the health outcomes.

[Table 4 here]

5.4. Event Study

We conducted event study analysis for checking the assumption of difference-in-differences using equation (2). We checked not only two-way fixed effect estimators but also alternative estimators to deal with negative weight issues in the staggered difference-in-differences approach (Goodman-Bacon 2021; De Chaisemartin and D'Haultfœuille 2020). The event study plots are in Figure 4 for c-section outcomes and Figure 5 for health outcomes. These plots show pre-trend assumption is held in this analysis.

[Figure 4 here]

[Figure 5 here]

6. Heterogeneity

We conducted heterogeneity analysis for health outcomes by mother's age. The main results show the no effect of closure on health outcomes. However, a subgroup may experience different shocks of closure.

6.1. Mother's age

Mother's age is one of risk-factor that contribute to the outcomes. We stratify the sample, the mother's age is under 25, between 25 to 34, and 35 and older. Table 5 shows most outcomes are not affected by the closure. The magnitude of birthweight varied across age categories, but these were insignificant. The rate of low birthweight and very low birthweight was not affected, these magnitudes were zero and insignificant. The effects on weeks gestation were also negligible and insignificant. The infant mortality rate per 1000 lives increased by 0.891 for mothers aged under 25, 0.085 for mothers aged between 25 and 34, but insignificant. Mothers aged 35 and over experienced a reduction of infant mortality rate by 0.539, this was also insignificant. The effect on neonatal mortality rate per 1000 lives was significant for mothers aged under 25, the rate increased by 1.159. On the other hand, the effect on the other two sub-groups was insignificant. The effect on the stillborn ratio was significant and decreased by 0.007 for mothers aged 35 and over.

[Table 5 here]

7. Robustness Check

We conducted three robustness checks, the effect of all clinic-based maternity ward closures, the effect on the number of clinics, and the specification test. These tests show the robustness of baseline results.

Our main result focuses on all hospital-based maternity ward closures. Clinics also provide delivery care for low-risk pregnant women in Japan. Therefore, we conduct the analysis using the same model with equation 1 for different closures. Identifying all clinic-based maternity ward closures is the same as the procedure for all hospital-based maternity ward closures.

Table A2 shows all clinic-based maternity ward closures did not affect c-section and non-c-section outcomes except for private hospitals. The c-section and non-c-section at treated municipalities were not changed after the closure. This is because the number of c-section deliveries by hospitals is more than that by clinics. The c-section at hospitals increased by 3.5 percentage points and non-c-section at hospitals decrease by 3.5 percentage points, but these are insignificant. The effects on c-section and non-c-section at private hospitals are significant, decreased by 6.6 percentage points and increased by 6.6 percentage points, respectively. The effects on c-section and non-c-section at public hospitals are insignificant, decreased by 3.3 percentage points and increased by 3.3 percentage points, respectively.

We checked the all-hospital based maternity wards closure on the number of clinics. If the number of clinics increased or decreased after the closures, clinics' outcome may be changed. Table A3 shows the effect on number of clinics was insignificant and decreased by 4.2 percentage points.

We conducted the specification test for covariates. We compare the model without covariates, the model with share of female aged 15-44 only, the model with log of total population. Table A 4 shows the little difference in the cesarean section outcomes across three models. The magnitude of health outcomes varies across models, but the significance is almost same. If the model includes log of total population, the effect on neonatal mortality rate was significant and increased by 0.363.

8. Conclusion

The coverage of delivery care by public health insurance is discussed in Japan. Concerns are raised about the decline in the number of medical institutions. Our study examined the effect of hospital-based maternity ward closures. We find the closures increased cesarean section by private clinics regardless of risk-factors. This result implies that "creaming" or maximizing profit by clinics. This study has limitations. First, we do not identify the hospital of birth. We cannot examine the effect of c-section on health outcomes. We cannot check the travel time to hospitals or clinics. Second, we do not assess the all-biological risks of c-section.

Our result has two policy implications. First, our study justifies the Japanese government policy change for delivery costs. If the delivery cost is covered by public health insurance, that policy mitigates the difference in incentives for medical institutions between natural birth and cesarean section. Second, centralization and differentiation policy can be improved.

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Figures and Tables

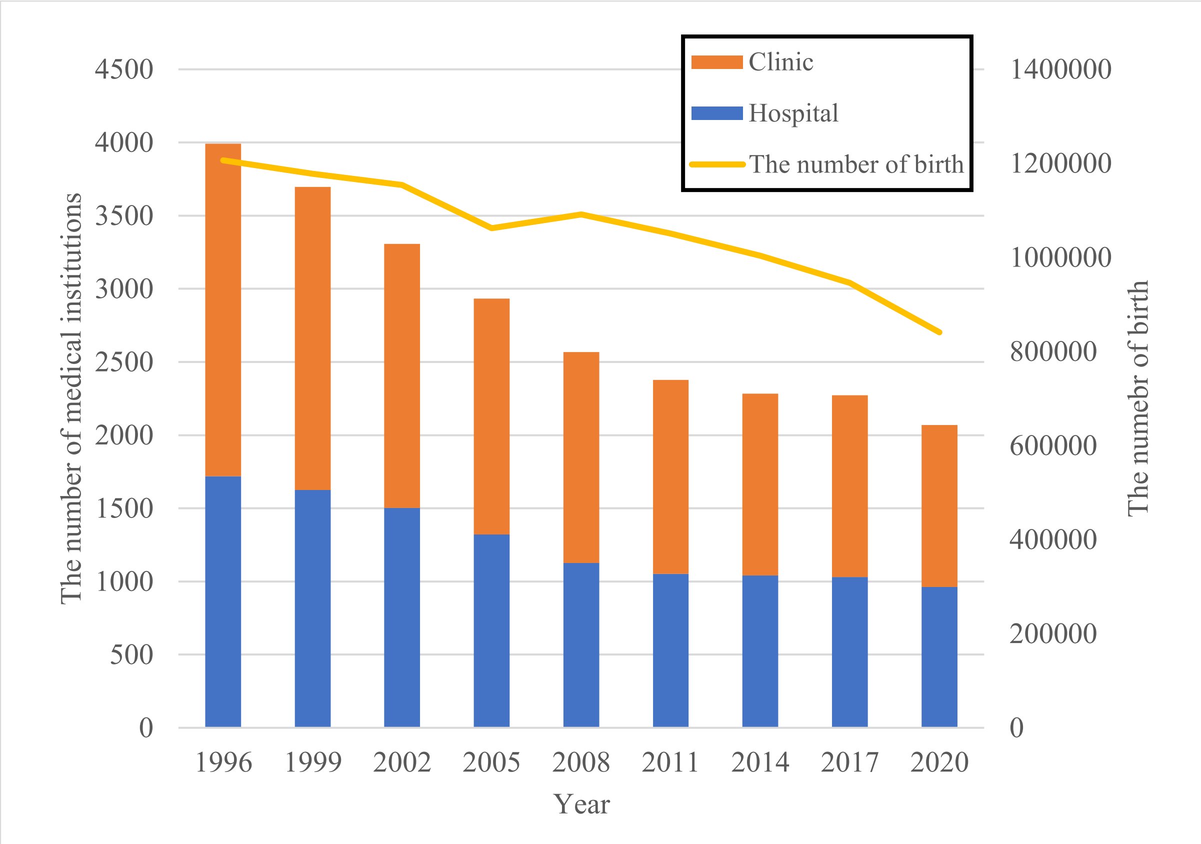
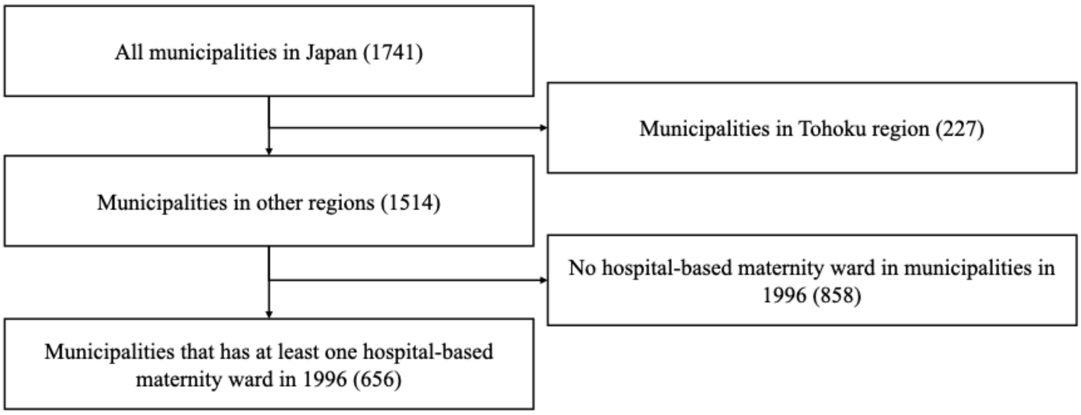


Figure 1. Trends in the number of medical institutions with delivery service and the number of births



	All wards closure	Some wards closure	No closure
Opening	Excluded (84)	Excluded (112)	Excluded (4)
No opening	Treatment (195)	Excluded (110)	Control (151)

Figure 2. Constructing the analytical sample: Identifying the municipality that experiences hospital-based obstetrics unit closure

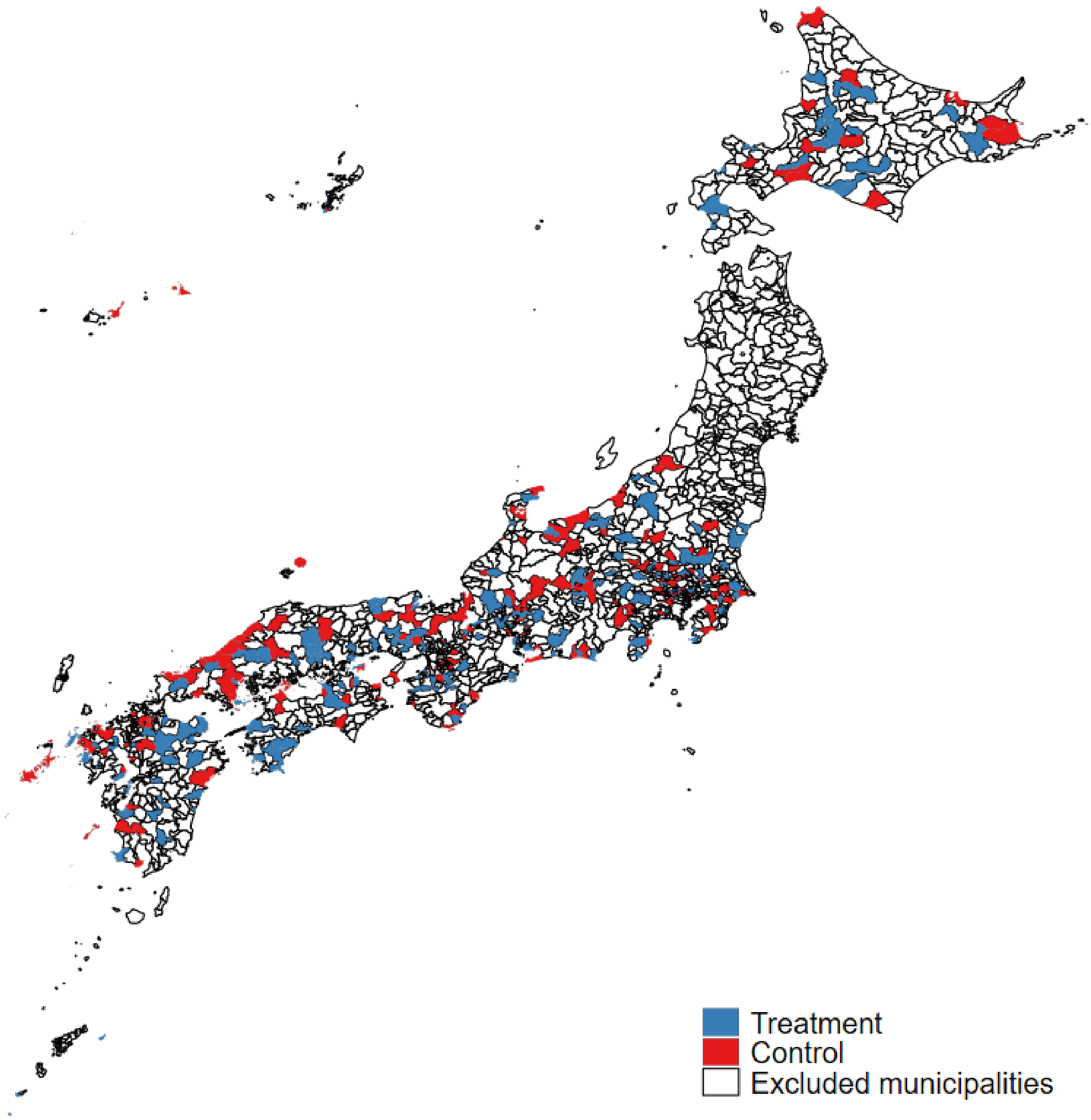


Figure 3. Treated Municipalities and Untreated Municipalities of Maternity Ward Closures

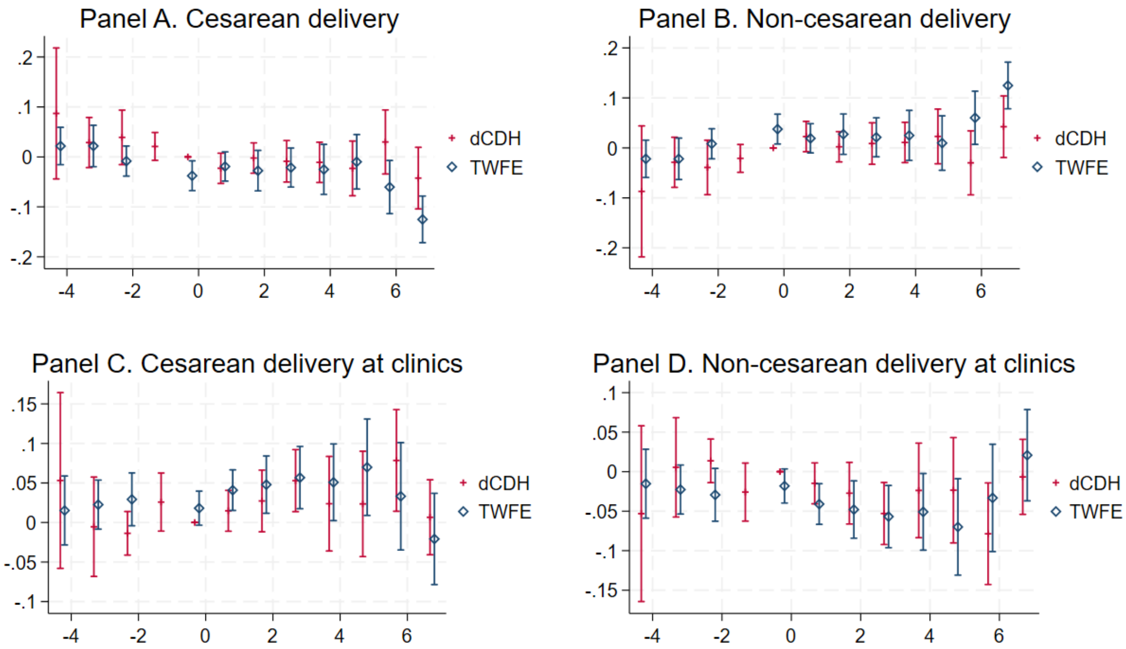


Figure 4. The event study results of closure on c-section outcomes

Notes: These estimates from equartion (2). These contains two estimators, two-way fixed effect and method by de Chaisemartin and D'Haultfoeuile (2024). TWFE refers two-way fixed effect estimators and dCDH refers method by de Chaisemartin and D'Haultfoeuile.

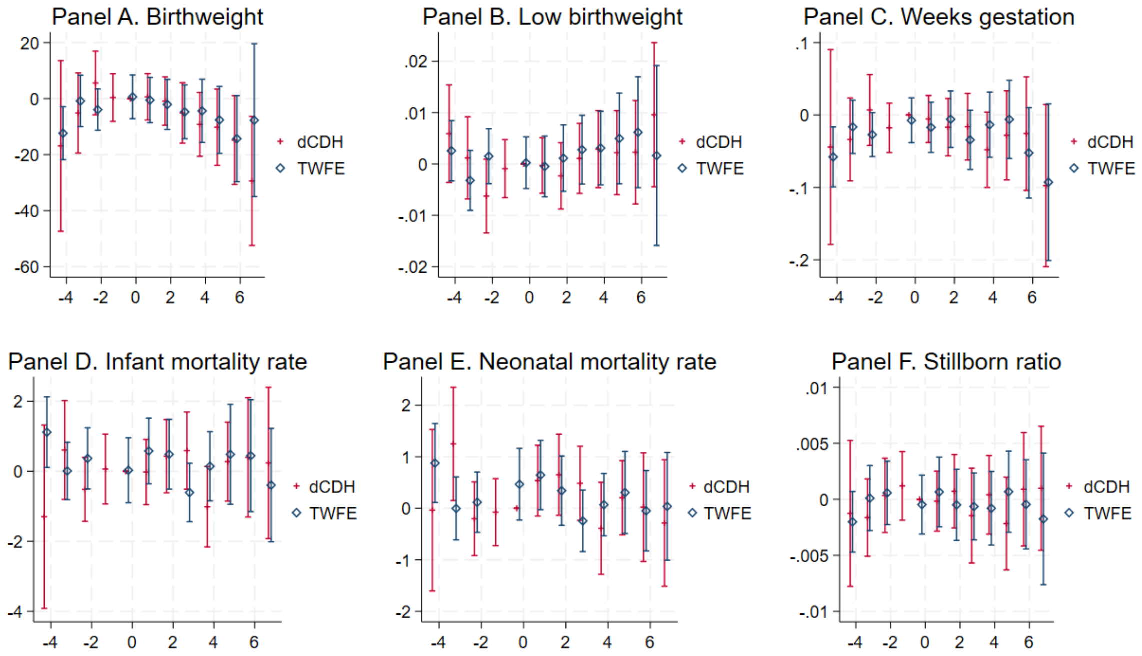


Figure 5. The event study results of closure on health outcomes

Notes: These estimates from equartion (2). These contains two estimators, two-way fixed effect and method by de Chaisemartin and D'Haultfoeuile (2024). TWFE refers two-way fixed effect estimators and dCDH refers method by de Chaisemartin and D'Haultfoeuile.

	(1) Untreated		(2) Treated (All Years)		(3) Treated (Pre)		(4) Treated (Post)	
	Mean		Mean		Mean		Mean	
Covariates								
Share female aged 15-44	0.170	(0.025)	0.159	(0.026)	0.172	(0.023)	0.149	(0.024)
Per capita health care policy expenditure	0.001	(0.001)	0.002	(0.005)	0.001	(0.002)	0.002	(0.006)
Health outcomes								
Birthweight	3020.033	(43.265)	3021.031	(50.177)	3037.917	(48.034)	3008.364	(47.989)
Low birthweight (<2500g)	0.091	(0.020)	0.091	(0.028)	0.085	(0.024)	0.095	(0.029)
Very low birthweight (<1500g)	0.007	(0.005)	0.007	(0.008)	0.007	(0.006)	0.008	(0.008)
Weeks gestation	38.784	(0.184)	38.777	(0.211)	38.850	(0.184)	38.723	(0.213)
Infant mortality ratio	2.772	(3.018)	2.594	(4.191)	3.047	(3.963)	2.253	(4.325)
Stillborn ratio	0.027	(0.011)	0.029	(0.014)	0.032	(0.013)	0.028	(0.015)
Neonatal mortality ratio	1.420	(2.146)	1.304	(3.005)	1.536	(2.797)	1.130	(3.142)
Cesarean section outcomes								
Cesarean section	0.174	(0.112)	0.154	(0.143)	0.158	(0.155)	0.145	(0.113)
Non-cesarean section	0.826	(0.112)	0.846	(0.143)	0.842	(0.155)	0.855	(0.113)
Other variables								
Fertility rate	46.526	(7.198)	44.348	(8.243)	46.965	(7.503)	42.384	(8.231)

Table 1. Summary Statistics

Notes: This table shows the summary statistics for untreated and treated municipalities. Untreated is municipalities that do not experience any openings and closures from 1996 to 2020. Column 1 is for untreated municipalities from 1996 to 2020. Treated is municipalities that experience all hospital-based maternity ward closures without opening from 1996 to 2020. Column 2 is for treated municipalities using all years, 1996 to 2020, column 3 is for treated municipalities using data until closure, column 4 is for treated municipalities using data after all closures. Standard deviation in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)
	C-section	Non-c-section	C-section at clinics	Non-csection at clinics	C-section at private clinics	Non-csection at private clnics
Post closure	-0.032**	0.032**	0.021*	-0.021*	0.021*	-0.021*
	(0.013)	(0.013)	(0.011)	(0.011)	(0.011)	(0.011)
Observations	2474	2474	1346	1346	1338	1338

Table 2. The effect of all hospital-based maternity wards closure on c-section

Notes: Columns (1)-(6) report estimates for c-section, non-c-section, c-section at clinics, non-csection at clinics, c-section at pricate clinics, and non-csection at private clinics. Covariates are share of female aged 15 to 44 and per capita health care policy expenditure by municipality. Fixed effects are municipality, time, and interaction between prefecture and time. Standard errors are clusterd at the municipality levels. C-section is cesarean delivery / total deliveries in municipality. Non-c-section is non-c-section deliveries / total deliveries in municipality. C-section at clinics is c-section delivery at clinics / total deliveries at clinics in municipality. Non-c-section at clinics is non-c-section delivery at clinics / total deliveries at clinics in municipality.

Abbreviation: C-section, cesarean section.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	(1) First delivery	(2) Twin birth	(3) Mother's age	(4) Not employed
Post closure	0.001	0.000	0.040	0.001*
	(0.003)	(0.001)	(0.029)	(0.001)
Observations	3114	3114	3114	3114

Table 3. The effect of all hospital-based maternity ward closure on risk-factors for childbirth by municipality level

Notes: Columns (1)-(4) report estimates for first delivery, twin birth mother's age, and not employed. The model is the same with equation (1). Covariates are the share of female aged 15 to 44 and per capita health care policy expenditure by municipality. Fixed effects are municipality, time, and interaction between prefecture and time. Standard errors are clustered at the municipality levels.

*p < 0.1, **p < 0.05, ***p < 0.01.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Birthweight	Low birthweight (<2500g)	Very low birthweight (<1500g)	Weeks gestation	Infant mortality rate	Neonatal mortality rate	Stillborn ratio
Post closure	1.490	0.000	0.000	0.005	0.032	0.292	-0.000
	(2.699)	(0.002)	(0.000)	(0.013)	(0.316)	(0.213)	(0.001)
Observations	3114	3114	3114	3114	3114	3114	3013

Table 4. The effect of all hospital-based maternity wards closure on health outcomes

Notes: Estimates come from the two-way fixed effects specifications. Covariates are share of female aged 15 to 44 and per capita health care policy expenditure by municipality. Fixed effects are municipality, time, and interaction between prefecture and time. Standard errors are clustered at the municipality levels.

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Birthweight	Low birthweight (<2500g)	Very low birthweight (<1500g)	Weeks gestation	Infant mortality rate	Neonatal mortality rate	Stillborn ratio
Panel A: Mother's age < 25							
Post	8.468	0.000	0.001	-0.003	0.891	1.159*	-0.002
	(6.233)	(0.004)	(0.001)	(0.024)	(0.835)	(0.647)	(0.004)
Observations	3106	3106	3106	3106	3106	3106	3009
Panel B: Mother's age from 25 to 34							
Post	1.126	-0.000	0.000	0.005	0.085	0.368	0.001
	(3.131)	(0.002)	(0.001)	(0.014)	(0.344)	(0.243)	(0.001)
Observations	3116	3116	3116	3116	3116	3116	3013
Panel C: Mother's age 35 & over							
Post	-2.223	-0.000	-0.001	0.045	-0.539	-0.773	-0.007*
	(6.839)	(0.004)	(0.001)	(0.029)	(0.733)	(0.619)	(0.004)
Observations	3115	3115	3115	3115	3115	3115	3012

Table 5. The effect of all hospital-based maternity ward closures on health outcomes by mother's age

Notes: Estimates come from the two-way fixed effects specifications. Covariates are share of female aged 15 to 44 and per capita health care policy expenditure by municipality. Fixed effects are municipality, time, and interaction between prefecture and time. Standard errors are clustered at the municipality levels.

*p < 0.1, **p < 0.05, ***p < 0.01.

Appendix

		Cesarean delivery			Other delivery		
		Primipara	Multipara	Total	Primipara	Multipara	Total
Admission charges	Observations	5	2	7	283	374	662
	Mean	1,272	579	1,074	872	815	838
	Standard deviation	1,387	146	1,183	441	581	525
Extra room charges	Observations	10	17	27	119	91	212
	Mean	616	380	468	257	258	258
	Standard deviation	606	296	441	165	173	168
Obstetric labor support fee	Observations	20	22	42	81	47	128
	Mean	1,764	1,531	1,641	1,741	1,724	1,735
	Standard deviation	532	610	579	500	611	541
Obstetric labor fee	Observations	2	1	3	221	363	590
	Mean	1,807	1,607	1,740	1,977	1,987	1,980
	Standard deviation	176	.	170	556	506	527
Newborn baby care fee	Observations	17	18	35	275	379	660
	Mean	649	508	576	398	373	383
	Standard deviation	259	263	267	165	160	162
Examinations and Medications	Observations	13	12	25	260	293	558
	Mean	197	96	148	119	108	112
	Standard deviation	228	92	180	111	106	108
Medical treatment	Observations	7	11	18	227	302	534
	Mean	141	185	167	179	227	206
	Standard deviation	175	249	219	141	199	177
Premium on obstetric compensation system for cerebral palsy	Observations	21	23	44	304	403	713
	Mean	87	84	85	83	83	83
	Standard deviation	18	6	13	5	4	4
Other	Observations	20	22	42	297	388	691
	Mean	185	325	258	241	228	233
	Standard deviation	179	415	328	237	201	217
Partial payment and others	Observations	19	22	41	110	78	189
	Mean	700	559	624	211	124	174
	Standard deviation	447	434	440	265	159	230
Total cost for pregnant women	Observations	20	22	42	295	390	690
	Mean	4,089	3,015	3,526	3,480	3,248	3,349

	Standard deviation	1,545	1,568	1,631	1,177	1,212	1,198
	Observations	19	23	42	224	226	452
Proxy receipt amount	Mean	3,161	2,965	3,053	3,388	3,365	3,370
	Standard deviation	401	662	562	198	324	304

Table A1. The cost structure of delivery care in Japan

Notes: This table is adapted from Noguchi (2025). The original version is in Japanese. The information on painless delivery is excluded from the original table. Mean and standard deviation are reported in USD (1 USD = 145 Japanese yen).

	(1) C-section	(2) Non-c-section	(3) C-section at hospitals	(4) Non-c-section at hospitals	(5) C-section at private hospitals	(6) Non-csection hospitals at private hospitals	(7) C-section at public hospitals	(8) Non-c-section at public hospitals
Post closure	-0.007	0.007	-0.035	0.035	-0.066*	0.066*	-0.033	0.033
	(0.019)	(0.019)	(0.022)	(0.022)	(0.033)	(0.033)	(0.029)	(0.029)
Observations	1315	1315	763	763	159	159	509	509

Table A2. The effect of all clinic-based maternity wards closure on c-section outcomes

Notes: Estimates come from the two-way fixed effects specifications. Covariates are share of female aged 15 to 44 and per capita health care policy expenditure by municipality. Fixed effects are municipality, time, and interaction between prefecture and time. Standard errors are clustered at the municipality levels.

*p < 0.1, **p < 0.05, ***p < 0.01.

	Number of clinics
Post closure	-0.042
	(0.036)
Observations	2768

Table A3. The effect of all hospital-based maternity wards closure on the number of clinics

Notes: Estimates come from the two-way fixed effects specifications. Covariates are share of female aged 15 to 44 and per capita health care policy expenditure by municipality. Fixed effects are municipality, prefecture-by-time fixed effects. Standard errors are clustered at the municipality levels.

*p < 0.1, **p < 0.05, ***p < 0.01.

	(1)		(2)		(3)	
Birthweight	1.294	(2.689)	1.454	(2.704)	1.984	(2.720)
Observations	3114		3114		3114	
Low birthweight	0.001	(0.002)	0.000	(0.002)	0.000	(0.002)
Observations	3114		3114		3114	
Very low birthweight	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Observations	3114		3114		3114	
Weeks gestation	0.004	(0.013)	0.004	(0.013)	0.003	(0.013)
Observations	3114		3114		3114	
Infant mortality rate	0.017	(0.313)	0.033	(0.317)	0.083	(0.304)
Observations	3114		3114		3114	
Stillborn ratio	0.000	(0.001)	0.000	(0.001)	-0.000	(0.001)
Observations	3013		3013		3013	
Neonatal mortality rate	0.293	(0.209)	0.291	(0.212)	0.363*	(0.211)
Observations	3114		3114		3114	
C-section at clinics	0.021*	(0.011)	0.021*	(0.012)	0.022*	(0.011)
Observations	1346		1346		1346	
Non-c-section at clinics	-0.021*	(0.011)	-0.021*	(0.012)	-0.022*	(0.011)
Observations	1346		1346		1346	
C-section at private clinics	0.021*	(0.011)	0.020*	(0.012)	0.021*	(0.011)
Observations	1338		1338		1338	
Non-c-section at private clinics	-0.021*	(0.011)	-0.020*	(0.012)	-0.021*	(0.011)
Observations	1338		1338		1338	
Share of female aged 15-44	-		X		-	
Log of total population	-		-		X	

Table A 4. Specification test

Notes: Column 1 includes no covariates. Column 2 includes share of female aged 15-44. Column 3 includes log of total population. Fixed effects are municipality, time, and interaction between prefecture and time. Standard errors are clustered at the municipality levels.

*p < 0.1, **p < 0.05, ***p < 0.01.