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What the COVID-19 School Closure Left in its Wake: Evidence from a Regression Discontinuity Analysis in Japan

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ABSTRACT

To control the spread of COVID-19, the national government of Japan abruptly started the closure of elementary schools on March 2, 2020, but preschools were exempted from this nationwide school closure. Taking advantage of this natural experiment, we examined how the proactive closure of elementary schools affected various outcomes related to children and family well-being. To identify the causal effects of the school closure, we exploited the discontinuity in the probability of going to school at a certain threshold of age in months and conducted fuzzy regression discontinuity analyses. The data are from a large-scale online survey of mothers whose firstborn children were aged 4 to 10 years. The results revealed a large increase in children's weight and in mothers' anxiety over how to raise their children. On the outcomes related to marital relationships, such as the incidence of domestic violence and the quality of marriage, we did not find statistically significant changes. These findings together suggest that school closures could have large unintended detrimental effects on non-academic outcomes among children.

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BACKGROUND

- To control the spread of COVID-19, the Japanese government suddenly closed schools on March 2, 2020.
- A sharp increase in the number of Google searches for the word "divorce" on March 2.



MOTIVATION & RESEARCH QUESTION

Marital relationships can affect parents and children in many ways.

Therefore, it is necessary to comprehensively investigate the impact of school closure on family well-being.

RESEARCH QUESTION

How did the school closure affect various outcomes related to children and family well-being?

KEY IDEA

• The Japanese government closed elementary schools in March 2020 yet exempted preschools. In this case:

The first graders in elementary school born in March, who are the youngest within the same school grade, experienced school closure in March.

In contrast, children born in April, who are the eldest preschoolers, did not experience school closure in March because preschools were generally open at that time.

This enables us to compare the two groups of children and parents who are faced with totally different school closure situations in March even with only a very small different in the timing of the children's birth.

KEY IDEA (CONTINUED)

- Due to this small difference in birth timing, these children and their families are likely to:
 - 1. Have similar characteristics.
 - 2. Experience a similar threat caused by the spread of COVID-19.
 - 3. Be exposed to other policies such as requests for physical distancing similarly.

However,

- These two groups faced totally different school closure situations in March.
- Thus, by comparing these two groups, we can identity the pure impact of school closure <u>in</u> <u>March</u>.

EXISTING STUDY

- There has been no (or few) study that estimates impacts of school closure on various outcomes related to children and family well-being comprehensively.
- Effects of school closure on child maltreatment (Baron et al., 2020) (US)
- There are many studies that explore how lockdown affects the incidence of domestic violence (DV), as a prominent outcome that affects families (Piquero et al., 2020; Sanga and McCrary, 2020; Leslie and Wilson, 2020; Mohler et al., 2020; Campedelli et al., 2020; Payne and Morgan, 2020; Baron et al., 2020).

PROBLEM IN ESTIMATING THE EFFECTS OF SCHOOL CLOSURE

- However, even with so much effort, it may be potentially impossible to identify the effects of school closures specifically in the countries that enforced a lockdown, because, in these countries, schools were closed jointly with the implementation of numerous other kinds of anti-COVID-19 policies.
- Therefore, it still remains a challenge for researchers to isolate the effects of "school closure" from those of other anti-COVID-19 policies.

WHY JAPAN?

- During the school closure period, other anti-COVID-19 policies with heavy restrictions (such as lockdown) were not implemented in Japan (unlike other countries).
 This makes it possible to separate the effects of school closure from the effects of other anti-COVID-19 policies.
- The Japanese government closed elementary schools in March 2020 yet exempted preschools.

This enables us to compare the two groups who faced totally different school closure situations even with only a very small difference in the timing of the children's birth.

By comparing these two groups, we can identify the pure impact of school closure.

CONTRIBUTIONS

Utilizing the experience of school closure in Japan, this study successfully estimates the pure impacts of school closure on the well-being of families comprehensively.

We implemented a large-scale online survey in a timely manner. Furthermore, by creating an original questionnaire covering almost all the potential impacts of school closure on families.



As we will see in the conclusion section, the results we have obtained yielded very important policy implications.

DATA

- Internet-survey company (Cross Marketing, Inc.)
- Survey Period : July 22, 2020 August 19, 2020.
- Requirements of Sample: Married women whose co-resident firstborn child was born between April 2, 2010 and April 2, 2016, which roughly corresponds to 4–10 years old.

Implementation

- 1. We sent out invitations to our survey to 44,218 women.
- 2. Among them, 22,553 mothers responded to our invitations and satisfied the requirements of the sample.
- 3. We also included a question asking about their willingness to participate in the main survey after having explained that the main survey includes some sensitive questions such as inquiring about their mental health and the marital relationship. Through this question, 17,860 mothers eventually agreed to move on to our main survey.
- 4. Ultimately, 15,836 mothers answered all the necessary questions.

OUTCOMES IN OUR STUDY

Changes Related to Children & Parents Caused by the COVID-19 Outbreak

Many yes-or-no questions about the changes in the respondent and her family members due to the COVID-19 outbreak.

「コロナ禍に伴う変化として該当するものをお選びください。」という質問項目。休校前後の変化に注目。

⇒レベルの差はコントロール済み (Differenced RDD) ⇒こうすることで、早生まれの差や、ここ1年間の過ごし方、親の生み分けに関わる社会的地位の 閾値周りでの差なども関係なくなる。

Domestic Violence

10 questions on DVs (i.e., 5 types and who did it). We also asked the frequency of the type of DV using the following three categories (i.e., 1. Never, 2. Sometimes, and 3. Frequently).

Satisfaction with Marriage

"'Are you satisfied with marital life?" with a 5-point Likert-type scale ranging from 1 for "not at all" to 5 for "very satisfied.".

Risk of Divorce

1. quarrel, 2. discussion of divorce with the spouse, 3. self-thinking of divorce, and 4. proposal of divorce from husband. The frequency of each item was evaluated on a 5-point Likert-type scale, ranging from "usually" for 5 to "none" for 1.

Quality of Marriage Index (QMI)

Moroi (1996)'s marital quality (Japanese version of Norton (1983)'s QMI) scale consists of six items regarding marital life, and each question was answered on a 4-point scale.

DESCRIPTIVE STATISTICS

- To check the representativeness of the respondents in our survey, we utilized J-SHINE that asks about the incidence of DVs and also includes other basic variables common to our covariates.
- We do not see any large difference between our data and J-SHINE in most of the mean values of basic covariates as well as the incidence of physical DVs.

This supports that our survey did not pick up a very specific population in terms of marital quality and family environment related to children.

	Our Su	irvey	J-SH	J-SHINE		
	Mean	S.D.	Mean	S.D.		
	(1)	(2)	(3)	(4)		
Basic Characteristics						
Age	37.31	5.25	36.97	4.72		
Number of Children	1.89	0.71	1.88	0.73		
Firstborn Child Is a Girl	0.49	0.50	0.50	0.50		
4-Year College Graduates: Mother	0.40	0.49	0.28	0.45		
4-Year College Graduates: Father	0.47	0.50	0.54	0.50		
Working (Mother)	0.55	0.50	0.48	0.50		
Regular Worker (Mother)	0.20	0.40	0.14	0.35		
Domestic Violence						
More than once $= 1$						
Physical DV	0.30	0.96	0.26	0.75		
Physical DV by Wife	0.15	0.49	0.14	0.45		
Physical DV by Husband	0.15	0.50	0.12	0.42		
Frequently = 1						
Physical DV	0.11	0.59	0.14	0.59		
Physical DV by Wife	0.05	0.30	0.06	0.32		
Physical DV by Husband	0.05	0.31	0.08	0.35		
N	15,836		746			

IMPACT OF SCHOOL CLOSURE ON "NON-SCHOOLING"

- The cutoff value 89 corresponds to the age-in-months (evaluated in August 2020) for children to move from preschool to elementary school.
- We utilize the increase in the probability of "non-schooling" at the threshold to identify the effects of schooling.



(b) Impacts on Probability of "Non-Schooling"



KEY ASSUMPTION FOR REGRESSION DISCONTINUITY DESIGN (RDD)

(b) Impacts on Probability of "Non-Schooling"



All factors other than the probability of going to school should be <u>continuous</u> at the threshold. If this is satisfied, the discontinuity in y (outcome) at the threshold should be caused by the discontinuity in the prob. of going to school.

CHECKS FOR CONTINUITY ASSUMPTION

(a) Number of Children



(c) 4-Year College Graduates





(d) Support from Grandparents Available (As of Feb.)



CHECKS FOR CONTINUITY ASSUMPTION (FOR OBSERVABLES)

(e) Regular Worker (As of Feb. 2020)

(f) Not Working (As of Feb.2020)



There is no discontinuity at the threshold for observable characteristics ! →Continuity assumption is satisfied for observable characteristics !

CHECKS FOR CONTINUITY ASSUMPTION (FOR UNOBSERVABLES)

Sample drops at the sensitive question are more likely to occur for mothers who experienced the school closure in March? \rightarrow We do not observe such a trend. (There is no statistically significant gap in the sample drop rate at the threshold.)

Figure B2: Check for Continuity in Sample Drop



This suggests continuity assumption is satisfied for unobservable factors as well.

"Continuity assumption" is satisfied for both observable and unobservable factors

The gap in the prob. of "Non-Schooling"

Outcome

FUZZY RDD

ŝ





The prob. of "Non-Schooling"个 by 0.623

Outcome increases by **B**

However, what we want to know is by how much the outcome would change if the probability of "Non-Schooling" increased from 0 to 1 at the threshold because that should be the exact effect of school closure.

At the threshold of 89, The prob. of "Non-Schooling"个 by 1



Outcome would increase by **β/0.623**

LOCAL LINEAR REGRESSION

- Idea: Estimate the linear model just around the cutoff value
- $89 b \le m \le 89 + b$



By doing so. . .

- We can estimate the local effect without being affected by data far away from the cutoff point.
- Even when the true function is not linear, the regression lines within the bins around the cutoff point can be close to linear.
- Local linear regressions provide a nonparametric way to consistently estimate the treatment effect in an RD design.

BANDWIDTH CHOICE

Trade-off

- Using a larger bandwidth yields more precise estimates as more observations are available to estimate the regression.
- If the true model is not linear, the linear specification is less likely to be accurate when a larger bandwidth is used, which can bias the estimate of the treatment effect.

Need to choose the optimal bandwidth.

In the main analysis, CCT bandwidth selector proposed by Calonico, Cattaneo, and Titiunik (2014) is used to calculate the optimal bandwidth. (MSE-optimal bandwidth choice)

In the robustness check, we use CCF bandwidth selector proposed by Calonico,Cattaneo, and Farrell (2018). This focuses on delivering confidence intervals with optimal coverage error rates (CER). (CER-optimal bandwidth choice)

EMPIRICAL RESULTS RELATED TO CHILDREN

AGAIN:「コロナ禍に伴う変化として該当するものをお選びください。」という質問項目。休校 前後の変化に注目。プラス、前の年の平時のことも聞き、断層はないことを確認。 ⇒レベルの差はコントロール済み (Differenced RDD) ⇒こうすることで、早生まれの差や、ここ1年間の過ごし方、親の生み分けに関わる社会的 地位の閾値周りでの差なども関係なくなる。(注:そもそもレベルでもObservable, Unobservableの両方に差はなかったことに注意。)



EMPIRICAL RESULTS RELATED TO CHILDREN (CONTINUED)



EMPIRICAL RESULTS RELATED TO CHILDREN (CONTINUED)

Table 2

RD estimates for the impact of school closures on variables related to children.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
		Sharp (Reduced Form)		Fuzzy (IV)					
Dependent Variable: 1 (Yes) or 0 (No)	Mean of Dep. Var.	Conventional	Bias-corrected	Conventional	Bias-corrected	Optimal Bandwidth	Ν		
My child gained weight									
	0.151	0.092***	0.096***	0.144***	0.154***	11.570	4,728		
		(0.022)	(0.026)	(0.035)	(0.042)				
I began to worry about how to raise my child more frequently									
	0.218	0.110***	0.124***	0.178***	0.202***	7.805	3,189		
		(0.032)	(0.036)	(0.053)	(0.059)				
I began to worry about my relationship with my child more frequently									
	0.157	0.064***	0.075***	0.101***	0.120***	9.769	4,003		
		(0.025)	(0.028)	(0.039)	(0.044)				
I began to leave my child home alone for a longer period of time (per day)									
	0.070	0.046***	0.052***	0.073***	0.084***	9.898	4,003		
		(0.017)	(0.019)	(0.027)	(0.031)				

Notes: Table 2 presents estimates from the conventional local-linear regressions as well as estimates to which the robust bias-corrected inference method (Calonico et al., 2014, 2020) is applied. Conventional heteroskedasticity-robust standard errors are reported in parentheses. For the estimates from the robust bias-corrected inference method, robust standard errors are reported. The CCT bandwidth selector proposed by Calonico et al. (2014) is used to calculate the optimal bandwidth. The same bandwidth is applied to the areas below and above the cutoff. A triangular kernel function is used to construct the estimators.*** p<0.01, ** p<0.05, and * p<0.1.

These discontinuities are statistically significant even at a 1 % significance level according to the RD estimations.

EMPIRICAL RESULTS ON PARENTS

We do not see clear discontinuities from any measure of marital relationships.



Age in Months of Firstborn Child

EMPIRICAL RESULTS ON PARENTS (CONTINUED)

Table C1: RD Estimates for the Impact of School Closures on Parents in August

	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
		Sharp (Reduced Form)		Fuzzy (IV)					
	Mean of					Optimal			
Dependent Variable:	Dep. Var.	Conventional	Bias-corrected	Conventional	Bias-corrected	Bandwidth	Ν		
Total Score of DVs: 10(Low) -30(High)									
	11.507	-0.048	-0.007	-0.075	-0.013	13.452	5466		
		(0.202)	(0.239)	(0.316)	(0.375)				
Subjective Marital Satisfaction: 1(Not at all) -5(Very Satisfied)									
	3.474	0.011	-0.001	0.017	-0.001	13.698	5466		
		(0.065)	(0.077)	(0.101)	(0.121)				
Total Score of Divorce-Risk Indexes: 4(Low Risk) -20(High Risk)									
	6.492	-0.121	-0.089	-0.190	-0.144	13.623	5466		
		(0.191)	(0.228)	(0.299)	(0.357)				
Quality of Marriage Index: 6(Poor) -24(Excellent)									
	16.913	0.181	0.253	0.285	0.403	11.928	4728		
		(0.310)	(0.369)	(0.488)	(0.580)				

The "hard-to-see" or "invisible" gaps in the figures are truly statistically insignificant.

• We have not obtained any significant results in marital relationship measures.

MARCH VS AUGUST

Table C2: RD Estimates for the impacts of School Closures on DVs

Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Sharp (Reduced Form)		Fuzzy	Fuzzy (IV)		
Total Scores of Each	Mean of					Optimal	
DV Dummy Variable	Dep. Var.	Conventional	Bias-corrected	Conventional	Bias-corrected	Bandwidth	Ν
Panel A. August							
•More Than Once $= 1$	1.217	-0.055	-0.021	-0.086	-0.035	13.171	5466
		(0.141)	(0.167)	(0.221)	(0.261)		
\bullet Frequently = 1	0.283	0.008	0.016	0.013	0.026	12.107	5116
		(0.086)	(0.103)	(0.135)	(0.162)		
Panel B. March							
•More Than Once $= 1$	1.265	0.187	0.220	0.296	0.353	9.583	4003
		(0.175)	(0.207)	(0.276)	(0.328)		
•Frequently $= 1$	0.341	0.126	0.109	0.200	0.175	10.248	4390
- •		(0.103)	(0.123)	(0.164)	(0.195)		

- The increase in the mean value of the dependent variable in March, but we do not observe any statistically significant results.
- Other measures of marital relationships also show a similar pattern, that is, we do not see any statistically significant results even in March.

SUB-SAMPLE ANALYSIS

(b) "My child gained weight."



• We found a larger weight gain among children without support from grandparents and without sibling(s).

SUB-SAMPLE ANALYSIS (CONTINUED)

(c) "I began to worry about how to raise my child more frequently."



• We found a large increase in childcare anxiety among mothers who lived in the seven prefectures with a high infection rate.

MAIN FINDINGS

The fraction of mothers whose child(ren) gained weight rose by 14.4 to 15.4 percentage points because of the school closure.

Mothers who worry over how to raise their children rose by 17.8 to 20.2 percentage points because of the school closure.

Note that the magnitude of these numbers is nonnegligible and that these impacts are statistically significant even at a 1 % significance level.

3

In contrast, we do not see any significant effect in other family outcomes, such as incidence of DV or quality of marriage index (Norton, 1983).

POLICY IMPLICATION

School closure has unexpected side effects on various nonacademic health outcomes, e.g., gaining weight.

It should not be ignored that schools do not solely give academic education to children but contribute to children's healthy lives. (Online education remains an incomplete substitute.)

Many parents in Japan worried about their relationships with their children because elementary schools did nothing except provide homework.

Schools should provide families with adequate online education as well as guidelines on how children and parents can spend their time at home in more healthy and productive ways.

THANK YOU SO MUCH !