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Effect of Non-Pharmaceutical Intervention against Covid-19 on Economic Situation in the Public Transportation:Evidence from Taxi Industry in Japan

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StudyOverview

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- Theme
  - Impact of Non-Pharmaceutical Intervention (NPI) in the Covid-19 pandemic on the economic situation in the public transportation industry.
- ResearchQuestion
  - How does NPI impact the economic situation in the public transportation industry?
- Data
  - Japanese taxi industry: prefectural monthly data from February 2020 to March 2021 (taxi companys' revenue, history of NPI, the situation of covid-19 infections, other socio-demographic information)
- Methods
  - OLS, Fixed-effect model, Matching (CEM)
- Results
  - NPI is associated with a reduction in taxi companys' revenue.
  - The association is larger in the early stage than in the later stage.

Scope of the study

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- Main policy measures before the vaccination
  - Before the vaccination, the widely-used policy measures to avoid infectio is Non-Pharmaceutical Intervention (NPI) such as “Shelter in place”, “Lockdown”, and “School closure” (Ren et al, 2021).
  - Almost NPI restricts peoples’ movement (Abouk, 2021).
- The public transportation in the covid-19 pandemic.
  - Demand for the public transportation declined under the pandemic (Tirachini and Cats, 2020) (e.g fig1).
- Question
  - Does NPI lead to financial crisis in the public transportation industry?

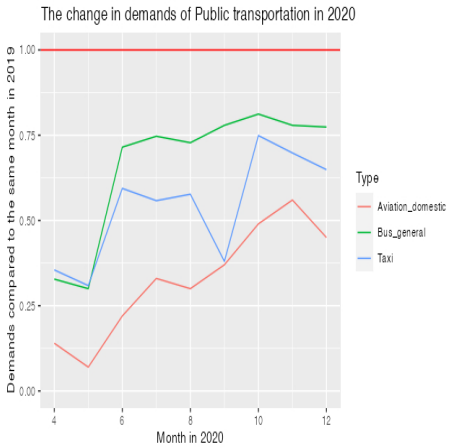

Fig1.The demand of the public transportation in Japan 2020 (/same month 2019).

Hypothesis and Data

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- Hypothesis
  - The negative economic impact of NPI and on the economic situation of the public transportation industry (demand, income, etc) (e.g Arellana et.al, 2020; Nian et.al, 2020; Przybylowski et.al, 2021).
    → **Hypothesis: NPI is associated with a reduction of the economic situation in public transportation.**

- Case
  - Prefecture-level taxi companys' monthly operating revenue in Japan (from Feb 2020 to March 2021):N=611
    - ⋆ **Data availability**:The data of taxi companys' revenue are published every month.
    - ⋆ **Hard replicating case**:Japan is one of the counties weak restriction in the pandemic.

NPI in Japan:The state of emergency

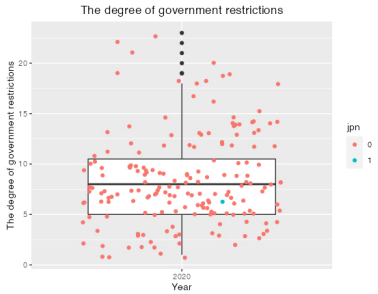

Fig2.The degree of government restriction to their citizens in the Covid-19 pandemic 2020. Data from Vdem (2021).

- NPI in Japan:The state of emergency.
  - Before January 2021, the central government could determine the area where declare and encourage reducing business hours, people staying home, school closures,**without punishments** (Akiyama, 2021).
  - Japan could be perceived as **one of countries with weak restrictions in the pandemic** (fig.2).

Model

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- Model
  - $$\frac{Revenue_{ifeb2020-march2021t}}{Revenue_{i2019t}} = \beta NPI_{it} + \gamma_1 Covid19_{it} + \gamma_2 Covid19_{it-1} + \delta \mathbf{Pref_{it}} + \eta_i + \epsilon_{it}$$

    - ⋆ *Revenue*:Mean of taxi companys' monthly operating revenue Prefecture i in month t, *NPI*:Whether NPI or not (firsts: April, May in 2020, seconds: January, February, March in 2021), *Covid19*:Deaths per 100 thousand by covid-19, *Pref* :The socio-economic, or demographic imformations of Prefecture i in month t (Over 65 Population,Population per density, Unemployment rate, Mean temperature), η: Prefecture fixed effect

    - ⋆ OLS, FE, CEM *This study uses the standard error clustered by prefecture.

Result:Total

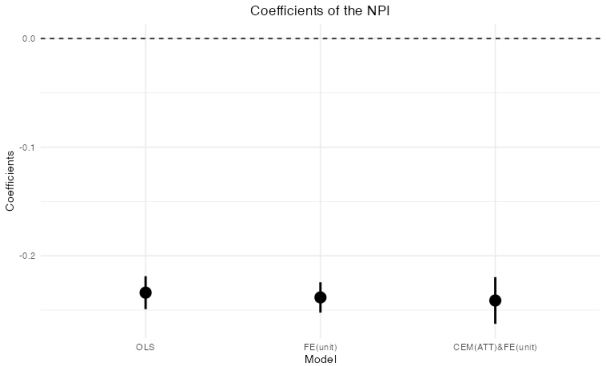

Fig3.Coefficients of the NPI.

- β=-0.235 ˜-0.241, SE = 0.009 ˜0.011
- 23.5 ppt revenue decline = 309,797 USD (Δ-0.19 sd) (= the monthly income of about 95 drivers in 2019.).

Result:Comparing the months

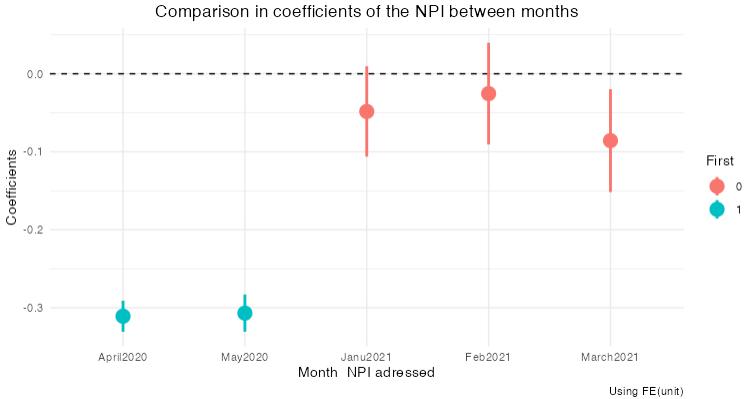

Fig4.Comparing the months when NPI was addressed.

- The association is larger in the early stage than in the later stage.
  - The intervention of NPI to peoples' movement gradually became weak (Abouk,2021; Dave, 2021).

Result:Estimation taking into concern baseline decrease

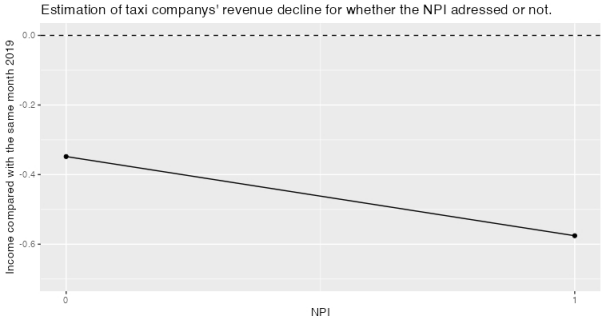

Fig5.Estimation of the taxi company's revenue decline for whether the NPI adressed or not.

- In addition to the baseline decline, NPI furthermore reduced taxi company's revenue (from -0.348 to -0.586).
- 58.6 ppt revenue decline = 772,545 USD (Δ-0.47sd) (= the monthly income of about 237 drivers in 2019.).

Conclusion

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- Results
  - NPI is associated with a reduction in taxi company's revenue.
  - The association is larger in the early stage than in the later stage.
- Implications
  - **Theoretically: Previous studies were replicated in hard cases (weak restricting country).**
  - **Practically: Recommendations or justifications for subsidies or employment securities.**
- Limitations
  - Not controlling for time effects common to all prefectures.
  - Generalizability to other industries or other countries.

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Thank you very much.

A1:Descriptive statistics of data use in this study

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Variables	Mean	SD	Min	Max
Revenue(DividedBySameMonthIn2019)	0.63	0.16	0.14	1.09
Deaths(Per100ThousandsPerMonth)	0.32	0.60	0.00	4.93
Cases (Per100ThousandsPerMonth)	15.85	28.88	0.00	289.97
Temperature(Monthly)	14.84	8.08	-4.40	30.70
Unemploymentrate(Monthly)	2.45	0.52	0.80	3.90
PopulationOver65	763531.92	680835.74	178000.00	3209000.00
PopulationPerDensity	6.57	11.95	1.00	63.00

TableA1.Descriptive statistics of data using in this study

A2:The assciation between NPI and taxi companys' revenue

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	NonFixed	NonFixed	Fixed(unit)	CEM(ATT)
NPI	−0.234(0.008)	−0.235(0.009)	−0.238(0.007)	−0.241(0.011)
LN(Deaths+1)	−0.038(0.015)		−0.047(0.016)	−0.032(0.020)
LagLN(Deaths+1)	0.040(0.018)		0.040(0.017)	0.066(0.022)
LN(Cases+1)		0.000(0.003)		
LagLN(Cases+1)		−0.005(0.003)		
Temperature	0.000(0.001)	0.000(0.001)	−0.001(0.000)	−0.001(0.001)
LN(Unemploymentrate)	0.051(0.032)	0.058(0.034)	0.021(0.039)	0.129(0.092)
LN(Over65population)	0.026(0.015)	0.026(0.015)		
LN(PPD)	−0.006(0.011)	−0.004(0.011)		
Constants	0.274(0.183)	0.281(0.181)		
Fixed effects			Unit	Unit
Num.Obs.	611	611	611	252
R2 Adj.	0.467	0.464	0.668	0.725

TableA2.The assciation between NPI and taxi companys' revenue comparing the same month in 2019

A3:Comparison of the association between NPI and taxi companys' revenue

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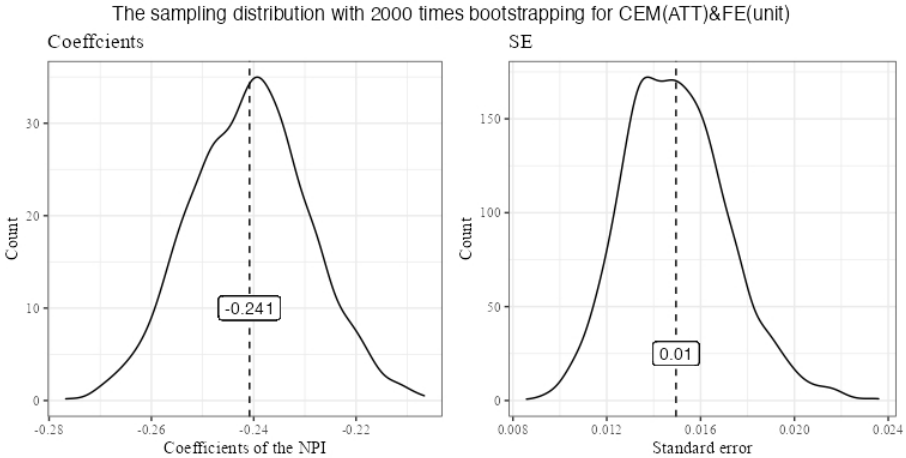
	April2020	May2020	Janu2021	Feb2021	March2021
NPI	−0.311(0.010)	−0.307(0.012)	−0.048(0.029)	−0.025(0.032)	−0.086(0.033)
LN(Deaths+1)	−0.138(0.026)	−0.127(0.020)	−0.167(0.023)	−0.098(0.027)	−0.128(0.026)
LagLN(Deaths+1)	0.064(0.043)	0.040(0.025)	−0.012(0.023)	−0.076(0.029)	0.063(0.035)
Temperature	−0.004(0.001)	−0.003(0.001)	−0.004(0.001)	−0.003(0.001)	−0.003(0.001)
LN(Unemploymentrate)	0.173(0.039)	0.193(0.038)	0.275(0.078)	0.157(0.059)	0.161(0.045)
Fixed effects	Unit	Unit	Unit	Unit	Unit
Num.Obs.	131	131	105	111	102
R2 Adj.	0.912	0.906	0.695	0.702	0.693

TableA3.Comparison of the association the NPI and taxi companys' revenue between months

A4: Bootstarapping



FigA4.The sampling distribution with 2000 times bootstrapping for CEM(ATT) & FE(unit).