Reproducibility Study: Have vehicle registration restrictions improved urban air quality in Japan

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Module: Natural Experiments Using R

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1 Introduction

The following study showcases that . . .

1.1 EDA

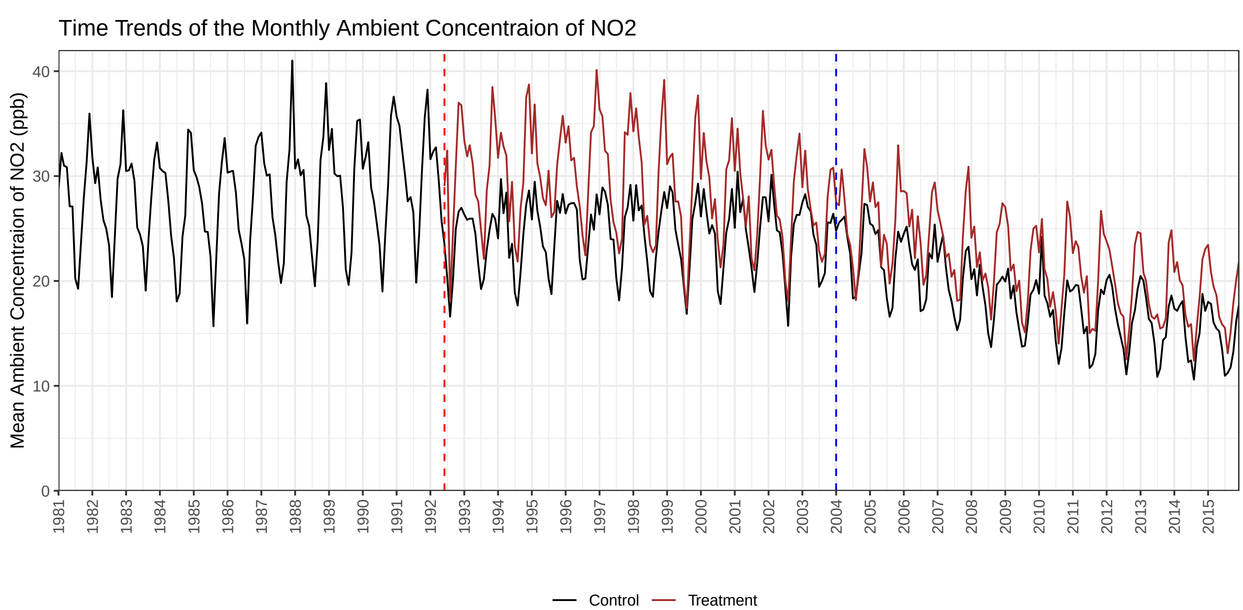
The first step was to do pre-processing of the data.

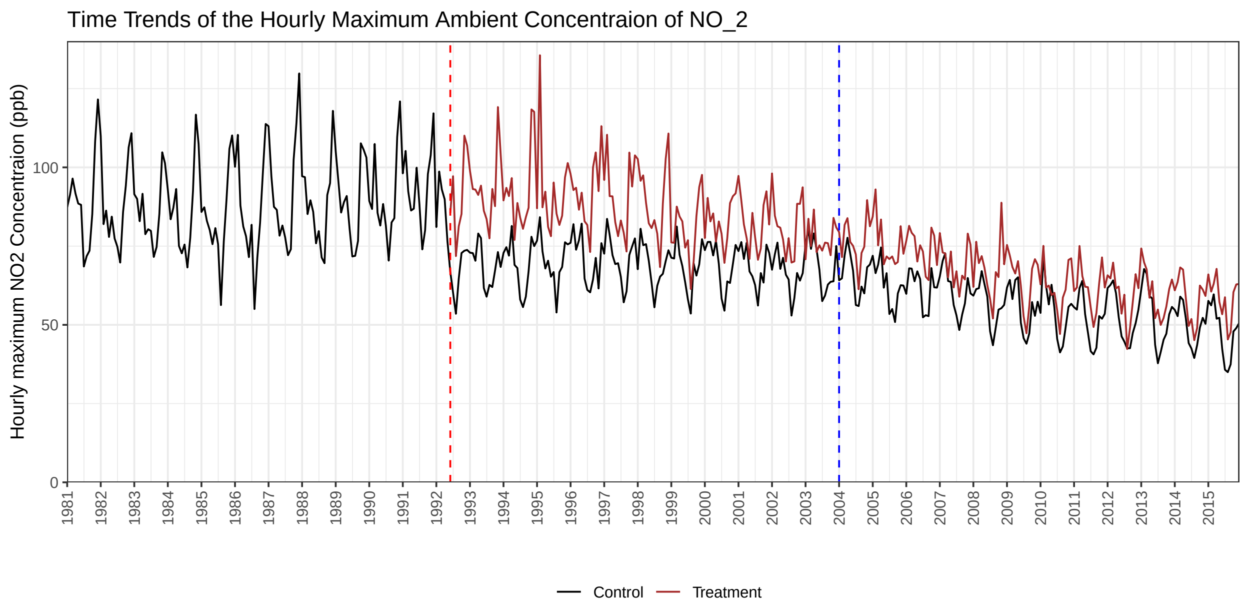
- convert the absolute number of months into a date format
- get the actual values for the the provided log of the monthly and hourly ambient concentration of NO2
- extract the month and year of the dates for a later fixed-effects feature

```
df <- read.csv("data/nishitateno_burke_2020.csv", sep = ";")
first_date <- as.Date("1981-01-01")
last_date <- as.Date("2015-12-01")

dates <- data.frame(
  y_date = seq(first_date, last_date, by = "month"),
  y_month = seq(252, 671, by = 1)
)
df <- merge(dates, df, by = "y_month", all.x = TRUE)
# get the actual value from the log of lnaverage_ndd
df$average_ndd <- exp(df$lnaverage_ndd) %>% round(2)
# get the actual value from the log of lnhmax_ndd
df$max_ndd <- exp(df$lnhmax_ndd) %>% round(2)

# add month and year column variables for fixed effects
df$month <- month(df$y_date)
df$year <- year(df$y_date)
```





From the above charts, it is clear that the intervention date was in June 1992. In addition, we do not appear to have data for the treatment group prior to the intervention date provided by Lukas Schmid. According to Nishitateno and Burke (2020), the treatment group covers 190 monitors in 109 designated municipalities in Tokyo, Kanagawa, Chiba, Saitama, Osaka, and Hyogo prefectures. The control group covers 35 monitors in five non-designated municipalities (Sapporo, Sendai, Hiroshima, Kitakyusyu, and Fukuoka). In addition, Nishitateno and Burke (2020) mention that they do not use the post-compliance period (January 2004 – December 2015) as the treatment period due to unclear cutoff as can be observed in blue above. The reason seem to be non-compliant vehicles had been replaced before the compliance obligation began induced through government support.

This has been verified below:

```
# Treament Group
df %>%
    filter(treatment1992 == 1) %>%
    filter(treatment_effects == 1) %>%
    group_by(m_code) %>%
    summarize(n = n()) %>%
    nrow()
```

```
## [1] 190
```

```
# Control Group
df %>%
    filter(treatment1992 == 0) %>%
    filter(treatment_effects == 0) %>%
    group_by(m_code) %>%
    summarize(n = n()) %>%
    nrow()
```

```
## [1] 35
```

Another column that seems to be missing in the provided data set is the daily maximum NO2 concentration.

2 Methodology

Nishitateno and Burke (2020, p. 454) illustrate, the identification strategy estimates the log of the monthly mean ambient concentraion of NO_2 using the following specification:

$$
\begin{aligned}
&\ln N_{m,t} = \alpha \\
&+ \sum_{\text{year }=1992}^{2015} \beta_{\text{year }} \left(\text{Treated}_m \times \text{Post}_{\text{year}}\right) \\
&+ \delta \boldsymbol{X}_{m,t} + \sum_{m=1}^{225} \theta_m \text{ Monitor }_m \\
&+ \sum_{t=1}^{420} \gamma_t \text{ Time }_t + \varepsilon_{m,t}
\end{aligned}
$$

Notation:

- $\ln N_{m,t}$ represents the log of the monthly mean ambient concentration of NO_2
- β_{year} change in NO_2 concentrations pre-intervention vs post-intervention period in comparison to the control group
- $_m$ is pollution monitor
- $_t$ is the month
- X is a vector of weather conditions (temperature, precipitation, sunlight duration, snowfall, wind, and cloud cover) as well as monitor-specific time trends
- θ monitor fixed effects (c_code) that account for time-invariant factors relevant to pollution level (e.g., location)
- γ extracted month-of-year fixed effect to control for any national-level monthly changes
- ε is the error term

2.1 Replication Modeling

```
# Monitor fixed effects (225 - m_code)
model1 <- feols(fml = lnaverage_ndd ~ treatment_effects * treatment1992 |
                  month + m_code, data = df)
# fixed effects months + Monitor fixed effects + Weather variables
model2 <- feols(fml = lnaverage_ndd ~ treatment_effects * treatment1992 +
                  temp + precip + daylight + snow + wind + cloud |
                  month + m_code, data = df)

# EXTRA: fixed effects months, weather and monitor-specific time trends (partially)
model3 <- feols(fml = lnaverage_ndd ~ treatment_effects * treatment1992 +
                  temp + precip + daylight + snow + wind + cloud |
                  month*year + m_code, data = df)

fixest::etable(model1, model2, model3, tex = TRUE)
```

Dependent Variable:	lnaverage_ndd		
Model:	(1)	(2)	(3)
Variables			
treatment_effects	-0.1288***	-0.1144***	-0.1280***
	(0.0136)	(0.0154)	(0.0103)
temp		0.0065	0.0168*
		(0.0072)	(0.0078)
precip		-0.0001	0.0002*
		(7.32×10^{-5})	(0.0001)
daylight		-0.0038***	-0.0005*
		(0.0004)	(0.0002)
snow		0.0029***	0.0025***
		(0.0004)	(0.0003)
wind		-0.0068	-0.0702***
		(0.0145)	(0.0114)
cloud		-0.1506***	-0.0452***
		(0.0154)	(0.0102)
Fixed-effects			
month	Yes	Yes	Yes
m_code	Yes	Yes	Yes
year			Yes
month:year			Yes
Fit statistics			
Observations	90,425	90,425	90,425
R^2	0.70091	0.72837	0.86814
Within R^2	0.05192	0.13896	0.08038

Clustered (month) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Interpretation

- the data provided seems to be missing 5 data points
- ...

2.2 Addons

Coefficients of the treatment variable when the pollution variables are measured by Hourly Maximum.

Daily Maximum is not possible as before mentioned due to missing data points. . .

```
hourly_model <- feols(fml = lnhmax_ndd ~ treatment_effects * treatment1992 +
                        temp + precip + daylight + snow + wind + cloud |
                        month + m_code, data = df)
hourly_max <- coef(summary(hourly_model))[["treatment_effects"]]
hourly_max
```

```
## [1] -0.1651359
```

3 Conclusion

References

Nishitateno, S., & Burke, P. J. (2020). HAVE VEHICLE REGISTRATION RESTRICTIONS IMPROVED URBAN AIR QUALITY IN JAPAN? *Contemporary Economic Policy*, *38*, 448–459. https://doi.org/10.1111/coep.12457