Discussion of "The Unintended Externalities of an Environmental Regulation: Evidence from the NOx Budget Trading Program" by Tse-Chun Lin, Yiyuan Zhou and Hong Zou

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NOx (Nitrogen Oxides)

- One type of air pollutions
  - For human: respiratory disease such as asthma.

    (In Japan, this chemical compound is one of the causes of Yokkaichi Asthma.)
  - For environment: photochemical smog and acid rain
- Fact: the decline in NOx Emission
  - Goldberg et al. (2021) find out that the world NOx emissions is declining 3.1%–4.0% per year between 2009 and 2018.

NOx Budget Trading Program (NBP) in the United States

- A cap and trade program created to reduce the regional transport of NOx emissions from power plants and other large combustion sources in the eastern United States. (quote from U.S. Environmental Protection Agency)
    - 8 eastern states between 2003 and 2008
    - 11 Midwestern and southeastern states between 2004 and 2008.
    - Other states had not implemented this program.

$\Rightarrow$ This difference is desirable for the DID analysis.

- According to Curtis (2018), it had a great impact on the decline in the emission of NOx.

$\Rightarrow$ Lin et al. (1) reexamine the impact of NBP and (2) investigate the spillover effect.

What This Paper Has Done

Lin et al. use the following DDD model:

$$\begin{aligned}\log(Emission_{s,i,j,k,t}) = \; & \beta_1 NBP_{s,j} \times Post_t \times HighEnergy_j \\ & + \beta_2 NBP_{s,j} \times Post_t + \beta_3 Post_t \times HighEnergy_j \\ & + \gamma PRoructionRatio_{s,i,j,k,t} + \delta FirmControl_{i,t-1} \\ & + Plant_j FE + Chemical_k \times Year_t FE + \epsilon_{s,i,j,k,t}\end{aligned}$$

- Interpretation of β_1
  1. the difference between implementation of NBP or not
  2. the difference between prior and posterior to the introduction of NBP
  3. the difference between high and low energy-consuming plants

Results

- The result of β_1 is estimated from +31% to +48%.
  - high energy-consuming plants emit more than low plants by the implementation of NBP.
- High energy-consuming plants emit more after NBP by about +22% to 39%.
  - This is because the change of emission by low energy-consuming plants (This is baseline) after NBP (i.e. β_2) is -9%.
  - Implication: high energy-consuming plants does not make efforts to reduce their emission in order to save costs.

Suggestions 1

1. More explanation about the spillover effect
Authors get an implication of the spillover effect with this study.
But how?
- If your model assumes only the term of $NBP \times Post$ and the coefficient of this variable is negative, we can say plants shifts from NBP states to non-NBP states (i.e. spillover).
- However, this study assumes many variables, and the coefficient of $NBP \times Post$ is negative but not significant.

2. A small sample size in terms of time
- The duration is from 2000 to 2007, and samples of pre and post NBP are four respectively.

  - This lead low efficiency.
  - So instead of OLS, GLS would be appropriate.

Suggestions 2

3. Is the control variable of "ProductionRatio" appropriate?

- ProductionRatio: the ratio of current-year to previous-year output
- This variable would have captured too much for the dependent variable of total emission.
  - This variable shows the 1% significant level in almost all models.

$\Rightarrow$ Thus, do the coefficients that the authors want to estimate (i.e. β_1 or β_2) really show the accurate results?

- Instead of ProductionRatio, I think adding a trend variable would be more appropriate (see, Curtis, 2018).

4. Make figures

I think studies with the DID model usually provide figures to explain estimation results for enhancement of intuitive understanding.

- At least the results of dynamic DID (or event study) require graphical explanations (i.e. Table 3).

Suggestions 3

5. Emphasize the originality of this paper

5-1. This analysis is the typical case of Pollution Haven Hypothesis. Recently, a growing number of papers studies this topic. Prior papers get the following results:

- Advanced countries: invest in environmentally regulated states or countries.
  - requirement of high compliance recently.
- Developing countries: Pollution Haven Hypothesis would be applicable.

5-2. High similarity to Curtis (2018), published by the Review of Economics and Statistics.

- This studied the same NBP policy with same method, although the dependent variable of his paper is employment.

$\Rightarrow$ Lin et al. will be more meaningful if authors emphasize the originality and contribution more.