AN EMPIRICAL STUDY OF TOKYO EMISSION TRADING SCHEME: AN EXPOST ANALYSIS OF EMISSIONS FROM COMMERCIAL AND UNIVERSITY BUILDINGS

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Overview

Emission trading schemes (ETS) have become a popular economic instrument to deal with climate change. EUETS has been the first comprehensive ETS to control carbon dioxide (CO_2) emissions. In the US, Regional Greenhouse Gas Initiative started in 2010 and the California system followed. In Asia, Korea introduced the first cap and trade scheme. Finally, China, the largest emitter of greenhouse gasses, implemented seven regional ETS as a pilot scheme and finally announced the introduction of a national-level ETS.

In Japan, the national government has not adopted emission trading scheme yet. Tokyo metropolitan government successfully introduced an ETS, namely, the Tokyo Emissions Trading Scheme (Tokyo–ETS), in 2010 (Arimura, 2015). This ETS is the first cap-and-trade ETS in Japan. The target of this scheme is large facilities and buildings. This is the first ETS to regulate emissions of greenhouse gasses from commercial buildings. Tokyo ETS consists of two phases. Phase I started in 2010 and ended in 2014. Phase II started in 2015 with more stringent emission targets. At the end of its Phase I, the Tokyo metropolitan government reviewed emissions from the regulated buildings and confirmed emission reductions from the Phase I.

Japan experienced the Great East Earthquake in 2011, followed by the nuclear accident in Fukushima. This nuclear accident caused problems of electricity supply in Japan. The shortage of electricity was severe especially in Tokyo since the nuclear power plants in Fukushima belong to the Tokyo Electric Power Companies, which has supplied electricity to the Tokyo area, almost in monopolistic way. There were several regulatory actions for electricity saving such as rolling blackouts, and the requests for voluntary power saving, following the shutdown of the nuclear power plants. In addition, electricity prices had increased during this period since the power companies had to rely on more expesive fuels such as natural gas or renewable energy. As a result of these things, the economic activity was prevented.

This situation led to a hypothesis that emission reductions in Tokyo areas may have been caused by the electricity crisis, rather than by Tokyo ETS. Thus, it is worth examining the exact impact of Tokyo ETS. This paper empirically investigates effects of Tokyo ETS using a facility-level panel data.

This paper contributes to the empirical literature of ETS. In the typical analysis of ETS, the researchers have focused the ex-ante analysis using a theoretical analysis or a computable general equilibrium (Böhringer & Lange, 2005). Recently, researchers such as Petrick & Wagner (2014) or Wagner et al. (2014) started to conduct ex-post analysis of ETS because the ex-post data have become available. This paper is in line with the recent development on the empirical literature.

Methods

We conducted a mail survey intended for the commercial building sector and universities in 2015. These two sectors were chosen for analysis as following reasons. First, under Tokyo ETS, commercial buildings are the major target of the regulation. There are few power plants and manufacturing facilities in

Tokyo. Second, both commercial buildings and universities have faced relatively less influences of economic fluctuations.

We sent questionnaires to 824 owners of commercial buildings and 340 universities in Japan. We received 414 replies from the commercial buildings and 271 from universities. The response rates were 50.2% and 79.7 % for commercial buildings and university buildings, respectively.

The owners of commercial buildings were asked to report their CO2 emission level from 2009 to 2013. They were also requested to report electricity consumption, energy consumption, the number of employees, the size of floor space, their experience of rolling blackouts, and any requests for energy savings from the power companies.

We also sent similar questionnaires to universities. Additionally, they were asked to report total number of students to capture the size of universities. Further, we asked the ratio of science/engineering students.

From the survey, we found that annual CO2 emissions from commercial buildings was 7,092 tons on average. Annual CO2 emissions from university buildings was 10,196 tons on average. By looking at the transition of annual average CO2 emissions from commercial buildings, we found that CO2 emission in Tokyo decreased after the ETS introduced in 2010 while emissions elsewhere increased in 2013 relative to 2009. In contrast, CO2 emissions from university builidings increased in 2013 relative to 2009 in all prefectures.

In addition to ETS, various factors can influence these changes in emissions. Among other things, these factors include economic situation, weather condition, and electricitiy prices. To quantify the impact of ETS, we estimated the following equations for the commercial buildings and universities.

$$E_{it} = X_{it,1}\beta_1 + X_{it,2}\beta_2 + X_{it,3}\beta_3 + \mu_i + \varepsilon_{it}$$

In this equation, Eit denotes emissions from building i in year t. Individual Effects are captured by μi. A vector of policy variables are expressed by X1. Characteristics of facilities are captured by X2. Other exogenous factors such as weather or vacancy rates of buildings are expressed by X3.

Results

We estimated various models for commercial buildings. Model 1, 3, 5 are base models, and model 2, 4, 6 are for examining two possibilities; (1) the difference of effectiveness across years and (2) whether the size of emission reductions depends on the size of facilities. To capture these effects, we added two interaction terms which are between Tokyo ETS dummy and year dummies, and Tokyo ETS dummy and the number of employees. As the result of Hausman's test, fixed effect models were accepted in all specifications.

In model 1, 3, 5, the estimated treatment effects of the ETS are negative and statistically significant. These results show the effectiveness of Tokyo ETS. From the results of model 2, 4, 6, we find that the coefficients of interaction terms are negative and statistically significant. It suggests that the effect of Tokyo ETS is different across years, and that the larger the building is, the larger the emission reduction is.

The coefficients of electricity price are negative and statistically significant. In particular, from the estimation result for the model 3, we find that the price elasticity of demand for electricity consumption is approximately 0.45%. Looking at the coefficients of dummy variables for the rolling blackouts and the request for voluntary power saving, we find no impacts on CO2 emissions, electricity consumptions and energy consumptions.

We also estimated various models for university buildings. In model 7, 9, 11, the estimated treatment effect of the ETS are negative and statistically significant. These results show the effectiveness of Tokyo ETS. Comparing with the results for commercial buildings, however, we find that impact of Tokyo ETS on university buildings is smaller than the one on commercial buildings. Looking at all the results, the coefficient of electricity price is not statistically significant indicating that university buildings are not sensitive to the electricity price change. In model 8, 10, 12, we included the interaction terms between Tokyo ETS dummy and the size of buildings, i.e. the size of the floor space and the number of students, to examine whether the amounts of emission reductions depend on the size. The coefficients of interaction term are not statistically significant.

The coefficients of rolling blackouts are negative and statistically significant, which can suggest that university buildings react strongly to the regulatory policy by the government. Also, we find that the request for voluntary power saving was significantly effective for less electricity consumption.

Conclusions

In this paper, we empirically investigated the effects of Tokyo ETS using individual a facility-level data of office buildings and universities. We found that Tokyo ETS overall has been successful in reducing CO_2 emissions relative to other regions. But, we did not control for impacts of permit prices. This is an area of future work.

References

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