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, Korean introduced the first cap and trade scheme. Finally, China, the largest emitter of Greenhouse Gas, implemented seven regional ETS as a pilot scheme and finally announced the introduction of 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 GHG emission from commercial buildings. Tokyo ETS consists for two phases. Phase I started in 2010 and ended in 2014. Phase II started in 2015 with more stringent emission target. Facing the start of Phase II of Tokyo ETS, the Tokyo metropolitan government reviewed emissions from the regulated buildings and confirmed emission reduction.

One should note, however, that Japan experienced the Great East Earthquake in 2011, which was followed by the nuclear accident in Fukushima. This nuclear accident caused the problem of electricity supply in Japan. The shortage of electricity was severe especially in Tokyo since the nuclear power plants in Fukushima belong to Tokyo Electric Power Companies, which has supplied electricity to Tokyo area, almost in monopolistic way.

Facing this crisis, Japanese government promoted energy saving behaviors and investment all over Japan. Further, the power companies faced difficulties in restarting their nuclear power plants after regulation inspections due to more stringent safety regulation and position from the public. This shutdown of the nuclear power plants made consumer of electricity to expect to higher electricity prices since the power companies have to rely on more expensive fuel such as natural gas or renewable energy. Consequently, the all the consumers expected higher electivity prices.

This situation led to a hypothesis that emission reduction 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 the effects of Tokyo ETS using 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, the researchers such as Petricky & 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 in 2015. We chose commercial building sector and universities for several reasons. First, under Tokyo ETS, commercial buildings are the major target of regulations. There are few power plants and manufacturing facilities in Tokyo. Second, both commercial buildings and universities face relatively less influence of economic fluctuations.

We sent questionnaires to 824 owners of commercial buildings and 340 universities all over 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.

Commercial building owners were asked to report their CO_2 emission level from 2009 to 2013. They were also requested to reports, the number of employees, the size of floor space and their experience of rolling blackouts and other requests for energy savings from the power companies.

We also sent similar questioners to universities. That is, university were requested to provide CO_2 emissions from 2009 to 2013. We also prepared questions specific to universities. For example, we asked the number of students to capture the size of universities. Further, we asked the ratio of science/engineering students as well as the number of students.

From the survey, we found that annual CO_2 emission from commercial buildings was 7092 tons on average. Annual CO_2 emission from university buildings was 10196 tons on average. By looking at the transition of annual average CO_2 emission from commercial buildings, we found that CO_2 emission in Tokyo decreased after the ETS introduced in 2010 while emissions elsewhere increased in 2013 relative to 2009. In contrast, CO_2 emission from university builidings increased in 2013 relative to 2009 in all prefectures.

In addition to ETS, various factors can influence thsese changes in emission. Amaong other thigs, thoese 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.

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

In this equation, Eit denotes emission from building i in year t. Individual Effects are captured by μi. A vector of policy variables are expressed by X_1. Characteristics of facilities are captured by X_2 . Other exogenous factors such as weather or vacancy rate of buildings are expressed by X_3.

Results

We have etimeated various models for commercial buildings. Model 1 is a pooled OLS estimation. Models 2 to 6 are fixed effect models. In model (1), the coefficient of Tokyo ETS dummy is negative and statistically significant. In model (2), after controlling individual effects, the coefficient of Tokyo ETS dummy is still negative and statistically significant. These result show the effectiveness of Tokyo ETS. In model (3), we included the interaction term between Tokyo ETS dummy and the number of employees to examine whether the size of emission reduction depend on the size. The coefficient of interaction term is negative and statistically significant. Thus, the larger the building is, the larger the emission reduction is. In models (5) & (6), we added the interaction terms between Tokyo ETS dummy and year dummies to examine the difference of effectiveness across years. The results hint that the effectiveness of ETS became greater as time went by during this period

We also estimated 6 modesls for university buildings. Model 1 is a pooled OLS estimation. Models 2 to 6 are fixed effect models. In model (1), the coefficient of Tokyo ETS dummy is negative and statistically significant. In model (2), after controlling individual effects, the coefficient of Tokyo ETS dummy is still negative and statistically significant. These result show the effectiveness of Tokyo ETS. In model (3), we included the interaction term between Tokyo ETS dummy and the size of buildings, i.e. the size of floor space, to examine whether the size of emission reduction depend on the size. The coefficient of interaction term is negative and statistically significant. Thus, the larger the building is, the larger the emission reduction is. In models (5) & (6), we added the interaction terms between Tokyo ETS dummy and year dummies to examine the difference of effectiveness across years. The results hint that the effectiveness of ETS differed year by year.

Through the estimation, we found that about half of the emission reduction in Tokyo are due to ETS while another half of the reduction was the result of the electricity price increase in Toyo area afther the earthquake.

Conclusions

In this paper, we empirically investigated the effects of Tokyo ETS using individual 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 the impacts of permit prices. This is an area of future work.

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