

# Chapter 7

## Target-Setting Emissions Trading Program in Saitama Prefecture: Impact on CO<sub>2</sub> Emissions in the First Compliance Period



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**Abstract** This chapter investigates whether the Target-Setting Emissions Trading (TSET) Program launched in 2011 by Saitama Prefecture in Japan had an impact on CO<sub>2</sub> emissions during the first compliance period. Facility-level data are used to estimate the causal relationship between implementation of the program and changes in CO<sub>2</sub> emissions. The results indicate that the TSET Program spurred emission reduction efforts. In addition, this chapter shows that the TSET Program also functioned as an incentive for facilities that are not covered by the program to lower their energy consumption. These findings indicate that the TSET Program succeeded in encouraging emission reduction efforts by the facilities, even though the program includes no penalty for facilities that do not meet emission goals.

**Keywords** Emissions trading · Climate policy · Treatment effect estimation

### 1 Introduction

In 2005, the European Union (EU) launched the EU Emissions Trading Scheme (EU ETS), which was the world's first international mandatory cap-and-trade program. Since then, emission trading has drawn attention as a policy instrument for the efficient reduction of carbon dioxide (CO<sub>2</sub>) emissions. In the US, the Regional Greenhouse Gas Initiative was established in 2005 in order to reduce CO<sub>2</sub> emissions from power plants in northeastern states by utilizing emissions trading. Outside Europe and North America, many emissions trading systems have recently emerged in Asia and the Pacific region at the regional, national, and local levels.<sup>1</sup>

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<sup>1</sup>A number of studies have attempted to estimate the impact of emissions trading programs on emissions, economic performance, and innovation. Martin et al. (2016) summarize and evaluate the existing literature on the impact of the EU ETS.

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Although Japan has not yet implemented a nationwide mandatory emissions trading program, the Tokyo metropolitan government started a mandatory CO<sub>2</sub> cap-and-trade program (hereinafter, the Tokyo ETS) in 2010 in order to cut CO<sub>2</sub> emissions from large emitters. The Tokyo ETS differs from the EU ETS in that it covers office buildings as well as factories.

One year after the Tokyo ETS was launched, Saitama Prefecture started the Target-Setting Emissions Trading (TSET) Program.<sup>2</sup> This program is very similar to the Tokyo ETS in many aspects. However, unlike the Tokyo ETS, the TSET Program has no penalty even when covered facilities are in non-compliance with the emissions reduction targets. It is an important research question to explore whether cap-and-trade schemes without enforcement measures like the TSET Program can provide incentives for emission reductions, and the aim of this chapter is to address this issue. Specifically, we investigate the causal relationship between the implementation of the TSET Program and CO<sub>2</sub> emission reductions. Through treatment effect analysis, we examine whether the program, which is a cap-and-trade scheme without enforcement measures, incentivized covered facilities to reduce their emissions.

The remainder of this chapter is organized as follows. Section 2 provides background on the TSET Program. Section 3 describes the research design for evaluating the causal effect of the TSET Program on CO<sub>2</sub> emission reductions. Section 4 explains the data for this analysis. Section 5 reports the empirical results and discusses the findings of this study. Section 6 concludes the chapter.

## 2 Background to the TSET Program

In 2009, Saitama Prefecture formulated the “Saitama Prefecture Global Warming Strategy Action Plan,” which set a target of reducing greenhouse gas (GHG) emissions by 25% below the 2005 level by 2020 (the target was revised to 21% in 2015, primarily due to the fact that the role of nuclear power was greatly diminished by the Fukushima accident in 2011). In order to achieve the reduction target, two schemes were introduced. One is the Saitama GHG Emissions Reduction Program, which requires business operators to formulate their own annual GHG reduction plans, including voluntary emission reduction targets and to report them to the Saitama Prefectural Government. This program, which started in FY 2010, covers business operators having facilities that are located in the prefecture and have total energy consumption of 1500 kiloliters or more per year in crude oil equivalent, as well as large-scale retailers whose store floor areas within the prefecture are 10,000 m<sup>3</sup> or more.

The other scheme is the TSET Program, which covers facilities that have total energy consumption of 1500 kiloliters or more per year in crude oil equivalent for three consecutive years. These facilities are given emission caps (i.e., emission targets) and allowed to trade allowances. The first compliance period of the TSET

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<sup>2</sup>For the design of the Tokyo ETS, see Chap. 6.

Program is the four years from FY 2011 to FY 2014, and the second compliance period covers the five years from FY 2015 to FY 2019. The method of allowance allocation is a grandfathering approach based on historical emissions.<sup>3</sup> Specifically, the volume of allowances initially allocated is determined in accordance with the following formula:

$$\text{Initial Allowance Allocation} = \text{BYE} \times (1 - \text{CF}) \times \text{YEARS}, \quad (1)$$

where *BYE* denotes base year emissions, *CF* indicates a compliance factor, and *YEARS* means the number of years of a compliance period. The base year emissions are defined as the average emissions of three consecutive fiscal years between FY 2002 and FY 2007. The compliance factor in the first compliance period is set as follows: 8% (*CF* = 0.08) for office buildings, commercial facilities, educational facilities, and hospitals, and 6% (*CF* = 0.06) for factories, waste disposal and treatment facilities, and water supply and sewage facilities. In the second compliance period, the compliance factor for the former increases to 15% (*CF* = 0.15) and that for the latter to 13% (*CF* = 0.13).

Under the TSET Program, covered facilities can utilize credits from several types of offsets in order to meet their emission targets. Emission reductions from small and midsize facilities located in Saitama Prefecture and those from large facilities outside the prefecture can be used for compliance. Forest sink credits and credits originating from renewable energy such as solar, wind, geothermal, hydro, and biomass are also available. In addition, excess credits from the Tokyo ETS are formally eligible as offset credits under the TSET Program because these two cap-and-trade schemes are officially connected.

If the volume of allowances that a covered facility holds exceeds its emission cap, the surplus allowances may be banked for the next compliance period. When covered facilities fail to achieve their emission caps, the TSET Program has no enforcement measure such as the imposition of penalties. This is a major difference between the TSET Program and the Tokyo ETS; the Tokyo ETS requires non-compliant facilities to reduce emissions by the amount of the reduction shortfall multiplied by 1.3, and if non-compliant facilities fail to meet this requirement, they are subject to penalties.<sup>4</sup> Under the Tokyo ETS, both the setting and the achievement of targets are mandatory, whereas the setting targets is mandatory but achieving them is voluntary under the TSET Program.

The Saitama Prefectural Government published a report on the achievement status for the emission targets under the TSET Program in the first compliance period. During the period, 608 facilities were subject to the program. Of these, 599 achieved their emission targets by reducing their own emissions and/or utilizing emissions trading. Therefore, 9 facilities remained non-compliant without penalty. The number

<sup>3</sup>Auctioning was not adopted as the method of initial allocation in the TSET Program.

<sup>4</sup>The names of non-compliant facilities are made public under the TSET Program. The Tokyo ETS also publicly announces the names of non-compliant facilities if they fail to meet requirement that they must reduce emissions by the amount of the reduction shortfall multiplied by 1.3.

of facilities that utilized allowance trading for compliance is 66: approximately 11% of the covered facilities.<sup>5</sup> This is slightly larger than the proportion of facilities that utilized emissions trading under the Tokyo ETS (see Chap. 6). Total annual emissions from the 608 facilities were 6.94 million tons of CO<sub>2</sub> on average during the first compliance period, which were 1.95 million tons less than the total volume of the facilities' base year emissions. This means that the facilities as a whole reduced their emissions by 22% compared to their base year emissions.<sup>6</sup>

### 3 Research Design

Because the business facilities regulated by the TSET Program are also affected by the Saitama GHG Emissions Reduction Program, their decisions on reducing CO<sub>2</sub> emissions may be influenced by both programs. In order to disentangle such combined policy effects, we assume two states of prefecture-level climate policy, namely, one in which both the TSET Program and the Saitama GHG Emissions Reduction Program are implemented, and one in which only the Saitama GHG Emissions Reduction Program is implemented. Let  $D_i$  denote an indicator of the two states. If the  $i$ th facility is regulated by both the TSET Program and the Saitama GHG Emissions Reduction Program (that is, if the facility is treated), then  $D_i = 1$ . If the  $i$ th facility is only subject to the Saitama GHG Emissions Reduction Program, then  $D_i = 0$ . Let  $Y_i(1)$  and  $Y_i(0)$  denote the outcomes at facility  $i$  when the facility is treated and when the facility is not regulated by the TSET Program, respectively. The outcome variable of interest here is the change in CO<sub>2</sub> emissions. We estimate the average treatment effect on the treated (ATET) as follows:

$$ATET = E[Y_i(1) - Y_i(0) | D = 1], \quad (2)$$

where  $E$  is the expectation operator.

While data are available to calculate  $E[Y_i(1) | D = 1]$  (changes in CO<sub>2</sub> emissions under the situation where the TSET Program is implemented),  $[Y_i(0) | D = 1]$  cannot be observed. To deal with this missing data problem, data for the counterfactual outcomes are constructed using information about facilities that are subject to only a program similar to the Saitama GHG Emissions Reduction Program.

In recent years, an increasing number of Japanese local governments have established their own mandatory programs for reducing GHG emissions. These programs include requirements such as preparing GHG reduction plans and submitting them to the local government offices. Gunma Prefecture, which is adjacent to northern Saitama, implemented a program that requires business operators to formulate their

<sup>5</sup>Trading prices for allowances are not disclosed under the TSET Program.

<sup>6</sup>For more details on compliance status under the TSET Program, see the Saitama Prefectural Government Official Website. <https://www.pref.saitama.lg.jp/a0001/news/page/2017/0516-01.html> [Accessed January 22, 2019].

own annual GHG reduction plans, including voluntary absolute emission targets, and to report them to the Gunma Prefectural Government (hereinafter, the Gunma GHG Emissions Reduction Program) in FY 2010, the same year that the Saitama GHG Emissions Reduction Program also started. The Gunma GHG Emissions Reduction Program covers business operators whose facilities within the prefecture consume in total more than 1500 kiloliters of energy in crude oil equivalent annually. Market-based instruments such as emissions trading schemes and carbon taxes have not been used for addressing global warming in Gunma Prefecture. Therefore, climate policies in Saitama are notably different from those in Gunma in that a program such as the TSET Program has been established only in the former. The existence of such a difference permits a quasi-experimental research design that can fulfill the aim of this study.

We estimate the ATET using a propensity score matching (PSM) method (Wooldridge 2010; Imbens and Wooldridge 2009). The facilities subject to the Gunma GHG Emissions Reduction Program are used as the control group, and the treatment group consists of the facilities regulated by both the TSET Program and the Saitama GHG Emissions Reduction Program. The probability of being treated is estimated by a logistic regression model. Each facility in the treatment group is matched with a single facility in the control group whose propensity score is closest.

To identify the ATET, PSM estimators are used in a difference-in-differences setting. Specifically, we construct the data for the difference between CO<sub>2</sub> emissions in each fiscal year during the first compliance period and those in FY 2010, which are used for comparing the outcomes between treated and control units. Because we use log-transformed data, the ATET estimated in this analysis represents the difference in the rate of change in CO<sub>2</sub> emissions.

## 4 Data

The data for annual CO<sub>2</sub> emissions from each facility subject to the TSET Program during the first compliance period were reported by the Saitama Prefectural Government.<sup>7</sup> Since the data for base year emissions were also published by the government, emissions targets for the facilities can be calculated using the data. The Gunma Prefectural Government reports voluntary absolute emission targets and annual CO<sub>2</sub> emissions under the Gunma GHG Emissions Reduction Program, which are aggregated data for the facilities in Gunma Prefecture that are owned by the business

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<sup>7</sup>The emissions data for facilities subject to the TSET Program during the first compliance period are available at the Saitama Prefectural Government Official Website. <https://www.pref.saitama.lg.jp/a0502/sakugen.html> [Accessed October 31, 2019].

operators subject to the program.<sup>8</sup> For our analysis, we therefore constructed aggregated data for the facilities regulated by the TSET Program; the data for the facilities subject to the TSET Program were summed for each of the business operators.

As covariates for estimating the propensity scores, emissions targets for each fiscal year and dummy variables denoting the types of business operators are used. The types of business operators are categorized as follows: waste disposal and treatment, water supply and sewage collection, education, medical services, business operators related to both education and medical services, business operators owing factories, and others.

Table 1 presents descriptive statistics for the samples. Some of the facilities regulated by the TSET Program were exempted from the program during the first compliance period because their emissions decreased enough to be excluded from being subject to the program. Therefore, the number of TSET facilities decreased during the first compliance period. This can be found even when TSET facilities are aggregated for each of the business operators, as shown in Table 1.

## 5 Results and Discussion

Table 2 shows the results of estimating the causal effect of the TSET Program on CO<sub>2</sub> emission reductions. The PSM estimate for the change in emissions between FY 2010 and FY 2011 is not statistically significant, suggesting that the TSET Program had little effect on emissions in the first fiscal year of the first compliance period. In contrast, the ATETs for the changes in emissions in fiscal years 2012, 2013 and 2014 compared with those in FY 2010 are statistically significant at the 1% level. This indicates that during the three fiscal years, the TSET Program induced the covered facilities to reduce their CO<sub>2</sub> emissions. Each estimated coefficient represents the difference in the rate of change in CO<sub>2</sub> emissions between the facilities regulated by the TSET Program and those subject to the Gunma GHG Emissions Reduction Program. In FY 2012, TSET facilities reduced CO<sub>2</sub> emissions on average by 11.7% points more than matched control facilities. The estimated coefficients for changes in emissions between FY 2010 and FY 2013 and between FY 2010 and FY 2014 are larger (15.9% points in FY 2013 and 18.9% points in FY 2014), indicating that TSET facilities made deeper emission reductions as the first compliance period went on.

Hamamoto (2020) investigates the impacts of the TSET Program on the adoption of low-carbon technology using facility-level data on the manufacturing sector, finding that the program promoted the adoption of high-efficiency machines and devices for the first three years of the second compliance period, whereas the program did not spur investments in high-efficiency equipment during the first compliance

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<sup>8</sup>For emissions data for business operators subject to the Gunma GHG Emissions Reduction Program, see the Gunma Prefectural Government Official Website. <https://www.pref.gunma.jp/04/e0100369.html> [Accessed October 31, 2019].

**Table 1** Descriptive statistics

Variable	Obs.	Mean	S.D.	Min.	Max.
<i>A: TSET facilities</i>					
Emissions in FY 2010	480	15,156.730	41,561.760	2252	737,334
Emissions in FY 2011	480	15,043.040	49,740.740	1884	946,355
Emissions in FY 2012	480	14,657.850	47,105.970	1093	886,457
Emissions in FY 2013	473	14,890.250	48,427.580	1113	903,533
Emissions in FY 2014	457	14,874.720	47,512.030	866	876,884
Targets in FY 2011	481	17,567.730	52,700.660	2188.3	962,305.3
Targets in FY 2012	481	17,607.790	52,736.500	2188.3	962,305.3
Targets in FY 2013	479	17,735.480	52,828.610	2188.3	962,305.3
Targets in FY 2014	479	17,806.910	52,888.850	2403.0	962,305.3
Factory	481	0.721	0.449	0	1
Water treatment	481	0.006	0.079	0	1
Waste treatment	481	0.017	0.128	0	1
Education	481	0.021	0.143	0	1
Hospital	481	0.033	0.180	0	1
Education and hospital	481	0.004	0.064	0	1
<i>B: Facilities in Gunma</i>					
Emissions in FY 2010	309	16,444.950	29,174.270	44	240,324
Emissions in FY 2011	309	15,477.480	28,005.210	41	238,345
Emissions in FY 2012	304	17,002.420	29,835.490	46	237,052
Emissions in FY 2013	300	18,504.140	33,254.110	46	311,101
Emissions in FY 2014	295	18,520.020	33,297.390	47	296,627
Targets in FY 2011	307	16,468.760	29,281.150	43	237,920
Targets in FY 2012	319	15,233.920	26,939.030	41	235,962
Targets in FY 2013	317	16,137.380	27,369.290	40	246,360
Targets in FY 2014	320	17,890.690	32,996.330	44	307,990
Factory	344	0.631	0.483	0	1
Water treatment	344	0.006	0.076	0	1
Waste treatment	344	0.026	0.160	0	1
Education	344	0.023	0.151	0	1
Hospital	344	0.032	0.176	0	1
Education and hospital	344	0.003	0.054	0	1

**Table 2** Average treatment effect: TSET facilities versus facilities in Gunma

ATET	Number of treated	Number of controls
<i>A: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2011</i>		
0.0274	480	307
(0.0141)		
<i>B: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2012</i>		
-0.1167***	480	303
(0.0271)		
<i>C: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2013</i>		
-0.1586***	472	299
(0.0264)		
<i>D: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2014</i>		
-0.1894***	457	293
(0.0288)		

Robust Abadie-Imbens standard errors in parentheses

\*\*\*Significant at the 1% level

period. These findings imply emission reduction measures that TSET facilities took to achieve their emission targets; the manufacturing facilities may have adopted relatively cheaper emissions reduction plans in the first compliance period such as improvements to equipment they already owned, whereas in the second compliance period, when the emissions targets became stricter, they allocated money and resources to introduce high-efficiency equipment (Hamamoto 2020).

Arimura and Abe (2020) examine the impact of the Tokyo ETS on emissions using a facility-level dataset for office buildings. They show that the Tokyo ETS caused a decrease of 6.9% in CO<sub>2</sub> emissions. Jun et al. (2020) investigate the effect of the Korea Emissions Trading Scheme (KETS) on CO<sub>2</sub> emissions, finding that the stringency of emission caps provided incentives for participating firms in the manufacturing and building sectors to improve carbon intensity. The results shown in Table 2 indicate that the TSET Program, as well as the Tokyo ETS and the KETS, can encourage emission reduction efforts.

To check the robustness of the above-mentioned results, we estimate the ATETs for changes in CO<sub>2</sub> emissions using an alternative dataset that includes facilities that were regulated by the Saitama GHG Emissions Reduction Program but were not subject to the TSET Program in the first compliance period (hereinafter, non-TSET facilities) as part of the control group; data for non-TSET facilities are added to the data for the facilities subject to the Gunma GHG Emissions Reduction Program. The data for non-TSET facilities are aggregated for each business operator that does not own any TSET facilities. In addition, the method for constructing the data for the treatment group is slightly changed: If a business operator owns both TSET and non-TSET facilities, the data for both types of facilities are summed for the



**Table 3** Average treatment effect: TSET facilities versus non-TSET facilities and facilities in Gunma

ATET	Number of treated	Number of controls
<i>A: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2011</i>		
0.0078	479	476
(0.0134)		
<i>B: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2012</i>		
-0.1001***	479	471
(0.0208)		
<i>C: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2013</i>		
-0.1742***	474	467
(0.0317)		
<i>D: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2014</i>		
-0.1626***	460	462
(0.0283)		

Robust Abadie-Imbens standard errors in parentheses

\*\*\*Significant at the 1% level

business operator.<sup>9</sup> In estimating propensity scores, actual emissions in FY 2010 and dummy variables denoting the types of business operators are used as covariates. The reason for using FY 2010 emissions is that many of non-TSET facilities set emission intensity targets and thus do not have absolute emission targets.

Table 3 summarizes the results of estimating the ATETs using the alternative dataset. The PSM estimates indicate that TSET facilities reduced CO<sub>2</sub> emissions more than the controls during the period from FY 2012 to FY 2014. Compared to the ATET in FY 2014 shown in Table 2 (18.9% points), however, the ATET in FY 2014 estimated using the alternative dataset is somewhat smaller. This might suggest the possibility that CO<sub>2</sub> emissions from non-TSET facilities declined more than those from the facilities subject to the Gunma GHG Emissions Reduction Program.

To examine this point, we estimate the ATETs for changes in CO<sub>2</sub> emissions using non-TSET facilities belonging to the business operators that do not own any TSET facilities as the treated units and the facilities subject to the Gunma GHG Emissions Reduction Program as the control units (the data for these facilities are aggregated for each business operator). Table 4 shows the results. The ATETs for the changes in emissions during the period from FY 2012 to FY 2014 indicate that non-TSET facilities belonging to the business operators that do not own any TSET facilities also reduced CO<sub>2</sub> emissions more than the facilities subject to the Gunma GHG Emissions Reduction Program. A possible reason for this is that non-TSET facilities made efforts to reduce their energy consumption in order to avoid being regulated under the TSET Program. If a facility has total energy consumption of 1500 kiloliters or more per year in crude oil equivalent for three consecutive years, it

<sup>9</sup>For data on facilities subject to the Saitama GHG Emissions Reduction Program, see the Saitama Prefectural Government Official Website. [https://www.pref.saitama.lg.jp/a0502/keikakouhyou.html](https://www.pref.saitama.lg.jp/a0502/keikakukouhyou.html) [Accessed November 1, 2019].

**Table 4** Average treatment effect: non-TSET facilities versus facilities in Gunma

ATET	Number of treated	Number of controls
<i>A: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2011</i>		
0.0224	167	309
(0.0298)		
<i>B: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2012</i>		
-0.0925***	167	304
(0.0313)		
<i>C: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2013</i>		
-0.1468***	167	300
(0.0370)		
<i>D: Change in CO<sub>2</sub> emissions between FY 2010 and FY 2014</i>		
-0.1999***	167	295
(0.0459)		

Robust Abadie-Imbens standard errors in parentheses

\*\*\*Significant at the 1% level

becomes subject to the program. This provision in the TSET Program can incentivize non-TSET facilities to suppress their energy consumption so as not to be covered by the program. Thus, the TSET Program may have spurred the facilities that are not subject to the program to reduce CO<sub>2</sub> emissions.

## 6 Conclusion

This chapter investigates the causal relationship between the implementation of the TSET Program and CO<sub>2</sub> emissions. Using facility-level data, the impact of the program on emission reductions is estimated by using a PSM approach. The results show that the TSET Program spurred the facilities subject to the program to reduce emissions during the period from FY 2012 to FY 2014. In addition, the results of estimating the ATETs for changes in emissions using the data for non-TSET facilities and the facilities subject to the Gunma GHG Emissions Reduction Program show that the former reduced CO<sub>2</sub> emissions more than the latter. This implies that non-TSET facilities likely reduced their energy consumption to avoid being subject to the TSET Program.

An attempt to introduce cap-and-trade schemes will, in most cases, provoke a political backlash, mainly from the industry sector. A cap-and-trade scheme that includes no penalties for failure to meet targets may be faced with weaker political opposition compared to programs with some form of enforcement measures. Unlike the EU ETS and the Tokyo ETS, where both target-setting and the achievement of targets are mandatory, the TSET Program is a different type of emissions trading system: a mandatory target-setting and voluntary achievement approach. This

paper reveals that cap-and-trade schemes based on such an approach can successfully provide incentives for covered entities to achieve their emission targets. A cap-and-trade scheme design like the TSET Program can be seen as one of the strategies in the political process of policymaking for combating climate change.

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