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Abstract

This paper investigates the impacts of the Target-Setting Emissions Trading (TSET) Program launched by Saitama Prefecture in Japan in 2011 on the adoption of low-carbon technology. Using facility-level data on the manufacturing sector, the causal relationship between implementation of the program and investment in high-efficiency equipment is estimated. The results show that the TSET 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 period. These results suggest that 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. These findings indicate that the TSET Program succeeded in encouraging emissions reduction efforts by facilities in the manufacturing sector covered by the scheme, even though the program lacks penalties for noncompliance.

Keywords: Emissions trading; Low-carbon technology; Technology diffusion
JEL classification: Q54; Q55; Q58

1. Introduction

In 2005, the European Union (EU) launched the EU Emissions Trading Scheme (ETS), which was the first mandatory, international cap-and-trade program in the world. Since then, emissions trading has drawn attention as one of the policy instruments for the efficient reduction of carbon dioxide (CO_2) emissions. In the US, the Regional Greenhouse Gas Initiative (RGGI) was established in 2005 to reduce CO_2 emissions from power plants within several northeastern states. The RGGI establishes a regional CO_2 emissions cap and allocates tradable CO_2 emissions allowances to power plants. Beyond Europe and North America, many emissions trading systems have recently emerged at the regional, national, and local levels in Asia and the Pacific region.

Although Japan has not yet implemented a nation-wide mandatory emissions trading program, the Tokyo metropolitan government started a mandatory CO_2 cap-and-trade program (hereafter referred to as the Tokyo ETS) in 2010 in order to cut CO_2 emissions from large emitters. The Tokyo ETS differs from the EU ETS in that it covers office buildings as well as factories (Arimura and Abe, 2019).

One year after the Tokyo ETS was launched, Saitama Prefecture started its Target-Setting Emissions Trading (TSET) Program. This program is very similar in many ways to the Tokyo ETS. However, unlike the Tokyo ETS, the TSET Program has no penalties, even when facilities covered by the scheme are not in compliance with emissions targets. It is an important research question to explore whether cap-and-trade schemes without enforcement measures, such as the TSET Program, provide adequate incentives for emissions reductions and technological innovation.

A number of studies have attempted to estimate the impact of emissions trading programs on emissions, economic performance, and innovation (Martin et al., 2016). In particular, the EU ETS has received a great deal of attention in the field of climate policy studies. Several researchers have examined the effect of the EU ETS on emissions abatement using aggregate emissions data and found that CO_2 emissions were reduced by almost 3% during Phase I of the program’s implementation (Ellerman and Buchner, 2008; Ellerman et al., 2010; Anderson and Di Maria, 2011). However, empirical studies that explore the impact of the EU ETS using aggregated country-level data have some disadvantages. First, the country-level data does not exclude firms that are not regulated by the EU ETS. Second, it is difficult to assess the causal relationship between the EU ETS and firms’ responses to this scheme (Martin et al., 2016). Several recent studies have attempted to overcome these disadvantages by using firm-level data.

Petrick and Wagner (2014) investigated the impact of the EU ETS on CO_2 emissions and on economic performance using micro-data on German manufacturing firms. They employed a matching approach to compare firms covered under the ETS as well as non-ETS firms. While they found the EU ETS had no significant effect on CO_2 emissions during Phase 1 of the ETS, the ETS firms were found to have reduced their CO_2 emissions by approximately 25 percentage points more than non-ETS firms during the first three years of Phase II. They also found that the EU ETS had no significant negative impact on firm output, employment, or exports.[1]

Borghesi et al. (2012) examined the impact of the EU ETS on the adoption of environmental innovations using a large sample of Italian manufacturing firms from the Community Innovation Survey dataset. They conducted a probit analysis and found that participation in the EU ETS may be a driver for the adoption of environmental innovations, but that the stringency of the scheme was not a key factor. Löfgren et al. (2013) explored the effect of the EU ETS on firms' investment decisions in carbon-reduction technologies. Using data on Swedish firms belonging to ETS and non-ETS sectors from 2002 to 2008, they showed that the EU ETS had no significant impact on either large or small investments.

Calel and Dechezleprêtre (2016) explored whether the EU ETS promoted patent applications for low-carbon technologies using patent data provided by the European Patent Office (EPO). They found that ETS firms increased their patent applications by 9.1% compared with non-ETS firms during the period from 2005 to 2009. This result implies a 0.83% increase in the total number of low-carbon patents filed at the EPO during the same period compared with the counterfactual scenario.

The impact of emissions trading programs on innovation has been of interest to environmental economists and policymakers. Kerr and Newell (2003) found that the US regulatory program for lead phasedown had a significant effect on the adoption of lead-reduction technology. Popp (2003) showed that the Sulfur Dioxide (SO_2) Allowance Trading Program in the US promoted patent activities in the field of higher-efficiency scrubbers. While these studies suggest that emissions trading programs implemented in the US had positive effects on innovation, Taylor (2012) provided empirical evidence against the effectiveness of the SO_2 Allowance Trading Program and the Nitrogen Oxides (NOx) Budget Trading Program in encouraging innovations in SO_2 and NOx control technologies. The effect of carbon trading on innovation has recently gained the attention of researchers (Borghesi et al., 2012; Löfgren et al., 2013; Calel and Dechezleprêtre, 2016), although a greater understanding of the efficacy of emissions trading programs in promoting the development and deployment of low-carbon technologies is needed.

The aim of this paper is to address this issue by examining whether the TSET Program has promoted the diffusion of technology. Specifically, we attempt to investigate the causal relationship between the implementation of the program and the adoption of low-carbon technology in the manufacturing sector using facility-level data. The level of the technology adoption is measured using the amount of investments in high-efficiency equipment. Whether the TSET Program, which is a cap-and-trade scheme without enforcement measures, incentivized the covered facilities to introduce equipment with high energy efficiency is investigated through treatment effect analysis.

The remainder of this paper is organized as follows. Section 2 provides background on the TSET Program. Section 3 describes the empirical strategy for evaluating the causal effect of the TSET Program on low-carbon technology diffusion. Section 4 presents the data used for this analysis. Section 5 reports the empirical results. Section 6 discusses the findings of this study. Section 7 concludes the paper.

2. Background on 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, mainly because the role of nuclear power was greatly diminished by the Fukushima accident in 2011). In order to achieve this target, two schemes were introduced. The first is the Saitama GHG Emissions Reduction Program, which requires business operators to formulate their own annual GHG reduction plans, including voluntary emissions reduction targets and to report them to the Saitama Prefectural Government. This program, which started in FY 2010, covers business operators with facilities located in the prefecture that have a total energy consumption of 1,500 kiloliters or more per year in crude oil equivalent as well as large-scale retailers with a total store floor area of 10,000 square meters or more within the prefecture.

The other scheme is the TSET Program, which covers facilities that have total energy consumption of 1,500 kiloliters or more per year in crude oil equivalent for three consecutive years. These facilities are given emissions caps (i.e., emissions targets) and are allowed to trade allowances. The first compliance period of the TSET Program was a four-year period from FY 2011 to FY 2014, and the second compliance period is the five-year period from FY 2015 to FY 2019. The method of allocating emissions allowances is a grandfathering-based approach using historical emissions. Specifically, the volume of allowances initially allocated was determined in accordance with the following formula:

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

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 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 fulfill their emissions targets. Emissions 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, hydropower, 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 emissions cap, the surplus allowances may be banked for the next compliance period. When covered facilities fail to achieve their emissions caps, the TSET Program has no enforcement measure such as the imposition of fines or penalties. This is a major difference between the TSET Program and the Tokyo ETS; the Tokyo ETS requires facilities in noncompliance to reduce emissions by the amount of the reduction shortfall multiplied by 1.3: facilities that fail to meet this requirement are subject to penalties.[2]

The Saitama Prefectural Government published a report on the achievement status for emissions targets under the TSET Program in the first compliance period. The number of facilities covered by the program was 608 during this period. Of these, 599 achieved their emissions targets by reducing their own emissions and/or trading emissions credits. Nine facilities were in noncompliance but were not penalized.[3]

3. Empirical Strategy

Because the business facilities regulated by the TSET Program are also affected by the Saitama GHG Emissions Reduction Program, their decisions on investments in abatement technologies may be influenced by both programs. To disentangle such combined policy effects, we assume two states of prefecture-level climate policy: the first is that both the TSET Program and Saitama GHG Emissions Reduction Program are implemented, and the second is that only the Saitama GHG Emissions Reduction Program is put into place. Let D_i denote an indicator of the two states. If the ith 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 ith facility is subject only 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 in the present paper is the volume of investment in high-efficiency equipment. We estimate the average treatment effect on the treated (ATET) as follows:

$$ATET = E\,[Y_i(1) - Y_i(0) \mid D = 1], \tag{2}$$

where E is the expectation operator.

To obtain information necessary for this analysis, a survey of facilities' behavior under the TSET Program, the details of which are described in the next section, was conducted in 2018. While the data on investment in high-efficiency equipment, which were gathered through the survey, can be used to calculate $E\,[Y_i(1) \mid D = 1]$, $[Y_i(0) \mid D = 1]$ cannot be observed. To deal with the problem of missing data, data for counterfactual outcomes are constructed using information about facilities that are subject only to a program similar to the Saitama GHG Emissions Reduction Program.

An increasing number of local governments in Japan have recently 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 own annual GHG reduction plans, including voluntary absolute emissions targets, and to report them to the Gunma Prefectural Government (hereafter referred to as the Gunma GHG Emissions Reduction Program) in FY 2010, the same year in which 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 1,500 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 climate change in Gunma Prefecture. Therefore, climate policies in Saitama noticeably differ 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 the present study. The survey collected information about facilities owned by business operators regulated by the Gunma GHG Emissions Reduction Program.

We attempt to estimate the ATET using a propensity score matching (PSM) method. The facilities subject to the Gunma GHG Emissions Reduction Program are used as members of 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 using 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.

The observation period, which was a 10-year period from FY 2008 to FY 2017, is partitioned into three terms. Period 0 includes the years before the implementation of the TSET Program (FY 2008–2010); Period 1 covers the years in the first compliance period (FY 2011–2014); and Period 2 includes the three years of the second compliance period (FY 2015–2017). Let I_{i0}, I_{i1}, and I_{i2} denote total investments in high-efficiency equipment during Periods 0, 1, and 2, respectively. Changes in total investments between two periods can be represented as $I_{i1} - I_{i0}$ and $I_{i2} - I_{i1}$, which are the outcome variables used in this analysis. In order to identify the ATET, PSM estimators are used in a difference-in-differences setting.[4]

The data used in this analysis do not cover all manufacturing facilities regulated by the TSET Program and those subject to the Gunma GHG Emissions Reduction Program because they were collected through a survey. Inverse-probability weighting (IPW) is a useful technique to deal with problems arising from the use of survey samples in estimating treatment effects. In the IPW method, the propensity score is used to form a weight. For the estimation of the ATET, treated units receive a weight of 1, and control units receive a weight of $P(D = 1|\mathbf{X})/(1 - P(D = 1|\mathbf{X}))$, where P denotes the propensity score and **X** is a vector of observed covariates (Hirano et al., 2003; Lee, 2005; Wooldridge, 2010). We employ the IPW method to estimate the causal effect of the TSET Program on total investments in high-efficiency equipment with the aim of checking the robustness of the PSM results.

4. Data

The survey about facilities' behavior under the TSET Program and the Gunma GHG Emissions Reduction Program was conducted from July to September 2018. Questionnaires were distributed to manufacturing facilities that had been regulated by the TSET Program during the first compliance period and manufacturing facilities subject to the Gunma GHG Emissions Reduction Program. The numbers of surveyed facilities in Saitama and Gunma were 402 and 325, respectively. The response rates were 50.0% in Saitama and 40.3% in Gunma.

The questionnaire designated an energy manager in each facility as a respondent. The questionnaire asked the respondents how much their facilities had invested in high-efficiency equipment each year from FY 2008 to FY 2017. In the questionnaire, high-efficiency equipment was defined as machines and devices using technologies with the highest level of energy efficiency that were available at the time of making decisions on investments in efficiency improvements.[5] Each respondent was also asked to supply facility-level data on total floor area and the number of employees in FY 2010 and FY 2014, which are used as the covariates in estimating the propensity scores. The data on total floor area and the number of employees in FY 2010 are used in identifying the ATET for $I_{i1} - I_{i0}$; the data for FY 2014 are used as the covariates for estimating the ATET for $I_{i2} - I_{i1}$.

Because the questionnaire required the respondents to provide somewhat old information about their facilities, more data were missing for the earlier years of the observation period. The number of facilities that supplied complete data on annual investments in high-efficiency equipment from FY 2008 to FY 2017 is 242. The sample that consists of these facilities is referred to as Sample A. We construct another dataset that includes facilities with missing data. In this sample, referred to as Sample B, if the respondent provided no answer to the question about investment in high-efficiency equipment for a given year, the investment by the facility in that year is regarded as zero yen. Using such a procedure for dealing with missing data results in a sample size of 332 facilities for Sample B. Table 1 presents descriptive statistics for the two samples. Some facilities regulated by the TSET Program during Period 1 were not covered during Period 2 because their emissions were decreased enough to be excluded from the requirements of the program. Therefore, in both samples, the number of covered facilities in Period 2 are fewer than those in Period 1.

5. Results

Table 2 reports the results of estimating the causal effect of the TSET Program on total investments in high-efficiency equipment. The first and second panels show the results when using Samples A and B, respectively. In both cases, the PSM estimates for the change in investments between Periods 0 and 1 are not statistically significant, suggesting that the TSET Program did not promote the adoption of high-efficiency machines and devices during the first compliance period. In contrast, comparing between Periods 1 and 2 yields PSM estimates that are statistically significant at the 5% level. This indicates that during Period 2, the TSET Program induced the covered manufacturing facilities to introduce equipment with high energy efficiency. The average increase in total investments in such equipment is estimated at 111 million yen when using Sample A and 131 million yen when using Sample B.

For the IPW estimates, the comparison between Periods 1 and 2 indicates that there was a statistically significant change in investments in high-efficiency equipment (at the 1% level), though the change in investments between Periods 0 and 1 was not statistically significant. As with the PSM results, these results suggest that the TSET Program spurred investments in high-efficiency equipment during Period 2, whereas the program did not have a significant effect on the adoption of such equipment in the first compliance period. The coefficients for the IPW are somewhat smaller compared with the PSM results; the average change in investments in high-efficiency equipment is estimated to be 102 million yen (using Sample A) and 97 million yen (using Sample B).[6]

Both of the results from the PSM and IPW analyses demonstrate that the TSET Program increased investments in high-efficiency equipment by a total of approximately 100 million yen from FY 2015 to FY 2017. This means that each manufacturing facility invested around 33 million yen per year in equipment with high-efficiency technologies during that period. If all manufacturing facilities covered by the TSET Program in the second compliance period (381 facilities) spent this amount of money on high-efficiency equipment as indicated by the sample, their total investments would amount to 12.6 billion yen per year.

6. Discussion

In the survey conducted to collect the data used in the estimation of the ATET, the manufacturing facilities covered by the TSET Program during the first compliance period were also asked a question about the extent to which the implementation of the program had promoted their activities to reduce emissions through the modification of machines and devices that they already possessed. The proportion of facilities that answered “highly promoted” or “promoted to some extent” was 72.2%, as shown in Table 3. This might explain why the TSET Program did not have a significant impact on the diffusion of high-efficiency technologies in the first compliance period. The introduction of the TSET Program induced manufacturing facilities to adopt improvements to machines and devices they already owned as relatively cheaper way of reducing emissions to attain their targets.

In contrast, from FY 2015 to FY 2017, the TSET Program incentivized the manufacturing facilities covered by the scheme to increase their investments in high-efficiency equipment. One possible reason for this is that emissions targets for these facilities became stricter in the second compliance period, with the compliance factor for manufacturing facilities increasing from 6% to 13%. The increase in the stringency of emissions targets may have promoted adoption of more costly options for reducing emissions, that is, investments in equipment with high-efficiency technologies.

These results indicate that the TSET Program succeeded in encouraging efforts by covered facilities in the manufacturing sector to reduce their emissions, despite the fact that the program lacks a penalty for facilities in noncompliance. The reason why such a cap-and-trade scheme without enforcement measures could spur emissions reduction activities is worth considering. Data suggesting such a reason were obtained from the survey used in estimating the ATET. In the survey, manufacturing facilities covered by the TSET Program were asked whether they had made efforts to reduce their emissions by themselves during the first compliance period. Of the 197 facilities, 174 answered “yes.” The survey then asked those facilities answering in the affirmative to what extent energy cost savings and greater profitability drove the decision to reduce CO_2 emissions. As shown in Table 4, 156 of the 174 facilities (89.7%) answered that energy cost savings and greater profitability were very strong or somewhat strong drivers of their decision to reduce CO_2 emissions. These show that most of the manufacturing facilities covered by the TSET Program regard reducing CO_2 emissions as an opportunity to increase productivity. The implementation of the TSET Program may have prompted these facilities to take advantage of such an opportunity.

7. Conclusion

This paper investigated the causal relationship between the implementation of the TSET Program and the adoption of low-carbon technology in the manufacturing sector. Using facility-level data, the impact of the program on investments in high-efficiency equipment was estimated by matching and weighting approaches using propensity scores. The results show that the TSET Program promoted the adoption of high-efficiency machines and devices for the first three years of the second compliance period, but that the program did not spur investments in high-efficiency equipment during the first compliance period. These results may reflect the compliance behavior of facilities as follows. In the first compliance period, manufacturing facilities adopted relatively cheaper emissions reduction opportunities, such as improvements to machines and devices they already owned. In the second compliance period, when their emissions targets became stricter, facilities made decisions to invest in introducing high-efficiency equipment.

These findings indicate that the TSET Program successfully incentivized facilities in the manufacturing sector that were covered by the scheme to make efforts toward achieving their emissions targets, even though the program lacks penalties for noncompliance. The introduction of the TSET Program may have been a trigger for adopting activities to reduce CO_2 emissions as an opportunity for productivity enhancement. Whether the program will be able to continue to have such an effect in future compliance periods, even without introducing enforcement measures, deserves to be investigated. Addressing this issue is a task for future research.

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Notes

1. The impact of the RGGI on CO_2 emissions was examined by Murray and Maniloff (2015). Using state-level data, they attempted to measure the emissions reductions caused by the RGGI and other factors such as the recession, renewable portfolio standards, and changes in natural gas prices by estimating econometric models. The results show that without implementation of the RGGI, CO_2 emissions from the power sector in the RGGI states would have been 24% higher.

2. The names of noncompliant facilities are made public under the TSET Program. The Tokyo ETS also publicly announces the names of noncompliant facilities if they fail to meet the requirement that they reduce emissions by the amount of the reduction shortfall multiplied by 1.3.

3. For more details on the status of compliance with 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]>

4. Facilities located in Saitama Prefecture are not regulated by the TSET Program if their total energy consumption for three consecutive years does not exceed 1,500 kiloliters per year in crude oil equivalent. Accordingly, numerous facilities operating in Saitama are subject to the Saitama GHG Emissions Reduction Program but not to the TSET Program. Such facilities make up the control group in the analysis of this study. However, the TSET Program may affect the behavior of these facilities to the extent that they make efforts to reduce their energy consumptions so that they avoid regulation under the program. The existence of such behavior leads to the violation of the stable unit treatment value assumption (SUTVA), which stipulates that the treatment received by any given unit does not affect other units' outcomes. Taking this into account, we avoid the use of data for facilities that are subject only to the Saitama GHG Emissions Reduction Program. For the SUTVA and other assumptions underlying PSM, see Wooldridge (2010) and Imbens and Wooldridge (2009).

5. Machines and devices that meet energy efficiency standards under the Top Runner Program at the time of decision-making on investments in efficiency improvements are also included in the category of high-efficiency equipment. This was explained to the respondents in the questionnaire. The Top Runner Program is a regulation implemented in Japan in 1999 with the aim of improving the efficiency

of energy-consuming products. For more information on this program, see the International Energy Agency Website. <https://www.iea.org/policiesandmeasures/pams/japan/name-21573-en.php [Accessed March 19, 2019]>

6. It was confirmed that the overlap assumption was satisfied. The data for checking whether the assumption is violated are available from the corresponding author upon reasonable request.

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Table 1. Descriptive statistics

	N	Mean	S.D.	Min	Max
Sample A					
TSET facilities in Period 1	242	0.58	0.49	0	1
TSET facilities in Period 2	242	0.56	0.50	0	1
Total floor area in 2010 (m^2)	226	23401.98	25634.85	805	224781
Total floor area in 2014 (m^2)	234	23960.47	26254.35	805	224781
Number of employees in 2010	205	254.91	336.61	10	3500
Number of employees in 2014	230	250.41	311.64	10	3500
Investment in high-efficiency equipment					
Period 0 (¥ million)	242	60.48	291.90	0	3821
Period 1 (¥ million)	242	92.77	327.68	0	3821
Period 2 (¥ million)	242	107.07	434.12	0	5830
Sample B					
TSET facilities in Period 1	332	0.61	0.49	0	1
TSET facilities in Period 2	332	0.58	0.49	0	1
Total floor area in 2010 (m^2)	283	25436.15	34678.20	805	294700
Total floor area in 2014 (m^2)	301	26671.54	34988.01	805	294700
Number of employees in 2010	252	257.20	350.87	10	3500
Number of employees in 2014	292	254.24	311.64	10	3500
Investment in high-efficiency equipment					
Period 0 (¥ million)	332	44.68	250.58	0	3821
Period 1 (¥ million)	332	71.72	283.07	0	3821
Period 2 (¥ million)	332	91.03	386.83	0	5830

Table 2. Impact of TSET Program on investments in high-efficiency equipment

	Change between Periods 0 and 1			Change between Periods 1 and 2		
	ATET	TSET facilities	Controls	ATET	TSET facilities	Controls
Sample A						
PSM	-61.45	125	78	111.35**	131	97
	(67.32)			(45.09)		
IPW	-37.30	125	78	101.60**	131	97
	(45.65)			(44.04)		
Sample B						
PSM	-56.78	157	90	131.10***	173	115
	(61.21)			(45.15)		
IPW	-36.90	157	90	96.92***	173	115
	(37.45)			(35.79)		

Robust standard errors in parentheses

***Significant at the 1% level

**Significant at the 5% level

Table 3. Effect of TSET Program on the modification of equipment

Question		Answer			
		Highly promoted	Promoted to some extent	Did not promote so much	Did not promote at all
To what extent did implementation of the program promote activities to reduce emissions through the modification of machines and devices that your facility already possessed?	N = 198	18.2%	54.0%	20.2%	7.6%

Table 4. Role of cost savings and profitability in promoting emissions reduction efforts

Question		Answer			
		Absolutely true	True to some extent	Not so true	Not true at all
To what extent is it true that the reason for making emissions reduction efforts was that CO_2 emissions reductions lead to energy cost savings and greater profitability?	N = 174	43.7%	46.0%	9.8%	0.6%