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Emissions trading schemes in Japan: their potential and possible impact

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Emissions trading schemes in Japan: their potential and possible impact

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Abstract

This paper examines the impact of introducing an emissions trading scheme (ETS) in Japan using an input-output model. Using demand forecast data from the Ministry of the Environment (2012), we examined the impacts of two cases: one in which emissions were reduced without introducing a scheme (the business as usual (BAU) case) and one in which a scheme was introduced (ETS case). In both cases, the aggregate repercussion effects were negative, but the negative impact was significantly greater in the ETS case (1.3 trillion JPY, which is approximately 0.14% of GDP). The negative repercussion effects are consistent with the results from MOE (2012). However, our study showed positive repercussion effects on employment regardless of employment status. This occurs because the labor absorptive capacity is low in sectors such as steel, where demand will decline due to the introduction of a scheme, so there is a small impact on employment; in contrast, sectors that benefit from the adoption of the scheme have high labor absorptive capacities. Accordingly, the adoption of an ETS in Japan would be positive for jobs but would not have a significant impact in terms of stimulating output.

Keywords Emissions Trading Scheme, Japanese Economy Growth, Input-Output model, Repercussion Effects

JEL: Q51, Q56, R11, R15

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1. Introduction

Since the adoption of the UN Framework Convention on Climate Change (UNFCCC) in 1992, the Conference of the Parties (COP) meetings have included discussions on measures to address global climate change. One measure under discussion is emissions trading systems/schemes (ETSs), which were proposed in the Kyoto Mechanism of the Kyoto Protocol from COP3 in 1997 combined with the offsets of the Clean Development Mechanism (CDM) and Joint Implementation (JI)[3].

Following COP3, ETSs spread to Europe. In the United Kingdom, trials of a domestic ETS for carbon dioxide (CO_2) were launched in April 2002. In January 2005, the 25 European Union countries launched the European Union Emissions Trading System (EU-ETS), which targets the steel industry, building materials producers, glass manufacturers, ceramics manufacturers, and power stations and oil refineries that own equipment and/or facilities that use ≥20 MW of power. In the United States, there was an early move away from the Kyoto Protocol following the start of the Bush administration, and the country developed its own domestic ETS. Currently, individual countries are continuing to move forward in designing their own ETSs, and there is little active international trading.

The COP meetings were originally forums to discuss the best way to cooperate and implement effective abatement initiatives on a global scale, but they have become a battleground in which individual countries try to avoid being placed in an inferior economic position. This has resulted in a lack of progress in international links between ETSs, which are one means of addressing global warming. The design of an ETS has significantly different impacts on different countries, so each country is seeking a system that gives it an edge, however small; thus, the design of an international system is a distant prospect. Furthermore, problems with the systems themselves are limiting activity in this area.

According to Arimura (2015), the problem with the CDM is that the project assessment, registration and processes required to issue credits are time- and labor-intensive. Before a project is implemented, approval of the project design methodology and emissions reduction measurements from the CDM Executive Board is necessary. Before the CDM Executive Board will issue credits, certifications from multiple agencies are required, such as the approval of the organization as a designated operational entity (DOE); thus, there are large opportunity costs before credits are obtained. These significant opportunity costs may prevent the enthusiastic participation of private-sector companies in the CDM. There is also the issue of uncertainty

[3] The historical origins of the ETS are said to be in the Clean Air Act in the United States in the 1970s. At that time, air pollution from factory emissions, especially acid rain caused by sulfur dioxide (SO_2), became a societal issue. In response, the Federal Clean Air Act was passed in 1970, and Title IV of the Clean Air Act Amendments in 1990 contained provisions to address acid rain. Phase 1, which was implemented over a five-year period starting in 1995, contained the first real-world test of such measures, which was a sulfur dioxide emissions permit trading scheme. Maeda (2009) discusses the historical background of ETSs.

regarding the volume of credits issued. Even if an organization spends a substantial period of time to pass the validation review and qualify as a DOE, it will not necessarily be registered by the CDM Executive Board, and the volume of credits that is actually issued may be less than was originally anticipated due to the large number of items monitored. This uncertainty also hinders the participation of businesses in the CDM arrangements.

As shown in Figure 1, Japan and other countries have developed proposals on how to overcome these issues. For example, Japan has suggested a bilateral Joint Crediting Mechanism (JCM) system that would simplify the procedures that lead to the issuing of credits, and the European Commission and International Energy Agency have proposed a Sectoral Crediting Mechanism (SCM). Trials of schemes that enable developing countries or international organizations to issue credits at the business level are underway. In addition, the United Nations has proposed the Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) program as a system to support reductions of greenhouse gas emissions and conserve forests. Advanced countries would fund forest conservation in line with abatement volumes and acquire credits.

Figure 1. Features of various emissions reduction mechanisms

	international credit mechanism			**sectoral credit mechanism**		
	Clean Development Mechanism	Joint Credit Mechanism	REDD plus	Government Crediting System	Tradable Intensity Standard	Installation-Based ETS
governance	CDM committee in UN	joint committee by government representatives from each country	UN/ bilateral governments	International regulation organization		
unit of reduction	each project		project/sector	sector		
contents of project	low carbon technology	low carbon technology including energy saving technology or products; preserve forests	planting/ replanting; preserve forests/ deterioration	energy intensive industry + transportation	energy intensity industry	
market trading	possible	impossible	possible/impossible	possible		
credit issue period	after the action			after the action		before the action
credit recipients	host country/ participants to the project	government/ participants to project		government	plant	
merits	mature institute	low transaction costs	big reduction volume	participation of high transaction cost sector	decrease of uncertainty in emission reduction	effective emission reduction
problems	high transaction cost	international acceptance	quality of reduction credit	uncertainty in emission reduction	linkage among sectors	setting the goal of developing countries' reduction

Source: Arimura and Takeda (2015)

However, problems are not confined to the systems. There is a plethora of complex and difficult problems, including the setting of inappropriate emissions quotas due to the failure to adequately consider the costs and damages associated with reducing CO_2 and other harmful gases, the designation of some countries as regulated and some as unregulated in line with the principle of Common But Differentiated Responsibilities (CBDR), differences due to the presence or absence of offsets, and inefficiencies because of the lack of dynamic analysis.

These political, institutional, and technical issues are interwoven, so investigations into ETSs are not being carried out as extensively as they were previously. However, there is still value in examining the impacts that an ETS would have in Japan and abroad. In particular, the Ministry of the Environment (MOE) in Japan has spearheaded the creation of a report (Ministry of the Environment 2012) that investigates reductions that would occur in cases in which an ETS is introduced and those in which it is not. It is thus possible to quantitatively analyze the effects of ETSs.

This paper presents an overview of previous analyses of the effects of ETSs and, based on data released by MOE (2012), conducts a comparative analysis of cases in which an ETS is introduced and those in which it is not.

We first provide an overview of the results of previous research, including a computable general equilibrium (CGE) analysis of the economic impact of introducing an ETS. Then, based on Ministry of the Environment data, we examine the impacts of introducing an ETS and not introducing an ETS on economic growth. Finally, we consider the difference between the negative impact of the cost of reducing emissions and the impact of new investment spending.

2. Literature Review

2-1. Previous research on the economic impact of the CDM

Takeda, Sugino, Arimura, and Yamazaki (2012) analyze the impact of international links between ETSs on Japan. They prepare two scenarios. In the first, Japan has direct links for the trading of emissions with countries obliged to reduce emissions (in Annex B regions). The second scenario includes indirect links. Under the CDM, Japan purchases Certified Emission Reductions (CERs) from countries that are not obliged to reduce emissions (in non-Annex B regions).

In the direct link scenario, because it is currently unclear what form international links will have and which regions will participate, several participation patterns are assumed for countries in Annex B regions, and the results of different patterns are compared and analyzed. In the indirect link scenario, the CER supply volumes are set exogenously. In the future, because it is uncertain how many CERs will be supplied, several patterns of CER supply volumes are hypothesized, and the results are compared and analyzed. The calculations employ the dynamic CGE model of Takeda *et al.* (2012). The data cover the 129 Global Trade Analysis Project (GTAP8) regions and 57 industrial sectors, which are integrated into 12 regions and 22 sectors. The simulations use the general algebraic model system (GAMS) program.

The setting of emissions quotas is usually thought to reduce production activity and thus have a major negative impact on production volumes, particularly for industries that export energy-intensive goods. However, the results of Takeda *et al.* show that the negative impact on production volumes in such industries is drastically reduced if there are international trading links in both the direct and indirect link scenarios. Furthermore, in the case of direct links, the negative impacts on GDP and income are reduced for any country that participates in international links, not just for Japan. In particular, a distortion arises when it is more profitable for exporters with emissions quotas to restrain domestic production and sell their emissions allowances than to produce domestically; income increases despite the possibility that ETSs may reduce production and decrease GDP.

2-2. Previous research on the economic impact of the SCM

Takeda, Yamazaki, and Morita (2015) analyze the impact on the domestic economy assuming that Japan adopts the SCM that was described previously. The analysis uses the previously described dynamic CGE model of Takeda *et al.* (2012). However, the GTAP8's CO_2 emissions data are problematic in that emissions for the Japanese steel industry are understated, so Embodied Energy and Emission Intensity Data for Japan Using Input-output Tables (3EID) 2005 beta values are used to supplement the data (Nansai and Moriguchi 2009). The reduction scenario assumes that six regions (Japan, the European Union, the United States, Australia and New Zealand, Canada, and Russia) reduce CO_2 emissions by 10% by 2020 compared to the business as usual (BAU) case. It assumes that Japan's SCM partners are in two regions: China and the rest of Asia. Eight scenarios using different sectors that are subject to the SCM are compared and analyzed.

From a macro perspective, the advantages of adopting the SCM are not large, but the burden is much lighter when the SCM is applied to energy-intensive sectors than when only individual efforts are undertaken. At the same time, discussions on the SCM are encouraged as a means of obtaining the cooperation of the steel industry, which has adopted a standpoint of opposing measures to combat global warming. The results also show that countries with high marginal abatement costs (such as Japan) import credits from those with low costs (such as China).

2-3. Simulations of regional ETSs in Asia

Ban and Fujikawa (2012) further subdivide East Asia to analyze the impact of introducing cross-border ETSs. They use the GTAP-E model to conduct simulations of a hypothetical Asian ETS. The simulations are conducted under three scenarios.

(1) Individual carbon tax (ICT): in countries that are assigned emissions quotas, all of the industries reduce CO_2 emissions by 30%. The reductions are implemented by individual countries' carbon taxes.

(2) Domestic emissions trade (DET): a domestic ETS is created. All of the industries that are assigned emissions quotas are able to participate in their country's ETS. Each individual industry does not necessarily reduce emissions by 30%, but the total emissions

abatement for the industries that are assigned emissions quotas in the domestic market must be 30%.

(3) East Asian international emission trade (IET): this scenario assumes an international ETS in East Asia. This enables countries with emissions quotas to develop an international ETS by trading with each other. It is not necessary for each country to reduce its emissions by 30%, but the total volume of emissions among the industries that are subject to the emissions quotas must be reduced by 30% on the international carbon markets.

The areas analyzed are Japan, China, South Korea, and the member countries of the Association of Southeast Asian Nations (ASEAN).

The results show that the more the trading market for the ETS grows (excluding China), the smaller the GDP loss. In contrast to other regions, the GDP loss is large for China in even the IET case. This is because China has the lowest marginal cost of abatement among the East Asian countries, and in the IET case, where demand for emissions credits increases, a country benefits by reducing its own production and becoming a seller of credits. This suggests the possibility that China will choose not to participate in an international East Asian ETS. The paper notes that the effectiveness of the international ETS overall decreases significantly without the participation of China. The authors then assume that other countries' emissions reductions are fixed at 30%, and they calculate how China's GDP losses and production volumes are affected by altering the volume of CO_2 abatement that is assigned to China. The results show that assigning an abatement ratio of 24% to China causes smaller GDP losses in the IET case than in the Chinese DET case as well, which creates an incentive for China to participate in international ETSs.

Namazu, Fujimori and Matsuoka (2013) assume an increasing impact of greenhouse gas emissions from emerging economies in Asia that are expected to experience rapid economic development in the future. They evaluate the feasibility of achieving global greenhouse gas abatement targets in 2050 on a country and regional basis in Asia. The countries assessed are China, India, Indonesia, Japan, Korea, Malaysia, the Philippines, Taiwan, Thailand, and Vietnam. The Asia-Pacific Integrated Model (AIM)/CGE (basic) model is employed, and the data cover national accounts from the UN (2007), industrial statistics from the OECD (2007) and energy data from the International Energy Agency (2009), which are used to create a social accounting matrix (SAM) and energy balance table. The analysis uses two hypothetical scenarios: a society that actively accepts innovation and change and one that does not. The analysis assesses the feasibility of reaching abatement targets under each scenario and demonstrates that it is possible for individual countries, excluding Japan and Korea, to cut global greenhouse gas emissions in half by 2050 solely through their own individual reductions.

However, emissions trading is essential for Japan and Korea to meet these targets, and the adoption of an ETS would reduce GDP losses.

The common conclusion of the studies discussed above is that when emissions abatement obligations are assigned at a country level, it is better to create an international ETS than to rely on the efforts of individual countries. The point of participating in a scheme is to reduce economic losses and resolve political problems, and there are also institutional benefits. Figure 2 summarizes the key findings of the prior research described above.

On the other hand, the effects of reduced GDP losses from these simulations are not large; they are a maximum of approximately 1.3%. If output losses are more severe than anticipated despite the costly introduction of ETSs, the main industry participants will not be enthusiastic supporters of the introduction of such schemes. Will output losses due to emissions abatement really be that severe? Furthermore, will the introduction of ETSs not result in increases in demand? A new investigation of the overall impacts of these two factors is necessary. Based on data released by MOE (2012), we examine the overall effects of introducing an ETS in Japan on the Japanese economy and the new demand that accompanies the introduction of the scheme using a simple methodology.

Table 2: CGE simulations of introducing ETSs in Japan

	Takeda et al. (2012)	Namazu et al. (2013)	Ban and Fujikawa (2013)	Takeda et al. (2015)
Aim	Analysis of the impact of international ETS links on the Japanese economy	Evaluation of the feasibility of reducing global GHG by half by 2050 on a country and regional basis in Asia	Simulation based on Asian ETS assuming that emissions reductions by advanced nations alone cannot maintain the current climate. Policy implications are based on the results.	Quantitative analysis of the impact of Japan introducing an SCM on the domestic economy
Data	112 global regions and 57 industrial sectors of GTAP7.1 (2004) are integrated into 12 regions and 22 sectors. Data for CO_2 emissions are from Lee (2008) derived from GTAP7.1 and are adjusted using 3EID (Nansai and Moriguchi, 2009)	SAM (2005) and energy balance table created using national accounts (UN 2007), industrial statistics (OECD 2007), and energy (IEA 2009). The data are replaced/reallocated to redress mismatches between the sector definitions, and adjustments are	GTAP7 data are integrated into 12 regions and 12 sectors. CO_2 emissions are from data from Lee (2008-a, 2008-b).	129 global regions and 57 industrial sectors of GTAP8 (2007) are integrated into 12 regions and 22 sectors. The CO_2 emissions data are the original GTAP8 data adjusted using 3EID (Nansai and Moriguchi, 2009).
Model	Multiregional, multisector sequential dynamic CGE model	AIM/CGE (basic) model	GTAP-E Model	Multiregional, multisector sequential dynamic CGE model
Results	International ETS links moderate the negative impacts of emissions regulations on Japanese GDP (largest reduction of 0.56%).	ETSs are needed for advanced countries, such as Japan and Korea, to meet 2050 targets and would reduce GDP losses by a maximum of 1.3%.	Rather than countries reducing emissions using a carbon tax, a domestic ETS would reduce GDP losses by 0.03%, and an international ETS would reduce	Introducing an SCM for the thermal power generation sector would reduce GDP losses by 0.18%.

3. Data and Method

MOE (2012) provides an analysis of how the emission rights trading scheme in Japan can influence domestic products and employment by providing 3 future scenarios in Japan with and without the scheme[5]. Table 3-1 shows those 3 cases, comparing the effects of some patterns of marginal reduction costs, such as 4,500 JPY/t-CO2 or 2,500 JPY/t-CO2, to be equivalent with the

[5] See MOE (2012).

price of external cre dits to determine the effect of using external credits in ETS cases, which are mentioned as case ETS-a, ETS-b, ETS-c and ETS-d in Table 3-2.

Table 3-1　3 cases with and without the Emission Rights Trading Scheme

case	abstract
①fixed technology	Technology level and energy efficiency are assumed to be fixed at 2005 level and be transmitted to the future at same level
②Business as usual (BAU)	Emission trade scheme is assumed not to be introduced, and each agent in this system is assumed to take relative less costly policy to reduce emission.
③Emission trade scheme (ETS)	Emission trade scheme is assumed to be introduced, and emission quota is allocated to each agent in this system, which means mandatory emission reduction is introduced. Also, all agents are assumed to use cost mitigation measures and take policy to reach to the reduction goal.
	MOE（2012）

Table 3-2　Outline of each ETS case

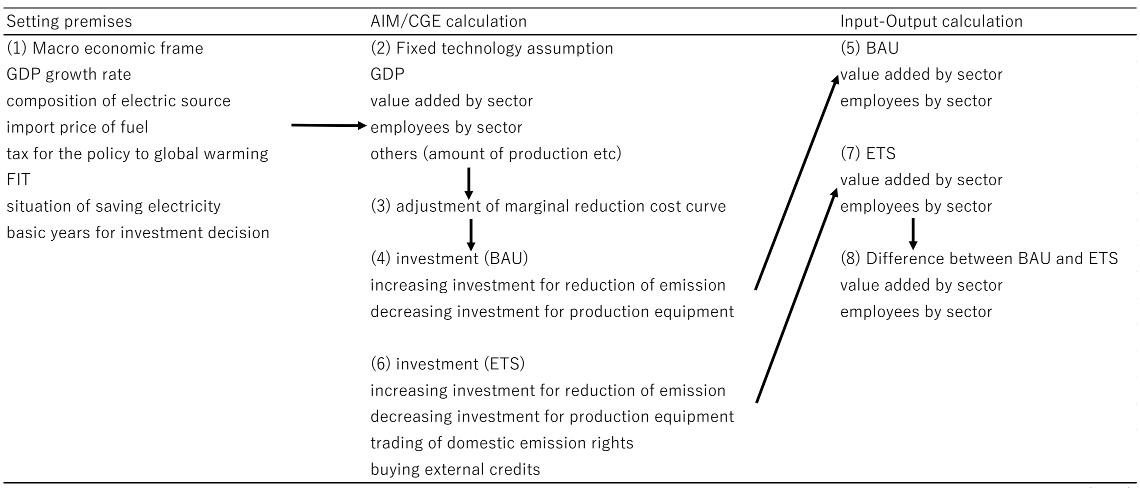
case ETSa	Emission quota (10% reduction) + External credit (2500JPY/t-CO2)
case ETSb	Marginal price and quota setting (4500JPY/t-CO2) + External credit (4500JPY/t-CO2)
case ETSc	Marginal price and quota setting (4500JPY/t-CO2) + External credit (2500JPY/t-CO2)
case ETSd	Marginal price and quota setting (2500JPY/t-CO2) + External credit (2500JPY/t-CO2)

MOE（2012）

Our calculation is based on data released by MOE (2012). We use the marginal abatement cost and data of the investment increment estimated by MOE (2012) and compare our results calculated by the Input-Output Table (2011) with MOE's (2012) results. MOE (2012) estimated both the demand induced by investments in equipment to meet the emission reduction policy and the marginal abatement cost by using AIM/CGE model. MOE (2012) calculated the positive impact of *new increased demand* of the investment to reduce emissions and to introduce equipment for the reduction, and the negative impact by *reduced demand* due to declining investment for new production because of buying external credits and introducing reduction policy (Fig. 3-1).

According to their calculations, we used data of the reduction policy of GHG assumed to be introduced by ETS as the new increased demand[6]. Table 3-3 is a result of the data matching with the Input-Output table for 190 sectors from 2011. We obtained the reduced demand from the summation of the list of reduction costs and additional costs from the BAU case in MOE (2012) [7]. We also allocated the 22 sectors in MOE (2012) into 190 sectors after we first classified each of the 22 sectors into 37 sectors of large classification in the Input-Output table. Second, we allocated them into small classification sectors according to the share of output of each small sector that corresponded to the large classification.

Fig. 3-1 Calculation procedure in MOE (2012)



Note: MOF (2012)

The 2011 Input-Output table we used here is the competitive import type, and equation (1) is a basic model excluding the import ratio.

$$\mathbf{\Delta X = [I - (I - M)A]^{-1} \Delta F} \quad \cdots \quad (1)$$

Here, $\mathbf{\Delta F}$ is an external vector of the change in demand, $\mathbf{[I-(I-M)A]^{-1}}$ is Leontief inverse

[6] MOE (2012), Table 4-6, p.92.
[7] MOE (2012), p.47, 50.

matrix excluding the import ratio and $\mathbf{\Delta X}$ is the induced total output.

We calculated both the BAU case and the ETS-c case (hereafter, simply ETS) as MOE (2012) examined, but with a sector size of 190.

Table 3-3. Policy menu for emissions reduction and investment

policy menu	amount of investment (unit price) (yen/t-CO2)	reduction volume (t-CO2) BAU	reduction volume(t-CO2): additional volume by ETS	total investment under BAU (million yen)	additional investment by ETS (million yen)	industry code	corresponding sector in IO
high efficient air conditioner (except Turbo freezing andabsorption type)	405,571	2,037,682	2,392,062	826,425	970,151	2914	Refrigerators and air conditioning apparatus
Regenerative burner(heat storage burner)	302,540	0	2,280,322	0	689,889	2919	Miscellaneous general-purpose machinery
supre effecitve transformer	1,306,748	218,737	256,778	285,834	335,544	3311	Electrical devices and parts
Invertor compressor	251,753	0	744,484	0	187,426	2912	Pumps and compressors
managing steam trap tube and drain collecting device	46,568	0	3,270,696	0	152,310	2919	Miscellaneous general-purpose machinery
small boiler of collectiong latent heat	115,184	728,565	855,272	83,919	98,514	2911	Boilers, turbines and engines
optimizing control of introducing outside air by CO2 concentration controller	88,087	0	797,606	0	70,259	3332	Electric measuring instruments
control of pump number	518,095	0	106,730	0	55,296	3332	Electric measuring instruments
renewing circulating pump	518,095	0	85,689	0	44,395	2912	Pumps and compressors
enforcement of heat insulation by industrial furnace with high heat insulation materials	50,941	498,624	585,341	25,400	29,818	2919	Miscellaneous general-purpose machinery
energy-saving combustion system in small and medium boiler	47,331	485,924	570,432	22,999	26,999	2919	Miscellaneous general-purpose machinery
efficiency increasing in boiler by exhaust heat collection equipment	137,445	153,713	180,445	21,127	24,801	2911	Boilers, turbines and engines
power recovery of steam turbine in steam decompression line	41,409	454,697	533,775	18,829	22,103	2911	Boilers, turbines and engines
high efficient boiler	237,824	64,076	75,220	15,239	17,889	2911	Boilers, turbines and engines
energy-saving of process line of chemical pulp digesting process by continuous digester	44,041	0	272,683	0	12,009	3014	Daily lives industry machinery
high conversion rate synthesis reactor, and ammonia processing line	12,533	0	950,685	0	11,915	3015	Basic material industry machinery
renewing to energy-saving cooling tower	3,087,385	2,594	3,045	8,009	9,401	2914	Refrigerators and air conditioning apparatus
operating ejecting pressure of compressor	64,142	114,795	134,760	7,363	8,644	2912	Pumps and compressors
high concentration size pressing for paper surface coating	7,652	0	839,676	0	6,425	3014	Daily lives industry machinery
fuel change from NLG heavy oil fired boiler to natural gas fired boiler	2,313	1,799,336	2,112,265	4,162	4,886	2911	Boilers, turbines and engines
declining outside air intake	106,228	29,444	34,565	3,128	3,672	2914	Refrigerators and air conditioning apparatus
updating to invertor stabilizer	181,167	13,844	16,562	2,508	3,000	3399	Other electrical machinery
prevention measures for leakage of air	14,737	158,148	185,652	2,331	2,736	2912	Pumps and compressors
an outside air inlet control system by CO2 concentration	62,799	35,819	42,048	2,249	2,641	3332	Electric measuring instruments
heat recovery system for boiler blow water	9,225	172,759	202,804	1,594	1,871	2919	Miscellaneous general-purpose machinery
reducing blowing aomount of vapor by vacuum distillation apparatus and recycling tower top vapor	4,283	0	407,314	0	1,745	3015	Basic material industry machinery
updating receiving and transforming facility	749,546	1,677	1,968	1,257	1,475	3311	Electrical devices and parts
a rotation-speed control system to fan of air conditioner	100,004	6,261	7,350	626	735	2912	Pumps and compressors
bar built-in drier	1,292	463,121	543,664	598	702	2919	Miscellaneous general-purpose machinery
energy saving fan belt for air conditioner and ventilation fan	101,873	3,302	3,876	336	395	2229	Other rubber products
control device for variable flow rate water pump	86,243	0	4,387	0	378	3332	Electric measuring instruments
control system of ventilating by temperature sensor	33,226	5,125	6,016	170	200	3332	Electric measuring instruments
heat recovery device of thermomechanical pulp	5,479	0	29,607	0	162	2919	Miscellaneous general-purpose machinery
heat insulation decorative boiler and pipe	240,430	0	159	0	38	2911	Boilers, turbines and engines
Total	8,982,189	7,448,243	18,533,938	1,334,103	2,798,424		

Source: MOE (2012) and the 2011 Input-Output table.

Table 3-4 Decline in predicted demand

sector list	(BAU) amount of money in demand decreasing , Unit: one million JPY	(BAU) amount of volume in demand decreasing, Unit: 1,000 t-CO2	(ETS) amount of money in demand decreasing , Unit: one million JPY	(ETS) amount of volume in demand decreasing, Unit: 1,000 t-CO2	sector code (190 sectors)	corresponding sector
Office	-446	28	-936	61	6699	Miscellaneous business services
Retail trade	-219	14	-471	33	5112	Retail trade
Information and telecomr	-318	21	-703	45	5911	Telecommunications
Hotels	-163	10	-356	22	6711	Hotels
Schools	-804	48	-1,610	94	6311	School education
Medical care	-319	20	-658	45	6411	Medical service
Publice service	-129	8	-294	19	6112	Public administration (local)
Gas supply	-197	12	-391	26	4621	Gas supply
Others	-623	37	-1,235	83	6911	Activities not elsewhere classified
Iron	-57365	3109	-149,683	9331	2699	Miscellaneous iron or steel products
cement products	-11426	657	-31,481	1726	2521	Cement and cement products
Chemistry	-19922	1029	-42,212	4564	2071	Medicaments
Petroleum refinery products	-8727	448	-20,993	1373	2111	Petroleum refinery products
Non-ferrous metals	-3259	188	-8,744	416	2711	Non-ferrous metals
Pulp and paper	-7993	839	-15,196	2440	1632	Paper, paperboard
Food products	-2290	123	-5,342	245	1119	Miscellaneous foods
Fabricated textile products	-2150	107	-4,510	189	1521	Wearing Apparel
Plastic products	-1153	60	-2,613	113	2211	Plastic products
Electronic components	-4002	216	-9,266	421	3299	Miscellaneous electronic components
Transportation equipmen	-3557	206	-9,576	450	3531	Motor vehicle parts and accessories
General industrial machi	-3448	195	-8,777	382	2919	Miscellaneous general-purpose machinery
Miscellaneous manufactu	-2718	154	-6,918	301	3919	Miscellaneous manufacturing products
Total	-131,228	7529	-321,965	22379		

Source: MOE (2012) and the 2011 Input-Output table.

4. Results and Implication

4-1 Repercussion effects

Table 4-1 shows the top 30 sectors that experienced an induced positive impact on total demand in the BAU case that we mentioned in Table 3-3 and 3-4. Although the total change in demand in the BAU scenario was 21.6 billion yen due to the increased demand for equipment relative to emission reductions and increased funds from purchases of external credits, as a result, the repercussion effects was -60.2 billion yen in total and the induced multiplier was -2.78. This result means that the total positive impacts to some sectors from the BAU case, which does not use ETS and only uses low-cost policies, could not exceed the total negative impacts to other sectors from decreased demand by emission reductions. Refrigerators and air conditioning apparatus, Electrical devices and parts, Boilers and Engines and Miscellaneous general-purpose machinery ranked higher in the table because these sectors had greater demand in the scenario. Additionally, Wholesale trade, Research and development, Miscellaneous non-ferrous metal products and Miscellaneous business services

Table 4-1 Induced impact of the BAU case

Rank	code	sector	Induced output (net) by BAU case (sum of positive and negative repercussion) unit: one million JPY
1	2914	Refrigerators and air conditioning	914,095
2	3311	Electrical devices and parts	386,982
3	2911	Boilers and Engines	154,670
4	2919	Miscellaneous general-purpose machinery	84,471
5	2729	Miscellaneous non-ferrous metal products	44,853
6	2899	Miscellaneous metal products	35,558
7	5111	Wholesale trade	33,227
8	6322	Research and development	32,131
9	2912	Pumps and compressors	29,269
10	6699	Miscellaneous business services	20,971
11	2631	Cast and forged steel products	15,243
12	6611	Goods rental and leasing (except car	14,489
13	2721	Electric wires and cables	11,378
14	2229	Miscellaneous rubber products	8,172
15	6911	Activities not elsewhere classified	7,744
16	5931	Information services	7,272
17	3299	Miscellaneous electronic components	6,365
18	3399	Miscellaneous electrical machinery	5,504
19	2211	Plastic products	4,412
20	1911	Printing, plate making and book	3,719
21	6632	Repair of machine	2,937
22	3113	Measuring instruments	2,889
23	6599	Miscellaneous non-profit services	2,858
24	3332	Electric measuring instruments	2,790
25	5511	Real estate agencies and rental	2,779
26	5731	Self-transport (passengers)	1,997
27	5781	Packing service	1,887
28	6811	Office supplies	1,760
29	5951	Image information, sound information	1,652
30	5721	Road transport service	1,589
		Total of 190 sectors	-60,165

had relatively large positive effects due to higher Forward Linkage Effects[8], while direct changes in demand in these sectors were negative before the calculation.

Table 4-2 shows the top positive impacts of the ETS case and the total impacts. Here, these results mean additional induced effects that result from the BAU case calculated previously, which is the net repercussive effect induced by the ETS scenario. However, because summation of direct demand change in the ETS case was already negative, the total repercussion effects were also - 1.29 trillion JPY, and the induced multiplier was 3.05. By sector, Refrigerators and air conditioning apparatus, Miscellaneous general-purpose machinery, and Electrical devices and parts ranked higher in the table because the direct demand in these sectors was estimated to be larger. Wholesale trade, Research and development, Miscellaneous non-ferrous metal products and Miscellaneous business services resulted in positive impacts due to the high Forward Linkage Effect, as well as the BAU case.

On the other hand, the sector that was calculated to see serious negative impacts is Pig iron and crude steel. The amount of money was -1.99 trillion JPY, and its absolute magnitude is almost equivalent with total positive effects in Refrigerators and air conditioning apparatus, which is 1.98 trillion JPY in BAU effects plus ETS effects. This means that the ETS would raise substitution in demand between the refrigerators sector and the pig iron sector as a result. The serious negative effects to Pig iron and crude steel look obvious because this sector is the largest sector of GHG emissions.

The tendency of these impacts in the BAU and ETS is generally similar, but there are some exceptions, which have opposite directions of impact between the two. Table 4-3 shows such results. Cast and forged steel products, Miscellaneous electronic components and Plastic products have positive induced effects under the BAU case, while those sector have negative effects under the ETS case. Conversely, Daily lives industry machinery and Basic material industry machinery have negative effects under the BAU case, but positive effects under the ETS case. That means that introducing the ETS would be bad for Cast and forged steel products, Miscellaneous electronic components and Plastic products. These results come from direct demands that are already assumed to be negative in Cast and forged steel products, Miscellaneous electronic components and Plastic products before the calculation of repercussions. The direct demands under the BAU case were also negative in these sectors, but the sum of repercussion effects became positive through the repercussive process. This means that the induced impacts under the ETS scenario in these three sectors are not sufficient to overcome their direct demand reduction due to the introduction of the scheme.

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[8] FLEs in these sectors were 8.2 in Wholesale trade, 3.16 in Research and development, 1.41 in Miscellaneous non-ferrous metal products and 5.63 in Miscellaneous business services, respectively.

Table 4-2 Induced impact of the ETS case

Rank	code	sector	Induced output (net) by ETS case (sum of positive and negative repercussion) unit: one million JPY
1	2914	Refrigerators and air conditioning apparatus	1,071,295
2	2919	Miscellaneous general-purpose machinery	1,028,109
3	3311	Electrical devices and parts	459,852
4	2912	Pumps and compressors	282,955
5	2911	Boilers and Engines	183,159
6	3332	Electric measuring instruments	129,833
7	2899	Miscellaneous metal products	79,138
8	2729	Miscellaneous non-ferrous metal products	68,083
9	6322	Research and development	32,812
10	5111	Wholesale trade	31,548
11	6699	Miscellaneous business services	22,491
12	6611	Goods rental and leasing (except car rental)	17,232
13	3014	Daily lives industry machinary	16,621
14	2229	Miscellaneous rubber products	12,640
15	3015	Basic material industry machinery	10,785
16	6911	Activities not elsewhere classified	7,441
17	5931	Information services	7,403
18	3399	Miscellaneous electrical machinery	6,361
19	2721	Electric wires and cables	5,889
20	6599	Miscellaneous non-profit services	4,273
21	1911	Printing, plate making and book binding	3,077
22	3113	Measuring instruments	2,569
23	5721	Road transport service	2,229
24	6312	Social education and miscellaneous	2,017
25	6811	Office supplies	1,969
26	5711	Railway transport (passengers)	1,441
27	5731	Self-transport (passengers)	1,039
28	5751	Air transport	679
29	5951	Image information, sound information	672
30	5511	Real estate agencies and rental services	663
		Total of 190 sectors	-1,286,841

Table 4-3 Contrasting results in each scenario

code	sector	Induced output (net) by BAU case (sum of positive and negative repercussion) unit: one million JPY	Induced output (net) by ETS case (sum of positive and negative repercussion) unit: one million JPY
2631	Cast and forged steel products	15423	-5390
3299	Miscellaneous electronic components	6365	-13254
2211	Plastic products	4412	-18,775
3014	Daily lives industry machinery	-1,081	16,621
3015	Basic material industry machinery	-1,437	10,785

4-2 Differences with previous simulations

To compare with MOE (2012), we converted our results to the Value-Added based effects that MOE employed by using the value-added coefficient from the Input-Output table (Table 4-4). MOE's result is a total negative effect of 10 billion JPY, while our result is - 653 billion JPY in total. The total repercussion effects are same direction in terms of negative, but there is a large difference in size (643 billion JPY). The different year's IO table that we used in our calculation and different model or assumption for the calculation may cause the difference, but an exact reason is ambiguous so far.

Table 4-4 Comparison with MOE (2012)

	results in MOE(2012), unit: one million JPY	results in this study, unit: one million JPY	difference
positive effecst to Value Added	910,000	3,067,145	2,157,145
negative effects to Value Added	-920,000	-3,720,244	-2,800,244
sum of both effects	-10,000	-653,099	-643,099

In addition, MOE (2012) is assuming that the GDP growth rate averages 1.8 % per year from 2011 to 2020. Therefore, we also calculated the GDP in 2020 by using the same growth rate after we interpreted the total gross value added in the 2011 IO table as the GDP in 2020. The result was approximately 570.8 trillion JPY. Likewise, we can calculated the repercussions to value added in 2020 by using the same growth rate, with resulted in Table 4-4 above. If we obtain the ratio of 2020 repercussions to GDP in 2020, we can interpret this as the GDP growth rate in 2020 by introducing the ETS. The rate was -0.14 %. According to Takeda (2012), the estimated GDP growth rate was -0.72 % if they introduce the ETS only within Japan. Our result is smaller than his estimation although they both show negative growth (Table 4-5).

Table 4-5 Comparison between GDP growths

	Takeda(2012)	This study
GDP growth in 2020	−0.72%	−0.14%

4-3 Influence on employment

By multiplying the repercussions above with employment coefficients, we could obtain the influences on employment by type of worker. Table 4-6 shows the results under the ETS case.

Table 4-6 Effects on employment in the ETS case (unit: person)

	effects to regular workers			effects to non-regular workers			effects to part time job workers		
Rank	Code	Sector	increasing number of employment	Code	Sector	increasing number of employment	Code	Sector	increasing number of employment
1	2919	Miscellaneous general-purpose machinery	35,788	2919	Miscellaneous general-purpose machinery	6,813	2919	Miscellaneous general-purpose machinery	948
2	2914	Refrigerators and air conditioning apparatus	21,770	2914	Refrigerators and air conditioning apparatus	3,955	2914	Refrigerators and air conditioning apparatus	621
3	3311	Electrical devices and parts	13,907	3311	Electrical devices and parts	3,237	3311	Electrical devices and parts	345
4	2912	Pumps and compressors	7,359	2912	Pumps and compressors	1,664	6699	Miscellaneous business services	262
5	2899	Miscellaneous metal products	4,910	6699	Miscellaneous business services	1,107	2912	Pumps and compressors	211
6	3332	Electric measuring instruments	4,311	3332	Electric measuring instruments	889	2899	Miscellaneous metal products	140
7	2911	Boilers and Engines	3,774	2899	Miscellaneous metal products	884	3332	Electric measuring instruments	140
8	6322	Research and development	1,576	2911	Boilers and Engines	407	2911	Boilers and Engines	128
9	5111	Wholesale trade	1,468	5111	Wholesale trade	351	6322	Research and development	66
10	6699	Miscellaneous business services	1,157	6322	Research and development	340	5111	Wholesale trade	48
11	2729	Miscellaneous non-ferrous metal products	1,148	2729	Miscellaneous non-ferrous metal products	203	6312	Social education and miscellaneous educational and training institutions	32
12	3014	Daily lives industry machinary	808	2229	Miscellaneous rubber products	149	6599	Miscellaneous non-profit services	26
13	2229	Miscellaneous rubber products	639	6611	Goods rental and leasing (except car rental)	124	2729	Miscellaneous non-ferrous metal products	23
14	3015	Basic material industry machinery	409	3014	Daily lives industry machinary	95	5931	Information services	18
15	5931	Information services	359	5721	Road transport service	82	2229	Miscellaneous rubber products	18
16	5721	Road transport service	292	6599	Miscellaneous non-profit services	78	6611	Goods rental and leasing (except car rental)	17
17	6611	Goods rental and leasing (except car rental)	289	6312	Social education and miscellaneous educational and training institutions	55	3014	Daily lives industry machinary	15
18	6599	Miscellaneous non-profit services	224	5931	Information services	50	5721	Road transport service	9
19	1911	Printing, plate making and book binding	173	3015	Basic material industry machinery	48	1911	Printing, plate making and book binding	9
20	3399	Miscellaneous electrical machinery	145	1911	Printing, plate making and book binding	36	3015	Basic material industry machinery	8
21	6312	Social education and miscellaneous educational and training institutions	104	3399	Miscellaneous electrical machinery	30	3399	Miscellaneous electrical machinery	5
22	3113	Measuring instruments	92	3113	Measuring instruments	20	6799	Miscellaneous personal services	5
23	2721	Electric wires and cables	78	2721	Electric wires and cables	17	3113	Measuring instruments	3
24	6911	Activities not elsewhere classified	43	6799	Miscellaneous personal services	11	5711	Railway transport (passengers)	2
25	5711	Railway transport (passengers)	37	5711	Railway transport (passengers)	5	2721	Electric wires and cables	1
26	5951	Image information, sound information and character information production	18	6911	Activities not elsewhere classified	4	5951	Image information, sound information and character information production	1
27	5751	Air transport	10	5511	Real estate agencies and rental services	3	5511	Real estate agencies and rental services	1
28	3331	Applied electronic equipment	10	5951	Image information, sound information and character information production	3	6911	Activities not elsewhere classified	0
29	5511	Real estate agencies and rental services	9	3331	Applied electronic equipment	2	5941	Internet based services	0
30	1649	Miscellaneous processed paper products	8	1649	Miscellaneous processed paper products	2	1649	Miscellaneous processed paper products	0
		Total of 190 sectors	44,511		Total of 190 sectors	8,601		Total of 190 sectors	552

As observed in the bottom row in this table, the impacts to employment regardless of the type of worker are positive, although the total repercussions in the ETS case were negative. The total numbers of increasing workers are 53,665 persons. By the type of worker, regular workers are 44,511, non-regular workers 8,601 and part time job workers 552. Sectors that can obtain more than ten thousand workers are Miscellaneous general-purpose machinery, with 43,459 in all type of workers, Refrigerators and air conditioning apparatus, 26,436 and Electrical devices and parts, 17,489, on the one hand. On the other hand, sectors that suffer a declining number of workers, not shown here, are Cement and cement products (-5,048), Pig iron and crude steel (-4,633) and Miscellaneous manufacturing products (-4,336), but each number is approximately 5,000 or less and the total impact on employment is positive. This means that the influence of sectors that suffer a decline in demand by introducing the ETS is relatively small because the absorption capacity of employment is low, while some sectors that can enjoy the benefit from the ETS have a relatively large capacity to increase workers. That is, the ETS can increase employment on the whole[9].

5. Concluding Remarks

In this paper, we examined the impacts of introducing ETSs in Japan. The main conclusions are as follows.

(1) Several previous studies that conducted simulation analyses using CGE models found that when emissions abatement obligations are assigned at an individual country level rather than each country reducing emissions on its own, it is better to establish an international ETS, and participation in the scheme will reduce economic losses.

(2) However, the simulations indicate that the GDP losses are not large. Additional analyses of the costs of introducing schemes and their impacts on demand are necessary.

(3) Based on demand forecast data from MOE (2012), emissions reductions under a BAU case (without introducing an ETS) and the ETS case result in negative repercussion effects in both cases. The negative impact is greater in the ETS case and reaches approximately 1.3 trillion JPY (0.14% of GDP).

(4) The finding of negative repercussion effects in the ETS case is consistent with the findings of MOE (2012). In addition, the negative impact on the forecast of the GDP in 2020 is similar to prior simulations, but the amount is not large.

(5) However, even in the ETS case, there is a positive repercussion effect on employment regardless of employment status. This occurs because the labor absorptive capacity is low in sectors where demand will decrease due to the introduction of an ETS, so there is a small

[9] According to MOE's (2012) estimation, the employment in service-related sectors such as office workers decreased from 24,000 to 7,000 in total, but the result in our calculation is quite limited.

impact on employment, whereas those sectors that benefit from the adoption of the scheme have high labor absorptive capacities.

The results indicate that the introduction of an ETS in Japan would have a positive impact on employment but no major stimulus on output. Furthermore, in reality, domestic emissions trading activity is not active.

The estimates of the marginal abatement costs and the accompanying impact on changes to demand in this paper rely exclusively on forecasts from MOE (2012). However, repercussion effect analyses such as that conducted in this paper depend partially on how the abatement costs are estimated. A limitation of this analysis is the reasonableness of our forecasts of the changes in demand.

In addition, this paper does not address the adjustment of abatement costs by market mechanisms, such as how abatement costs are equalized (or decrease) among the main industry participants via an ETS. This point remains an important topic for future evaluation.

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