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Emissions Trading and International Competitiveness:

Case Study for Japanese Industries

Jusen Asuka[*] Kei-Ichiro Kanamoto[**], and Lu Xiang Chun[***] **December 2010**

Abstract:

Environmental regulatory measures, such as emissions trading system, are popular options adopted by many nations and regions, and how they affect corporate activities and behavior as well as the international competitiveness of industries is of a vital interest to stakeholders. The paper analyzes a number of previous studies on this subject and estimates international competitiveness and carbon intensities of Japanese industries through industry and product level assessment, using the methodology adopted for the analysis of EU's Emissions Trading Scheme (EU ETS). In addition, various options for allocating emission allowances are reviewed in terms of three trade-off factors, such as efficiency, equity and political tolerance. The paper also describes a case study on a hot rolled steel plate manufactured in Japan to determine demand function, price elasticity, substitute elasticity, and domestic and international market shares, using the statistical data on demand-supply trends and price fluctuation. The study also identifies how emissions trading system can affect demand, supply, and trade patterns of a product, and analyzes the range of carbon constraints among nations and regions, which competitor corporations in trading partner nations must face.

The result indicates that:

1) In EU and the United States, the introduction of emissions trading system significantly influences industries with higher carbon intensities and severer international competition, such as iron and steel, aluminum, pulp and paper, fertilizers, cement and lime, and inorganic chemicals. However, the combined share of these industries in Gross Domestic Products (GDP) is less than 2% each for EU and the US, and the expected rise in unemployment rate is less than 2%, assuming that, in the case of the US, emission allowances are allocated at the carbon price of 15 US$/t-$CO_2$ and entire cost increases are passed onto product prices as an opportunity cost.

2) The effects on other industries can be considered less than those sustained by labor cost changes or exchange rate fluctuation.

[*] Tohoku University/Institute for Global Environmental Strategies (IGES)
[**] Tohoku University
[***] Tohoku University

3) The products manufactured by Japanese industries, including iron and steel, cement, petrochemicals, detergents, and pulp and paper, tend to show higher carbon intensities in general.

4) The case study of hot-rolled steel plates manufactured in Japan indicates that changes occurred in product prices, demand-supply situation, and trade patterns following the introduction of emissions trading system are relatively smaller than the changes seen in the past 10 years, assuming that emission allowances are allocated by auction (at the carbon price of 3000 Yen/t-CO2), and entire cost increases are passed onto product prices. The demand for domestic products will decrease by around 3%, which coincides with the conclusions from similar studies on iron and steel products in EU and the US.

5) Considering energy efficiency improvement and energy price hikes in trading partner countries, especially China, the discussion in the past may have over-estimated the risks of carbon leakage that may occur due to differences in carbon constraint levels.

Above findings suggest that the best way to mitigate the risks of Japanese corporations losing international competitiveness might be to adopt a measure similar to those in EU ETS, climate bills in the US, and a bill proposed in Australia that auctions emission allowances, in principle, while offering them free of charge to industries and products that have higher risk of losing international competitiveness, according to the assessment using benchmark method. To be specific, actual measure must select and determine which industries require protection due to their carbon intensities and trade dependencies, and identify actual products and their concrete values to be subjected to benchmark methods in order to ensure efficiency and to reduce administrative costs.

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1. Introduction

1. Introduction

The introduction of an emissions trading system can affect the corporate activities of an impacted industry in many different ways, but their response is inevitably dependant on the following three factors: 1) additional costs incurred in order to comply with the new system, 2) how much of the cost increase can be passed on to product price increases, and 3) whether there are any cost effective, readily available methods to help lower their current emission levels.

If a company can increase prices to cover entire cost increases as an opportunity cost, and market demand does not fluctuate, the introduction of an emissions trading system will not affect its profitability. Realistically, however, market demand most likely fluctuates. Companies that manufacture internationally traded goods may feel restraints in their ability to increase prices due to the fear of losing export opportunities or the rising risk of being taken over by the imported goods of a competitor.

On the other hand, a number of empirical and economic model studies in the past may have overestimated the risks of "losing vigor in corporate activities due to environmental constraints", "loss of international competitiveness due to emissions trading," and "occurrence of carbon leakage." Some studies exemplified the environmental tax and emissions trading scheme (ETS) introduced in the European Union (EU), which actually increased both the profits and production quantities of most of the subjected corporations. (World Bank 2008, Grubb et al. 2009.) It is necessary to discuss thoroughly the quantification of such effects on each nation, system, industry sector, product or corporation.

Despite the empirical data to the contrary, there is a growing consensus among the EU, the US, Australia, and Japan that "the introduction of emissions trading systems leads to the loss of international competitiveness." Now, whether it is true or not, the notion is affecting domestic policies of certain countries. To mitigate any effects on the international competitiveness, some countries are contemplating on measures to protect industry sectors and products that would have their international competitiveness adversely affected by the introduction of an ETS. For example, free allocation of emission allowances to such industries and corresponding trade measures are being reviewed for programs such as the EU ETS, the US's Acts on Clean Energy and Security (ACES), and Australia's Carbon Pollution Reduction Statutory (CPRS).

In this study, we shall formulate a quantitative analysis of how product price increases, induced by the introduction of an emissions trading system in Japan, will affect both producers and consumers. We will reference other studies as well as the three programs instituted in the EU, the US, and Australia. In addition, we shall review the measures used to mitigate any adverse effects, including the methodologies of emission allowance allocation.

For this purpose, Chapter 2 analyzes previous studies on the loss of international competitiveness and carbon leakage. It also describes methodologies used to identify the carbon intensive and/or internationally competing industry sectors that may lose international competitiveness due to the introduction of an emissions trading system. Chapter 3 examines the actual designing of several systems instituted in other countries (the EU, the US, and Australia), their methodologies of emission allowance allocation, and their current situation. Chapter 4 identifies carbon intensive and internationally competing industry sectors in Japan, applying the methods used by the systems previously described in chapters 2 and 3. Chapter 4 also includes a case study of hot-rolled steel plate manufacturing industry in Japan, documenting their price increases in the past, and changes in trade patterns. Chapter 5 discusses actual policy options for Japan when introducing a mandatory emissions trading system, with emphasis on reviewing other countries' policies to mitigate any adverse effects. Lastly, Chapter 6 summarizes the current global situation, and draws conclusions regarding future challenges.

2. Past Discussions

Past discussions

2.1.Environmental constraints and corporate activities

2.1.1. Pollution haven hypothesis and Porter hypothesis

The relationship between the degree of environmental constraints and the impact on the marketplace is an ongoing dilemma. In many countries, such relationships have been used to warn against the introduction of excessive regulatory measures, emphasizing the frequently used expression of "co-existence between environment and economy." Two examples of such a viewpoint are the "pollution haven hypothesis" and the "Porter hypothesis."

The pollution haven hypothesis was developed on the basis of David Ricald's theory of relative production cost which argues that the differences in environmental conservation costs can adversely affect the competitiveness of a nation and/or a corporation. (Frankel 2005) This hypothesis concludes that, in a free-trade world, polluting corporations tend to gravitate to the nations with the most lenient environmental regulatory measures, leading to concerns that a country with stricter environmental measures may lose international competitiveness, thus resulting in carbon leakage to other nations.

Critics of this hypothesis state that "corporate management decisions are not so short-sighted," especially are those made by corporate managers in energy intensive industry sectors requiring colossal investments in facilities and manpower. Such managers exert substantial time and effort in determining what regulatory measures may be required at possible future sights of operation. Corporations in such industry sectors are not likely to make a short-sighted investment, and there are many empirical studies which support such a viewpoint. (For example, Jaffe et al. 1995, Greenstone 2002, and Cole and Elliott 2005)

The Porter hypothesis goes beyond such criticism to the pollution haven hypothesis, declaring that "properly designed environmental regulatory measures can stimulate technological innovation, leading to cost reduction and quality improvement. As a result, corporations in a country with a forerunner environmental regulatory measure can attain competitive superiority over corporations in other countries. (Porter and Linde 2005) The hypothesis proposes a causal relationship that "introduction of properly designed environmental regulatory measures provides a tangible opportunity for raising the potential of technological innovation which may have otherwise been overlooked - since corporations might not voluntarily make the environmentally optimum selection during their decision-making process." (Itoh, 2003)

The majority of empirical studies support this Porter hypothesis, while studies supporting the pollution haven hypothesis are considerably fewer. (Shimada 2006) Alternatively, recent studies using the econometrics model or general equilibrium model for carbon constraints have indicated that carbon constraints may have a neutral or negative effect on international competitiveness. (IPCC 2001, Cosbey and Tarasofsky 2007, and Weber and Peters 2009)

Care should be taken in generalizing the conclusions of various studies, since each uses different assumptions or conditions, and differentiating the effects of environmental constrains from other factors is fundamentally difficult. (Wiedmann et al. 2008, World Bank 2008)

In this paper, therefore, we will define international competitiveness and carbon leakage, describe the actual designing of emissions trading systems, and review an optimum system using a case study on a specific industry and product.

2.1.2. Definition of international competitiveness

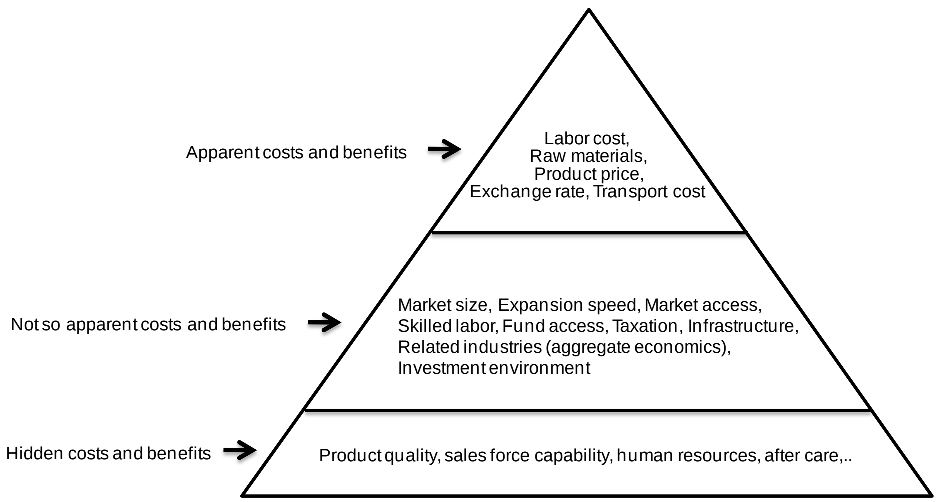
The generally accepted concept of international competitiveness is the definition proposed by Krugman (1994) which says "international competitiveness is a concept applied to an individual corporation, or industry activity, rather than a nation".

It is frequently defined, in general and in theory, as the competitiveness of a corporation or an industry sector having "a capability to sustain profits and market share" (domestic and international). (Reinaud 2005a)[1]

If the production cost of a corporation rises in comparison with its international competitor for any reason, such as the introduction of an emissions trading system, that particular corporation is going to face a disadvantage in price competition in domestic and overseas markets, possibly resulting in a loss of profits and market share. Loss of profit will further reduce the motivation for new investment, and may lead to an increase in unemployment.

However, international competitiveness is affected not only by "raw material cost"2 involving the cost to purchase emissions allowances, but also by changes in other costs: for example labor costs, product sales prices, exchange rate, etc. In addition, the management decision on new operation sites and new investment is strongly influenced by market access, financial access3, presence of related industry sectors4, transportation costs, raw material procurement costs, skilled labor, taxation, infrastructure cost, investment in environment etc. (Sijm et al. 2004, Aldy and Piser 2009) International competitiveness may also be affected by other intangible qualitative factors such as product quality, sales force capability, human resources and after-care services. (Figure 2.1)

Figure. 2.1 Factors considered in corporate management decision-making for new operation site selection



Source: Prepared by authors

[1] Japan Machinery Center for Trade and Investment defines international competitiveness as the multiplication of business profitability and world market share and has analyzed the competitiveness of about 300 companies in the world. The analysis result indicated that the delay in the development of business strategy and the lagging market exploration in emerging countries can be the factors for a loss of competitiveness.

[2] Emissions allowance purchasing and raw materials purchases are similar in cost to a company that purchases emissions allowances for actual use; allowing such costs to be classified as "inventory of raw materials and storage."

[3] Generally speaking, energy consuming industries are capital intensive.

[4] This is due to the so-called "agglomeration economies".

There are considerable differences in the views of government policy-makers and corporate management in terms of international competitiveness. For example, if a corporation manufacturing a product in its own country produces the same product in a different country, the policy-makers of its own country tend to consider the move as a loss of competitiveness. With corporations becoming increasingly globalized, business management of many corporations consider the move to another country as “the success story of overseas investment” for their company, in terms of cash flow improvement, as well as capital increase.

It is important to recognize that a number of factors can influence “international competitiveness.”

2.1.3. Definition of carbon leakage

Generally, the size of carbon leakage is defined as follows: (IPCC 2001)

Formula 2.1.

Ratio of Carbon Leakage (%)

$$= - \Delta CO_2N / \Delta CO_2M \times 100$$

Here, ΔCO_2N is the increment of CO_2 emissions in a country (or region) M with greater carbon constraints, and ΔCO_2M is the decrease of CO_2 emissions in non-carbon constraining country (or a region) N.

The fundamental presumption for the occurrence of carbon leakage is the presence of a country or region with different stringencies in carbon constraints than other countries or regions. Another presumption is the change in production cost incurred by a corporation of region M (with greater carbon constraints) that may lead to a change in trade patterns (in the short term) or in decision-making for new investments (in the long term), and hence to a possible loss of international competitiveness.

In view of net global emission volume, the differences in energy efficiency play a significant role. For example, if a corporation transfers 100% of their production quantity to region N, where energy efficiency is inferior to that in region M, then the carbon leakage will be greater than a value of 100%. If both regions have similar or equivalent energy efficiency, or region N has better energy efficiency than region M, the production transfer will not lead to increased global emissions - although it will result in the loss of international competitiveness and production leakage. It would be considered, however, as having had no carbon leakage.[5]

If carbon leakage registers as a negative number, as described later, it is called spill-over, initiating a transfer of energy saving technology to other countries or regions. Such spill-over effects will eventually lead to an emissions reduction in region N.[6]

2.2. Loss of international competitiveness and the channels of carbon leakage

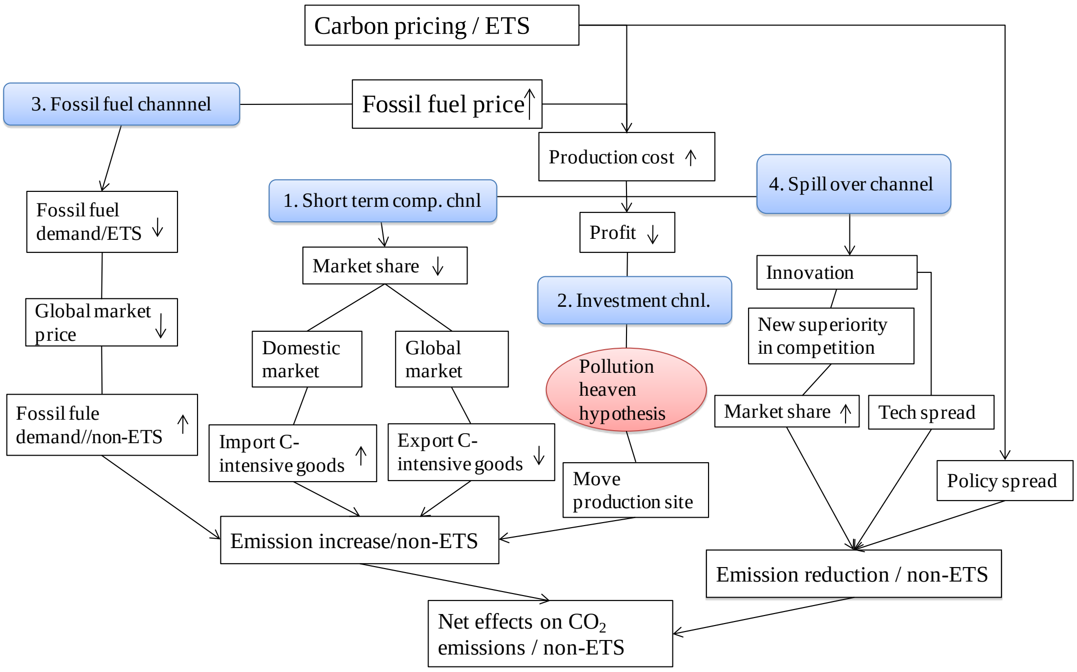
A channel or a system that leads to the loss of international competitiveness and carbon leakage can be: 1) short term competition channel, 2) investment channel, 3) fossil fuel channel, or 4) spill-over channel. (Figure 2.2)

2.2.1. Short-term competition channel

When the product of a corporation in an energy intensive and internationally competitive industry looses market share to a corporation that is not subjected to carbon constraints, the former corporation is also loosing a percentage of its domestic and international markets. This is the channel called short-term competition channel. Many analysis and institution designs today use only this short-term competition channel on their subjects. (Figure 2.3)

[5] This is what EU Commission defined.(de Bruyn et al. 2008)
[6] Sijm (2004) defines carbon leakage as “negative spill-over.”

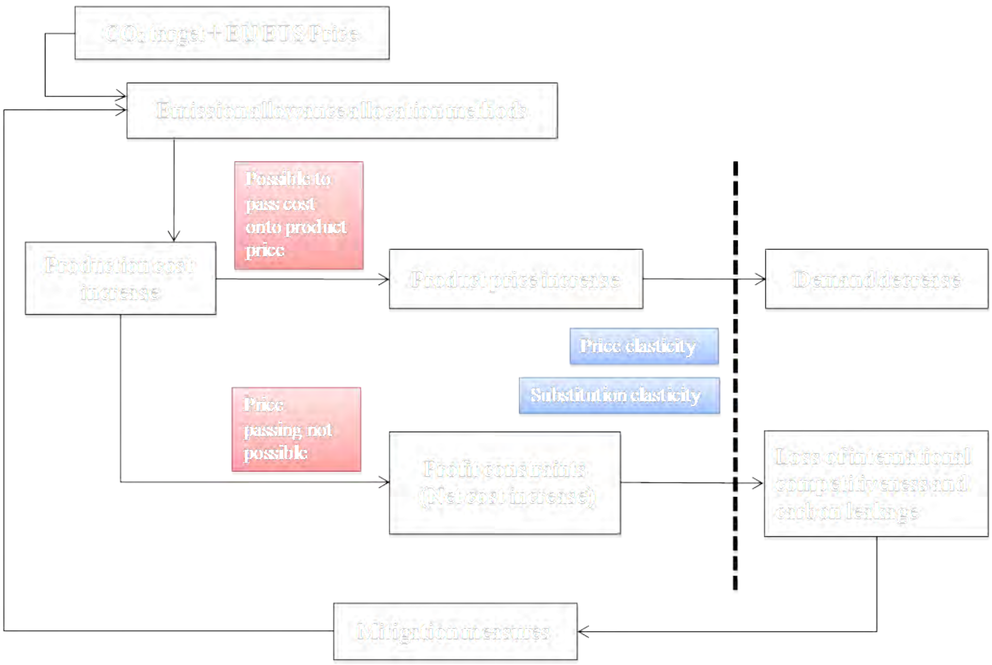
Figure 2.2. Four channels of losing international competitiveness and carbon leakages



Source: Renaults (2005a) and Droge (2009) modified

Note: ETS – Those countries and regions with emissions trading system introduced, non-ETS – those countries and regions without emissions trading system

Figure 2.3. Mechanism of carbon leakage and loss of international competitiveness



Source: de Bruyn et al. (2008) modified

2.2.2. Investment channel

When selecting a new factory site, corporations in energy intensive and internationally competitive industries tend to choose countries with fewer carbon constraints. However, as discussed above, numerous factors influence the decision-making for major investments or factory construction; not just environmental constraints and energy costs. On the other hand, newly built facilities in less regulated areas are not necessarily less energy efficient. Unfortunately, due to the longer time-frames in investment decision-making, there are only a few studies and quantitative analysis on this subject.

2.2.3. Fossil fuel channel

Fossil fuel channel is where a corporation in a country with carbon constraints reduces the consumption of fossil fuels, which in turn lowers global prices. Lower fossil fuel prices, in turn, increase overall fossil fuel consumption in the world hence increasing global greenhouse gas emissions. Only a few studies have reviewed the difficulty of differentiating demand-supply change due to carbon constraints from such factors.

2.2.4. Spill-over channel

This is negative carbon leakage as described previously. It is a channel through which carbon constraints induce technology to change[7], while promoting the gradual scale-up of a carbon intensive industry, leading to a gradual decrease of production costs. As a result, a corporation in a country with stricter environmental constraints may become a stronger competitor internationally. A spill-over channel promotes technological transfer and diffusion in both software and hardware, so even a country with lenient carbon constraints will find their emission quantities reduced. This is a topic of growing interest and recently there have been more studies initiated on this channel.

[7] Sijm (2004) demonstrated that carbon constraints in the EU actually promoted technology development and transfer in the 3 fields of iron and steel, solar panel, and biomass energy. The relationship between carbon leakage and spillover effects was detailed in Gerlah and Kuik (2007).

2.3. Analytical approaches of previous studies

In this section, we shall discuss previous studies that assessed policy effects of environmental constraints, especially global warming policies such as carbon tax and emissions trading systems. Methods used in previous studies can be classified in one of the following four approaches: 1) General equilibrium model approach; 2) Econometric approach; 3) Partial micro-economic approach; and 4) Partial equilibrium model approach. (de Bruyn et al. 2008)

2.3.1. General equilibrium model approach

It has been a general practice to use Computable General Equilibrium (CGE) models to project and simulate carbon leakage. For example, IPCC (2001) sums up the calculation results of several general equilibrium models to determine the scale of carbon leakage incurred upon the introduction of a carbon tax of 5-20% by year 2020.[8] Still, some studies indicated structural problems in the use of the general equilibrium model as described below (Fujino 2005, Barker et al. 2007, Gerlagh and Kuik 2008):

First, the model is generally used to calculate overall effects on a nation, but it cannot determine detailed effects on each industry sector or product.

Secondly, each model has significantly different sensitivities toward the easiness of capital transfers, price elasticity, and substitution elasticity, and the calculation result of a model is largely dependent on these factors.

Thirdly, the model uses data for one year.

Fourthly, it is ignorant in the effects of technology spill-over.

Fifthly, it does not contemplate on the presence of technologies that provides different emission coefficients in power industry and iron and steel industry.

Sixthly, it does not incorporate actual trends of crude

[8] It determined 5-20％ as central values among all the model results actually reviewed. The actual values showed wider ranges. (Gerlagh and Kuik 2008)

oil prices.

Seventhly, it does not incorporate the effects of emissions trading system introduction.

Eighthly, the model only provides ex-ante analysis and does not make ex-post verification.

Such systemic issues require a certain degree of reservation in the interpretation of analytical results obtained from a general equilibrium model. (Sijm 2004, de Bruyn et al. 2008, Reinaud 2008a)

2.3.2. Econometric approach

Unlike simulation of a general equilibrium model or partial equilibrium model, this approach is used to chronologically analyze ex-post the actual changes in prices and trade patterns that have occurred due to environmental constraints, making it the starting point of many studies on the environment and trade. It is not an appropriate approach to determine overall effects or future prospects of a large scale system, such as EU ETS, but it is a tool to assess how the introduction of emissions trading can affect the profits of a specific industry sector. For example, Sijm et al (2008) indicated, using actual data, that the power industry in the EU received massive windfall profits during the EU ETS introduction by passing the costs along in higher prices. [9]

2.3.3. Partial micro-economic approach

This approach formulates a partially static micro-economic (or meso-economic) analysis based on statistical data and an industrial relationship table. It enables the estimation of any change in performance, such as profitability, due to an increase in actual production cost, as well as the scale of a product price increase in an individual corporation or industry sector. Therefore, this approach has been used to determine carbon intensive industry sectors and their overall effect on the GDP of a country. Typical examples of this approach are the case studies of UK industries done by Hourcade et al. (2007) and Mckinsey and Ecofys (2006), as described later. Many other studies use a similar methodology to analyze situations in other countries (such as Germany, the Netherlands, and the US). This approach, however, cannot incorporate any indirect effects (for example the increase in raw material prices), and has difficulty in quantitatively estimating the scale of carbon leakage. With such limitations, the more preferable use for this approach is in combination with other approaches.

[9] Windfall profit is difficult to define, but it is more common to interpret it as "temporally excessive profits earned without any efforts put forth by the corporation." For details, refer to Box 3.1 of Chapter 3.

2.3.4. Partial equilibrium model approach

Unlike the general equilibrium model approach, this partial equilibrium approach is designed to project the ex-ante effects on individual industry sectors rather than on the overall effects of a national economy or industry as a whole. This approach not only compliments any defects of the general equilibrium model, but also allows the estimation of actual effects on an industry sector that is at higher risk of losing international competitiveness and carbon leakage. Recent studies have proposed many models utilizing this approach. A partial equilibrium model, however, has difficulty incorporating any positive economic effects on a national economy or industry sectors. It frequently resorts to the adoption of unrealistic presumptions similar to the general equilibrium model, therefore, reservations should be taken to portray any results in very generalized terms when using this approach.

2.4. Analysis of EU's environmental tax, EU ETS, and the US's ACES bill

This section describes the contents and outcome of recent case studies from the viewpoint of the four approaches mentioned in section 2.3: the general equilibrium model, econometric, partial microeconomic, and partial equilibrium model. The subjects of these studies are: 1) EU's environmental tax, 2) the EU ETS, and 3) the US's ACES bill

2.4.1. EU's environmental tax

Sijm et al. (2004)

Sijm (2004) formulated an empirical analysis relating the effects of EU's overall environmental policies on corporate activities in the energy intensive industry sectors, with emphasis on selection of new operation sites. They concluded that the impact of carbon or market constraints was less than those of other factors such as scope of market demands, labor costs, and transportation costs. They found it difficult to compare results from the general equilibrium model with the empirical analysis as the former was designed to project the future, while the latter identified events from the past.

Barker et al. (2007)

Barker et al. (2007) analyzed ex-post, using the quantitative economic approach, whether environmental taxes unilaterally introduced (and enforced from 1995 to 2005) in six EU member countries (Denmark, Germany, Netherlands, Finland, Sweden, and UK) led to any carbon leakage. The results indicated that only extremely low carbon leakage occurred in association with the introduction of environmental taxes. Surprisingly, in some cases, they found a so called spill-over effect had created a negative leakage.

World Bank (2008)

World Bank (2008) declared that the EU's environmental taxes were causing a significant adverse effect on the cement industry sector. In other industry sectors, however, they found the taxes had led to production volume increases and, in the case of the paper industry, export volume increases as well. After analyzing the data they reasoned production volume had increased because the tax return system, incorporated as a form of governmental indemnification, acted as a subsidy, thereby causing some industrys' production to increase.

2.4.2. EU ETS

The relationship between the EU ETS, international competitiveness and carbon leakage has been analyzed by various studies. Some reviewed overall institutional effects on the economy, and others assessed changes in the profitability of individual corporations. The most representative studies are described below in chronological order.

Reinaud (2005a, 2005b)

Reinaud (2005a, 2005b) identified the historic trend of international trade patterns among energy consuming industries. Based on statistical data, they estimated how the EU ETS affected each industry sector using the partial microeconomic approach. According to their study, when the price of power was estimated to rise by 21%, 1) the aluminum industry would suffer the largest impacts in terms of production cost increases, followed by the cement, iron and steel, and newspaper printing industries; and 2) if the cost increases were passed on, with a sales price increase of 5%, it would cause a 6% decrease in demand.

Mckinsey and Ecofys (2006)

Mckinsey and Ecofys (2006) identified the effects the EU ETS introduction had on corporate profitability by estimating production cost increases using the partial micro-economic approach. The study presumed that power generation industries would purchase emission allowances by auction and could pass on 100 % of any cost increases by raising power prices. Other industries would have 95% of their allowances allocated free of charge through a grand-father clause. Their conclusion indicated that industries as a whole would suffer few effects in the short to mid-term. The results of their sector-specific analysis are as follows:

- The power industry sector would find their profits increased (though they may differ significantly, depending on the ratio of their free-of-charge allowance allocation)
- In the iron and steel industry sector, the effects

would be larger for blast furnaces, and smaller for those with electric furnaces.

- For the pulp and paper industry sector, a free-of-charge allocation could mitigate the effects to a small degree, depending on the paper manufacturing methods used.
- Effects on the cement industry sector would largely depend on the ratio of allowances allocated free of charge, and their ability to pass any cost increases on by raising sales prices.
- Effects on the petroleum refining industry sector would tend to be neutral overall.
- The most significant impacts were projected for the aluminum industry sector - especially in new aluminum plating.

Stern (2007)

Using the partial micro-economic approach and industrial relationship analysis, Stern (2007) concluded that carbon intensive industry sectors, such as oil refining, coal, paper, iron, fertilizer, transportation, chemicals, plastics, and non-ferrous metals were most likely to be affected by the introduction of the EU ETS. Since these industry sectors have a higher ratio of inter-regional trades within the EU however, the potential for production quantity leakage and carbon leakage to other non-EU regions would be small.

Hourcade et al. (2007)

Hourcade et al. (2007) by Climate Strategies Group used the partial micro-economic approach to calculate emission allowance purchasing costs against gross value added for the various carbon intensive industries to identify vulnerable energy-consuming corporations.[10] The results of their individual industry sector analysis are summarized below:

- The aluminum industry has a higher than average intensity of carbon emissions.
- The cement industry also has higher carbon intensity, but suffers fewer effects from the EU ETS introduction due to their lower trade intensity.
- When emissions allowances are auctioned off, cement and power industries have the ability to increase their profit margins by raising product prices. Aluminum industry, on the other hand, can barely maintain their profit margins.
- Among the chemical industry sector, non-organic chemical companies suffer a greater impact than others due to a higher intensity of carbon emissions.

Carbon Trust (2008a)

Carbon Trust (2008a) concluded that, according to the combined results of the partial micro-economic approach and partial equilibrium model study, the industry sectors to suffer the largest effects of an emissions trading system introduction, whether in the US or the UK, would be the five sectors of iron and steel, aluminum, pulp and paper, cement and lime, and inorganic chemicals, due to higher carbon intensive emissions and stronger international competition. However, it also indicated that: 1) these industry sectors represent only 0.5% of GDP for either the US or UK; and 2) the effects of an emissions trading system introduction on product prices and competitiveness could be less than the effects of international labor cost differences and exchange rate fluctuation.

Carbon Trust (2008b)

Carbon Trust (2008b) calculated price elasticity, including changes in production volume, demand, net profit, and carbon leakage. They concluded that the introduction of the EU ETS did cause carbon leakage, but it was less than 1% for industries as a whole. However, carbon leakage in both the iron and steel sector and cement sector exceeded 1%. In the case of the iron and steel industry, demands

[10] There are always some emissions from any product manufacturing processes, but not all energy consuming industry sectors are considered carbon intensive. Note that this study is one of the earliest ones which calculated carbon intensity of industrial plant emissions.

within the EU region were estimated to decrease by 2%, and production quantity by 2.5-9% (depending on price elasticity of the various iron and steel products), assuming they could pass along 50% of allowance costs (30/t-CO2 Euro) by increasing product prices. In this circumstance, however, if 50% of emission allowances were allocated free of charge, the net profit of corporations in these industry sectors would stabilize and possibly increase instead.

Sijm et al. (2008)

Sijm (2008) used both the econometric approach and economic model analysis to determine that many power companies earned windfall profits during the first phase of the EU ETS (from 2005 till 2007), though the extent of their profits depended on the environment of competition in each region.[11] Moreover, it proposed a shift toward the auctioning of emissions allowances, greater control of power prices, and taxes imposed on any windfall profits corporations earned in order to reduce similar windfall profits in the future.

De Bruyn et al. (2008)

They estimated the carbon intensity and international competitiveness of each industrial sector in the Netherlands using a methodology similar to the one adopted in Climate Strategies (2007). Furthermore, utilizing interviews, surveys and existing research, they calculated the extent of "net cost price up" to determine the capability of each industry sector to pass along cost increases in the form of higher sales prices,. According to their study, the direct cost of the EU ETS in the Netherlands is about 0.2% of its GDP, assuming an emissions allowance price of 20 Euro/t-CO2, with 50% of that passed along in higher consumer prices. The production volume of industry sectors with a higher carbon intensity and stronger international competition shares only a small portion of the Netherlands' GDP as a whole (except for the iron and steel industries who each have a share of 1.1% of GDP). Their analysis concluded that the individual industry sectors of aluminum, fertilizers, iron and steel, and non-organic chemicals in the Netherlands may have resulted in profit decreases and carbon leakage due to their higher carbon intensity made more acute by strong international competition.

Reinaud (2008a, 2008b)

Reinaud (2008a) summarized the conclusions of previous studies relating the EU ETS introduction and the loss of international competitiveness. It concluded that: 1) in discussing the relationship between international competitiveness and carbon leakage, one must not forget that the purpose of a government's decision to impose carbon constraints is to mitigate global warming, not to hinder the growth and development of industry and private corporations; 2) carbon constraints is only one of many factors considered in a corporate management's decision-making process; and 3) contrary to the predictions of many economic model calculations conducted before the introduction of the EU ETS, no significant effects on international competitiveness or carbon leakage have been realized since its installation. The study revealed that concerns raised by those model projections are, so far, unfounded for the EU ETS.

In addition, Reinaud (2008b) analyzed actual changes in the market of energy consuming industry sectors and indicated that the aluminum industry, consuming colossal amounts of electric power, was at a greater risk than the othere sectors of losing international competitiveness.

Monjon and Quirion (2009)

Monjon and Quirion (2009) assessed institutional design options for the third phase of the EU ETS (such as border tax adjustments, allocations based on actual emissions, and refunds) by creating a static partial equilibrium model (CASE II). Data was used for the three industry sectors of cement, aluminum, and iron and steel in the EU's 27 member countries, as well as outside the EU region. They quantitatively identified the fact that border tax adjustment could

[11] In the UK, power companies were said to earn a one year windfall profit of one billion euro in 2005. (Carbon Trust 2006)

prevent carbon leakage considerably, though such measures might cause a drawback in efficiency.

Graichen et al.(2009)

Using a methodology similar to that of Hourcade et al. (2007) mentioned above, they calculated the carbon intensity of various industry sectors in Germany. As in the case of the UK and the US, they found industry sectors such as iron and steel, aluminum, pulp and paper, fertilizers, cement and lime, and inorganic chemicals at risk of loosing international competitiveness. More specifically, since Germany has higher emissions intensity in the power sector than the UK, they pointed out that power consuming pulp and paper and the inorganic chemicals industry sectors had the highest risk. On the other hand, some products showed higher risks in the UK due to a higher trade intensity, such as oil refinery products.

Kember et al. (2009)

Kember et al. (2009) identified the effects of the EU ETS introduction on nine major companies in the region through interviews and surveys. They concluded that 1) the EU ETS had not caused any significant cost increases, rather other factors such as rising energy costs and a stagnant economy had.; 2) in terms of international competitiveness, they found no significant decreases in production quantity, increases in unemployment, or decline of market shares; 3) the one exception was the power consuming aluminum industry sector, which experienced significant cost increases due to a power price increase; 4) carbon constraint was just one of many factors considered by corporate management, and its weight did not cause any considerable shifts in corporate decision-making; 5) corporations were elevating their capability to monitor and report on greenhouse gas emissions while actually realizing energy saving opportunities; and 6) corporations were more concerned with the future risk of losing international competitiveness, when the third phase of the EU ETS will be put into effect.

2.4.3. US's ACES Bill

The following studies were not calculated to directly analyze the US's ACES Bill except the last one, the US EPA (2009). They are studies based on the assumption that carbon constraints, similar to those depicted in the US's ACES Bill, would be imposed on corporations and industries in the US.

Bassi et al. (2009)

Bassi et al. (2009) analyzed the effects on the four industry sectors of iron and steel, aluminum, chemicals and paper using the partial equilibrium model. They concluded that if carbon constraints would be imposed on the US's domestic products only, the international competitiveness of American corporations would experience a significant negative impact for the next 20 years. However, it also noted that the earlier corporations adopted emission reduction measures, the sooner they could diminish the costs of those measures.

Houser et al. (2008)

Houser et al. (2008) used the partial micro-economic approach to determine the risk of losing international competitiveness among five industry sectors: iron and steel, non-ferrous metals (aluminum and copper), non-ferrous mining (cement and glass), pulp and paper, and basic chemical products. The study examined the ratio of emissions allowance purchasing costs (carbon intensity) to the total shipped value of those industries' products in the US. Their combined carbon emissions equaled about half of all industrial emissions, or 6% of total US emissions. Meanwhile, their share in the US's gross domestic production was only 3% with employees measuring about 2% of the US's total. The study offered discouraging views on the adoption of trade measures to mitigate adverse effects, especially in regard to the border tax adjustment against imports from China. The imports from China had a smaller share of the market (for example, 14% in the cement industry, 7% in iron and steel, 3% in aluminum, 4% in pulp and paper, and less than 1% in the case of basic chemicals) thus making a border tax ineffectual.

Aldy and Pizer (2009)

Aldy and Pizer analyzed effects of the ACES bill on US manufacturers' production levels using the partial equilibrium model. They concluded that the average production volume of the US's manufacturing sector would decrease by 1.3% while demand would decrease by 0.6%, assuming an emissions allowance purchasing price of 15US$/t-CO2. The difference of 0.7% would relocate overseas (production volume leakage), while the decrease in manufacturing jobs would be nearly zero. For the iron and steel, cement, and lime industry sectors that had a 10% or greater carbon intensity (carbon costs / shipped values), the decrease of production volume was 4%, and the decline of demand was 3%, leaving 1% that would relocate overseas. Nevertheless, it was quantitatively proven that the introduction of emissions trading to the US would result in production decreases due to lower domestic demands, rather than production quantity leakage or carbon leakage to overseas.

US EPA (2009)

The US EPA (2009) made an economic assessment of the ACES bill using the general equilibrium model around the time of its submission to Congress. The main feature of the ACES bill was the use of output-based rebating[12] designed to mitigate any loss of international competitiveness. According to this paper, such a feature could minimize production volume decreases in protected industry sectors in comparison with the reference case (i.e. BAU case). However, it would also lower efficiency, leading to a 2% rise in emissions allowance prices - hence passing on the financial burden to the American people as a whole. Such an action would intensify the adverse effects on the US's GDP in the long term compared to a bill without "output based rebating of emission allowances".

[12] In this paper, the production quantity and emissions quantity, to be reconciled ex post at the end of this fiscal year in output, is called "actual production" or "actual emissions". On the other hand, annual production quantity or emissions quantity before this last year are referred to as "historical production volume" or "past volume." Refer to Chapter 3, Section 3.1 Figure. 3.1.

2.4.4. Conclusion

Almost all case studies on the effects of the EU ETS-phase 1 indicated that there were "no adverse effects such as loss of international competitiveness or risk of carbon leakage." Moreover, the analysis of the EU ETS-phase 3, to start in 2013, and the proposed ACES bill in the US, indicated that the industry sector as a whole would not have significant adverse effects. The only exceptions may be in some carbon intensive and internationally competitive industries - mainly iron and steel, aluminum, fertilizers, cement and lime, and in-organics. These studies also identified that within the existing framework of carbon constraints: 1) the effects of carbon related pricing increases would likely cause a demand decrease rather than any production relocation; and 2) job losses due to global warming measures would be less than those job losses already occurring among the manufacturing sectors.

Factors contributing to these conclusions include system design (free allocation, excess allocation, and the presence of cost reducing opportunities), and a competitive environment (range of product prices and profitability). In the US's ACES bill, system design such as the incorporation of an output-based rebate could significantly mitigate the loss of international competitiveness and the potential for carbon leakage.

Nevertheless, many other factors could influence international competitiveness. For example, labor costs, products' sales prices, exchange rates, market access, fund availability, presence of relevant industries, transportation costs, raw material procurement costs, a skilled labor force, tax system, infrastructure costs, investment environment, product quality, capability of sales forces, human resources, and after-care services. Environmental constraints or carbon constraints have, so far, proven to be a very minor factor among them.

Moreover, even if there was production leakage, and new energy consuming facilities relocated to developing countries, those newly built facilities would likely have higher energy efficiency than the average existing facilities in developed countries.

(Refer to Chapter 4, section 4.6). In addition, many of the above case studies did not contemplate spill-over created by international cooperation. If such a factor were to be incorporated, carbon leakage would be reduced significantly.

Still, if stronger carbon constraints are imposed, and allocation by auctioning becomes main stream, there is no denying that carbon intensive and internationally competitive industry sectors will eventually feel the growing effects of it. We must also note there has been no change in the number of corporations entering into long term contracts with power companies to secure power supply. Undoubtedly, the results of previous studies were insufficient to determine long term investment and we need to have a more detailed discussion on system designs as described in Chapter 3.

2. 5. Methods of selecting carbon intensive industries

The most critical factor in determining an emissions allowance allocation method is to select carbon intensive and trade-dependent industries that need protection from carbon leakage, and the possible loss of international competitiveness.

As described in Chapter 3 as well as others, the EU ETS, the US's ACES Bill, and the Australian CPRS utilize a carbon intensity index obtained through the use of formula 2.1 or similar method as the primary index in selecting the protected industries.

Formula 2.1

Carbon intensity = Carbon constraint burden / Scale of businesses and profits of carbon related industry

In formula 2.1, the numerator shows the range of carbon constraint burden expressed in CO2 emissions (direct and/or indirect emissions), and emission allowance purchasing costs for corporations (direct and/or indirect emissions). The denominator shows the extent of industry sectors' business and profits - expressed, optionally, in gross profits, production quantity, shipment amount, business expenses, or profits. To estimate direct and indirect emissions, both the EU ETS and the US's ACES Bill use CO2 emissions and power consumption, assuming 100% of additional costs will be passed on by raising prices. The newest legislation, the Australian CPRS, includes in addition to the above, indirect emissions such as: 1) steam used as an energy resource; and 2) natural gas and its components (for example, methane and ethane) used as raw materials.[13]

Therefore, in the case of the EU ETS, for example, they have selected industry sectors slated for protection based on the risk of losing international competitiveness and the potential to mitigate carbon leakage. The sectors were chosen through primary quantitative screening and allocated an emissions allowance through an auctioning process.[14] Their selection for protected industry sectors was based on both a carbon intensity standard[15] and a trade intensity standard (for example the ratio of import/export levels in domestic production values). The former standard of carbon intensity was obtained from the Net Value Added at Stake (NVAS) for classifying emissions allowance purchasing costs of each industry sector, where incremental costs were passed on as higher power prices, and from the Maximum Value Added at Stake (MVAS) for emissions allowance allocated by auction (between 100% and 70% of allowances) to all industry sectors.

Table 2.3 indicates merits and demerits of each option, for either the numerator or the denominator, of formula 2.1 based on the views expressed by each industry sector representative at the stakeholders meeting for the Australian CPRS bill.[16]

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[13] The bill submitted by the Australian Government considers more details of corporate burden than the EU ETS or US Congress's climate bill does. (Australian Government 2008a, Australian Government 2000b, Australian Government 2009a, and Australian Government 2009b)

[14] Actually, the EU ETS has decided to auction emissions allowances to power companies in it's phase three.

[15] NVAS is the power price increase for a corporation purchasing power from power companies. So, if a corporation is not emitting CO2 except for power consumption, NVAS value is equal to MVAS value.

[16] In Australia, government officials, industry association representatives and NGOs have held meetings to discuss the assessment of each option, including carbon intensities, and have disclosed the proceedings of each meeting in the form of a government bulletin. In EU, they emphasize equity and objectivity in selecting protected industry sectors, and in determining benchmarks. They disclose their decision process on the EU ETS web site from time to time.

Table 2.3. Criteria for selecting carbon intensive industries

		Expla-nation	Merits	Demerits	Supporting governments and entities (Entities shown are Australian only)
Numerator	CO_2 emissions ($t\text{-}CO_2$)	Manufacturing process emissions	Carbon pricing not required	Carbon cost burden unknown	Australian government
	Emission allowance purchase amount (Yen)		Indicate actual cost burden	Depend on emission allowance price fluctuation	EU and US governments
Denominator	Production amount (Sales amount)	Production quantity X Price		Easy to get data. Approximation of Gross Value Added	Australian government
	Shipping amount	Production amount – inventory	Indicate the market supply quantity		US government
	Gross Value Added	Production amount – raw material cost	Indicate constant performance of corporation	Difficulty to get data (Some cases with no data for product)	Australian government, Australian petroleum research institute, construction and forestry and mining labor unions
	Operating cost		Reflect emission allowance purchase cost as sales cost on profit and loss statement	Index such as sales amount is important in new investment decision. Sales cost is more advantageous to capital intensive industry and disadvantageous to labor intensive industry.	Australian Chevion
	Earnings before interest and tax (EBTI)		Help corporations vulnerable to profit reduction due to cost increase.	Not necessarily help carbon constraint sensitive corporations but advantageous to industry with higher profit expectancy rate. Values quite changeable. Sometimes possible to intentionally reduce profits to save taxes.	Australian labor union

Source: Prepared by authors

2. 5. Methods of selecting internationally competitive industries

The second index in quantitative screening is used to determine whether a corporation is exposed to international competition or not. Whether a corporation is vulnerable to international competition can be expressed as standard or index, indicating the possibility of passing along the production cost increase, due to carbon constraints, by raising product prices. It would include: 1) share of internationally traded products; 2) price elasticity and substitute elasticity; 3) import/export price equilibrium; and 4) qualitative assessment of international competition - at present and for the future. (Australian Government 2009a)

The first option, the share of internationally traded products, is determined by the vulnerability of a corporation in an internationally competitive sector using the amount of imports and exports for a product, corporation or industry sector. However, even a product with fewer exports and/or imports may experience changes in trade patterns, depending on the stringency of carbon constraints. On the contrary, a product with a higher share of imports and/or exports may not face any change in trade patterns if it's price is determined by the market.

The second option, pricing elasticity and substitute elasticity[17], is used to determine any changes in competiveness against other companies' products, based on past trends of actual demand vs. price fluctuations. They are effective indices in terms of finding the real potential for passing cost increases on in the form of higher prices. However, time, price levels, and the scope of price changes also influence competitiveness. Realistically, these indices may not be appropriate if the level of the price hikes, due to carbon constraints, will exceed the range of past price fluctuations. Moreover, it is not always easy to obtain statistical data to calculate the values of price elasticity and substitute elasticity.

The third option, import/export equilibrium prices, is used to compare overseas prices to domestic product prices under as much the same conditions as possible. This is achieved by adding export shipment costs and duties after adjusting prices according to current exchange rates. However, prices can be determined by using less transparent institutional factors, such as a long term contract, making it more difficult to consider factors other than price (for example: differences in quality and services).

Lastly, the fourth option, qualitative standards, is an effective index where the quantitative evaluation of export and import amounts is difficult. This index will review the competitive environment of each product in detail including both regulation and non-tariff barriers. Still, the index experiences inherent problems in providing an objective and transparent evaluation, and its administrative costs can be a challenge.

[17] In this paper, price elasticity and substitute elasticity of hot-rolled thin steel plate (one kind of iron and steel products) were calculated for those products manufactured in Japan, as shown in Chapter 4, section 4.3.

As described above, each option has various merits and demerits. In terms of objectivity and simplicity of use, the first option of import and export levels would be the most appropriate. All three of the EU ETS, US's ACES bill, and Australia's CPRS have adopted the standard or scale of trade activities for quantitative criteria in selecting internationally competing industry sectors as their "primary screening" tool.

The standard for measuring trade activity is called trade intensities, which have several definitions and calculation formulas.

Weber and Peters (2009) and Stern (2007) defines the trade intensity of each industry in a region or nation as the share of imports from the total regional supply of a specific industry sector from a foreign region or nation added to the share of exports of the total regional or national demands in the foreign region or nation (Formula 2.2).

$$t_j = \frac{e_j}{y_j} + \frac{i_j}{y_j + i_j - e_j} \qquad (2.2)$$

Here, "*tj*" is the trade intensity of an industry "*j*", "*ej*" is the gross export amount of an industry "*j*", "*ij*" is the gross import amount of an industry "*j*", and "*yj*" is the gross national products of an industry "*j*".

Hourcade et al (2007), which reviewed the effects of the EU ETS introduction, and Houser et al. (2008), which analyzed US's ACES Bill, calculated trade intensities using much simpler formulas similar to Formula 2.3. The EU Commission and the US's ACES bill have also adopted formula 2.3.

$$t_j = \frac{e_j + i_j}{y_j + i_j} \qquad (2.3)$$

More importantly, both formula 2.2 and formula 2.3 have proven that trade intensities have a positive correlation with import and export amounts. (Although the value calculated using formula 2.3 is slightly less than the value calculated by formula 2.2).

3. Design of domestic and regional institutions

3. Design of domestic and regional institutions

3.1. Allocation methods

3.1.1. Efficiency

The process governments use to issue emissions allowances, and to distribute them to CO2 emitting entities, is called initial allocation. This initial allocation method is one of the most difficult processes during the introduction of an emissions trading system, and can influence both efficiency and, potentially, a loss of international competitiveness.

Therefore, we shall first examine various allocation options which have been introduced, or are undergoing introduction in various countries. The assessment will determine any differences in efficiency, or requirements for the "minimum cost to attain target."

Allocation options introduced or under review in Europe, the US, Australia and Japan can be classified into one of four types:

Option 1: Paid allocation (auctioning)

Option 2: Free allocation with a benchmark based on past records

Option 3: Free allocation with a benchmark combining allocation and rebates based on actual emissions

Option 4: Free allocation through a grand-fathered provision

Paid allocation is the method, where a corporation will purchase its required amount of emissions allowances through an auctioning process held by the government. As in the case of carbon tax, monies generated from auctioning becomes part of the national government's revenue.

Benchmark methods for free allocation options are used to determine the amount of emissions allowances based on a standard value (for example, energy/ CO2 emissions per product unit weight), production quantity (past records or current performance), or net operation rate.

Grandfathered allocation determines the amount of emission allowances for the current period by correlating it with past emissions quantities.

Benchmark methods can be assessed in either of two ways, depending on whether they will incorporate differences in fuel types and factory types or not.

Generally, the selection of paid vs. free allocation considers the distribution of allowances, rather than the efficiency of a system. (Montgomery 1972) However, such notion applies only to the simplest methods of allocation. When considering the actual introduction of a free allocation option, the method itself or its rules may lead to so-called "distortion" in a system, preventing the target achievement of minimum cost. Table 3.1 indicates the different levels of efficiency among allocation options to make what we call an "efficiency pyramid".

<Explanation>

Option 1: Most efficient

Option 2a: Allocation is free of charge. When there is a rule to submit emissions allowances to governments upon closure, a company gets an incentive to continue existing facilities rather than closing inefficient facilities. Since this option invites an distortion of obstructing the construction of new facilities, it is less efficient than the above Option 1.

Option 2b: In the case of benchmark method that contemplates on the differences in fuels used and facility types, facilities with higher emissions from fossil fuel use need to purchase more emissions allowances, causing no incentive to transfer to renewable energy, etc., thus lowering the inefficiency, in addition to the efficiency reduction caused by the distortion mentioned above in option 2a.

Option 3a: In the case of allocation based on production volume at the end of the previous period (actual production volume), it provides an incentive to increase production volume further. In addition, the price signal to the market due to the passing of production cost to market price will not be sufficient, so that incentive for energy saving at the demand side will be decreased, further reducing efficiency.

Option 3b: In the case of benchmark method that contemplates on the differences in fuels used and facility types, facilities with higher emissions from fossil fuel use need to purchase more emissions allowances, causing no incentive to transfer to renewable energy, etc., thus lowering the inefficiency, in addition to the efficiency reduction caused by the distortion mentioned above in option 3a.

Option 4: In the case of grand-fathering method, each facility can get additional emissions allowances depending on the past records of emissions, so there will be less price signal to the market due to the passing of cost increase onto market price. In this way, incentives for energy supply side to improve efficiency and fuel shift will be lessened causing decrease of efficiency in addition to the efficiency reduction caused by the distortion mentioned above in option 4.

Table 3.1. Differences in allocation method efficiencies

Allocation options		Impacts	Increase production quantity at existing facilities		Prioritize the continuation of existing facility over building new facility		Decrease energy saving investment and demand. Adverse effects on the promotion of alternatives	
	Option number	Types of distortion	Advantage to big emitters	Increase production	Promote continuation of existing facilities	Advantage to big emitters	Less incentives for demand side reduction	Less incentive for supply side reduction
Paid allocation (Auction)	1							
Free allocation (Benchmark: allocation based on past)	2a	Consider past production /production capacity only			X			
	2b	Consider the differences of used fuel types and plant types			X	X		
Free allocation (Benchmark: Performance base allocation/ rebate)	3a	Consider actual production quantity only		X	X		X	
	3b	Consider differences in used fuel and plant types	X	X	X	X	X	
Free allocation (grand-fathering)	4	Past emission	X	X	X	X	X	X

Source: Grubb et al (2009) and Neuhoff (2009) adjusted.
Note: X indicates direct distortion occurred depending on allocation methods

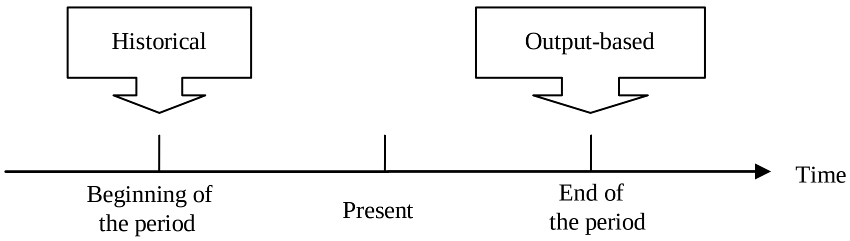
As seen here, each option provides different levels of efficiency due to "distortion" caused by various factors. These factors can be classified into the following five categories:

The first category offers free allocation to new entrants or closed facilities. Such an allocation option may prevent the construction of new and more efficient facilities, resulting in a reverse incentive that would encourage the continued operation of a less efficient facility.

The second involves the further fragmentation of benchmarks where factors, such as the difference in fuel and plant types, are added as the basis for benchmarks offering free allocation. Any facilities that have been using high-emissions fossil fuels may discover they will need to purchase emissions allowances. This could act as a disincentive toward the shift to renewable energy, and discourage efficiency.[18]

The third is the so-called "output-based allocation/rebating". It states that production and emissions quantities at the end of the term shall be construed as the production and emissions quantities for that term. Emissions allowances would then be allocated free of charge based on the benchmark of output.

Figure 3.1. Differences between output- based and historical



<Explanation>

If emission allowances are allocated based on output at the end of the period, then the eventual result of producing and emitting actions taken today (output at the end of the period) will be reflected on the emission allowances for the next period. This will create an incentive to increase production and emission quantities of today. On contrary, if emission allowances are allocated based on the historical records of emissions and production volume, it will not crease such incentive.

Such an allocation option may lead to the problem of so-called relative targets and ex-post adjustment methods[19], providing incentives for corporations to increase production volume before emissions are determined at the end of the term. In this way, it will harm efficiency, and for this reason, EU ETS prohibits the use of "output-based" options. (Grubb et al. 2009)

The fourth category is when the presence of free allocation limits the cost increase to be passed on to prices. This sends only a weak price signal to the market, and provides insufficient energy saving incentives to the demand side, damaging the efficiency of the system.

[18] During the first phase of the EU ETS (2005-2007), France, Germany and Italy made initial allocations of emissions allowances to power generating facilities based on the fuel-specific benchmarks on emission quantities per fuel consumption.

The fifth is when early action is not valued due to the prospects of a grand-fathered provision or a plan to update existing system at a future date. This results in creating reverse incentives which increase emissions quantities from the current level, rather than the expected decrease.

In addition to these 5 categories, we need to consider the possibility of a government's failure to properly utilize revenues from emissions allowance auctioning.

As mentioned later, however, the EU's bill, the US's ACES bill, and the Australian CPRS bill all set rules that give new entrants free allocation of emissions allowances, and if any plant closes, it is to return any emissions allowances to the government. Such rules are set mainly because it is more politically acceptable to corporations. Moreover, the US's ACES bill adopts output-based rebating which protects corporations from losing international competitiveness, while also preventing corporations from earning windfall benefits. [20]

3.1.2. Trade-off relationships

Pros and cons of each allocation option are summarized in Table 3.2

.

Table 3.2. Merits and demerits of allocation

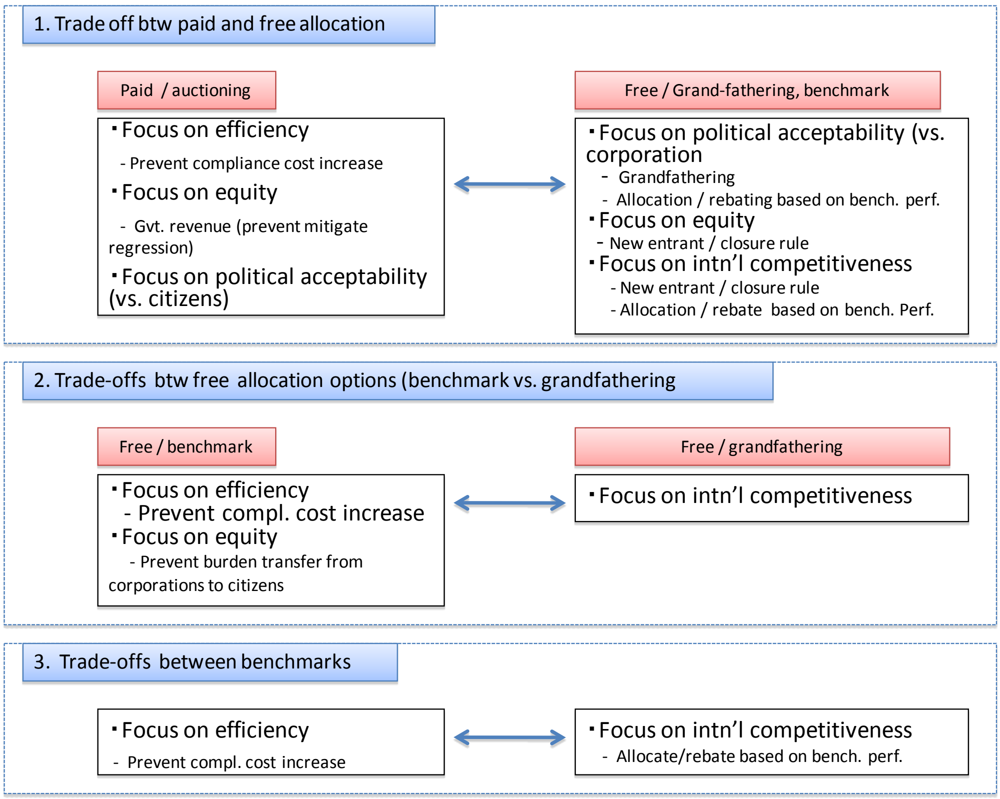
		Contents	Merits	Demerits	Adopting countries
Paid allocation	Auctioning		Economically most efficient (sending out appropriate price signal, minimize national compliance costs). Prevent the occurrence of windfall benefits	Lower political acceptability (for corporations) Possible loss of international competitiveness and carbon leakage	EU ETS, US's ACES Bill, Australian CPRS Bill
Free allocation	Benchmark (allocation based on past records)	Past production quantity X Intensity benchmark	Economically more efficient than Grand-fathering	Economically less efficient than auctioning. No revenue for national treasury. Difficult to determine benchmark values.	EU ETS, Australian CPRS Bill
	Benchmark (allocation and rebating based on performance base)	Actual production volume X intensity benchmark	Higher political acceptability (for corporations) Mitigate the loss of international competitiveness and carbon leakage than the case of benchmark based on the past records. Prevent the occurrence of windfall benefits	Less economically efficient than the case of benchmark based on the past record. Abandon gross volume control. No revenues for national treasury. Difficult to determine benchmarks. Less allocation during economic recession, making compliance more difficult.	US's ACES Bill
	Grand-fatheri ng	Emission quantity in the past	Highest political acceptability (for corporations). Mitigate the loss of international competitiveness and carbon leakage	Lowest economic efficiency. Unfair. Many negative incentives. No revenues for national treasury. Higher probability of windfall benefits	

Source: Prepared by authors

[20] Although gross emissions will increase, there will be fewer emissions allowances available for sale in the market, so windfall benefits will occur less often.

Figure 3.2 further organized allocation methods in view of trade-off relationships among three factors: 1) efficiency, 2) equity, and 3) political acceptability

Figure 3.2. Trade-off relationships among allocation options



Source: Prepared by authors

For example, the efficiency factor described above is the most important element in an emissions trading system, but the introduction of such a system will become more difficult unless political acceptability is addressed. Moreover, political acceptability embraces its own trade-off relationships between acceptance by the general public (residential as well as transportation sectors) and by the corporate industrial sector. If the primary objective is to mitigate the loss of international competitiveness, then free allocation is preferable for corporations. (Demailly and Quirion 2006, Demailly and Quirion 2008a, and Demailly and Quirion 2008b) Yet, such a system will lessen efficiency and make it impossible to attain required targets at minimum expense. (Oka 2008, Neuhoff and Matthes 2008, Fisher and Fox 2009, Takeda et. al. 2009) The allocation system has not yet resolved the problem of distribution of burden, and if emissions allowances are distributed to corporations leniently, citizens as a whole are forced to pay that "debt". On the other hand, if an auctioning system is added, though not readily acceptable to corporations, it would be politically acceptable – especially if those auctioning revenues are used to provide compensation for for price increases to lower income residents.

Furthermore, if new entrants find themselves forced to purchase emissions allowances while existing facilities are allowed to have free allocation, new entrants would likely feel that the system is unfair, or even creating an unlawful barrier, obstructing the legal viewpoint of "freedom of businesses." In view of system efficiency, however, it is certainly preferable to pay allocation to new entrants so they will consider and select lower emissions fuels and technologies. In this way, the efficiency of the system as a whole improves and the target attainment cost for Japan will be minimized. In terms of mitigating the risk of carbon leakage and loss of international competitiveness, the grand-fathered provision is most preferable. Yet, it raises the cost burden for the general population, making it unfair and a unacceptable solution to them. [21]

Driesen (2009) indicated that there were technical difficulties in both the benchmark methods and the grand-fathered method. These technicalities, as well as the massive lobbying activities by the subjected corporations resulted in the delay of any system introduction, continuation, or maintenance, which increased administrative costs, and lowered system efficiency.

With such complex trade-off relationships between efficiency, equity and political acceptability to consider, each nation or region is currently undertaking the task of designing the best system possible for their own unique situation.

3.1.2. Basic framework of allocation methods

As a result of their review of trade-off relationships, the EU ETS, the US ACES Bill, and the Australian CPRS Bill all set up a basic framework of emissions allowance allocation as follows, with only a few slight differences among them.

- Industry sectors, other than carbon intensive and internationally competitive sectors that need protection, shall have paid allocation of emissions allowances in principle. Especially for the power generation industry sector who will pay allocation more dominantly in order to prevent any windfall benefits, although some of their production cost increases are to be passed on to higher power prices.
- For all carbon intensive and internationally competitive industry sectors to be protected, emissions allowances are allocated free of charge, basically through the benchmark method.
- The numbers used in the benchmark method as an efficiency standard (for example CO2 emissions per unit production) shall not be set as fuel- or facility-type-specific.
- For new entrants, free allocation based on the benchmark method will be applied using the same calculation standards as for those existing facilities, to maintain equity.
- In the case of a facility closure, any remaining emissions allowances will be returned to the government.
- The ratio of paid allocation shall be increased gradually.
- Some reduction and rebating measures shall be introduced for lower income residents.

Although the EU ETS and Australia's CPRS use the benchmark method, such benchmarks are based on past records of production quantities for allocation of emissions allowances ex-ante. The US's ACES bill, on the other hand, uses an output-based method to rebate ex-post, mitigating the loss of international competitiveness, and preventing the occurrence of windfall benefits. Moreover, the US's ACES bill is going to allocate emissions allowances to power suppliers, rather than to power generators. In such cases, power generating companies will purchase emissions allowances from power suppliers, but power suppliers will be obligated to use the revenue for Demand Side Management (DSM). In this way, the ACES bill is designed to prevent windfall benefits, control power price hikes, and promote demand side management.[22]

The Australian Government started it's system introduction much later than the others, and indicated in the CPRS bill submitted to its Parliament that: 1) during an economic recession, government will allocate additional emissions allowances free of charge; 2) government will buy back emissions allowances at a set unit price; 3) government will compensate all utility price increases which occur due to the enforcement of the bill, to low income families - especially those on welfare. Thus, the bill is designed to build a more politically acceptable system for both corporations and the general population.

[21] In the US, the media criticized free allocation of emissions allowances to corporations as a give away, though some argued that it would be quite a small amount if considered over the long term. (Starvins 2009)

[22] Since this controls price hikes of electricity and the end user's price, it will undermine energy-saving incentives on the demand side. Therefore, Sweeny et al. (2009) concluded that it is preferable to allow the passing along of power price increases as is, while providing direct income compensation to lower income households in order to achieve emissions reduction targets efficiently.

Box 3.1. Passing along costs and windfall benefits

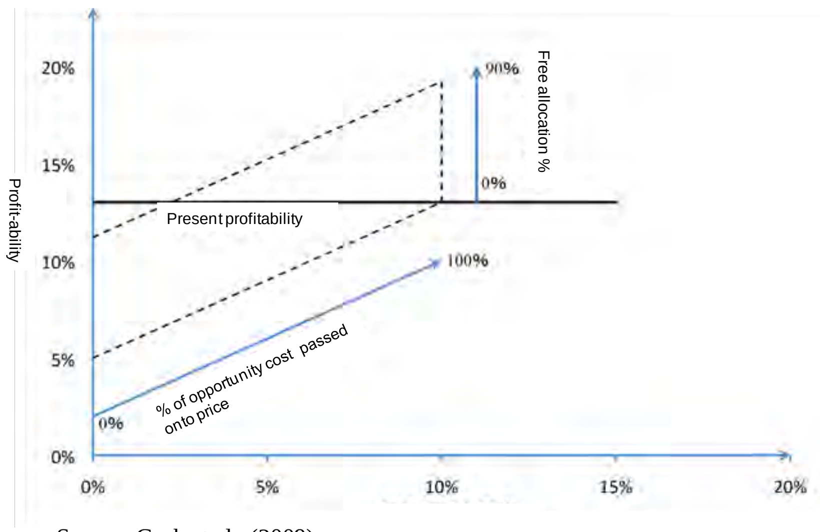
Figure. 3.3 illustrates the relationship between passing along costs and profitability, with the vertical axis showing corporate profitability, and the horizontal axis indicating the end product price hike due to emissions allowance purchases.

When emissions allowance prices are taken as an opportunity cost (profits which are lost by selecting a certain action, rather than other options), corporations will chose to own tradable commodities, whether the allocation from the government is free or not. Corporations then pass the market price of emissions allowances on by increasing their product prices, which is ordinarily an acceptable procedure in commerce. However, this ultimately gives windfall profits to such corporations if 1) if there is no change in market demands; 2) a low cost reduction opportunity exists; and 3) emissions allowances have been allocated in excess.

During the EU ETS's First Phase (2005-2007), many corporations received a free or generous allocation of emissions allowances and passed along their values to higher product prices as an opportunity cost. (Ellerman and Buchner 2008) As a result, almost all industry sectors under the EU ETS earned profits. (Grubb et al. 2009) Power companies in countries with a less competitive environment, especially Germany, the Netherlands, and the UK, raised electricity prices as an opportunity cost, and earned significant profits. (Carbon Trust 2006, Sijm et al. 2008) The fact that the power price decreased by 5-10 Euro/MWh when the price of emissions allowances crashed in May 2006 (price dropped by 10 Euro/t-CO2) proved that power companies had passed on their electricity prices. At that time the electricity price decline could not be linked to price fluctuations of any other raw materials or fuels. However, it was later proven that the ratio of price passing by power companies was between 60-100%. (Sijm et al. 2006)

Nevertheless, power companies received a storm of criticism for earning such colossal amounts of windfall benefits, which was said to have approached several trillion yen. That incident was one of the major reasons why the EU ETS gradually switched allocation methods from free allocation to paid allocation. This fact demonstrates that the allocation issue is actually a distribution issue, and giving generous compensation to corporations will not only damage efficiency, but also raise a sense of unfairness among citizens who see corporations receiving an excessive distribution of national wealth. Criticisms on windfall benefits are heard not only in the EU, but also in the US, where researchers used to point out such defects even as far back as the 1990's. (Cramton and Kerr 1998) Later, during the process of actual system design for emissions trading in the US, policy-makers of the US Government found major challenges in resolving the issue of windfall benefit prevention, regarding the EU ETS as an example of the type of legislation to avoid. (Orszag 2007, Williun-Derry and de Place 2008)

Figure 3.3. Cost increased to be passed onto prices and the profitability



Source: Grub et al., (2009)

3.2. EU ETS

3.2.1. Overall situation

In December 2008, the European Commission submitted the Climate Change – Renewable Energy policy package to the EU Congress and the Council of the European Union where it was discussed, modified and finally adopted. The package contained the EU's own target of a 20% greenhouse gas emissions reduction from the 1990 level by 2020 (if other countries make equivalent efforts, the target could climb further to a 30% reduction). This is equivalent to a 14% reduction from the 2005 level, with the EU ETS industry sectors scheduled to reduce emissions by 21%, while other sectors (residential, transportation and commerce) are to reduce by 10%. (In this case, the 14% reduction was distributed to the EU ETS sectors and non-EU ETS sectors in a way which minimized the sum of the reduction costs for both categories.)

The discussion of allocation methods for the EU ETS's third phase (after 2013), ongoing as of November 2009, indicated that the EU would plan to make an initial allocation of emissions allowances by auctioning, at least in principle. The reasons for selecting paid allocation include a response to the criticism on the windfall profits corporations earned in the past, a way to improve overall efficiency, and the need to reduce administrative costs. Actually, the basic system they plan to introduce will be: 1) for the power sector, 100% of allowances will be auctioned off after 2013; 2) in the case of sectors other than the power sector, 100% auctioning will be done before 2027 (20% auctioning by 2013, and 70% by 2020); 3) initial allocation for new entrants will be directly allocated to such facilities rather than each nation, under the unified rules based on overall quantity in the EU (EU-wide allocation); 4) in order to achieve a EU-wide emissions target of 1.72 billion tons by 2020, the gross amount of emissions allowances distributed each year will be reduced by 1.74% annually after 2021 until 2028, then, this 1.74% reduction per year will be continued; and 5) 88% of emissions allowances allocated by auctioning will be distributed to each nation based on their 2005 emissions quantity, while income from auctioning will become revenue for each national government.[23]

Another major change in the third phase will be the transfer of authority to the EU Commission. (Shinzawa 2009) The initial allocation during the third phase will be done by the central government of the EU, so that each member nation can eliminate the burden of designing it's own allocation plan, as they did in the case of the first and second phases. In addition, 88% of emissions allowances for emissions trading sectors will be distributed to each nation as an initial allocation, but, for the consideration of economic and emissions gaps among the 27 EU member countries, the remaining 10% will be distributed to the 19 lower income member nations.

3.2.2. Measures to mitigate the loss of international competitiveness

As discussed above, the EU plans to adopt allowance auctioning as a dominant method, but they will need to provide free allocation to those "industries to be protected" such as carbon intensive and internationally competitive industries, which are selected based on a certain set of standards. The ratio of free allocation to such industry sectors will be calculated on the basis of benchmarks for "Best Available Technology (BAT), with a maximum of 100%.

The standards that will determine the carbon intensive and internationally competing industry sectors can be either qualitative or quantitative. At first, quantitative standards will be used for rough screening, and when quantitative standards fail to provide the proper answer, or if the corporate side makes an appeal toward selection, then qualitative standards will be used to examine and confirm the selection. Moreover, the standards and selection decisions will be reviewed and verified every five years. Consideration will be made for international

[23] Regarding the EU ETS sectors, individual corporations can expect equal treatment regardless of their location within the EU equalizing competition conditions within the region. However, by distributing more of the auction revenues to lower income nations, these countries gain the ability to provide more compensation. This policy for free initial allocation of emissions allowances is not done to adjust distribution, but to separate distribution adjustment from the initial allocation of emissions allowance. (Shinzawa 2009)

situations such as the results of COP 15 in Copenhagen, and the size of each emissions reduction commitment proposed by each of the other countries. Figure 3.4 and Figure 3.5 indicate such processes.

Figure 3.4. Selection process of protective industries

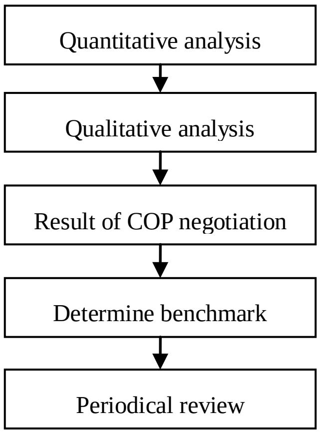
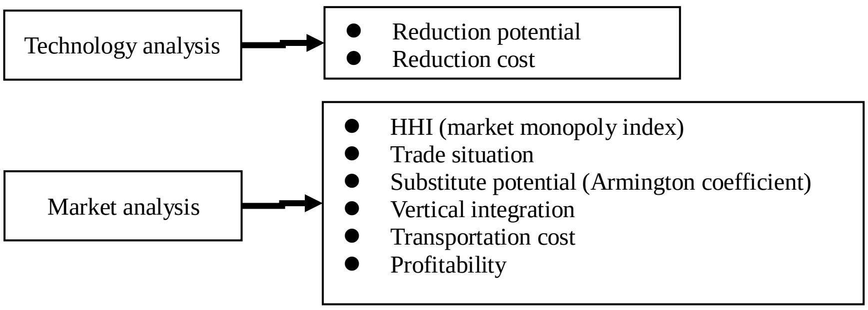


Figure 3.5. Contents of quantitative coefficient



<Explanation on HHI and Vertical Integration>

HHI (Herfindahl-Hirschman index) is a number to indicate a market oligopoly. The larger the number of this index, the larger the market oligopoly causing many companies, other than dominant corporations, to become “price takers;” The potential to pass along price increases will be lower. If the vertical integration number is higher, on the other hand, corporations tend to purchase less mid-product from other companies (procurement within the same company group) in anticipation that they are not likely to find those products substituted by overseas products.

3.2.3. Actual qualification standards

During the third phase of the EU ETS, the Maximum Value Added at Stake (MVAS) of emissions allowance purchase costs will be calculated for every sector, assuming that all emissions allowances will be auctioned off. The following formulas, either (i) or (ii), are used as the conditions for the selection of all protected industry sectors that can apply for exemption/rebating measures.

(i) MVAS > 5% and trade intensity > 10% (30Euro/ t-CO2)

Or

(ii) MVAS or trade intensity >30％

3.2.4. Actual industry sectors that have qualified

Tables 3.3, 3.4, 3.5, and 3.6 indicate the industry sectors that satisfy the above conditions (NACE-4 classification level: 256 sectors) among industry sectors and products that the EU Commission has disclosed.

Table 3.3. Industry sectors with higher direct expenses

	5% GVA < Direct expenses < 30% GVA	30% GVA < Direct expenses	Direct expenses < 5% GVA
Industry sectors	Lignite mining, sugar, oil refinery products, plate glasses, hollow glasses, iron/ferroalloy, iron smelting	Cokes, cement, lime	
Ratio	3%	1%	96%

Source: European Commission (2009b)

Table 3.4. Industry sectors with higher indirect expenses

	Indirect expenses＞5%GVA and trade intensity＞10%	Indirect expenses＞5% GVA and trade intensity ＜10%
Industry sectors	Paper/cardboard, starch and starch products	Limestone mining, gypsum/chalks, brick tiles/calcinated clay products

Source: European Commission (2009b)

Table 3.5. Industry sectors with higher trade intensity

	Trade intensity < 10%	10% < Trade intensity < 30%	Trade intensity > 30%
Number of industry sectors	43	54	134

Source: European Commission (2009b)

Table 3.6. Industry Sectors with GVA ratio (direct expense and indirect expense) of 5% or greater

Name of industry sectors	GVA ratio (direct and indirect expenses) (%)	Trade intensity (%)
Lignite mining	5.26	0.90
Limestone mining, gypsum/chalk	6.11	4.36
Mining (chemical and fertilizer minerals)	>5% and <30%	61.09
Paper, cardboards	7.80	27.21
Cokes	>30%	NA
Oil refinery products	15.06	17.33
Industrial gas production	8.93	4.17
Plate glasses	7.11	21.01
Hallow glasses	8.84	24.32
Cement	59.33	6.87
Lime	45.15	2.56
Iron, steel, ferroalloy	11.26	31.17
Aluminum	11.81	37.99
Iron smelting	11.68	NA

Source: European Commission (2009b)

Here, the size of carbon intensity is defined as the Net Value Added at Stake (NVAS) of each industry sector's emissions allowance purchase cost when the cost increases in the power sector are passed on to higher power prices, or as MVAS when all the emissions allowances are allocated to each industry sector via auctioning. Indirect cost is NVAS, while direct cost will be NVAS subtracted from MVAS. Gross Value Added (GVA) is the net added value.

According to de Bruyn (2009), the threshold of trade intensity was 20%, and that of carbon intensity (in the case of the EU, a ratio of CO_2 cost in GVA) was 8% during the first half of 2008. However, these were mitigated to 10% and 5% respectively through negotiation. Additonsally, the German Ministry of Economy and Industry insisted that both the "cement industry and oil refinery industry should be included in free allocation", resulting in the condition (ii) being added.

Also according to de Bruyn (2009), due to the addition of the (ii) condition on trade intensity, the number of industry sectors receiving free allocation rose to about 140 industry sectors out of a total of 258 (note: as described later, the number ultimately reached 151 industry sectors), and their share of industry sector CO_2 emissions was estimated to be close to 93%.

Several industry sectors received qualitative analysis through the process described in Figure 3.7. Table 3.6 indicates actual names of such industry sectors, their reasons to be selected, and the result of analysis indicating the outcome of the government's decision.

Table 3.7. Industry sectors received qualitative analysis

Industry sectors	Reason for receiving qualitative analysis	Judgment by EU Commission
Plywood	Some early reduction actions. More pressure from international competition	Need protection
Casting technology	Difficult to advance technology. Lower profit margin. Buyer monopoly.	Need continuous review
Textiles	Lower profit margin. More pressure from international competition. Lower vertical integration rate.	Need protection
Plastics	Higher pressure from international competition. Lower vertical integration rate.	Need protection
Bricks, tiles construction materials	NA	No need to protect.

Source: European Commission (2009b)

On September 18, 2009, the Sub-committee on Climate Change among EU Committees announced the list of industries to be protected. According to them, 146 industry sectors met the quantitative qualification among 258 industry sectors in total. Among them 117 industry sectors showed higher than 30% trade intensity, 27 sectors had greater than 5% NVAS and greater than 10% trade intensity, with 2 sectors having greater than 30% NVAS and greater than 10% trade intensity. In addition, 5 industry sectors met the qualitative conditions. Thus, overall 151 industry sectors were selected as sectors to be protected. (EU Commission 2009a)

These industry sectors will each receive 100% of their emissions allowance free, based on benchmarks. Other industry sectors will receive 80% of their emissions allowance free based on benchmarks beginning in the year 2013. The percentage will be reduced yearly to reach 30% by 2020 and eventually down to 0% by 2027.

According to the EU Commission, the emissions of those protected industry sectors would share about 25% of the total emissions from all EU ETS sectors, and about 75% of total emissions from the EU ETS manufacturing sectors.

3.2.5. Future schedules and challenges

If the aforementioned rules proposed at this point will be applied to EU corporations, the number of industry sectors to be protected will exceed 150, allowing too many industry sectors with a large percentage of total emissions, from all industry sectors as a whole who will receive free allocation.[24]

Although the work to identify actual benchmarks for each industry sector or product is proceeding at present, the EU is finding it difficult to make progress due to the differences in industry classifications[25], numerous product types, and regional differences, as well as addressing gaps in technologies and fuel uses among the 27 EU member countries. [26] Therefore, it is actually conceivable that the EU may re-review the protective industry sector selection criteria, as well as the rules of determination, in fear of administration cost increases and efficiency decline.

The EU plans to adopt the list of protective industry sectors, compiled by the EU Parliament, in December 2009 after further discussions are completed in October and November 2009. Then, a decision must be made on the EU regionally common allocation method for the third phase, to be implemented after 2013. It will need to be adopted by the European Commission before June 30, 2011, but discussions must first take into account international situations - for example the extent of the commitments made by the developed countries, and the concerns of the developing countries. More twists and turns in the methods and issues are expected before the final decision is made.

3.3. US's ACES Bill

3.3.1. Overall situation

On June 26, 2009, the House of Representatives passed Bill No. H.R.2454 "the American Clean Energy and Security Act of 2009" (ACES Bill), submitted by Representative Henry Waxman, the Chairman of the Energy and Commerce Committee of the House of Representatives, and Representative Edward Markey, Chairman of the Energy and Environment Sub-Committee, on March 31, 2009. The votes were 219 ayes and 212nays, with 3 abstaining.[27] The major part of the bill defines the reduction target as: 1) reduction of greenhouse gas emissions from sectors covered by a domestic emissions trading system would be 3% by 2012, 17% by 2020, 42% by 2030 and 83% by 2050 in comparison to the 2005 level; and 2) offset credits, that can be used to attain reduction targets, would be 100 million tons per year for each of domestic offset (credits from greenhouse gas emissions reduction projects in non-ETS sectors) and international offset (credits from JI or CDM). In the implementation stage of this bill, the main feature is a linear reduction path, and auctioning from which revenue can be used to self-finance a so-called Green New Deal policy.

3.3.2. Measures for international competitiveness

The ACES bill, which has passed the House of Representatives, incorporates two major mitigation measures: free allocation, and trade measures for both carbon intensive industries, and internationally competitive industries.

- **Free allocation**

Emissions allowances will be allocated to carbon intensive industry sectors free of charge from 2012 untill 2029 with a certain percentage of allowances to be rebated back based on ex-post calculation rather than ex-ante. The quantity of free emissions allowance allocation will be 44.60 % (about 2 billion t-CO2) of the relevant quantity in 2012, and will gradually be reduced to reach 7% (about 0.25 billion t-CO2) by 2029. In principle, free allocation will not be available after 2030. However, if the climate

[24] The EU Commission prepared the list of protective industry sectors for publication in September 2009. For this list, the Commission assumed 70% auctioning rather than 100% auctioning for recalculation. Still, there was no difference in the list of protective industry sectors.

[25] Even if an industry sector was not selected as a protected industry sector at the first screening, they were chosen later since some industry sectors manufacture multiple types of products, a couple of which might have a higher risk of losing international competitiveness. This has been the fundamental problem raised when using NACE or industrial relationship tables for classifying industry sectors. Moreover, there is no statistical data that can be used for any other way of classification than the current one.

[26] In November 2009, the EU consigned Ecofys Co. to recommend products that could be subjected to benchmarks, and the actual number for each. (Ecofys et al. 2009) Refer to Chapter 5, section 5.1 of this paper.

[27] The "Clean Energy Jobs and American Power Act" (CEJAP) bill proposed by Senator Kerry, Chairman of the Senate Foreign Relations Committee, and Senator Boxer, Chairman of the Senate's Environment and Public Works Subcommittee, also passed the Senate Environment and Public Works Subcommittee on November 5, 2009. In this paper, we analyzed the ACES bill only, as both have almost the same contents.

of international trade does not change by then, free allocation will be allowed to continue after 2030. Moreover, they will establish International Reserve Allowances, under which importers will be obliged to purchase emissions allowances.

The most notable characteristic of the US's ACES bill is the introduction of output-based rebating for emissions allowance allocation until 2020, which is designed to minimize windfall benefits and to mitigate the loss of international competitiveness. Therefore, under the ACES system, corporations can receive additional rebates for emissions allowance with any increase in production volume. Some researchers criticize this feature, citing that it may constitute subsidies for production volume increases, and reward lower efficiency. (Grubb et al. 2009, Starvins 2009)

As described above, the US's ACES bill is to allocate allowances not for power generating companies, but power supply companies. Such systems were incorporated to prevent windfall benefits while controlling power price hikes, and to promote demand side control of power consumption. On the other hand, some prefer a system which provides compensation to low income households, rather than controlling power price hikes, as preferable in terms of system efficiency. (Sweeny et al.2009)

- **Trade measures**[28]

When the President determines, at any time during the introduction of the bill, that it has led to carbon leakage, he can 1) review the quantity of free allocation to that trade intensive industry sector; 2) request rebating of emissions allowances upon the importation of products to the US; or 3) take both measures 1) and 2). (Applicable after 2020 only)

However, the above measures are not applicable to the industry sectors which have 85% or more of imports manufactured by a country that fulfills any one of the following conditions:

(i) The country that has ratified the same international agreement as the US, and has committed to the same greenhouse gas emissions reduction program, with the same level of stringency, as the US.

(ii) The country that is a member of a multilateral or bilateral emissions reduction agreement on the industry sector to which the US is also a member.

(iii) The nation where the most recent greenhouse gas intensity of the industry sector is less than that of the US.

In addition to the above, the least developed countries (LDCs) are exempt from these measures, as well as any nation which shares less than 0.5% of the world's greenhouse gas emissions, and less than 5% of imports to the US.

Discussions of trade measures have a long history in the US, and bills presented to the Congress in the past included some form of trade measures. (Asselt et al. 2009). Developing countries, on the other hand, criticized the US's measures as "a new protectionism in the name of global warming measures," and even President Obama expressed concern when the ACES bill passed the House of Representatives. [29]

3.3.3. Actual qualification conditions

According to the estimate made by the US think-tank, Peterson Institute, the industry sectors that meet such conditions are listed as such in Table 3.8. (Houser et al. 2008)

(i) Ratio of energy costs vs. shipped amount, or ratio of emissions allowance purchase costs vs. shipped amount > 5%, and
Trade intensity > 15% (calculated with 20US$/ t-CO2)

Or

(ii) Ratio of energy costs vs. shipped amount, or ratio of emissions allowance purchase costs vs. shipped amount > 20%

The formula to calculate each rebate amount is as follows:

[28] Trade measures are in a way the "last resort", and their very presence has more significance than their actual application. Refer to Chapter 5 Section 5.1 about trade measures.

[29] Since the late 1990's there have been many disputes between China and the US regarding iron and steel products, resulting in petitions to the WTO, and appeals under the US's anti-dumping law. The Chinese side protested against the US while introducing their own export regulation, decreasing the redemption rate of export promotion taxes. For details, refer to the Chapter 5 of this paper, Chen (2008), Houser et al. (2008), and Asuka (2009).

Direct costs: Production (actual) X Average CO2 unit requirement of the industry sector X 0.85

Indirect costs: Power consumption (actual) X power unit requirement of the industry sector X emissions intensity X 0.85

In the case of the US's ACES bill, a second level of rebates was provided, not only for direct costs, but also for indirect costs in addition to the aforementioned output-based rebates. This is the primary difference between the US's ACES bill and the EU's ETS.

Table 3.8. Industry sectors subjected for rebating on actual production base under ACES Bill

Industry sectors					Energy intensity	Carbon intensity	Trade intensity
	Energy	Intermed iate	Indirect	Total	Energy cost /shipment amount	GHG costs /shipment amount	(Export+Import) /(Production+ Import)
Alkali, chlorines	6.2	4.2	8.2	18.6	27.5	8.8	28.5
Aluminium	4.9	6.4	36.7	48	19.4	19.3	67
Iron ore mining	0.7	0	1.2	2	17.3	3.3	26.9
Plate glasses	2.9	0.7	1.1	4.7	17.2	4.2	47.9
Cement	30.8	45.7	8.2	84.7	15	23.6	15.5
Glass containers	2.7	0	2.5	5.2	14.6	3.5	18.5
Nitrogen fertilizers	10.1	28	2.3	40.4	14.2	29.2	85.5
Other brown glass and glass products	3.6	0	1.5	5.2	11.6	3.9	58.2
Corn	14.5	0	4.4	18.9	11.3	5.7	18.8
Mining of copper, nickel, lead, and zind	0.6	0	1.2	1.8	11.2	2.2	25.1
Mining of other metals	1.1	0	1.1	2.3	10.8	2.2	36.7
Other clay products	0.2	0	0	0.3	10.6	3.6	25.1
Tobacco production	0.4	0	0.2	0.7	8.9	1.6	91
Mining of gold, silver and other metals	0.9	0	1.2	2.1	8.8	1.7	20.7
Wool products	2.2	0	2.5	4.7	8.5	2.2	16.8
Fishery	1.5	0	0	1.5	8.5	1.4	96.7
Paper and newspaper production	24.4	0	17.9	42.3	8.3	2.5	29.5
Pulp production	2.7	0	0.8	3.6	8.3	2.5	92.3
All other inorganic chemicals	7.2	5.1	16.7	29	8.3	4.5	58.1
Graphite production	4.9	0	0.4	5.3	8.3	10.5	23
Cotton production	1.1	0	0.6	1.7	8	1.5	62.1
Ceramic walls and tiles	0.7	0	0.3	1	7.6	2.5	63.1
Plywoods	1.6	0	3.5	5	7.3	1.9	30.2
Iron, steel ferroalloy production	91.8	56.6	37.3	185.7	6.6	6	35.7
Wheat production	8.6	0	2.5	11.2	6.3	1.2	36.3
Synthetic rubber	2.7	0	2.3	5	6.2	1.8	40.4

Industry sectors					Energy intensity	Carbon intensity	Trade intensity
	Energy	Intermed iate	Indirect	Total	Energy cost /shipment amount	GHG costs /shipment amount	(Export+Import) /(Production+ Import)
Other organic chemical products	68.5	5.9	17.1	91.5	6.1	3.2	51.9
Other non-ferros metals (except Copper and Aluminum)	0.9	0.8	2.2	4	6.1	2.5	128.7
Artificial dyes	1.1	0	1.9	3	5.7	1.3	46.7
Artificial rubber	1.7	0	1.2	2.9	5.6	1.2	59.9
Carbon graphite products	0.5	0	0.8	1.3	5.5	1.5	50.1
Nuts production	0.3	0	0.5	0.8	5.3	1.1	68
Petrochemicals	19.3	3.6	5.3	28.2	5.1	1.3	15.3
Refractory manufacturing	0.9	0	0.4	1.3	5	1.7	37.1
Pots and porcelain products	1.1	0	0.6	1.7	5	1.7	63
Emissions	323.4	157	185	665.4			
Ratio in US's total emissions, 2006	8.60%	48.90%	7.90%	9.40%			
Rebate quantity	274.9	133.5	157.2	565.6			
Ratio in 2014 emissions	5.44%	2.64%	3.11%	11.18%			

Source: Houser (2009)

The US's Environmental Protection Agency, and Energy Information Agency of the Department of Energy, have made detailed analyses about the system's efficiency, and projected impacts on prices and economy. According to their analysis, adopting ex-post output-based rebating will decrease the efficiency of the system as a whole due to emissions allowance price increases.[30] (USEPA 2009, USDOE2009)

3.3.4. Actual industry sectors that meet qualification conditions

According to estimates made by the US's think tank, Peterson Institute, 35 industry sectors under NAICS 6 digit classification levels will qualify. (Houser et al. 2009) Among them, 26 will be in the manufacturing sector, 4 in mining, and 5 in agriculture. (Table 3.8) These industry sectors represented 9.4% of the US's total CO2 emissions in 2006. If emissions allowances equivalent to 85% of those emissions are given back to corporations as a rebate, then their share will increase to 11.2% of total emissions allowances by 2014, assuming production quantity and efficiency are the same as today. These industry sectors employ 0.3% of the total workforce, and produce about 1.4% of the US's GDP. Therefore, the analysis concludes that "these numbers are not necessarily large in comparison with overall changes. For example, continuous declines in the number of employees are already happening, and are found in all the industry sectors as a whole."

3.3.5. Future schedules and challenges

Supporters of the US Government and the US's ACES bill (CEJAP Bill by Kerry-Boxer, in the case of the Senate) have high hopes for the Senate to pass the ACES bill before COP 15, being held in Copenhagen, Denmark in December 2009. At

[30] Refer to Chapter 2 Section 2.4 of this paper.

present, however, the Obama Administration is facing strong resistance from the American people over the Medical Reform bill submitted to Congress which is overshadowing the ACES bill. It is likewise being criticized for "contributing to big government," an intentional argument developed by opposition groups. In addition, global warming measure opposition groups, supported by fossil fuel industries, are criticizing the bill saying that "an international framework without the participation of China and India is unfair", and "loss of international competitiveness is against the national interests of the US." In view of the possibility of the bill being voted on by the Senate before COP 15, a more pessimistic view of its passing is unfortunately becoming the main stream.

3.4. Australian CPRS Bill

3.4.1. Overall situation

On February 6, 2008, Mr. Wong, the Australian Minister for Climate Change and Water, made a statement on the global warming policies of a new administration, and emphasized a domestic emissions trading system as the core of such policies. On March 17, 2009, the Australian Government announced a draft of the Carbon Pollution Reduction Scheme (CPRS) bill. On May 4, 2009, however, Minister Wong announced a one year postponement for the start of CPRS, delaying it until July 2011, while adding protective measures against a worldwide economic depression.

The allocation method adopted in Australia's CPRS bill is basically auctioning, as is the case for Europe and the US, but it provides free allocation to internationally competing and carbon intensive industry sectors with a gradually decreasing ratio of free allocation. For the first four years from the initial implementation, CPRS will provide emissions allowances (AEU) at a unified price with a government buy-back provision at the same price. This unique allocation method is the most significant feature of the CPRS bill.

The unified price of AEU is as follows:

- From 2011 to 2012 at the initial implementation, all emissions allowances issued shall be allocated at the price of A$10/t-CO2. Corporations will not be allowed to use these AEU for banking purposes.
- For four years after 2012, there will be a price cap of A$40/t-CO2. Additional allocation of AEU will be available in unlimited amounts as long as the corporation pays the current price.

3.4.2. Measures for the loss of international competitiveness

The CPRS Bill refers to internationally competing and carbon intensive industry sectors as Energy Intensive and Trade Exposed (EITE) industry sectors, and emphasizes support for such industry sectors and coal fueled power stations as stated below:

- At the beginning of the system design, about 25% of total emission allowances will be allocated free to EITE industries. If EITE industries grow at the same rate as other industries, about 45% of total emission allowances will be allocated to EITE industries by 2020.
- Among EITE industries, the most affected sectors will receive 90% of emissions allowances free for the first year, with an additional 5% free allocation added, giving those industries a 95% free allocation for the first year.
- Those EITE industries who are less affected would have 60% free allocation with 10% more for the first year, giving them a 66% free allocation.
- The ratio of free allocation to EITE industries may be decreased 1.3% per year, depending on the degree of their contribution toward improving carbon productivity in Australia.
- For the first four years after initial implementation, the government can buy back emissions allowances(AEU) at the unified price of A$10/t-CO2.

In addition, the Australian Government offers a one time free allocation of emissions allowances to the most carbon intensive coal powered plants. On such occasions, the Government will provide about 3.9 billion Australian Dollars for these measures based on the projected initial price of AS$25/t-CO2.

3.4.3. Actual qualification conditions

Industries requesting protection are required to meet either (i) or (ii) stated below:

(i) To receive 90% free allocation: Ratio of CO2 emissions in total sales (Australian dollars) > 2000, or ratio of CO2 emissions in net value-added >6000

(ii) To receive 60% free allocation: Ratio of CO2 emissions in total sales (Australian dollars) > 1000 and < 1999, or ratio of CO2 emissions in net value-added >3000 and < 5999.

In either case, trade intensity must be greater than 10%. However, the Australian CPRS Bill's definition is trade intensity = (Export amount + import amount) / Production amount (formula), which is different from the trade intensity definition adopted by either EU's ETS or US's ACES.

3.4.4. Actual industries that meet the qualification conditions

As of today, the following industries are under review by the Australian Government for protected industry status (Baker & Mckinsey 2009)

90% free allocation category:

Black carbon, methanol, silicon, plate glass, newspaper printing, copper smelting

60% free allocation category:

Glass containers, white titanium

Under review:

Aluminum smelting, aluminum production, Carbamid, chlorine gas/salt solution, pure ethanol, aluminum conjugation, gold, zirconium conjugated gold, magnesium, synthetic ruby

3.4.5. Actual industries that meet the qualification conditions

This CPRS bill passed the Lower House of Australian parliament on June 4, 2009. On June 15, 2009, however, the Special Committee for Climate Policies of the upper house submitted a report that reviewed the economic assessment of the CPRS bill. The report recommended not to adopt the bill unless additional measures were incorporated, such as promotion of methane recovery, and energy policies for provincial governments. Probably because such a report was submitted, the Upper House of Australian Parliament rejected the government's draft of the CPRS bill by a majority of votes.[31] The Radd Administration submitted the bill again in November 2009 and, if rejected again, the Prime Minister may decide to hold a general election, dissolving the current membership of both Upper and Lower Houses simultaneously.

3. 5. Comparison of climate bills in various nations

Table 3.9 summarizes this chapter by illustrating the different system designs of the EU ETS, US's ACES Bill, and Australia's CPRS bill from the viewpoint of selecting industries that are carbon intensive, are competing internationally, and require some degree of protection. The table highlights the following common and contrasting factors.

3.5.1. Threshold of carbon and trade intensities

The EU ETS and the US ACES Bill use MVAS, or an index similar to MVAS, for carbon intensity. The actual thresholds used to identify carbon intensive industries are the same for both at 5%. The thresholds of trade intensities are 10% and 15%, respectively. In the case of the EU, satisfying trade intensity criteria only is sufficient for identification as a protected industry. This allows the EU's system to provide more protection for industries competing internationally.

3.5.2. Positioning of paid allocation (auctioning)

After the EU ETS's first phase - which resulted in giving huge windfall benefits to corporations and setting a bad example of an emissions trading system

[31] The Green Party and the Conservative Party opposed the bill for "too lenient reduction targets". When comparing their situation with a Japanese political scenario, it is like haveing the Liberal Democrats, who lost power, criticize a proposal by Democrats, who have won the election, as submitting a"too lenient reduction target." However, even among NGOs, there are differences in opinion about the assessment of CPRS. For example, WWF is supporting the bill while Greenpeace is opposing it.

- both the US's ACES bill and Australia's CPRS bill are planning to adopt the paid allocation system. It will be offered as the basic option right from the start of implementation. In addition, all three bills plan to use most of their auctioning revenues to subsidize the introduction of renewable energy, and to compensate low income households, thus securing political acceptability among citizens

Table 3.9. Comparison of institution designs among three countries (regions)

	EU ETS	US's ACES Bill	Australian CPRS Bill
Assumed price of emission allowance	30 Euro/t-CO2	20 US$/t-CO2	Not necessary
Precision of industry sector classification	NACE 4 (258 industry sectors)	NAICS 4-6 digit (about 500)	Unknown
Share of industry sectors subjected	151/(total 258)	35/(total about 500) (Manufacturing 26, mining 4, agricultural 5)	17/(total number unknown)
Carbon intensity threshold	MVAS＞5％ (and trade intensity＞10％) (30% or over for carbon intensity alone)	Ratio of emission allowance purchase cost in total shipment amount＞5％ (and trade intensity >15％) (20 % or more for carbon intensity alone)	Ratio of CO2 emission quantity in total GVA>1000 (and trade intensity＞10％)
Trade intensity threshold	10％ or more (30 % or more for trade intensity alone)	15％ or more (zero for trade intensity alone)	10% or more (Zero for trade intensity alone)
Special economic measures	None	None	Yes (90→94.5, 60→66)
Number of classification clusters	2 (protect and not protect)	2 (protect and not protect)	3 (protective industries are further divided into two)
Ratio of CO2 emissions of subjected industrial sectors	93% (of industry total)	9.4% Of US total (year 2006)	
Ratio of number of employees in the subjected industry sectors		0.3% of total number of employees. About 1.4% of the US's total GDP	
Treatment of trade intensity	Important	Regard it with certain degree of importance	Important
Calculation of activity volume	Ex-ante	Ex-post	Ex-ante
Lowering of efficiency		2% increase in emission allowance prices	

Source: Prepared by authors

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3.5.3. Administrative costs

All these countries, and groups of countries, attempt to minimize the benchmark rate in order to lower administrative costs – which would otherwise rise due to the additional technical difficulties and the lack of availability of data. However, it also creates a dilemma, as these factors are in direct opposition with political acceptability. In fact, with a pattern of businesses who are actively lobbying, and with governments making compromises, frequently right before an actual benchmark format is determined, there have been further increases in administrative costs instead.

3.5.4. Efficiency

The US's ACES bill has allowed sacrifices in efficiency by introducing an output-based allowance rebating system. In comparison, the Australian CPRS bill plans a more extensive free allocation system at the beginning, as they set more importance on political acceptability by local corporations.

3.5.5. Reflections on industrial structures

The US has a higher percentage of export/import than the EU. Because of this, the US is more focused on the possible loss of international competitiveness. However, their total import/export amount, in energy-consuming industries, is smaller. Also, jobs and production quantities of the1 manufacturing industry have declined significantly. For this reason, emissions trading is not likely to lead to a production quantity leakage, adverse effects on GDP or employment according to the analysis made by Aldy and Pizer (2009), for example.

3.5.6. Green New Deal

The US's ACES bill sets special importance on investment in energy savings and renewable energy as an economic stimulus measure, and the US Federal Government has high expectations for revenues from paid allocation to fund subsidies for such measures. The EU ETS and Australia's CPRS bill also plan to use auctioning revenues to promote renewable energy introduction. Also, most prominantly in Germany, the revenues provide funding for greenhouse gas emissions reduction projects overseas, with an emphases on developing countries.

3.5.7. Data availability

The Australian CPRS bill uses the carbon intensity formula shown in Chapter 2, Section 2.5, Formula 2.1 of this paper, and the Australian Government recognizes Gross Value Added as a preferable denominator. They have allowed production amount or sales amount also, in view of data availability. (Australian Government 2009b)

4. Analysis of the Japanese industries

4. Analysis of the Japanese industries

4.1. Selecting carbon intensive and internationally competitive industries

This section defines carbon intensity utilizing formula 4.1, together with the same methodology as that used by the EU ETS and others, based on the Hourcade et al (2007) described in Chapter 2 Section 2.5. This method provides the necessary data and information for the selection of those carbon intensive industries and internationally competitive industries which need policy protection.

$$\text{Carbon Intensity} = \frac{\text{Purchasing Costs of Emission Allowances}}{\text{Gross Value Added (GVA)}} \quad (4.1)$$

To accomplish this objective, we obtained the Net Value Added at Stake (NVAS) for each industry by calculating the purchasing cost of emissions allowances (in the case of the Government of Japan, auctioning allowances to the power industry only were used). We also obtained the Maximum Value Added at Stake (MVAS) for each industry by calculating the purchasing costs of emissions allowances, (for the Government of Japan, auctioning allowances to all industry sectors were used). At the same time, we identified the relationship between the trade intensity of each industry and the amount of domestic production.

NVAS, *MVAS*, and trade intensity were obtained by using the following formula:

$$NVAS_i = \frac{\varepsilon E_i}{v_i} \quad (4.2)$$

$$MVAS_i = NVAS_i + \frac{\tau D_i}{v_i} \quad (4.3)$$

$$t = \frac{e_i + m_i}{x_i + m_i} \quad (4.4)$$

Here, E_i was the power consumption of sector i[32], ε was the electric power price increase when emissions allowance price was τ, v_i the Gross Value Added of sector i, τ the emissions allowance price given externally, D_i direct CO2 emissions of sector i, t trade intensity, and e, m, and x were export amount, import amount and domestic production amount, respectively.

Electric power price ε was obtained by the following formula 4.5:

$$\varepsilon = \tau \times \text{Average emission coefficient of all power sources} \quad (4.5)$$

Note that we used the inter-industry relations table from the year 2000 which integrated the various industry sectors into 401 sectors for the calculation of Gross Value Added, export amount, import amount, and domestic production. For CO_2 emissions, we used formulas from 3EID of the National Institute for Environmental Studies which coincided with the 401 sectors of the inter-industry relations table. For power consumption volume, the input-output data from the year 2000 inter-industry relations table that integrated industry sectors into 401 sectors was used. For the average power coefficient of all power sources, we used 0.378 kg-CO_2/kWh - which was the end use CO_2 emissions source unit of the year 2000 announced by the Federation of Electric Power Companies - at the emissions allowance price of 3000Yen/t-CO_2.

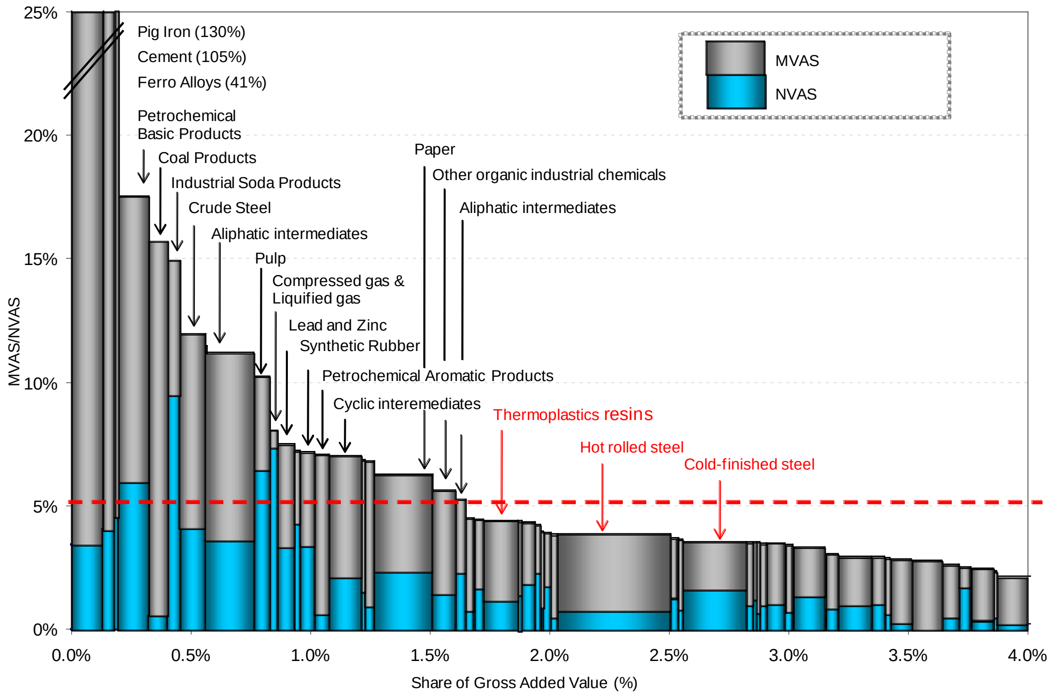
4.1.1. Effects on Overall Industry Sectors of Japan

Figure 4.1 shows the calculation results of carbon intensity for the industry sectors with a MVAS of 2% or greater. The vertical axis indicates MVAS and NVAS, with the horizontal axis showing the share of each industry sector's overall domestic production

[32] The power consumption quantity of the input-output table of the inter-industry relations table can be divided into one of business use, and the other of self powered generation. In this report, we assumed that the electric power for business use was purchased from the grid, and used that data for calculating NVAS.

amount. Industry sectors with a MVAS of 5% or greater are shown with names only. As mentioned above, the analysis described in section 4.1 of this report covers 401 sectors designated under the inter-industry relations table from the year 2000, and assumes an emissions allowance price of 3000 Yen/t-CO_2.

Figure 4.1. Effects on each industry



From this data we find that: 1) the share of industry sectors with a MVAS of 2% or greater of total Japanese production is about 3.2%; 2) the number of industry sectors with a MVAS of 5% or greater is 17; and 3) pig iron[33] and cement sectors have a relatively higher MVAS compared to other industry sectors studied.

4.1.2. Effects on iron and steel related products

Figure 4.2 indicates the carbon intensity of iron and steel related products, with the horizontal axis representing trade intensity.

From this data, we find that: 1) pig iron has high carbon intensity but relatively low trade intensity, 2) ferroalloy has both high carbon intensity and trade intensity, and 3) steel pipes, plated steel and other iron and steel products all have high trade intensity.

4.1.3. Effects on cement related products

Figure 4.3 indicates the carbon intensity of cement related products, with the horizontal axis representing trade intensity.

From this, we find that: 1) carbon and graphite products have a high trade intensity; 2) cement has a higher carbon intensity, but relatively lower trade intensity.

[33] The reason Japanese pig iron indicates a higher MVAS than those in the EU and the US, obtained through similar analysis, is: 1) pig iron production has especially high carbon intensity compared to other production processes used in the iron and steel industry; and 2) analysis in the EU and the US did not specifically allocate a category specifically for pig iron. Nonetheless, care is needed when making an international comparison of MVAS values since each country adopts different classification methods and disaggregate levels.

4.1.4. Effects on pulp and paper related products

Figure 4.4 indicates carbon intensity of pulp and paper related products, with the horizontal axis representing trade intensity

From this, we find that 1) pulp products have both high carbon intensity and trade intensity; and 2) paper, Japanese paper, and paperboard carbon intensity, are high but their trade intensity levels are not.

4.1.5. Effects on pulp and paper related products

Figure 4.5 indicates the carbon intensity of inorganic and chemical fertilizer related products, with the horizontal axis representing trade intensity.

From this, we find that: 1) soda industry products have extremely high carbon intensity but trade intensity is low; and 2) both carbon intensity and trade intensity of chemical fertilizers, inorganic pigments, and other inorganic chemical products are high.

Figure 4.2. Effects on iron and steel products

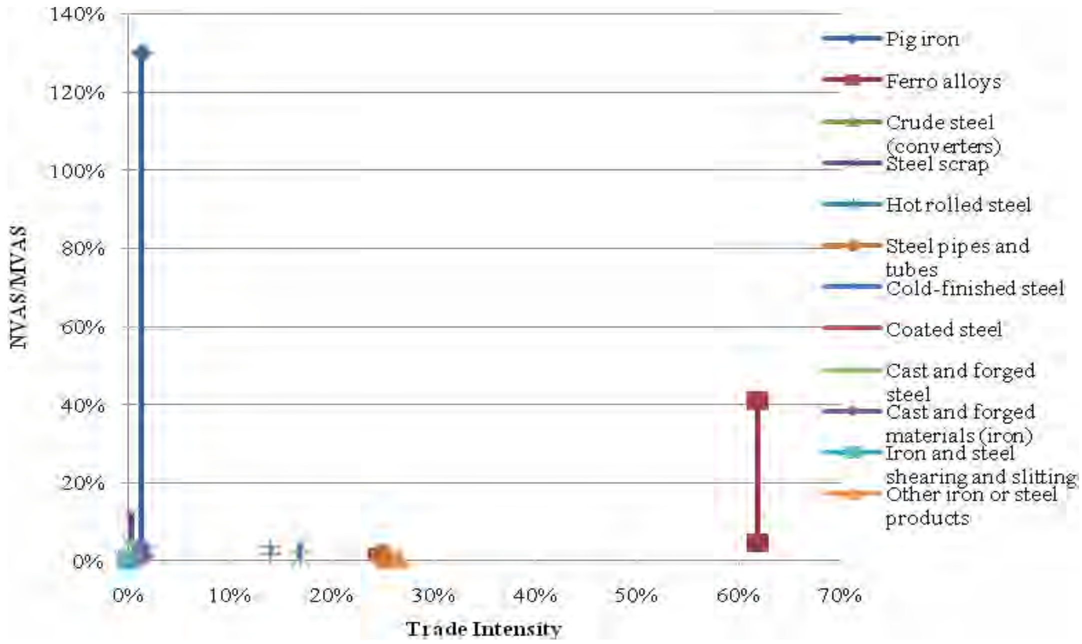


Figure 4.3. Effects on cement products

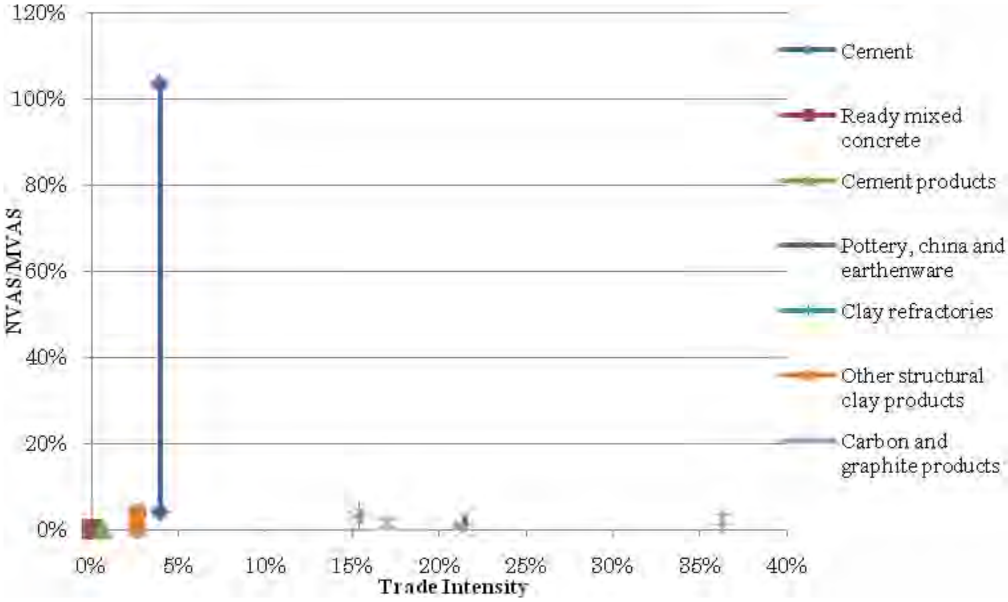


Figure 4.4. Effects on pulp and paper products

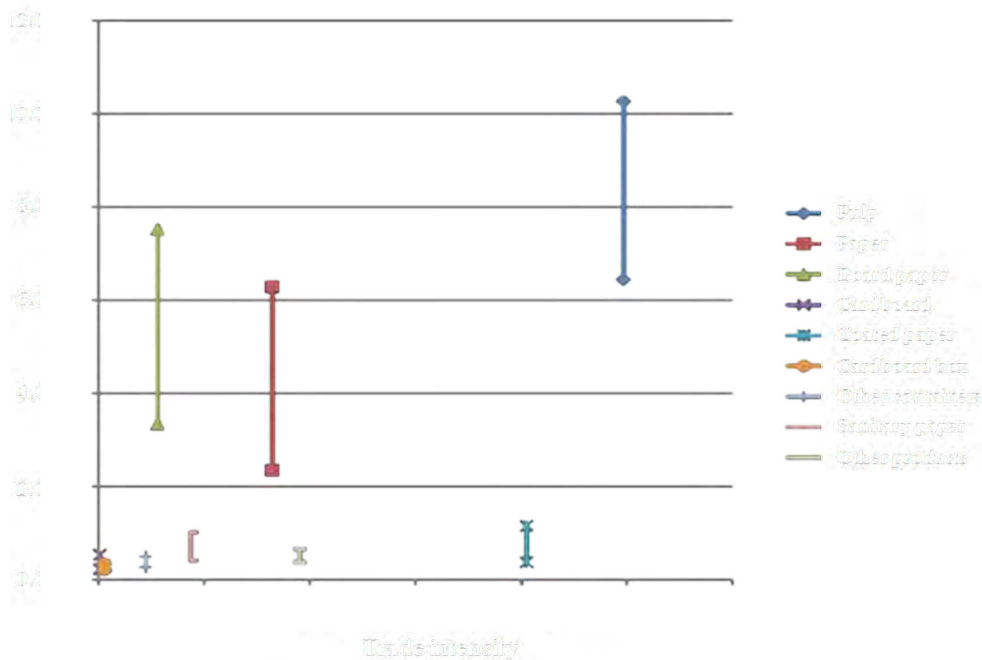
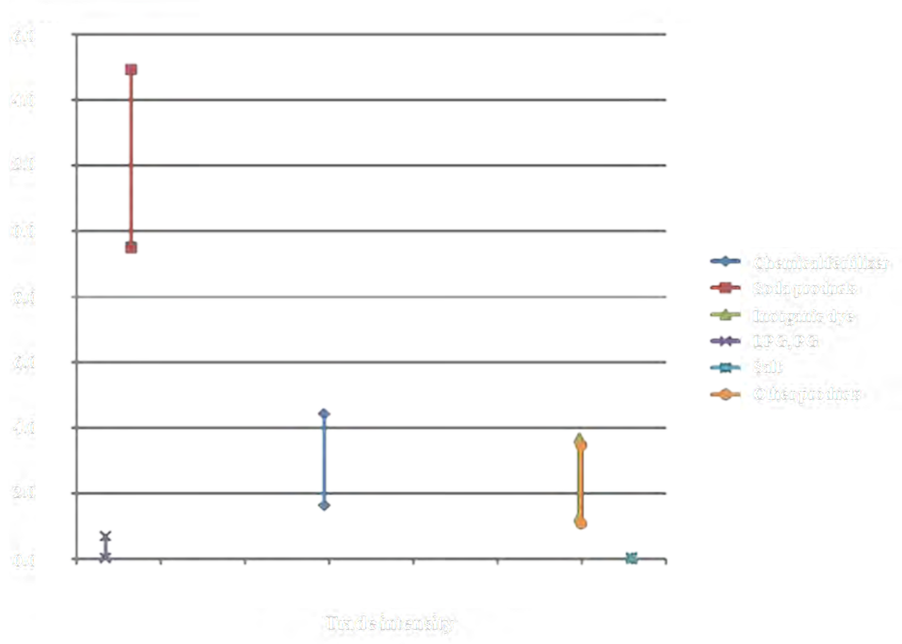


Figure 4.5. Effects on inorganic chemical and chemical fertilizer products



From this, we find that: 1) soda industry products have extremely high carbon intensity but trade intensity is low; and 2) both carbon intensity and trade intensity of chemical fertilizers, inorganic pigments, and other inorganic chemical products are high

4.1.6. Effects on pulp and paper related products

Figure 4.6 indicates carbon intensity of automobile related products, with the horizontal axis representing trade intensity.

From this, we find that most automobile related products have high trade intensity but low carbon intensity.

4.1.7. Effects on textile related products

Figure 4.7 indicates carbon intensity of textile related products, with the horizontal axis representing trade intensity.

From this, we find that most textile products have high trade intensity but low carbon intensity.

Figure 4.6. Effects on automobiles and automobile related products

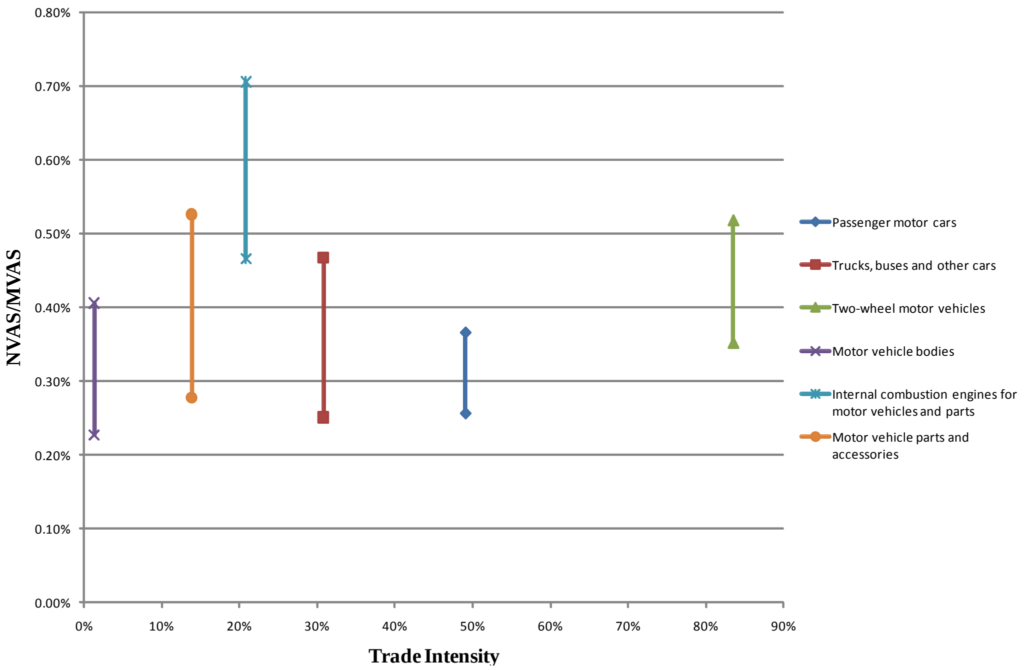
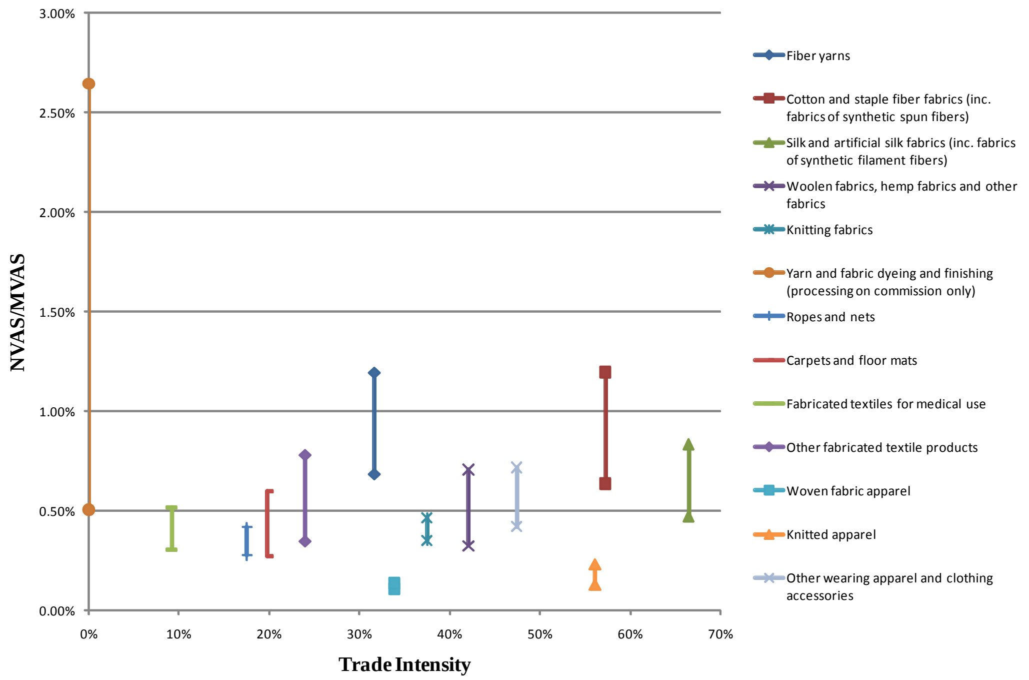
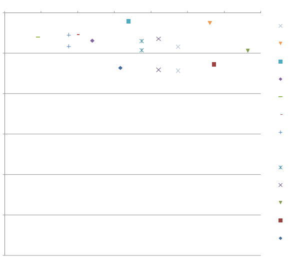


Figure 4.7. Effects on textile products





4.2. Estimating the degree of product price increases

This section is to quantify the range of product price increases caused by the purchasing cost of emissions allowances.

The advanced studies of Stern et al. (2007) and Weber and Peters (2009) used industrial inter-relationship analysis to estimate the changes in product prices when emissions allowance prices were £70/t-CO_2 and \$30/t-CO_2, respectively. Since Weber and Peters (2009) used the most commonly accepted method of industrial inter-relationship analysis on environment (Leontief 1970), we calculated the estimates using the same method.

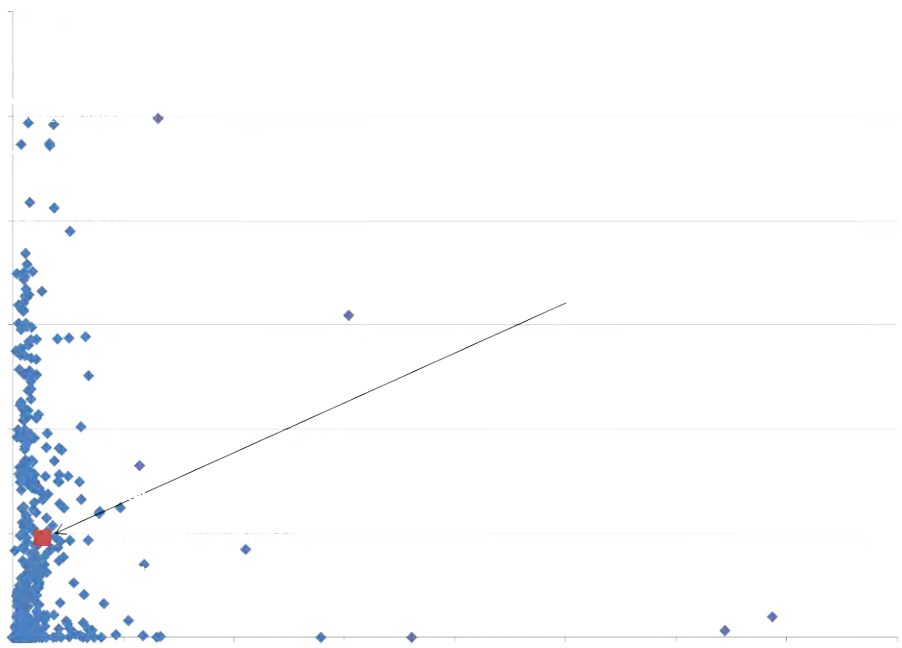
The range of produce price changes can be calculated using the following formula 4.6:

$$\Delta p = \tau F(I\text{-}A)\text{-}1 \qquad (4.6)$$

Here, Δp is the range of product price changes, τ the emissions allowance price, F the linear vector of direct environmental burden per production amount, I a unit matrix, and A the input coefficient matrix. The direct sectoral CO_2 emissions used in these estimates are data from the same 3EID (2007) as was used in formula 4.5.

Figure 4-8 indicates the results of industrial inter-relationship analysis, with the horizontal axis showing the product price change ratio and the vertical axis indicating trade intensity.

Figure 4.8. Product price changes when emission allowance purchase costs are passed onto product prices in Japan



Note: Subjected industry sectors are those same 401 sectors as are in the industry inter-relationship table, and were calculated using an emissions allowance price of 3,000 yen/t-CO_2.

From the above Figure, we find that: 1) the average product price increase ratio is 1.25% for the industry sector as a whole, and 2) price increase ratios of cement, pig iron, crude steel, ferroalloy, self power generation, hot rolled steel and others exceed 10%. Note that one of the iron and steel products, hot-rolled thin plate, used in the analysis discussed in 4.3 and 4.4 of this chapter, is included in hot-rolled steel in the inter-industry relations table with the 401 sectors. From Figure 4.6, therefore, we find that the hot-rolled thin plate has a product price increase ratio of about 11%.[34]

Table 4.1 summarizes the results of the aforementioned studies in the UK and US, and those estimated in this report:

Table 4.1. International comparison of the range of produce price increase

	Inter-industry relations table	Emission Allowance Price	Product price change ratio (economy as a whole)
Japan (this study)	Year 2000	3000Yen/t-CO_2	1.25%
US (Weber and Peters 2009)	Year 2002	30 US$/t-$CO_2$	1.5%
UK (Stern 2007)	Year 2003	70 £/t-CO_2	<1%

Source: Table prepared by authors.

From the above table, we find that: 1) there is not much difference among the three countries, despite different emissions allowance prices used[35]; 2) for most industry sectors, the product price change ratio does not exceed 2%, and 3) any differences among the three countries can be explained by differences in industrial structure and rates of advancement in energy savings.

It is difficult to determine objectively whether the Japanese industry's average ratio of 1.25% is large or small. However, it certainly falls well within the range of previous price change ratios.

Note that Stern (2007), referenced here, indicated that in the case of the United Kingdom, the industrial inter-relation analysis showed that sectors such as petroleum refinery, fishery, coal, paper manufacturing, iron and steel, fertilizer, transport, chemicals, plastics and non-ferrous metals, having a higher risk of losing international competitiveness, were traded mostly within the EU region or among developed countries which could mitigate such risk.

On the other hand, Weber and Peters (2009) concluded that sectors in the United States had a higher risk of losing international competitiveness, since they had a greater number of trades with developing countries than the United Kingdom. However, in the case of energy consuming industrial sectors, their ratio of exports and imports were small, 20% and 15% respectively, so they constituted only 4% of Gross Value Added in the United States as a whole in 2004.

[34] After section 4.3 of Chapter 4 in this report, the effects of product price increases on trade pattern will be calculated at a rate of 11%.

4.3. Relationship between price changes and trading patterns

In order to determine how the ability to pass on additional costs of emissions allowance purchases (incurred upon the introduction of an emissions trading system) to product price affects trade patterns, it is essential to analyze the relationship between trade patterns and price changes which have actually occurred in the past. (Reinaut 2005a)

In this section, therefore, we will take, as an example, hot-rolled thin plate, an iron and steel product. We will identify the quantitative relationship of product price differences between domestically manufactured products, and products imported from overseas (subtracting the price of domestically manufactured product from the import price of the overseas product) over the past 10 years. The example will include production quantities, import and export quantities from and to other countries as well as market shares in each country.

Hot-rolled thin plate was chosen for this study because it is one of the most generally produced products among iron and steel companies in Japan, and is considered to have high international competitiveness as a highly valued steel product. At present, Japanese companies import hot-rolled thin plates from China, Korea, and Taiwan, and export mainly to China, Korea and Thailand.

The domestic prices of domestically manufactured hot-rolled thin plates were referred to in the data reported by the Daily Iron and Steel Newspaper. The data on import prices and import quantities of Chinese, Taiwanese and Korean products, as well as the export quantities of domestically manufactured products, were referred to in the trade statistics of the Ministry of Finance. The data on the production quantity of domestically manufactured products, the import/export ratio of domestically manufactured products, and the market shares of China and Thailand were referred to in the data from the Japan Iron and Steel Federation.

4.3.1. Changes in prices of hot-rolled thin plates in Japan

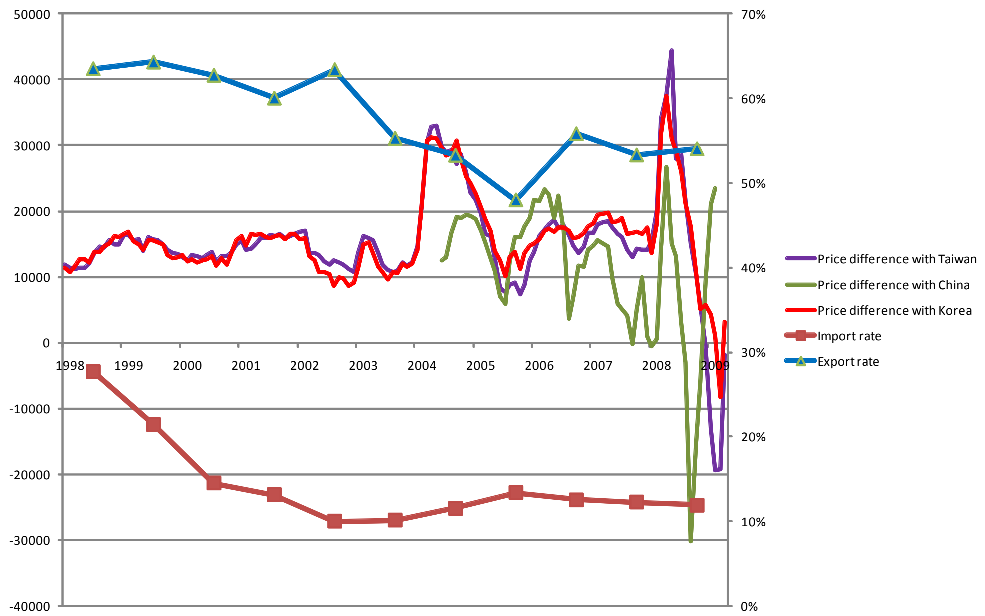
Figure 4.9 indicates the prices of hot-rolled thin plates manufactured in Japan as well as those imported from Korea, China and Taiwan, 1998 - 2009.

From this data, we find that: 1) the price of domestically manufactured products ranged from about 40,000 - 110,000 Yen/ton, while imported products were priced from about 20,000 - 140,000 Yen/ton; 2) until 2003, the price of domestically manufactured products fluctuated in relation to changes in imported product prices from Korea and Taiwan, but they no longer correlated after 2004; and 3) the correlations between Korean and Taiwanese product prices and domestic product prices were relatively higher, but that with Chinese product prices was lower. Note that not only the price of hot-rolled thin plates, but also the prices of many iron and steel products increased after 2004 due to rising demand, and increased further in 2008 due to the drastic increase of raw material costs. They plunged later in that year however, due to a demand decrease following the 2008 financial crisis.

4.3.2. Trends of price differences and import/export ratios

Figure 4.10 indicates the price difference between domestically manufactured hot-rolled thin plates and those imported from overseas, the export ratio of domestically manufactured products (export amount /production amount), and the import ratio (import amount /production amount) for 1998 - 2009.

Figure 4.10. Price differences (domestic price – import price) in the past and trend of international trade ratio



The data shows that: 1) when price differences widened in 2004, the export ratio decreased while the import ratio increased; 2) when price differences rapidly widened in 2008, neither the export ratio nor the import ratio showed much change; and 3) since 2002, the export ratio has been in decline, but the import ratio has stayed the same at around 10-13%.

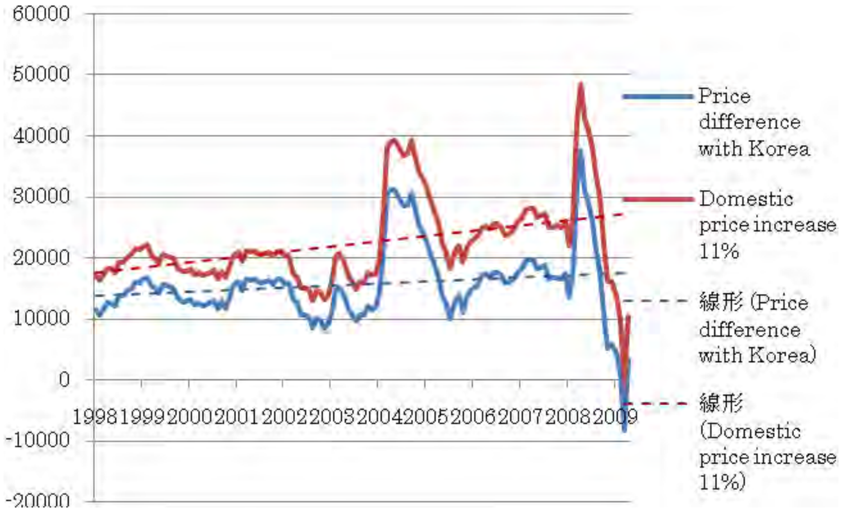
Price differences changed dramatically after 2002, indicating that the prices of domestically manufactured products were not necessarily affected by the import prices of overseas products.[36]

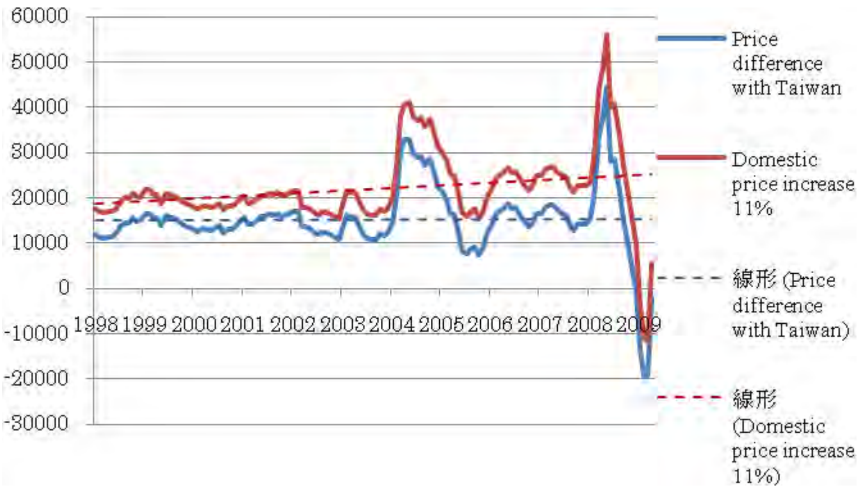
4.3.3. Scale of impact of price increases

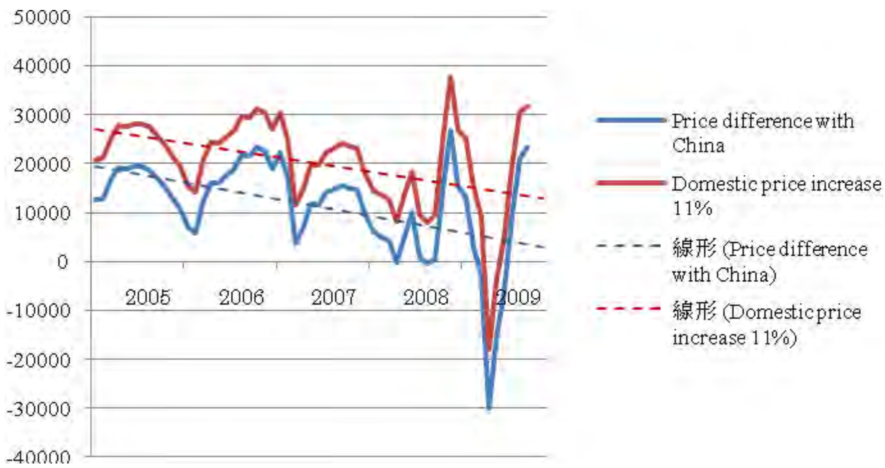
Next, is to determine the impact of the price increase rate of 11% (refer to the section 4.2 Figure 4.6). This is the range of product price increases due to the passing on of additional costs from emissions allowance purchases. The numbers are calculated using the industrial inter-relation analysis mentioned in section 4.2, then compared with the fluctuation of product prices in the past.

[36] If the impact was larger, Japanese corporations would have changed their domestic product prices to be more in line with overseas product prices. As they did not, the graph showing price differences over time does not show large ups and downs; rather it shows the prices staying flat. Such a result suggests factors other than overseas product prices are influencing the price of domestically manufactured products.

Figure. 4.11. Fluctuation of price differences and comparison with the largeness of price difference increase due to cost passing







From this data, we find that the range of price difference fluctuation due to the 100% passing on of emissions allowance purchase cost to product prices (11% produce price increase) is relatively smaller than the historical fluctuation of price differences.

4.3.4. Trends of price differences and export and import ratios

Figure 4.12 shows price differences of hot-rolled thin plates, domestic production quantities, and imported quantities per exporting country, 1998 - 2006.

From this data, we find that: 1) when price difference widened in 2004, domestic production decreased, 2) in 1999 and 2002 domestic production increased despite the decrease in price differences.

4.3.5. Trends of price differences and export quantities per destination country

Figure 4.13 indicates the price differences and export quantities per destination country for hot-rolled thin plates (from 1998 to 2008).

From this data, we find that: 1) export quantities of domestically manufactured products to each destination country correlate with each other, and 2) despite the widened price difference in 2004, export quantities of domestically manufactured products increased.

Figure 4.12. Trends of Japan's domestic production and import quantity per origin

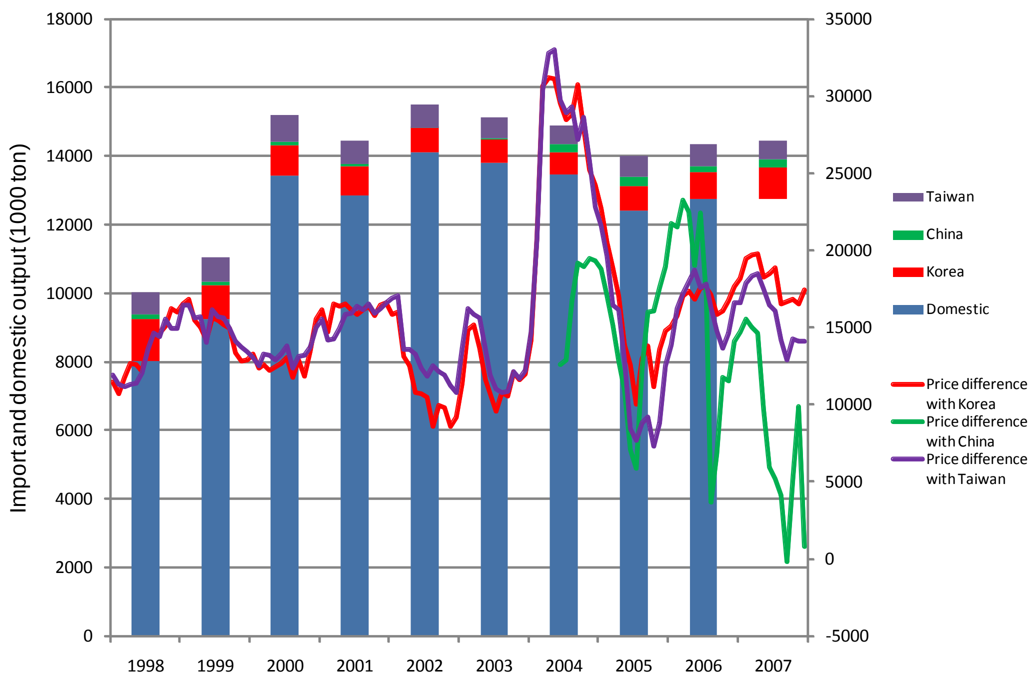
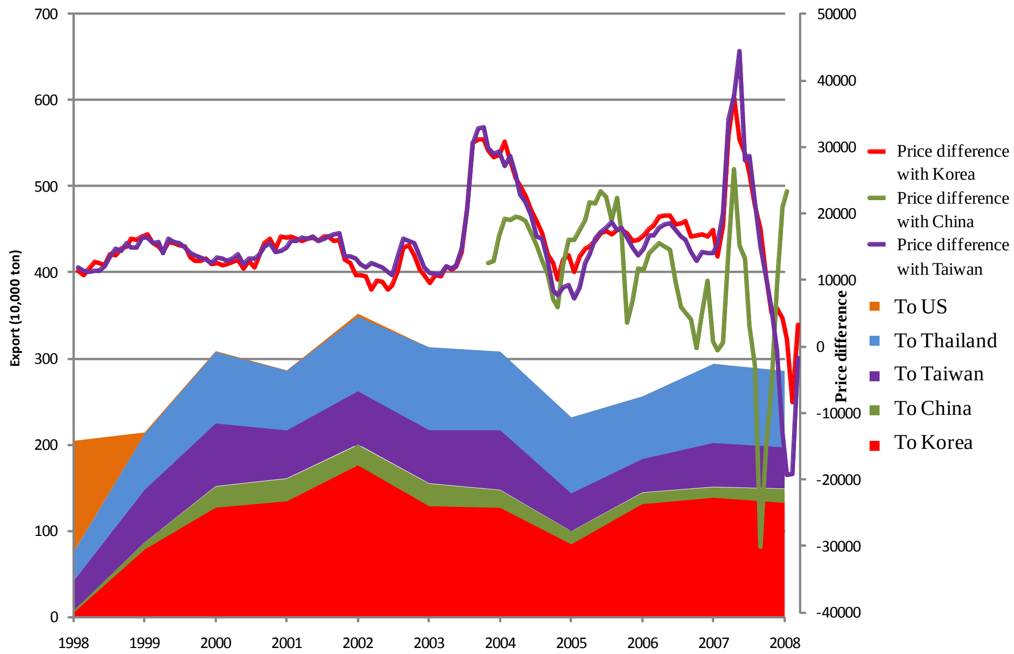


Figure 4.13. Trends of export quantities per destination



4.3.6. Price changes and their relationship with product share of the Chinese market

Figure 4.14 indicates the price differences in hot-rolled thin plates and market share of Japanese products in China (from 2001 to 2008).

From this data, we find that: 1) when price differences widened in 2004, the market share of Japanese products declined, and 2) in 2007 and 2008, despite the widened price difference, the market share of Japanese products did not decrease.

4.3.7. Price changes and their relationship with Thai market shares

Figure 4.15 indicates the price differences of hot-rolled thin plates and the market share of Japanese products in Thailand (from 1998 till 2007).

From this data, we find that: 1) when price differences widened in 2004, the market share of Japanese products in Thailand declined, and 2) in 2006, the market share of Japanese products did not decline despite widened price differences.

Figure 4.14. Price differences (domestic price – import price) in the past and market shares in China

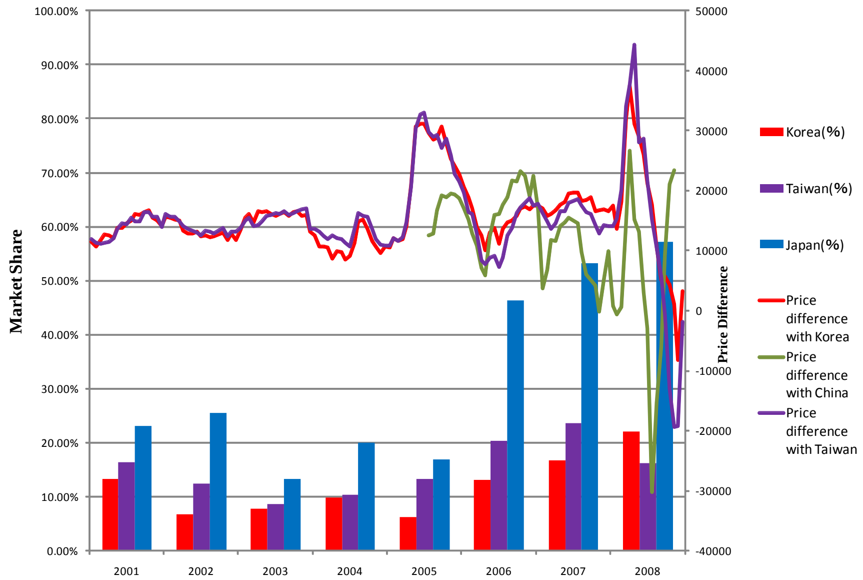
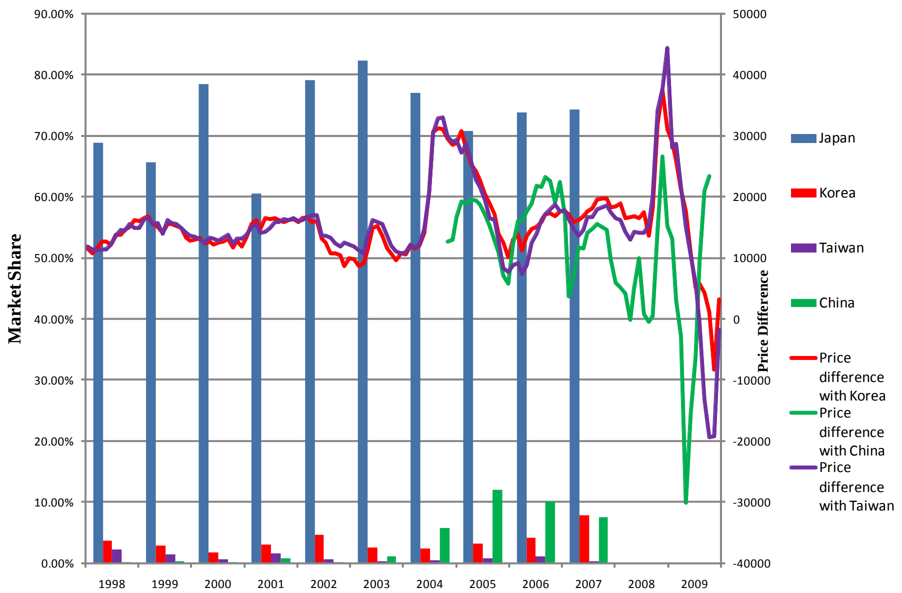


Figure 4.15. Price differences (domestic price – import price) in the past and market share in Thailand



4.4. Calculations of demand function, price elasticity, and substitute elasticity

This section quantifies the relationship between domestic demands and price increases due to the passing on of emissions allowance purchasing costs to product prices for hot-rolled thin plates manufactured in Japan. For this, the demand function of domestically manufactured hot-rolled thin plates is obtained by regression analysis. Price elasticity value is calculated using this demand function, and substitute elasticity (Armington coefficient) is calculated based on Gallaway et al. (2003).

4.4.1. Estimation of demand function

There are two types of demand volumes in the Japanese market which are defined by the following two formulas.

- Demand D for domestic products only (domestic sales):

D = Domestic Production – Export Quantity (4.7)

- Net Demand D* adding demand for import products to demand for domestic products (domestic net demand):

D^* = Domestic Production + Import Quantity – Export Quantity (4.8)

Once defined, demand functions of the domestic market are formulated for demand quantity, and defined for each, as in the following formulas 4.9 and 4.10.

$$D = a_0 + a_1 p_d + e_d \qquad (4.9)$$

$$D = b_0 + b_1 p_d + e^*_d \qquad (4.10)$$

Here, p_d is the domestic market price of hot-rolled thin plates manufactured domestically, and e_d and e^*_d are error ranges for each.

When the coefficients of demand functions 4.9 and 4.10 are calculated by regression analysis, using the data for price, production quantity, import quantity, and export quantity of hot-rolled thin plates from 1998 and 2006 as given in section 4.3, the results are the same as the following formulas 4.11 and 4.12.

$$D = \underset{(0.0021)}{2075.4770} - \underset{(0.2926)}{0.0091}\, p_d \qquad R^2 = 0.1561 \qquad (4.11)$$

$$D^* = \underset{(5.74E-5)}{3837.2630} - \underset{(0.1804)}{0.0123}\, p_d \qquad R^2 = 0.2402 \qquad (4.12)$$

These demand functions show a negative correlation between demand quantity and price, but the correlation coefficients are relatively smaller (at -0.0091 and -0.0123). The reason may be that hot-rolled thin plates have the characteristic of being intermediate asset products which have a more stable demand quantity.

Moreover, net demand quantity, which takes import quantity into account, shows greater resilience than demand for domestic products only. Thus, import products have a certain degree of influence over the domestic market, and can be explained from the calculation of price elasticity as follows.

4.4.2. Estimation of price resilience

Price elasticity of demand function can be defined as follows:

$$\delta = -\frac{\Delta D / \Delta p_d}{D / p_d} \qquad (4.13)$$

From the demand functions 4.9 and 4.10 stated above, price elasticity can be obtained from the following formula.

$$\delta = -\frac{a_1 \overline{p}_d}{a_0 + a_1 \overline{p}_d} \tag{4.14}$$

Here, $\overline{p}_d$ is the average price estimated for the period concerned.

Using formulas 4.11 and 4.12, the demand functions give the price elasticity of δ = 0.2923 and δ^* = 0.1945 for the period of 1998 - 2006.

According to the results, when the price of domestically manufactured hot-rolled thin plates fluctuates by 1%, the demand for domestic products changes by about 0.29%, and the net demand of the domestic market, including import quantities, changes about 0.19%. In addition, this indicates that the price sensitivity of the domestic market demands can be mitigated by imported products.

4.4.3. Estimation of substitute elasticity

To calculate substitute elasticity (Armington coefficient), the following assumption is adopted.

The Japanese domestic market consists of demand D for hot-rolled thin plates manufactured in Japan, and their imported quantity M_i (i =1,…n, import country). The domestic demand for hot-rolled thin plates is a form of gross assets and can be put into production as can other production factors of labor and capitals.

This gross asset can be defined by the following formula 4.15.

$$C = \left[\alpha_0 D^\rho + \sum_i \alpha_i M_i^\rho \right]^{1/\rho} \tag{4.15}$$

Here, C is the gross asset (hot-rolled thin plates), α_0 and α_i are the ratios of demand for imported products and domestic products, and ρ is the strength of preference in product variation

Assuming that corporations seek to maximize profits, and the expenditure for each element stays at the same level, the following formula 4.16 is obtained by minimizing the cost of gross assets (for example, in the case of linear and homogenous production function).

$$\frac{D}{M_i} = \left(\frac{\alpha_0}{\alpha_i} \frac{p_i}{p_d} \right)^{\frac{1}{1-\rho}} \tag{4.16}$$

Here, p_i is the product price of imported products from country i.

Based on the results of this First-order conditional expression, the substitute elasticity (Armington coefficient) between domestically manufactured products and imported products can be estimated.

First, formula 4.16 is linearized as follows:

$$\ln\left(\frac{D}{M_i}\right) = c + \frac{1}{1-\rho} \ln\left(\frac{p_i}{p_d}\right) \tag{4.17}$$

Here, $c = \frac{1}{1-\rho} \ln\left(\frac{D}{M_i}\right)$, and, by differentiating both sides, following formula is obtained to indicate substitute elasticity σ.

$$\sigma = \frac{\partial\left(\frac{D}{M_i}\right) \Big/ \partial\left(\frac{p_d}{p_i}\right)}{\frac{D}{M_i} \Big/ \frac{p_d}{p_i}} = \frac{1}{1-\rho} \tag{4.18}$$

Therefore, if other trade influencing variables, such as exchange rates, and net per capita income of each county, are not taken into account, and the price and demand quantity are instantly harmonized in the market, the basic calculation model can be constituted as follows.

$$y_{it} = g_0 + g_1 x_{it} + u_{it} \tag{4.19}$$

Here, $y_{it} = \ln(D_t/M_{it})$, $x_{it} = \ln(p_{dt}/p_{it})$, and u_{it} is the error range of *iid* (independent identity distribution).

Furthermore, from the result of time series data analysis based on Gallaway et al. (2003), short term and long term substitute elasticity can be obtained using the following formula.

$$\Delta y_{it} = g_0 + g_1 \Delta x_{it} + g_2 y_{it-1} + g_3 x_{it-1} + \varepsilon_{it} \quad (4.20)$$

Here, $\Delta y_{it} = y_{it} - y_{it-1}$, and $\Delta x_{it} = x_{it} - xi_{t-1}$, short substitute elasticity is g_1, and long term substitute elasticity is $-g_3/g_2$.

As mentioned in section 4.3 of this report, the quantities of hot-rolled thin plates imported from Korea, China, and Taiwan from 1998 - 2007 were 94% of total import quantities in Japan (averaged over 10 years). Therefore, assuming that all imported products are from these three countries, it is possible to calculate substitute elasticity, both short term and long term, against domestic products.

Using formula 4.20, as well as prices, production quantities and import quantities of hot-rolled thin plates, the substitute elasticity of Japan-Korea, Japan-China, Japan-Taiwan, and Japanese domestic demands and overall import quantities (with totals for all 3 countries) can be obtained as follows: (Table 4.2)

Table 4.2. Substitute elasticity of overseas imports against domestic products

	Short term	Long term
Substitute elasticity of Korean imports against domestic products	0.19	0.29
Substitute elasticity of Chinese imports against domestic products	-0.98	-0.44
Substitute elasticity of Taiwanese products against domestic product	0.30	1.43
Substitute elasticity of imported products from 3 countries against domestic products	0.23	1.00

Source: prepared by authors

With the only exception being China[37], the substitute elasticity values of Japan-Korea, Japan-Taiwan and Japan-imported products are smaller for short term than for long term. This indicates the characteristics of international trade where the long term demand ratios of Japanese vs. total imports or against imports from other countries, shows a greater range of adjustment relative to price changes.

The short term elasticity against import totals from 3 countries is 0.23, and long term elasticity is 1.00. Therefore, long term elasticity is about four times as large as short term elasticity. These Figure are greater than the results by Gallaway (2003) which were two times as large on average for the 309 manufacturing sectors. This indicates the large effect of substitute elasticity of hot-rolled thin plates. According to Gallaway et al. (2003), however, 2 or more is large. Values used in past studies that estimated international competitiveness and carbon leakage using the general equilibrium model were mostly 1 or larger, as shown in Table 4.3. (Gerlagh and Kuik 2008)

[37] A negative elasticity value means that there are no alternating relationships between products. Such values are generally non-existent with products for which alternatives are available. In reality, however, prices and demands change in international and domestic markets due to numerous factors, so negative resilience values may appear.

Table 4.3 Substitute resilience values used in general equilibrium model

Model names	Studies	Substitute elasticity	carbon leakage
Deep	Kallbekken 2006, 2004	4	0.06
G-Cubed	Mckibbin and Wilcoxon 1999	1	0.06
Gem-E3	Bernard and Vielle 2000	6	0.13
Gem-E3	Bernard and Vielle 2000	6	0.04
GREEN	Burniaux and O.Martins 2000	4	0.05
GREEN	Burniaux and O.Martins 2000	4	0.02
GTAP-E	Burniaux and Truong 2002	19	0.04
GTAP-E	Burniaux and Truong 2002	19	0.04
GTAP-E	Kuik and Gerlagh 2003	7	0.16
GTAP-E	Gerlagh and Kuick	5	0.14
GTAP-EG	Paltsev 2001	4	0.11
MIT-EPPA	Babiker and Jacoby 1999	3	0.06
MIT-EPPA	Babiker 2005	8	0.20
MS-MRT	BMR 1999	4	0.19
MS-MRT	BMR 1999	4	0.16
WorldScan	Bollen 2004	10	0.17
Light	Light et al. 1999	4	0.21
MIT-EPPA	Babiker 2005	∞	1.15
GTAP-E	Kuik 2006	3.3	0.15

Source: Gerlagh and Kuik 2008

As stated in Chapter 2 Section 2.3, the amount of carbon leakage obtained by the general equilibrium model largely depends on substitute elasticity, which suggests that the calculation results of many general equilibrium models may have overestimated carbon leakages.

4.5. How price increase changes demand/supply and trading patterns (Impacts of emission trading systems)

As described in Chapter 4 Section 4.2, when a company passes 100% of the emissions allowance purchasing cost of 3000 Yen/t-CO_2 on to the product's price, the product price is estimated to increase by about 11%, according to the results of the industrial inter-relation analysis.

The regression analysis of the aforementioned formulas 4.11 and 4.12 results in the demand for domestic production products, and net demand including imported products to be decreased by 3.22% and 2.14%, respectively. Furthermore, when production leakage is defined as "impacts on demand only for domestic products minus impacts on net demand (consumption)" to indicate the impact on competitiveness in accordance with Aldy and Pizer (2009), we obtain the calculated value of 1.08%. This result is almost equivalent to the results of Aldy and Pizer (2009), which analyzed the market impact of an emissions trading system introduction in the US's iron and steel industry (with the result of 15 US$/t-CO2), and also that of Carbon Trust (2008b), which analyzed the market impact of an emissions trading scheme introduction in the EU's iron and steel industry (with the result of 30 Euro/t-CO2 with 50% cost passed on to prices). (Table 4.4)

Table 4.4. Impacts of product price increase due to the passing of emission allowance purchasing cost upon the demand for iron and steel products

Industry sector (products)	Impacts on the demand for domestic products only	Impacts on the net demand (consumption)	Impacts on international competitiveness (largeness of production quantity leakage)
Iron and steel products as a whole (the US: Aldy and Pizer 2009)	- 2.7%	- 1.8%	- 0.9%
Iron and steel products as a whole (EU: Carbon Trust 2008b)	-2.5 – 9%	- 2%	- 0.5 – 6.5%
Hot-rolled thin plates (Japan: this report)	- 3.22%	- 2.14%	- 1.08%

Source: prepared by authors

Note: Carbon price used in Aldy and Pizer (2009) was 15 US$/t-$CO_2$, in Carbon Trust (2008b) was 30 Euro/t-CO_2 with 50 % cost passed onto price, and in this report 3000 Yen/t-CO_2.

Note also that the result in Carbon Trust (2008b) shows ranges rather number, as they did sensitivity analysis using different assumptions on substitute elasticity.

Aldy and Pizer (2009) also identified impacts on other industry sectors, as well as the manufacturing sector as a whole. For example, the demand decrease in the US's manufacturing sector as a whole was about 4%, while production quantity leakage was about 1%.

It is difficult to say whether the above numbers are large or small. Aldy and Pizer (2009), however, determined that their values were small in comparison to past changes in demand and production quantity, and only a few industry sectors required measures to mitigate any risk of losing international competitiveness. Moreover, Aldy and Pizer (2009) conclude that the production increases accompanying product price increases indicates a shift from high carbon intensive products to less carbon intensive products, proving that the introduction of emissions trading systems has led to more effective emissions reduction. As such an event is the most preferable outcome, it is desirable to form trade measures that can strengthen carbon constraints of trade partner countries in order to mitigate the loss of international competitiveness.

In Japan, production leakage values for iron and steel products as a whole are smaller than those of hot-rolled thin plates which have high carbon intensity.

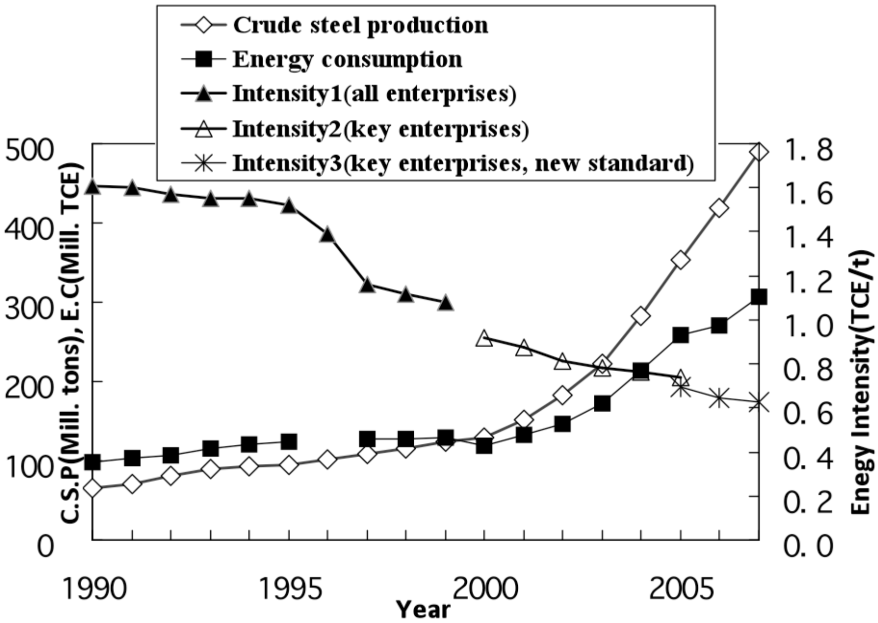
4.6. Carbon constraints in China

In this section, we review the amount of carbon constraint in China, a major trading partner with Japan.[38]

Figure 4-16 illustrates the trend of energy consumption and energy intensity (energy consumption per unit of crude iron production) in the iron and steel industry of China, showing that energy consumption increases and production quantity expands as energy intensity decreases.

[38] Refer to Box 5.2 of Chapter 5 regarding the iron and steel industry in China.

Figure 4.16. Trends of energy consumption and energy intensity in Chinese iron and steel



As shown here, energy saving activities in the Chinese iron and steel industry are expanding mainly among large to middle scale corporations. Table 4.5 shows a comparison of energy intensity for Japan and China as of 2004.

Table 4.5. Comparison of energy intensities in iron and steel industries of Japan and China (Unit: MJ/ton, year 2004)

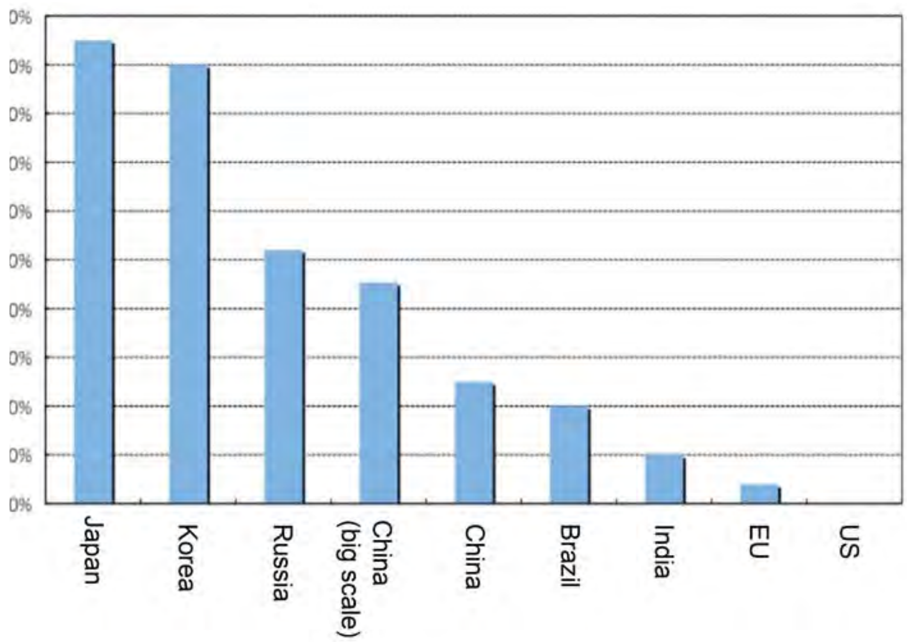
		Energy consumption intensity	Cokes production process	Sintered steel production process	Pig iron production process	Converter steel production process	Rolling molding process
1	Major Chinese companies	20.64	4.16	1.94	13.65	0.99	2.72
2	Smaller Chinese companies	30.59	6.71	3.18	17.32	2.20	8.40
3	Highest level in China	17.45	2.58 (Bao Shan)	1.52 (Hang Zhou)	11.57 (Bao Shan)	-0.11 (Wu Han)	1.57
4	Average in Japan	19.20	2.78	1.55	11.59	-0.08	1.81
Gap within China	2 - 1	9.95	2.54	1.24	3.68	1.21	5.68
	2 - 3	13.14	4.13	1.65	5.75	2.31	6.83
	1 - 3	3.19	1.58	0.42	2.07	1.10	1.15
Difference between China and Japan	1 - 4	1.43	1.38	0.39	2.05	1.07	0.90
	2 - 4	11.39	3.93	1.63	5.73	2.28	6.58
	3 - 4	-1.76	-0.20	-0.03	-0.02	-0.03	-0.24

Source: Ning Ya-Dong, Yutaka Tonooka, 2008

From this table, we find that: 1) energy efficiency in the highest level of iron works in China is better than the average efficiency of Japanese iron works; 2) The Bao Shan Iron Works, at the highest level in China, is now on level with the most advanced iron works in the world. The difference between the major Chinese iron works and China's highest level of iron works has shrunk to 10-15%; 3) considering that the major competitors with Japanese corporations are the highest level iron works in China (that are manufacturing high tech iron and steel products equivalent to Japanese products), their production increase does not necessarily lead to a significant increase in global emissions.[39]

In the background of such a trend is the rapid introduction and nationalization of energy saving technologies. For example, the most typical energy saving devise in the iron and steel field, Coke Dry Quenching (CDQ), has been installed, or is to be installed, in 45 % or more of coke ovens in Chinese iron and steel corporations. (Dan 2008) As shown in Figure 4.17, the result shows an internationally high dissemination rate.

Figure 4.17. International comparison of dissemination of Cokes Dry Quenching (CDQ) at iron foundry (2007)



Source: IEA (2007)

[39] In the case of high tech steel discussed in this section, energy consumption per unit production does not differ much between Japan and China. Therefore, considering the difference in emissions intensity of power generation industries, emissions increases due to Chinese production increases will not necessarily lead to a significant increase in global emissions. Refer to the discussion of carbon leakage in Chapter 2 Section 2.1.

We find that, in regard to CDQ: 1) its installation is more advanced in China than in the EU, the US, or any other developing country[40]; 2) a 60% CDQ installation rate in 2020 means that China will double its current 30% rate in 15 years.

In regard to another typical energy saving technology in the iron and steel industry, China has been moving forward with a technology called Top-pressure Recovery Turbine (TRT) for blast furnaces. In fact, 49 out of 56 blast furnaces in China have TRT installed presently. (Dan 2008).

Therefore, the remaining challenges the Chinese iron and steel industry faces in terms of energy saving activities are: 1) a strong growth of market demand for iron and steel products; 2) dominance of smaller scale blast furnaces; 3) a higher ratio of converter processes, and for electric furnaces to use a greater amount of pig iron in their ratio of raw materials. (Kawasaki and Zhao 2009)

To overcome such challenges, options may include demand restraints, unification and abolition of small scale blast furnaces, and increased use of scrap irons. But, these options are not practical considering the fact that in China it is essential to avoid options that may lead to unemployment and hence to social instability.[41] In addition, accumulating the proper amount of scrap iron will take time. What China needs for the future is the introduction of an advanced technology that has not been commercialized or thoroughly disseminated, even in Japan, such as a molten reduction process or CCS. Therefore, China's situation is not so simple that "everything will be resolved if Japan transfers[42] its technologies." (Asuka et al. 2009, Asuka 2009, and Asuka 2008a)

Moreover, even tighter carbon constraints are projected for the iron and steel industry sector in the future. The following table 4.6 indicates the dissemination rate of each technology, and targets values of energy intensity in the iron and steel industry from 2005 to 2050 under a "low carbon scenario", analyzed by a Chinese government-related think tank.

[40] CDQ is the technology to recover sensible heat from cokes to generate power. As it was originally invented in Russia, its dissemination rate is quite high in Russia, but lower in Europe and the US. The reason for a lower dissemination in Europe and the US can be varied, but the major reason is lower energy prices. For a comparison of energy prices in various countries, refer to Hoshino et al. (2009), and China's Development and Reform Committee Energy Research Institute Task Force (2009).

[41] Ambitious efforts to unify, abolish, or close plants and corporations are ongoing in energy consuming industries. According to the Chinese Government, for example, thermal power plants closed between January and May of 2008 totaled 868 units with a combined capacity of 5.79 million KWh. Among them, 133 units (4.49 million KWh) were coal fired plants, and 681 units (0.83 million KWh) were petroleum fired plants with an average capacity of 6700 KWh per unit. Average capacity of the closed coal power plants was 34000 KWh. Total assets of the closed thermal power plants was estimated to be 11.7 billion Yuan (or about 175.5 billion Yen), with a debt amount of 6.7 billion Yuan (or about 100.5 billion Yen). The number of people affected by the closures is an estimated 56000, with 39000 among them being employees. Closure of small scale thermal power plants was implemented in 18 provinces and autonomies. In a review of the regional distribution of plant closures, the ratio was much higher among private companies in remote regions with a total of 3.69 million KWh capacity closed, which once shared 64% of the total (China Information Agency SearChina, July 1, 2008)

[42] For a detailed discussion of the technology transfer of global warming measures, refer to Asuka (209b).

Table 4.6. Technology dissemination rate and energy consumption (low carbon scenario)

Index	2005	2020	2035	2050
Cokes Dry Quenching (CDQ) dissemination rate (%)		60	80	100
Molten reduction introduction rate (%)		5	15	50
Blast furnace pulverized coal injection (kg/t iron)		200	220	230
Top-pressure Recovery Turbine (TRT) dissemination rate (%)		95	100	100
Converter gas recovery (m3/t steel)		90	100	100
Ratio of electric furnace steel (%)		25	45	60
Ratio of iron and steel (%)		0.75	0.65	0.60
Rolling advanced technology dissemination rate (%)		70	80	100
Energy intensity (kg-ce/t)	760	650	564	525
Comparison with international standards	Achieve the world's highest level by 2030			

Undoubtedly, this scenario is one of many scenarios aiming for a low carbon society, and it signifies merely a target which they may aim for.

Yet, as a country that has not only carbon constraints but also energy saving constraints, it is the target of China for corporations and governments alike, to aim for, and exert much effort in order to achieve these goals, for the sake of further economic growth.

Nonetheless, it is most likely that China will continue to strengthen carbon constraints, and any corporations studying the possibility of advancing into China needs to fully recognize such possibilities

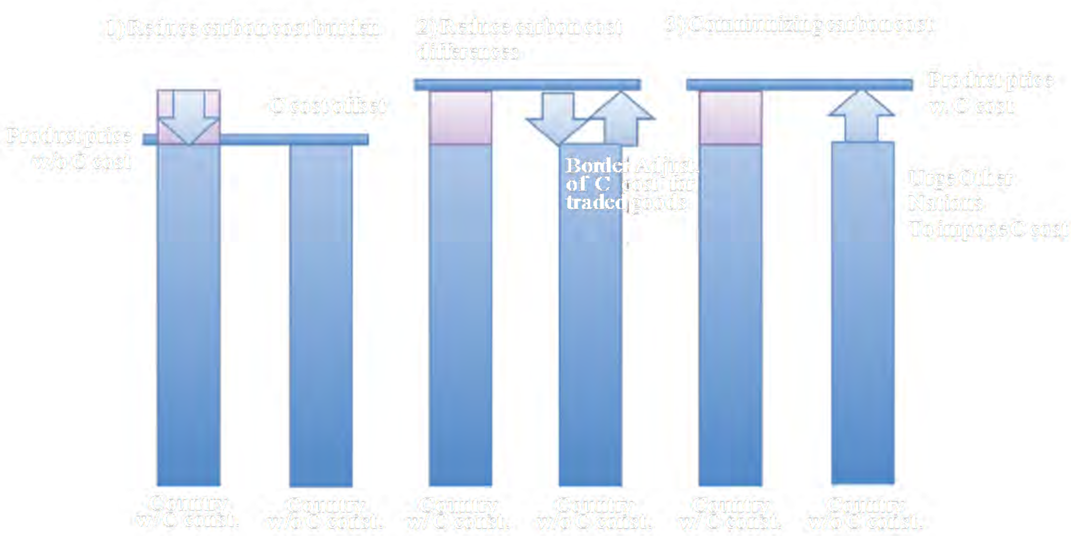
5. Policy options for Japan

5. Policy options for Japan

5.1. Reviewing options to mitigate the loss of international competitiveness

When there is concern that corporations are losing international competitiveness due to carbon constraints[44] imposed through the introduction of an emissions trading system, governments may choose to adopt several measures to mitigate the loss. The measures can be classified into three categories: 1) reduction of carbon cost burden, 2) reduction of carbon cost differences, and 3) communization of carbon cost. (Figure 5.1)

Figure 5.1 Three types of measures to mitigate the loss of international competitiveness



Source: Neuhoff (2008)

As shown in the above Figure 5.1, the first category of mitigation is to reduce the carbon cost burden of a corporation, so that during the introduction of the emissions trading system it won't lead to product price increases. The second category for reducing carbon cost differences imposes a carbon cost to a product being imported from an unregulated nation at the national border. By doing so, the domestic market price of the imported product will increase. The product exported to an unregulated country will, in turn, receive a rebate on the carbon cost burden from the regulated country's government. By reducing the carbon cost difference, the product price in the unregulated country will not increase. The third category, communization of carbon cost, will allow a country to impose similar carbon constraints as their own onto other countries.

44 Whether to have carbon constraints or not is different from having a carbon tax or an emission trading system. Regulation on fossil fuel consumption can be considered carbon constraint. Refer to Box 5.2

To classify these three categories in terms of actual government measures, they can be divided into seven categories: 1) free allocation of emissions allowances; 2) tax reduction and subsidies; 3) international off-set system (CDM etc.); 4) trade measures; 5) sectoral commitment; 6) voluntary export regulation of developing countries; and 7) consumption base accounting.

Table 5.1 indicates actual contents of such categories, and describes the details of individual measures.

Table 5.1 Options to mitigate the loss of international competitiveness

Category	Names of mitigation options	Contents	Merits	Demerits	Countries adopting the option (institution)
1) Reduce carbon cost burden	Free allocation	Emission allowances allocated free of charge	Easy to implement (unilateral implementation possible)	Lower efficiency. Higher administrative costs	EU, US, Australia
	Tax reduction (Improve production cost structure)	Lower corporate tax, and social welfare cost	Easy to implement (unilateral implementation possible)	Lower efficiency. Higher administrative costs	Australia
	Subsidies (Subsidies for capital investment)	Subsidies for capital investment to save energy, etc.	Easy to implement (unilateral implementation possible)	Lower efficiency. Higher administrative costs	EU, US, Australia
	International off-set	Use international emissions trading and CDM	Easy to implement (use existing mechanism)	In the case of CDM, reduction of global greenhouse gas emission is not attainable. Image of funds draining from national treasury.	
2) Reducing the differences in carbon cost	Trade measures	Adjust carbon cost differences at the border	Practically imposing carbon constraints in non-carbon constraint nation, Improve political acceptability of domestic emissions trading system introduction, etc.	Difficult to determine countries and products subjected to the measure, and to calculate carbon contents. Challenge in reconciling with WTO rules and the principle of "common but differentiated responsibility"	Suggested in EU and US
	Sectoral commitment	Impose commitment to a certain industry sector in developing countries	Practically imposing carbon constraints to non-carbon constraint nations	Need commitment by developing countries. Difficult to determine the benchmark value.	EU and Japan are asking developing countries to take this measure
	Voluntary export control by develop-ing countries.	Developing country governments to impose export tax, etc.	Practically imposing carbon constraints to non-carbon constraint nations. As it is voluntary, possible to avoid image of retaliation	Need developing countries' commitment. As it is not sustainable and legally binding commitment under UNFCCC, difficult to get international recognition	China
3) Communizing carbon cost	Consumption base account-ing	Impose responsibility to consumption side about the greenhouse gas emission upon manufacturing	Practically imposing carbon constraints to non-carbon constraint countries. Clarify the responsibility of consumers.	Need international cooperation and coordination. Data availability is poor. Need to make fundamental change in current accounting system.	Researcher proposal level. However, the awareness of carbon footprint is growing.

S: Prepared by authors

5.1.1. Reviewing options to mitigate the loss of international competitiveness

Description

Free allocation is the allocation of emissions allowances to corporations, free of charge, through a grand-fathered provision or benchmark method. As described in Chapter 3 Section 3.1 of this paper, paid allocation, or auctioning, is preferable in terms of efficiency (target attainment with minimum cost). Despite this fact, free allocation is popularly adopted as a major mitigation measure in the EU ETS and in bills discussed in the congresses of the US and Australia, mainly due to its political acceptability to corporations.

Advantages

- Free allocation imposes the minimum economic burden to corporations, and has high political acceptability to corporations.
- Compared with other options, it can be implemented unilaterally and does not require commitments from other countries.

Disadvantages

- Free allocation causes lower efficiency compared to paid allocation, since it is not possible to attain target at minimum cost.
- There is a large potential for significant lobbying by industry associations and individual corporations, which can lead to higher administrative costs.
- Could be misconstrued as creating production subsidies
- May be at risk of generating windfall profits
- Possible increase of burden by non-ETS sectors, compared to ETS sectors
- With no possible price increase to cover a cost increase, it sends a weaker price signal to the market, and can induce lower efficiency by discouraging a shift toward less carbon intensive products.
- When allocation options such as output-based rebating, ex-post reconciliation (relative targets), and updating of allocation are adopted, incentives for corporations to adopt early emissions reduction will not work.
- It has no effect on carbon leakage through available investment channels.[45]

Future Prospects

Although free allocation creates several problems such as lowering efficiency and increasing administrative costs, it is likely to become the principal measure in many national systems for it's ability to mitigate the short to mid-term loss of international competitiveness. It's actual system design will face two major challenges: 1) the selection criteria to identify free allocation industry sectors; and 2) the methods used to determine actual values of designated benchmarks. Especially in regard to benchmarks, there are numerous issues demanding difficult decisions such as 1) selection methods for free allocation products and industry sectors; 2) stringency of actual numbers when determining the range of emissions reduction; 3) whether to implement updating or not; 4) selection of production activity levels using historical data or current performance; and 5) handling of intermediate products (for example clinkers and cement). Also, an increase in lobbying activities are expected, so political introduction costs will grow at a significant level, despite the initial appearance of lower cost.

5.1.2. Tax reduction and subsidies

Description

In order to mitigate cost increases for corporations due to the introduction of carbon constraints,

[45] As free allocation does not change the carbon constraints of other countries, particularly developing countries, it won't offer any risk mitigation due to leakage through investment channels, i.e. "a corporation selects an overseas location for a new facility". For carbon leakage methods and channels, refer to Chapter 2 Section 2.2

governments can reduce corporate taxes, decrease social welfare cost burdens for corporations, and provide subsidies toward investments in greenhouse gas reduction projects in the form of a direct rebate back to corporations.

Advantages

- As it gives direct compensation to corporations, it has high political acceptability from corporations.
- A reduction of corporate taxes and social welfare cost burdens will decrease average production costs.
- Subsidies to greenhouse gas emissions reduction projects can lower the average production cost, while decreasing emissions allowance prices, helping to reduce marginal costs for other industry sectors.
- May possibly generate a "double dividend"

Disadvantages

- If only certain industry sectors are subjected to this system, conformity with WTO rules (in this case the agreement on subsidies and trade-off measures) may become a problem.[46]
- Could generate inequity between corporations or industries.
- The effects of corporate tax reduction may differ depending on the overall size of the tax rates and the current paid amount of corporate taxes.
- The effects of corporate burden reduction, such as the reduction of social welfare costs, may depend on whether the industry is capital intensive or labor intensive.
- Large administrative costs are required, especially with a subsidy system which has higher administrative costs than tax reduction methods.
- Subsidies to greenhouse gas emissions reduction projects may become subsidies for energy consumption, lowering efficiency[47].

Future Prospects

According to the empirical analysis done in the Netherlands, the following features are indicated: 1) protected industry sectors generally pay lower taxes and tend to be more capital intensive, so the benefits of tax reduction are small; 2) subsidies to greenhouse gas emissions reduction projects are especially effective in both the iron and steel industry and the fertilizer industry (in the case of the Netherlands); 3) the effects are less for aluminum and non-ferrous metal industries; and 4) generally, subsidies to greenhouse gas emissions reduction projects are highly effective but have a low efficiency rate. (de Bruyn et al., 2008)

These measures highlight the problem of how to distribute the burden fairly among corporations or industries. Especially when the measures used target specific industries, corporations wishing to be included in the system may resort to large scale lobbying activities.

5.1.3. International offset (CDM and others)

Description

Corporations are required to comply with their reduction targets not only by implementing greenhouse gas emissions reduction within the companies, but also by purchasing international credits under such mechanisms as international emissions trading, Clean Development Mechanism (CDM), and Joint Implementation (JI).

Advantages

- These measures can lower the reduction target compliance costs of corporations, and of entire

[46] Subsidies for the introduction of specific technologies may not become an issue, but general subsidies may be construed as state aid, which is frequently disputed in the EU. Refer to Johnston (2008).

[47] Since this will make it easier to select technology options rather than production quantity adjustment options, efficiency to achieve target at minimum cost will be lower.

countries, while lessening the range of carbon leakage. For example, analysis of the climate bills discussed in the US Congress indicates that, if the use of international offset is not allowed, the emissions allowance prices in the US will increase by 91%, and an additional reduction of 39 billion tons will be needed for ETS corporations as a whole (from 2015 to 2050). (USEPA 2009) In addition, Paltsev (2001) indicates that the availability of international offset could shrink the size of carbon leakage by half.

Disadvantages

- These measures tend to receive criticism as funds to purchase credits (taxes from the national treasury) flow out to other countries, although the criticism is largely based on a misunderstanding of the process over the long term.
- Using international credits without a thorough review of costs versus benefits may be deemed as a negative factor by corporations and even the country as a whole. Since it is difficult to make quantitative comparisons of negative factors and positive factors on domestic emission reduction (such as energy saving programs, domestic fund flow and investment, economic growth, long term improvement in productivity, infrastructure development, job creation, air pollution prevention, reinforcement of energy security, etc.), decision-making will become a much more complicated process.
- Under the current situation of uncertainty, working with a post 2012 framework design, it is difficult to predict demand, supply and price levels for emissions credits. Consequently, corporations will face difficulty when making management plans and investment project decisions.
- As these are existing schemes, mere participation in these mechanisms will be insufficient if we are to send out the message of "implementing new measures."

Future Prospects

In Japan, international emissions trading and CDM are sometimes criticized as ineffective, but in the international community, they are frequently valued as a rational tool to prevent carbon leakage or excessive economic burden.[48] This means that, whatever the post 2012 international framework for global warming measures will become, it is not likely that international offset systems themselves will disappear.[49] Therefore, it is important for the Japanese society to recognize the value these programs can offer.

5.1.4. Trade measures (border adjustment)

Description

Trade measures are a way to pay back carbon costs to corporations for product exports, while imposing carbon costs to importers for product imports. Originally, the EU, especially France, suggested the application of trade measures against the US's Bush administration. Later, they expanded the target countries to include developing countries as well. The US's bill identifies China as well as other emerging economies as target countries for trade measures.

Advantages

- As a tool that can affect investment actions of other countries, trade measures are the most

[48] In regard to the assessment of CDM, opinions vary depending on the different viewpoints of researchers, policy-makers, and corporations. Some of their arguments seem to ignore the differences between international trading and domestic trading and are therefore less conclusive.

[49] At present, discussions are ongoing at COP and other forums to reform CDM. However, negotiation frequently leads to confrontation between those wishing to expand credit supply and those hoping to improve credit quality and environmental integrity. It will likely require additional time to develop an actual framework design.

effective option. At least theoretically, they can respond to carbon leakage through normal investment channels.

- Trade measures are more efficient than free allocation options as they make it possible to raise product prices when it is necessary to cover cost increases.

Disadvantages

The disadvantages of trade measures can be divided into two major problems: 1) technology issues and 2) legal issues. (Refer to Box 5.1)

(1) Technology issues

- In principle, trade measures must cover every product related to carbon leakage, both domestic and overseas, and be able to accurately determine the carbon content of each product. In addition, the measure must make it possible to impose the same carbon cost to domestic and imported products whether it is a direct or indirect cost.
- The measure must cover downstream products, also. If a trade measure covers upstream products only (for example iron and steel), the introduction of such a measure will simply result in the loss of international competitiveness for end products (such as automobiles) in carbon constrained countries.
- It is difficult to assess the implementation of "comparable efforts " with other countries. Moreover, the relationship with the major principle of "common but differentiated responsibility" is difficult to construe.
- When exports share only a small part of a country's production, new trade measures from other countries are less of an influence to the policies of the exporting country. For example, the share of iron and steel exports from China to the US is small, so trade measures adopted by the US have only a limited influence over policies of the Chinese Government or actions taken by Chinese corporations.
- Trade measures require close international coordination and cooperation, and each technological aspect will require another increase in administrative costs.

(2) Legal issues

While fewer studies deny the need for conformity with WTO rules, others point to the technological difficulties when introducing trade measures. (Recent studies include WTO 2009 and Tarosofusky 2008) However more studies are indicating the need to review each trade measure due to frequent dynamic changes, and state that no one can present an opinion as definite unless it has been properly reviewed by a court of law. (Ismer and Neuhoff 2007, de Bruyn et al. 2008, Droge et al. 2009)

Future Prospects

In addition to technology issues there is a need to determine: 1) whether to impose burdens through taxation or emissions allowance purchases; 2) which countries and sectors will be subjected to the system; 3) whether to impose a burden on imports, exports or both; and 4) how to best use the revenue that will be generated.

Needless to say, the risk of causing trade frictions with other countries is not a small issue. Therefore, it is unlikely the government would actually enforce such trade measures. Yet, considering the effectiveness of such measures in demonstrating the government's strong will to its own people, the legislation of trade measures may provide the advantage of improving political acceptability. In this context, the discussion of trade measures will likely continue well into the future.

Box 5.1. Trade measures and compliance with WTO rules

As discussed previously, there are two types of trade measures, one pertaining to imports and one to exports. In this paper we discuss these measures assuming that, in the case of carbon tax introduction, the adjustment of carbon cost burdens, due to emissions trading, is the same as border tax adjustment.

(1) Import product taxation

In this case, the major problem is conformity with two equal treatment principles: "National Treatment" and "Most Favored Nation Treatment".

a. National Treatment

Article III of GATT prohibits the unequal treatment of imported products. However, the exporting nation's right to impose taxes on exports at a rate equivalent to the domestic tax is recognized. If the tax is calculated in direct relation to the carbon contents of the product, how will the carbon contents be calculated, and how will the "correct tax amount" be determined if the product is manufactured in different countries, through different processes and in different environments using different types of energy and a different co-efficient for emissions?

As a simple measure to solve such problems, a unified calculation method is proposed. It will use the carbon contents of the product or substitute product which has been manufactured using Best Available Technology (BAT), or an average technology level regardless of the actual carbon contents or production methods. (Ismer and Neuhoff 2007)

b. Most Favored Nation Treatment

Article I of GATT prohibits preferential treatment of countries. Nations cannot be treated differently due to differences in the global warming measures they have adopted. Yet, in order to do so requires a thorough knowledge of the global warming measures adopted by those countries, and a quantitative assessment of the scale of carbon constraints. These are not easy matters. (Refer to Box 5.2)

Despite difficulties, the application of GATT Article XX of the exception clause (in order to protect the lives of people and living organisms and their health, or to conserve finite natural resources, a measure that violates the equal treatment principle may be allowed) may solve the problem of conformity with WTO rules to a certain extent.

(2) Tax exemption for exports

A major issue is conformity with the Agreement on Subsidies and Countervailing Measures (SCM). In order to prevent excess rebating, which can be construed as subsidies for domestic products, it is necessary to incorporate a rebate calculation method using the BAT approach.

In addition, an emissions trading system poses it's own unique issues such as the need to consider price fluctuation. Nevertheless, many researchers warn against the excess use of national border tax adjustments to avoid a trade war. For example, Neuhoff and Ismer (2008) propose an agreement to restrict the overuse of trade measures, which would include developing a positive list under UNFCCC.

Box 5.2. Actual carbon constraints in China

The presence of carbon constraints does not necessarily mean the presence of a carbon tax or an emissions trading system. Any restrictions on fossil fuel use can be construed as practical carbon constraints. However, to verify the actual scope of carbon constraints is not easy, especially in developing countries where data availability and nominal enforcement of regulations pose challenges. Still, it is necessary to verify the criticisms of "no global warming measures" and "no carbon constraints" frequently heard of emerging economies, especially China.

Here, we shall focus on the domestic price of energy as an index of carbon constrains. Energy prices in China have undergone several drastic increases in the last several years. In the Shanxi Province, which is considered the energy base of China, various new taxes or tax increases were implemented from 2007 to 2008 that included: 1) a new tax of 15 Yuan/ton imposed as a reserve fund for the Maintenance Cost Fund; 2) a resource tax was raised by 2.5 to 3.2 Yuan/ton; 3) resource compensation cost was raised from 1% of sales revenue to 3-6%; 4) payment per ton of mining right establishment (6 Yuan/ton of reserve on average) was auctioned off ; 5) a new tax of 14 Yuan/ton for ordinary coal, 18 Yuan/ton for anthracite, and 20 Yuan/ton for coking coal was imposed as a reserve for the Coal Sustainability and Development Fund; 6) a new tax of 10 Yuan/ton was imposed as an environmental cost; 7) a new tax of 5 Yuan/ton was imposed for a Coal Industry Conversion Fund. Because of these new taxes and tax increases, the production cost of coal was estimated to have risen by 70-80 Yuan. (Horii 2008) After July 2008, China implemented further drastic price increases, such as a 16.7% price increase for gasoline, 18.1% for light oil, and 4.7% for electric power bringing the average price to 25 Yuan/KWH.

Because of these tax burdens, today's domestic energy prices in China are not much different from those of developed countries. For example, the end price of coal for a power station as of 2006 was 62.3 US$/ton for China, while for the US and Japan it was 38.6 US$/ton and 51.5 US$/ton respectively at the exchange rate of 1 US$ = 7.979 Yuan. In addition, the price for industrial electric power use was 0.065 US$/KWh for China, 0.061 US$/KWh for the US, 0.051 US$/KWh for France, and 0.065 US$/KWh for Korea. (State Development and Reform Committee, Energy Research Institute Task Force 2009)

Furthermore, the Chinese Government has already implemented voluntary export control for energy consuming industries and their products. To be specific, their measures include: 1) as of July 2007, 2,831 items of energy consuming industries have been excluded from export promotion tax rebates; 2) since August 2007, taxes on lead, zinc, copper, tungsten, and several other minerals have increased by three to sixteen fold; 3) in July 2007, a 15% export tax was imposed on several aluminum products; 4) beginning in January 2008, export taxes on semi-products of the iron and steel industry, such as steel rods, reinforcing rods, thin plates, etc. were increased by 15%; and 5) in January 2008, the export tax on iron and steel products, ferrous alloy, cokes, steel billet, etc was increased by 25%.

Trade friction has already occurred between China and the US over iron and steel products. According to Chen (2008), the number of anti-dumping lawsuits against China in the US was largest in the iron and steel industry and it's products with 23 lawsuits between 1990 and 2006. (China, as a single country, received the largest number of anti-dumping lawsuits.) To avoid trade frictions and to explore new markets elsewhere, China's share in iron and steel imports to the US declined from 11% in 1998 to 7% in 2005.

Nevertheless, the Chinese Government adopted the above mentioned measures to avoid trade restrictions, while reinforcing export control over energy consuming products. These measures are as effective as having the EU and the US impose border tax adjustments to Chinese products; and the amount of Chinese exports are actually decreasing today. Wang and Voituries (2009) estimated that the "voluntary export controls China implemented from 2006 to 2008 in the form of new taxes and tax increases would be equivalent to 30-40 Euro/t-CO2 of national border tax adjustments implemented by importers for iron and steel products, and 18-26 Euro/t-CO2 for aluminum products." These Chinese export products, through voluntary export control, have actually priced carbon emissions at a level equivalent to EU ETS prices.

5.1.5. Trade measures (border adjustment)

Description

A sectoral approach is where there is agreement or cooperation between the same industry sectors of different nations.[50] (Refer to Box 5.3) For example, an international agreement could be made for determining the target intensity for a certain sector, such as energy consumption or greenhouse gas emissions per unit of crude production quantity in the iron and steel industry, involving the same industry across all developing countries.[51] However, this approach would place caps on sectors as a whole, so it may be equal to imposing a much more severe commitment on some developing countries than before.

Advantages

- It is effective at imposing partial carbon constraints on developing countries since it can respond to carbon leakage through investment channels. There are high expectations for this approch as a mid to long term mitigation measure.
- It is useful in persuading those industry sectors which have been opposing the introduction of a domestic emissions trading system to comply.
- It can facilitate technology transfer, as this approach reveals the actual condition of each sector in the various developing countries, leading to new business opportunities and reinvigorating economic growth.

Disadvantages

- It requires developing countries' governments and corporations to realize the need for such an approach, and to accept its introduction. For this, it would require political negotiation as well as international cooperation and coordination.
- Because of limited data availability and such diversity among corporations, it is difficult to establish a baseline and/or benchmarks.

Future Prospects

While pressure from the international community is mounting against emerging economies such as China's, the intensity target in any one target sector is an option that has only a small possibility of acceptance by such countries. Governments and research institutes of many countries actively studied the possibility of sectoral intensity targets for developing countries such as China.

Despite pressure from the international community to accept such targets, however, President Hu Jintao of China announced a commitment in the form of a CO2 intensity target at the UN Climate Summit on September 22, 2009. China selected the form of their commitment to be a numeral target for the country as a whole, rather than a sectoral commitment.

Therefore, at least for the near future, China is not likely to make a public announcement of the commitments designed for a certain industry sector only. Still, there is a possibility that, as a result of international negotiation, China may agree to a commitment for a specific sector in a way that would compliment the CO2 intensity target for China as a whole.

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[50] Recent studies include Bodansky (2007), Baron et al. (2007), Baron et al. (2009), Colomber and Neuhoff (2008), and Asuka (2008b).

[51] A system to provide credits tradable in an international market. When a developing country determines its' intensity target (benchmark), and reduces emissions more than the target, is called Sector Crediting Mechanism (SCM). For the last several years, various research and surveys were conducted on its feasibility. In the end, however, it was found to have less likelihood of introduction at COP 15 as a new system under UNFCCC, because 1) difficulty in determining the actual number for benchmarks; and 2) merit to developing countries had not yet been established. (Refer to Box 5.3)

5.1.6. Voluntary export control by developing countries

Description

This is an option for developing countries to voluntarily impose export controls of carbon intensive products (for example, China imposes an export tax on iron and steel products. Refer to Box 5.2). In view of the history of trade friction between China and the international community, Muller and Sharma (2005) identified voluntary export controls as a significant commitment for global warming measures. Wang and Voituriez (2009) estimated the scale of "indirect" carbon constraints in China.

Advantages

- As it is voluntary, it is not likely to invite trade sanctions.
- It offers governments the opportunity to impose practical carbon constraints.
- Tax revenues from voluntary controls can be added to the national treasury of a developing country's government.

Disadvantages

- It is not a legally binding system under UNFCCC, so it really sends only a weak message of "actually implementing global warming measures" to the international community.
- Developing countries must implement the measures based on a thorough recognition of its needs, a difficult and expensive process.
- It is not a lasting measure and may fluctuate depending on the current economic and political climate.[52]

[52] In the case of China, for example, the Government reviewed the exclusions of the rebating system shown in Box 5.2 after the global economic crisis of 2008. Droge et al. (2009) concluded that "China's voluntary export control is a practical carbon constraint, but it is not a lasting measure and its transparency is questionable."

- Market environment has a strong influence over the enforcement of such a measure. As an example, if a product is a price-follower in the market, it practically blocks any price increases, making it difficult to implement this option.
- For the consumers of importing countries, it means another price increase of imported goods.

Future Prospects

In the case of China and the US, for example, trade friction has already become apparent in iron and steel and other industries. In response, the Chinese Government voluntarily established a series of export control measures.[53] Such policies which impose export taxes are likely to continue, as no major changes in today's policies, such as energy saving, renewable energy introduction and air pollution policies are foreseen, other than some of those policies being strengthened in the future. On the other hand, developing countries may introduce carbon taxes or an emissions trading system to replace or correlate with existing energy related taxes. Nevertheless, the international community is largely ignorant of energy and global warming policies adopted by the developing countries, whose current programs may act sufficiently as practical carbon constraints. In a sense, misunderstanding and ignorance of other countries' policies may have hindered international negotiations and international cooperation. What is needed is to deepen the communication between exporting and importing countries, as well as developed and developing countries.

[53] Such voluntary control is not necessarily aiming to mitigate climate change and to prevent air pollution, but may have various purposes for exporting governments including tax revenue increases. Its' purpose and effectiveness may differ, depending on price elasticity, and market situation (for example, whether the product is a price decision-maker or price-follower). To determine the primary purpose is difficult and requires case-by-case study. In the case of China, however, energy saving is one of it's most outstanding purposes.

Box 5.3. Relationship between sectoral commitment and sectoral approach

A series of different terms used in Japan, such as "sector-specific approach", "sector approach" and "sectoral approach" (in English "sectoral approach" is used most frequently, with "sector-based approach" used occasionally) are frequently misused, leading to the dissociation, misunderstanding, and confusion in relation to the way the terms are used in the international community. The following are the most common definitions:

1) A term to describe the proposal that requires developing countries to commit to emissions reduction limits for a specified sector.

2) A term to describe the proposal to create an international framework that does not pose national gross targets on developing countries and developed countries. Instead it establishes an international joint organization that mandates each country to set and implement sectoral reduction targets, and controls and monitors those targets as a whole. (The official position of the Government of Japan for international negotiations until the Davos Meeting in January 2008)

3) A term to describe the proposal that focuses on efficiency (for example, emissions per unit of product production) which is a benchmark used to differentiate emissions reduction targets of developed countries.

4) A term to describe the proposal to set national gross targets for the sum of emissions reductions in each sector.

Among the above, term 1) is closest to Sector Crediting Mechanism (SCM) which the EU is proposing, as well as the Sectoral Commitment discussed in this paper.

Originally, it was the US's think tank, Center for Clean Air Policy（CCAP）, who used the term "Sectoral approach" for the first time in the world, and presented its' concept systematically. Later, the International Energy Agency (IEA) and the German think tank, Ecofys, published papers describing the outline of the approach and proceeded with the study of an actual system design. (Baron et al. 2007, Ecofys 2007, and Baron et al. 2009) However, all these studies and papers follow the basic concept of CCAP, so the concept and definition set forth by CCAP, which can be called a missionary of the sectoral approach, has become the apparent global common term.

The key point, in actual system design of the sectoral approach advocated by CCAP, is to set an intensity efficiency target or benchmark – for example CO2 emissions per unit product production. It would then be applied to a specific industry sector or sub-sector of any developing countries that have inferred there is an extremely low possibility of accepting gross national targets, at least for the short term. By doing so, it will practically impose gross emission caps as numerical targets to at least some of their emissions, if not for all national emissions. Having shown itself to be the simplest and most effective, the term described in above 1) is the CCAP term generally used in the international community.

This sectoral approach is a proposal, which developed countries present to developing countries as the combination of both "sticks" and "carrots." What these "sticks" are has not been clarified yet, nor have the "carrots." But the global effects of this approach will be to advance emissions reduction in developing countries, and possibly to enhance global emissions reduction limits further. On the other hand, it may provide a more lenient intensity target cap to some countries, thereby hindering the progress of a global emissions reduction limit, if a less stringent form of emissions trading system is introduced. In short, the sectoral approach may provide either positive or negative effects, depending on the way benchmarks are set. Actually the setting of benchmarks is the biggest challenge with this approach. Each country must develop its' own benchmarks by differentiating benchmarks numerically for each sector, and determining the path for achieving it with consideration taken for the nation's specific situation (energy mix, policies, industrial structure, economic growth, activities, etc. of today and in the future). Moreover, when these benchmarks have been agreed upon internally, they must receive approval from the international community.

5.1.7. Consumption based accounting

Description

In the past, the accounting of a nation's greenhouse gas inventory was formulated using production based accounting, and determined by calculating emissions within the national borders. Consumption based accounting is used to calculate emissions attributed to the consumption of products by adding emissions attributed to imported products, and subtracting those attributed to exported products. (Peters 2008, Wiedman et al. 2008, Peters and Hertwich 2008)

Advantages

- This option can discourage the consumption of carbon intensive products.
- It can resolve questions or concerns over carbon leakage.[54]

Disadvantages

- This option covers both permanent and intermediate products which can be varied in type and kind, as well as supply chains. With so many variables, it is difficult to make an accurate calculation of each carbon footprint.
- Generally speaking, there is no such system that can calculate consumption on the consumer side, except in the case of electricity.
- It is difficult to determine the boundaries and emissions co-efficiency of raw materials such as electricity, aluminum, and iron.

Future Prospects

At present, consumption based accounting is drawing much attention. Interest continues to grow because: 1) ever-progressing globalization; 2) increasing trends among corporations to determine carbon footprints and to adopt carbon labeling of products; 3) widening of quantitative dissociation between production based accounting and consumption based accounting; 4) increased pressure from the international community on developing countries to implement emissions reduction[55]; 5) rising concerns over the loss of international competitiveness among the EU and the US; 6) movement to determine benchmarks for each product in order to compare energy saving efforts; and 7) MRV capacity building in developing countries. (Droge et al. 2009) In fact, already in place is the Carbon Reduction Commitment of the UK (CRC)[56] which imposes controls for consumption of electric power on the consumption side.

At the macro level, also, the concept of consumption based accounting presents the same structure as those measures which "provide merits earned by consumers to producers as credits", such as those seen in "natural gas exports of Canada"[57] and "energy saving technology exports of Japan."

Consumption based accounting will continue to draw attention in the foreseeable future. The technical problems it embraces will likely prevent it from ever replacing production based accounting, but it will continue to be useful as a supplementary method for some time.

[54] As importers select lower carbon intensive products, it practically imposes carbon constraints on the exporters, thereby preventing carbon leakage.

[55] To respond against such pressures, China frequently calculates their "emissions associated with exports". (For example, Weber et al. 2008)

[56] CRC is a mandatory cap and trade system for major corporations and public institutions, addressing emissions not subjected to the Climate Change Agreement or the EU ETS. (Entities subjected to CRC are supermarkets, universities, government organizations, etc.) Their allocation method is by auctioning. In addition to emissions caps, economic incentives and Corporate Social Responsibility incentives are offered.

[57] The Canadian government's proposal was rejected by COP 8 in 2002.

5.2. Methodology to allocate emissions allowances and selection of industries to be protected

5.2.1. Combining free allocation and paid allocation

The first step is to confirm the analytical result of paid and free allocation methods for emissions allowances. As described in Chapter 3, paid allocation has advantages over free allocation in the following terms:

- To embody Polluter Pay Principle (PPP), which is central to environmental measures.
- To avoid corporate windfall profits
- To send out the correct carbon price signal to the market
- Alleviate the need to calculate emissions allowances for each industry58
- Possible use of auctioning revenues to mitigate GDP losses
- Lower administrative costs
- Rewards for early reduction actions.
- Fair to new entrants

In reviewing the results, it becomes clear that paid allocation makes it possible to overcome the inefficiencies and complexities of free allocation.

Next, from the comparison between the two free allocation options of a benchmark method and a grand-fathered provision, the superiority of a benchmark method can be summarized as follows:

- Can promote the dissemination of advanced technologies
- Higher transparency in allocation
- Can be used to calculate fair emissions allowances for new entrants
- Provides rewards for early reduction actions
- Sends proper carbon price signals to the market

Paid allocations have many more advantages than free allocations. Among free allocation options, the benchmark method has more advantages than a grand-fathered provision. As discussed in Chapter 3 Section 3.1, however, free allocation options are more effective in terms of mitigating the loss of international competitiveness. As discussed here, current political reality makes it difficult to adopt paid allocation options that auction off all emissions allowances. The Government of Japan is more likely to review policy options that combine different options including auctioning, the benchmark method, and a grand-fathered provision.

Table 5.2 indicates the comparison of different policy combinations from the three different viewpoints of efficiency, administrative costs[59] and carbon leakage risk reduction.

[58] The primary concern is how to set emissions allowances for the sectors subjected to an emissions trading system, and how to share the cost burden between emissions trading system sectors and non ETS sectors. Such sectors would include fuel consumption by businesses, households and transportation, with the exception that electric power is subjected to ETS at upstream. Basically, the methods can be: 1) a cap set on the economy as a whole which will be shared equally by each sector (for example, if the nation-wide target on CO2 is a 25% reduction, every sector will reduce emissions by 25%); or 2) set emissions allowances in a way to equalize marginal reduction costs for each sector. The latter has greater economic rationale, but the problems of data availability and reliability remain. Whether it is efficient enough to allocate caps based on marginal costs has been studied and proved possible under the AIM model of the National Environmental Research Institute.

[59] Here, administrative expenses include the cost of responding to the many lobbying activities of corporations.

Table 5.2. Combination of options for emission allowance allocation

Combination	Efficiency	Adm. Cost	Equity	Consider early action	Mitigate Intn'l comp.	Transparency	Mitigate GDP loss
1) 100% auctioning	6	6	6	6	1	6	6
2) Mainly auctioning with benchmark for protected industries	5	5	5	5	2	5	5
3) Mainly auctioning with grandfathering for protected industries	4	4	4	4	3	4	4
4) Mainly benchmark, with grandfathering for protected industries	3	1	3	3	4	3	3
5) Mainly grandfathering with benchmark for protected industries	2	2	2	2	5	2	2
6) All grandfathering	1	3	1	1	6	1	1

Note: Evaluate each option in 6 grades. "6" is the highest and "1" is the lowest grade.
Source: Prepared by authors

As we reiterated in this paper, only a limited number of industry sectors have a real risk of losing international competitiveness. Considering the comparison of results shown in Table 5.1, therefore, the second combination of "mainly auctioning with benchmarks to protect an industry sector" is the most preferable option.

Since the power generation sector is unrelated to the loss of international competitiveness (with zero trade quantity), direct allocation of emissions allowances by auctioning will be the preferred method for this sector in terms of efficiency and fairness.

5.2.2. Combining free allocation and paid allocation

Generally, benchmarks for the allocation of emissions allowances can be calculated by the following formula:

$$FA = AL \times BMe \qquad (5.1)$$

Where,
FA: Free allocation quantity (t-CO2/Yr.)
AL: Activity level (t-Product/Yr.)
BM: Benchmarks (t-CO2/t-Product)

Activity level can be estimated by the following formula:

$$AL = C \times CF \times AF \qquad (5.2)$$

Where,
C: Equipment capacity
CF: Equipment operation rate (past record or standard value)
AF: Adjustment factor

Benchmark calculation formula is as follows:

$$BMe = BMenergyE + BMfuelmix + BMprocessE \qquad (5.3)$$

Where,
BMenergyE: Benchmark for energy intensity (GJ/t-Product)
BMfuelmix : Benchmark for used fuels (t-CO2/GJ)
BMprocessE: Benchmark for production process emissions (t-CO2/t-Product)

Therefore, to determine benchmarks and allocation quantity, the following steps must be taken:

Step 1: Establish a benchmark boundary

Step 2: Establish an energy intensity benchmark for new, increasingly efficient technology (for example, the top 10%)

Step 3: Determine fuel usage and process emissions benchmarks

Step 4: Determine activity level

5.2.3. Principles of a benchmark method

This section describes the principles for determining benchmark values in general.[60] (Ecofys and Fraunhofer Institute for Systems and Innovation Research 2009):

- Set a benchmark for each product, and apply the same technology benchmark to the same product. This principle is also known as "one-product, one-benchmark"
- Set the same benchmark for the production of similar products, regardless of equipment types, years of operation, size, raw materials, or climate conditions.
- If any intermediate products are traded, set a different benchmark for them.
- Set a benchmark on fuel, regardless of equipment type or location.

5.2.4. Benchmark for the EU ETS

Upon consignment by the EU Commission, a consulting firm, Ecofys, conducted interviews with a number of industries and surveyed available literature in order to propose the following benchmark values in October 2009. (Ecofys et al. 2009)

[60] These are principles focused on 1) efficiency, and 2) availability of intermediate product substitutions. For details, refer to Chapter 3 of this paper, Cremer (2009), and Ecofys et al. (2009).

Table 5.3. Industry sectors and products for which actual benchmark is proposed under EU ETS

Industry sectors	Number of products	Product names
Iron and steel	4	Cokes, sintered iron, molten pig iron, electric furnace steel
Chemicals	8	Nitric acid, high value-added products made by steam cracking method, adipic acid, ammonia, hydrogen/synthetic gas, soda ash, aromatic compounds, black carbon
Cement	1	Clinker
Oil refinery	2	High value-added chemical products, etc.
Pulp and paper	9	Kraft pulp, thermo-mechanical pulp, reused paper, newspaper printing paper, non-coated paper, coated paper, tissue paper, card board for containers, paper boards for cartons
Lime	2	Limestone, dolomite
Ceramics	7	Lump clay, top-coat bricks and paving materials, tile, etc.
Glasses	3	Glass plates, hollow glass, glass fiber
Aluminum	4	Alumina, new aluminum ground metal, secondary smelting of aluminum
Mineral wool	1	
Plaster	4	Quicklime, ordinary plaster, glass fiber reinforced lime etc.

Reference: Ecofys et al. (2009)

According to their results, 45 products in 11 industry sectors are now subjected to benchmarks having been identified as the products needing protection.[61]

5.2.5. Selection of protective industries in Japan

n reference to benchmarks established for the EU ETS as described above, and existing studies in Japan[62], actual Japanese industry sectors and products that will be subjected to benchmarks can be identified. Sectors will be chosen through the establishment of carbon intensity and trade intensity standards as explained in Chapter 2, Sections 2.5 and 2.6 of this Paper, and on the basis of the following concepts:

Condition 1: Identify industry sectors in 401 sectors of the Industry Inter-relationship Table that are, for example, a carbon intensity of > 5% and a trade intensity of > 10%[63].

[61] The relationship between these results and the 151 protected industry sectors chosen by the EU's analysis as described in Chapter 3 is not known. However, in the case of the EU ETS, the carbon leakage prevention system and benchmarks were designed simultaneously, so that Ecofys et al. (2009) seemed to have developed benchmarks for these 45 products in view of the 151 sectors already identified. In other words, they identified these 45 products after conducting interviews with various stakeholders, taking into account the 151 sectors as the products in which benchmark development is technically feasible and will have real significance.

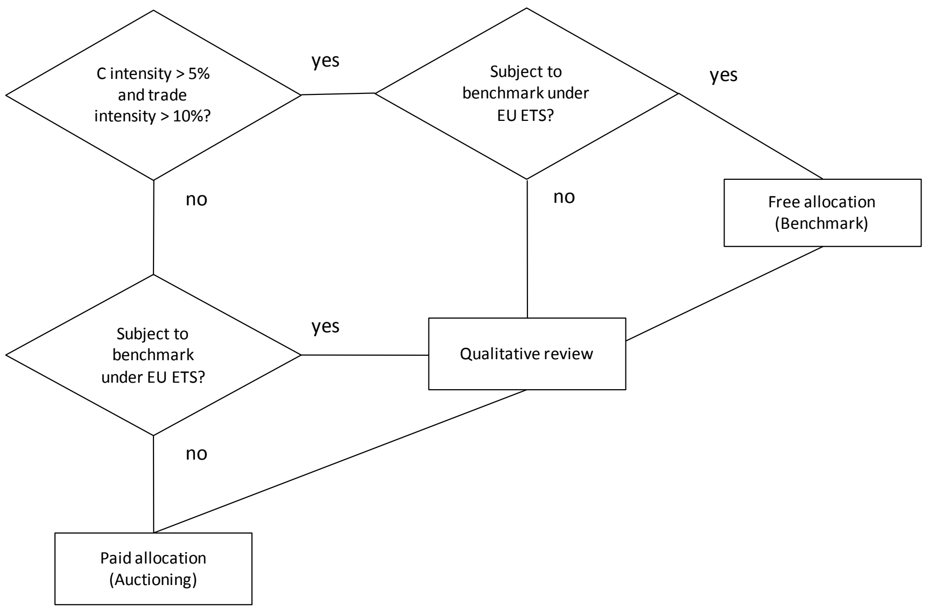
[62] In Japan, the Sub-committee to determine standards for factories, etc under the Energy Saving Standards Committee of National Resources and Energy Study Group is undertaking the discussion of actual intensity values for the iron and steel industry. (Japan Iron and Steel Association 2008)

[63] The EU and the US set the threshold of carbon intensity at 5%. In reference to trade intensity, Japan is more dependent on international trades, so its threshold is set at 10% for the moment (the EU is 30%, and the US is 15%) However, both the EU and the US set thresholds only on carbon intensity and trade intensity. In Japan, it is likely that the "appropriate" threshold will be determined by combining several different values. Such extra work will increase administrative costs, while inviting massive lobbying activities and an arbitrariness which will be difficult to resolve. In the end, it could become an unfair system, as the industry sector with the loudest voice will likely win more advantages. These are a few of the

Condition 2: Among these industry sectors, any sectors or products that are subjected to the benchmark method under the EU ETS are to adopt the EU ETS benchmark value unconditionally.

Condition 3: If the above industry sectors are not subjected to the benchmark method under the EU ETS, they must determine their own benchmark values. Condition 4: Even if condition 1 is not applicable, any industry sector or product that is subjected to a benchmark under the EU ETS must determine whether it requires protection through that benchmark using qualitative analysis.

Figure 5.2 Flow Chart in determining allocation methods



Source: Prepared by authors

problems which may have to be faced while incorporating a free allocation option.

6. Conclusion

6. Conclusion

6.1. Japan's mid to long term reduction targets and system design

At present, the Government of Japan has set mid to long term targets for a 25% reduction of greenhouse gas emissions from the 1990 level by 2020, and an 80% reduction by 2050. The numbers may fluctuate however, depending on the outcome of future international negotiations. To achieve these targets there remains the need for a drastic shift in Japan's industrial structure toward a sustainable low carbon society.

Policy options available to the government include regulatory measures, emissions trading, carbon tax, and subsidies. In view of current difficulties introducing internationally common carbon taxes by a number of countries, however, it is certain that Japan needs a policy mix with an equitable emissions trading system at the core.

Still, there are many policy options involved in an emissions trading system, and the government must select those options which are the most efficient and fair while reducing administrative costs. Otherwise, the introduction of an emission trading system will lead to nationwide cost increases, and could be perceived as being against national interests.

To select actual options for building the emissions trading system, the government must take into account the risks of carbon leakage and the possible loss of competitiveness by international corporations. For this purpose a thorough discussion based on quantitative analysis will be required. It will be essential to analyze past case studies, historical data, present and future competitive conditions, and conduct simulations using economic models.

6.2. Analyzing the risks of losing international competitiveness

With the above issues in mind, we conducted both qualitative and quantitative analyses of an emissions trading system introduction. We focused on Japanese corporations, and how they would be impacted, including their risk of carbon leakage and possible loss of international competitiveness.

The results indicated that: 1) during the first phase of the EU ETS (2005-2007) EU corporations increased both corporate profits and production quantities; 2) the analysis of the US's emissions trading system bill also indicated that there was no carbon leakage and no loss of international competitiveness occurred, except in the case of a few industry sectors and products; 3) in the US and the EU, industry sectors such as iron and steel, aluminum, fertilizers, cement and lime, and inorganic chemicals had a higher risk of losing international competitiveness, 4) in the case of Japan, however, no notable aluminum industry exists its cement and lime industry has lower trade intensities, except for carbon and graphite products and porcelain; 5) the demand function obtained from the statistical data of the past indicated that, if paid allocation was set at a carbon price of 3000 Yen, and if 100% of that cost is passed on to higher product prices as an opportunity cost, demand would decrease due to the price increases. In iron and steel products there would be about a 3% decrease in the US, the EU, and Japan alike; and 6) carbon constraints are beginning to happen in developing countries now, including China..

These indications suggest that there is no need to be concerned about large carbon leakage or overseas transfer of Japanese corporations upon the introduction of an emissions trading system in Japan.

6.3. Actual emissions trading system design

Still, some form of protective measures should be in place upon the introduction of an emissions trading system in order to protect corporations from the loss of international competitiveness. Actual policy options should include: 1) allocating free of charge emissions allowances; 2) tax reductions and subsidies; 3) international offset mechanism (CDM etc.); 4) trade measures; 5) sectoral commitment; 6) voluntary export control by developing countries; and 7) consumption based accounting. The most practical and realistic option is the free allocation of emissions allowances. In fact, both the US and Australian governments adopted this option, having learned from the experiences of the EU ETS first phase. The EU will also adopt this option during the third phase of the EU ETS (after 2012).

Therefore the most preferable and fundamental principle, when designing an emissions trading system in Japan, should be to adopt paid allocation (auctioning) as the main option. Then, provide free allocation to the carbon intensive and trade dominant industries only, based on a benchmark method in order to mitigate the risk of losing international competitiveness. By using auctioning revenues to mitigate and prevent any adverse effects of global warming measures, such as GDP loss, the combination of free and paid allocation of emission allowances will provide the best and most balanced option for the Japanese Government.

6.4. Final argument

As stated at the beginning, Japan cannot achieve its greenhouse gas emissions target of a 25% reduction by 2020 from the 1990 level, and a 80% reduction by 2050, unless it takes drastic measures to shift its industrial structure toward a sustainably low carbon society. The funding needed to suport such a shift is a necessary and essential investment in order to realize a low carbon society in Japan. Moreover, the adoption of carbon constraints does not necessarily mean the elimination or destruction of the traditionally strong ethics of our Japanese companies “to produce things.” On the contrary, carbon constraints will eventually create new industries which will need to produce new things, creating more jobs, and making Japanese corporations more internationally competitive in the mid to long term.

Nevertheless, actual system designs of an emissions trading system must embrace various policy options and, despite time constraints, Japan must review and compare these options thoroughly, giving consideration to all pertinent issues. Upon review and comparison, it is important to examine any trade-off relationships between efficiency, political acceptability and equity in order to determine the best policy. We hope that with the right global warming policies in place, Japan will enjoy an even stronger, more independent future

Appendix

Appendix: 401 industries' carbon intensities, trade intensities, and ratio of output values in total Japanese GDP

Industry relations table for 401 inudstry sectors,their carbon intensities, trade intensities and share in domestic production (Listed in order of the largeness of MVAS. with blue shades)

For reference, those industry sectors with MVAS 5% or larger, and trade intensities 10% or larger is shown

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Pig iron	3.46%	129.97%	1.30%	0.13%
Cement	4.13%	103.69%	3.93%	0.05%
Ocean transportation	0.00%	55.78%	99.64%	0.19%
Ferro alloy	4.53%	41.02%	61.84%	0.01%
In-house power generation	0.00%	39.31%	0.00%	0.13%
Basic petrochemical products	5.93%	17.52%	3.13%	0.13%
Coal products	0.61%	15.67%	6.50%	0.08%
Soda industry products	9.50%	14.93%	3.22%	0.06%
Crude iron (Electric furnace)	4.13%	11.99%	0.33%	0.11%
Industrial power generation	0.48%	11.52%	0.17%	1.62%
Salt	0.74%	11.49%	32.98%	0.01%
Aliphatic intermediate products	3.58%	11.24%	24.18%	0.19%
Pulp	6.43%	10.26%	24.83%	0.07%
Aviation	0.07%	9.46%	50.26%	0.27%
Compressed gas/liquefied gas	7.42%	8.04%	1.70%	0.03%
Paperboard	3.34%	7.51%	2.80%	0.07%
Sewage **	3.23%	7.36%	0.07%	0.12%
Lead, Zinc (incl. reuse)	4.33%	7.22%	10.46%	0.02%
Synthetic rubber	3.39%	7.20%	18.65%	0.06%
Petrochemical aromatic products	0.66%	7.06%	17.23%	0.06%
Cyclic intermediates	2.13%	7.01%	57.47%	0.13%
Synthetic dye	0.92%	6.89%	77.97%	0.01%
Rayon, acetate	1.53%	6.88%	40.44%	0.01%
Other synthetic resins	0.96%	6.80%	57.72%	0.04%
Paper and Japanese paper	2.34%	6.28%	8.22%	0.24%
Heat supply industry	1.76%	6.03%	0.00%	0.02%
Other organic chemical products	1.47%	5.65%	29.86%	0.09%
Coastal and inner sea transportation	0.03%	5.62%	0.35%	0.10%
Aluminum (incl. reuse)	2.29%	5.26%	57.31%	0.04%
Cast/forged iron	0.76%	4.53%	0.52%	0.03%
Waste treatment (public service) **	0.26%	4.52%	0.00%	0.13%
Chemical fertilizer	1.65%	4.43%	14.70%	0.04%
Thermoplastic resin	1.19%	4.41%	18.59%	0.15%
Methane derivatives	1.42%	4.39%	35.95%	0.01%

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Synthetic fiber	1.85%	4.32%	30.92%	0.06%
Refractory products	2.30%	4.25%	15.43%	0.03%
Plasticizers	0.90%	3.95%	6.63%	0.01%
Copper	1.78%	3.92%	31.27%	0.03%
Other construction materials (soil and stones)	0.47%	3.89%	2.62%	0.03%
Hot rolled steel products	0.76%	3.85%	16.89%	0.47%
Inorganic pigments	1.30%	3.70%	29.86%	0.03%
Starch	0.83%	3.65%	6.23%	0.02%
Animal fats	1.01%	3.59%	36.46%	0.00%
Cold-rolled finished steel product	1.59%	3.55%	13.98%	0.27%
Glassfiber and glassfiber products	0.97%	3.55%	19.25%	0.03%
Glucose, syrup, isomerized sugar	1.22%	3.53%	4.32%	0.01%
Cast iron pipe	0.67%	3.52%	1.52%	0.02%
Carbon and graphite products	1.03%	3.51%	36.31%	0.02%
Other inorganic chemical products	1.09%	3.47%	29.97%	0.08%
Sugar	0.79%	3.44%	15.43%	0.03%
Cast iron and forged steel products	1.34%	3.32%	1.38%	0.14%
High-functional resin	0.85%	3.06%	31.25%	0.05%
Plated steel	1.02%	2.98%	23.79%	0.14%
Thermoset plastic	1.07%	2.96%	25.69%	0.06%
Special purpose forest product (incl. hunting)	0.59%	2.92%	22.92%	0.02%
Porcelain and china	0.29%	2.84%	21.45%	0.09%
Fishery (coastal, offshore, and pelagic)	0.00%	2.80%	18.41%	0.13%
Waste treatment (industrial)	0.11%	2.69%	0.01%	0.22%
Dyeing and fixing	0.51%	2.64%	0.00%	0.07%
Metal and minerals	2.19%	2.61%	98.47%	0.00%
Other non-ferrous metals	1.70%	2.50%	70.25%	0.05%
other ceramics, earth and stone products	0.40%	2.49%	17.00%	0.09%
Fats and oil processed products	0.41%	2.37%	26.42%	0.01%
Coal	2.08%	2.36%	94.42%	0.00%
Other non-metal minerals	1.20%	2.13%	94.83%	0.00%
Petroleum products	0.20%	2.13%	15.34%	1.23%
Plate glass, safety glass	0.56%	2.08%	12.54%	0.06%
Flower bases, flowerings, trees, etc.	0.25%	2.05%	4.21%	0.06%
Other chemical end produces	0.63%	1.97%	30.92%	0.19%
Steel pipes	0.45%	1.95%	24.88%	0.09%
Other glass products	0.71%	1.90%	27.67%	0.10%
Ice-making	1.84%	1.85%	0.02%	0.01%
Plant oil	0.58%	1.84%	11.66%	0.06%
Railway cargo transportation	1.43%	1.81%	3.30%	0.02%
Ceramic raw material minerals	0.78%	1.70%	27.51%	0.02%
Tires, tubes	0.83%	1.65%	39.17%	0.10%
Railway car repair	0.60%	1.65%	0.00%	0.04%
Movie theater	1.09%	1.51%	2.37%	0.02%

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Non-ferrous metal cast materials	0.52%	1.50%	0.35%	0.10%
Public bath industry	0.40%	1.48%	0.00%	0.05%
Agricultural chemicals	0.71%	1.48%	13.49%	0.04%
Leather and fur industry	0.69%	1.45%	33.97%	0.01%
Road cargo transportation	0.07%	1.37%	5.01%	1.28%
Copper processing products	0.72%	1.34%	29.91%	0.06%
other non-ferrous metal products	0.74%	1.34%	33.74%	0.06%
Livestock feed	0.47%	1.30%	11.55%	0.10%
Aluminum rolling products	0.73%	1.30%	13.92%	0.12%
Photosensitive materials	0.53%	1.21%	50.44%	0.08%
Cotton and stable fiver textiles (Incl. synthetic ,monofilament textile)	0.64%	1.20%	57.23%	0.03%
Yarns	0.68%	1.19%	31.63%	0.03%
Gelatin, adhesives	0.34%	1.19%	13.96%	0.03%
Sea farm industry	0.10%	1.17%	17.77%	0.06%
Soaps, detergents, surfactants	0.34%	1.15%	9.47%	0.08%
Painting paper, treated paper for construction	0.37%	1.15%	20.25%	0.06%
Inner water fishery and fish farm	0.55%	1.11%	15.09%	0.01%
Polishers	0.46%	1.10%	20.89%	0.02%
Natural science research institutes (industry)	0.56%	1.09%	8.93%	0.06%
Dairy farm products	0.30%	1.07%	5.94%	0.21%
Other food products	0.32%	1.04%	11.92%	0.15%
Sanitary paper materials and products	0.40%	1.01%	4.38%	0.05%
Resource recycling, processing, and treatment	0.49%	1.01%	12.48%	0.16%
Retort pouch foods	0.17%	0.97%	0.05%	0.02%
Other iron and steel products	0.44%	0.96%	26.48%	0.02%
Buses	0.04%	0.93%	2.49%	0.18%
Accessories, powers, metal products, and tools for plumbing works	0.59%	0.92%	18.16%	0.09%
Other education and training institutes (Public sectors)**	0.21%	0.90%	0.00%	0.06%
Agricultural service (except veterinary)	0.55%	0.90%	0.00%	0.05%
Frozen foods	0.38%	0.90%	0.08%	0.06%
Bottled or canned agricultural products	0.27%	0.89%	38.85%	0.02%
Milling	0.23%	0.89%	2.04%	0.07%
Plastic products	0.61%	0.89%	8.10%	1.07%
Nuclear fuels	0.52%	0.86%	2.28%	0.02%
Organic fertilizers (except those listed otherwise)	0.25%	0.85%	1.05%	0.02%
Chicken meat	0.48%	0.83%	0.29%	0.03%
Railway passenger transportation	0.77%	0.83%	2.42%	0.66%
Silk, rayon textiles (incl. synthetic lint fiber textiles)	0.47%	0.83%	66.46%	0.03%
Crude oil, natural gas	0.80%	0.83%	98.78%	0.01%
Bottled and canned animal husbandry products	0.25%	0.83%	2.76%	0.01%

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Cereal cleaning	0.56%	0.81%	0.97%	0.29%
Other electric machines and apparatus	0.56%	0.81%	59.69%	0.19%
Bottled or canned marine products	0.14%	0.81%	8.73%	0.02%
Amusement parks	0.54%	0.78%	1.23%	0.52%
Other textile industry product	0.35%	0.78%	23.98%	0.06%
Other metal products	0.48%	0.77%	10.26%	0.35%
Electronic tubes	0.40%	0.76%	49.98%	0.05%
Noodles	0.20%	0.76%	2.93%	0.11%
Hired cars, taxis	0.03%	0.76%	2.52%	0.25%
Plastic footwear	0.35%	0.75%	53.62%	0.01%
Industrial water	0.67%	0.72%	0.00%	0.01%
Warehouses	0.70%	0.72%	2.55%	0.14%
Other clothes and personal articles	0.42%	0.72%	47.40%	0.04%
Wool, linen other textiles	0.32%	0.71%	42.05%	0.02%
Internal combustion engines and parts for cars	0.47%	0.71%	20.86%	0.50%
Vegetable (outdoor or in-house)	0.03%	0.70%	3.59%	0.26%
Optical cable	0.51%	0.69%	59.53%	0.03%
Semiconductors	0.43%	0.69%	73.73%	0.13%
Rubber footwear	0.30%	0.69%	71.64%	0.01%
Internal combustion engines for ships	0.37%	0.68%	28.59%	0.05%
Wood chips	0.57%	0.68%	70.07%	0.01%
Bearings	0.48%	0.68%	33.88%	0.10%
Social education (non-profit)*	0.54%	0.68%	0.00%	0.02%
Other education and training institutes (industry)	0.07%	0.67%	0.14%	0.09%
Plywood	0.45%	0.67%	23.42%	0.08%
Aviation facility management (industry)	0.51%	0.66%	50.48%	0.01%
Other pulp, paper, paper processed products	0.36%	0.65%	9.53%	0.11%
Integrated circuits	0.49%	0.63%	69.23%	0.53%
Other rubber products	0.32%	0.63%	12.55%	0.20%
Macadam	0.35%	0.61%	0.02%	0.07%
Bolts, nut, rivets, and springs	0.35%	0.61%	16.37%	0.13%
Natural science research institutes (public sector)**	0.42%	0.60%	0.00%	0.13%
Paving materials	0.53%	0.60%	0.16%	0.04%
Carpets floor covers	0.27%	0.60%	19.76%	0.02%
Electric wires and cables	0.39%	0.59%	32.17%	0.11%
Magnetic tapes and disks	0.32%	0.58%	57.13%	0.05%
Liquid crystal elements	0.47%	0.58%	21.18%	0.16%
Cement products	0.16%	0.57%	0.60%	0.17%
Batteries	0.37%	0.56%	45.74%	0.11%
Fish cakes	0.22%	0.56%	0.79%	0.05%
Electric bulbs	0.28%	0.56%	19.16%	0.05%
Inter-company research and development	0.37%	0.55%	0.00%	1.11%
Water supply, small water supply	0.52%	0.54%	0.13%	0.32%

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Other optical instruments	0.45%	0.54%	65.54%	0.07%
Pigs	0.49%	0.54%	0.03%	0.05%
Household dishes, sushi, lunch boxes	0.15%	0.54%	0.03%	0.27%
Cardboards	0.22%	0.53%	0.07%	0.07%
Aviation facility management (national and public)**	0.47%	0.53%	6.01%	0.02%
Automobile parts	0.28%	0.53%	13.88%	1.62%
Bicycles	0.35%	0.52%	83.51%	0.07%
Coffee shops	0.18%	0.52%	2.20%	0.14%
Fiber for sanitary materials	0.30%	0.52%	9.21%	0.01%
Metal containers and metal plates for can manufacturing	0.25%	0.51%	2.15%	0.18%
Social education (national and public)**	0.41%	0.51%	0.00%	0.12%
Steel ships	0.41%	0.50%	82.47%	0.14%
Seasoning	0.20%	0.50%	3.83%	0.16%
Railway cars	0.35%	0.50%	11.83%	0.04%
Classification unknown	0.09%	0.50%	6.04%	0.44%
Other ships	0.43%	0.50%	39.04%	0.01%
Metal products for construction	0.28%	0.49%	0.93%	0.28%
veterinary services	0.05%	0.49%	0.00%	0.01%
Other paper containers	0.26%	0.49%	2.23%	0.09%
Teas and coffees	0.30%	0.48%	4.94%	0.10%
Truck, busses, and other vehicles	0.25%	0.47%	30.80%	0.25%
Salted, dried, or smoked products	0.18%	0.47%	10.72%	0.07%
Knitted materials	0.35%	0.46%	37.45%	0.01%
Ceremonial services	0.22%	0.46%	0.08%	0.24%
Printing inks	0.22%	0.46%	13.41%	0.04%
Japanese inns and other lodgings	0.26%	0.46%	20.32%	0.87%
Confectionaries	0.18%	0.46%	3.97%	0.27%
Material	0.07%	0.45%	43.74%	0.04%
Machine tools	0.36%	0.45%	38.26%	0.08%
Medical services (national and public)	0.18%	0.45%	0.00%	0.62%
Cosmetics and toothpaste	0.34%	0.45%	12.54%	0.17%
Gravels, quarry	0.21%	0.45%	4.29%	0.04%
Goods for exercises	0.24%	0.44%	33.74%	0.05%
Theaters show business facility	0.33%	0.44%	2.14%	0.01%
Paints	0.22%	0.44%	10.60%	0.10%
Laundry, cleaning, textile dying services	0.12%	0.44%	0.01%	0.31%
Electric rotating machines	0.32%	0.44%	34.04%	0.13%
Meat processed products	0.17%	0.43%	11.34%	0.09%
Ropes and nets	0.28%	0.42%	17.55%	0.01%
Social security businesses (national and public) **	0.37%	0.42%	0.00%	0.09%
General restaurants (excl. coffee shops)	0.20%	0.41%	4.36%	1.54%
Turbines	0.21%	0.41%	51.20%	0.05%

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Iron and steel chassis slit businesses	0.27%	0.41%	0.00%	0.15%
Cargo transport businesses	0.07%	0.41%	6.55%	0.04%
Other electronic parts	0.34%	0.41%	25.09%	0.95%
Gas and oil appliances, heaters, kitchen apparatus	0.19%	0.41%	3.33%	0.10%
Car bodies	0.23%	0.41%	1.34%	0.19%
Agricultural preserved foods (excl. bottles and cans)	0.15%	0.41%	36.67%	0.06%
Harbour transportation	0.02%	0.40%	38.26%	0.15%
Social insurance businesses (non-profit)*	0.34%	0.40%	0.00%	0.05%
Other wood products	0.26%	0.40%	10.69%	0.13%
Bicycles	0.25%	0.40%	41.73%	0.02%
Lumbering	0.30%	0.40%	28.29%	0.11%
Pens, pencils, stationeries	0.29%	0.40%	42.38%	0.04%
Water transport facility management**	0.03%	0.40%	38.21%	0.01%
Metal products for construction	0.23%	0.39%	1.64%	0.28%
Other seafood	0.16%	0.38%	22.35%	0.11%
Other industrial machines and apparatus	0.23%	0.38%	17.55%	0.23%
Agricultural and forestry related public words	0.09%	0.38%	0.00%	0.28%
Motors	0.20%	0.38%	25.87%	0.12%
Inner combustion engines electric accessories	0.26%	0.38%	11.42%	0.17%
Breads	0.16%	0.37%	0.64%	0.14%
School lunches (national and public) **	0.10%	0.37%	0.00%	0.09%
Passenger cars	0.26%	0.37%	49.09%	1.27%
Clocks	0.27%	0.36%	62.91%	0.04%
Agricultural machines	0.17%	0.36%	7.02%	0.07%
Other general machines, apparatus and parts	0.22%	0.36%	28.48%	0.11%
Drugs, pharmaceuticals	0.21%	0.36%	10.88%	0.68%
Information recording media	0.28%	0.35%	39.73%	0.03%
Metal furniture, equipment	0.19%	0.34%	11.04%	0.09%
Frozen seafood	0.22%	0.34%	42.78%	0.17%
Entertaining restaurants	0.13%	0.34%	2.37%	0.72%
Freezers, moisture adjustment equipment	0.21%	0.34%	7.52%	0.13%
Other office machines	0.24%	0.34%	17.38%	0.11%
Cardboard boxes	0.21%	0.33%	0.29%	0.14%
Town gas	0.16%	0.33%	0.06%	0.25%
Medical equipment and machines	0.19%	0.33%	39.80%	0.10%
Medical service (public service co.)	0.16%	0.33%	0.00%	0.75%
Wooden fittings	0.18%	0.32%	3.83%	0.07%
Copying machines	0.23%	0.32%	44.02%	0.14%
Other alcohol drinks	0.06%	0.31%	21.91%	0.07%
Small personal belongings	0.19%	0.31%	62.60%	0.05%
Metal machine tools	0.22%	0.31%	29.28%	0.17%
Medical service (Medical service corporations)	0.16%	0.31%	0.00%	2.14%
Machine repair	0.27%	0.31%	0.00%	0.64%

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Wooden furniture, fittings	0.21%	0.30%	16.94%	0.16%
Roads, highways and other public works	0.08%	0.30%	0.00%	1.01%
Construction and mining machines	0.17%	0.30%	28.67%	0.20%
Electric lighting apparatus	0.16%	0.30%	13.68%	0.09%
Printing,, make-ups, bookbinding	0.19%	0.30%	0.76%	0.74%
School lunch (private schools)*	0.08%	0.30%	0.00%	0.00%
Weapons	0.11%	0.30%	8.74%	0.04%
Other transportation machines	0.18%	0.30%	16.37%	0.08%
Metalwork machines	0.22%	0.30%	24.54%	0.08%
Road transportation facility services	0.26%	0.30%	0.05%	0.36%
Various repair works (except listed otherwise)	0.15%	0.29%	0.05%	0.02%
Textile machines	0.19%	0.29%	65.80%	0.05%
Household electric appliances (excl. air conditioner)	0.24%	0.29%	11.83%	0.25%
Physics and chemicals apparatus and machines	0.16%	0.29%	65.16%	0.01%
Pumps and compressors	0.19%	0.28%	29.78%	0.20%
Soft drinks	0.08%	0.28%	0.91%	0.36%
Hygiene (industry)	0.17%	0.28%	0.00%	0.03%
Other manufactured products	0.15%	0.28%	8.72%	0.21%
Nursing care (home)	0.16%	0.28%	0.00%	0.14%
Leather footwear	0.18%	0.27%	30.78%	0.03%
Dairy farming	0.24%	0.27%	0.00%	0.09%
Other textile ready-made products	0.17%	0.27%	22.10%	0.06%
Camera	0.18%	0.26%	54.20%	0.05%
Bedding	0.18%	0.26%	33.03%	0.03%
Wire electric communication equipment	0.18%	0.26%	22.06%	0.19%
Retail sale	0.17%	0.25%	0.07%	3.79%
Public services (Central) **	0.10%	0.25%	0.00%	1.19%
Boilers	0.09%	0.25%	8.35%	0.05%
Transport machines	0.17%	0.25%	15.99%	0.12%
Ready-mixed concrete	0.09%	0.25%	0.04%	0.19%
Other industrial heavy electric equipment	0.18%	0.24%	60.29%	0.08%
Public works for rivers, sewage, and others	0.08%	0.24%	0.00%	1.03%
Private sector non-profit organization for corporations	0.04%	0.24%	8.52%	0.11%
Video equipment	0.23%	0.24%	68.70%	0.15%
Other communication services	0.19%	0.23%	0.00%	0.01%
Electric audio equipment	0.18%	0.23%	31.50%	0.20%
Knitted clothes	0.13%	0.23%	56.08%	0.09%
Metal molds (dies)	0.15%	0.23%	11.67%	0.18%
Public broadcasting	0.19%	0.23%	0.00%	0.07%
Other aviation incidental services	0.19%	0.23%	39.83%	0.05%
Hygiene (national and public) **	0.08%	0.23%	0.00%	0.06%
Sport facilities, parks, amusement parks	0.11%	0.23%	1.04%	0.27%

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Barbers	0.04%	0.23%	0.01%	0.09%
Nursing care (facilities)	0.11%	0.23%	0.00%	0.28%
Real estate lease and rent services	0.14%	0.23%	0.00%	0.64%
Other personal services	0.13%	0.22%	0.06%	0.05%
Advertisement	0.13%	0.22%	5.53%	0.95%
Other electronic communication equipment	0.13%	0.22%	14.72%	0.04%
Bags, luggage, other leather products	0.16%	0.22%	64.17%	0.03%
Computer accessories	0.17%	0.22%	63.02%	0.43%
Home air conditioners	0.16%	0.22%	11.96%	0.12%
Other electric communication	0.20%	0.22%	1.32%	0.33%
Sake	0.09%	0.22%	0.42%	0.07%
Industrial robots	0.15%	0.22%	43.55%	0.08%
Public services (local government) **	0.11%	0.22%	0.00%	2.58%
Airplanes	0.15%	0.22%	51.42%	0.10%
Other machines for special industries	0.14%	0.22%	56.78%	0.21%
Bicycle race and horse race facilities and teams	0.12%	0.22%	1.28%	0.19%
Other civil engineering and construction	0.08%	0.22%	0.00%	0.64%
Wiring tools	0.13%	0.21%	54.08%	0.06%
Converters, transformers	0.19%	0.21%	47.65%	0.03%
Analyzers, testers, weight measures, measuring instrument	0.13%	0.20%	31.06%	0.14%
Real estate agents, management	0.16%	0.20%	0.00%	0.37%
Movies and videos producers, and suppliers	0.13%	0.20%	6.71%	0.16%
Semi conductors manufacturing equipment	0.14%	0.20%	66.87%	0.21%
Railroad track construction	0.10%	0.20%	0.00%	0.15%
Whiskies	0.04%	0.19%	45.17%	0.02%
Switch control equipment and panel boards	0.14%	0.19%	29.64%	0.28%
Construction repair	0.07%	0.18%	0.00%	0.94%
Cellular phones	0.09%	0.18%	8.06%	0.17%
Toys	0.13%	0.18%	42.68%	0.07%
Social welfare (non-profit) *	0.10%	0.18%	0.00%	0.27%
Commercial broadcasting	0.05%	0.18%	0.00%	0.24%
Humanity research institutes (national and public) **	0.02%	0.18%	0.00%	0.01%
Natural science research institutes (non-profit) *	0.08%	0.18%	0.00%	0.00%
Wireless electric communication equipment (excl. cellular phones)	0.08%	0.18%	11.47%	0.17%
Computers (except personal computers)	0.09%	0.17%	63.80%	0.09%
School education (private) *	0.08%	0.17%	0.00%	0.56%
Food processing machines	0.10%	0.17%	53.38%	0.03%
Electronic appliances	0.13%	0.17%	32.18%	0.23%
Chemical machines	0.13%	0.17%	18.28%	0.11%
Beers	0.05%	0.17%	0.77%	0.29%
Musical instrument	0.12%	0.17%	36.10%	0.03%

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Social welfare (national and public) **	0.08%	0.16%	0.00%	0.16%
Private lesson facilities	0.12%	0.16%	0.02%	0.36%
Cable broadcasting	0.09%	0.16%	0.00%	0.04%
Beef cattle	0.10%	0.16%	0.38%	0.07%
Service equipment	0.09%	0.16%	9.89%	0.16%
Beauty businesses	0.04%	0.16%	0.01%	0.25%
Non-residential construction (not wooden)	0.06%	0.16%	0.00%	1.34%
Ship repairs	0.12%	0.15%	15.20%	0.02%
Civil engineering and construction services	0.03%	0.15%	8.55%	0.43%
Personal computers	0.07%	0.15%	32.67%	0.26%
Power facility construction	0.08%	0.15%	0.00%	0.13%
Rice	0.03%	0.15%	0.75%	0.25%
Fixed telecommunication	0.12%	0.15%	1.33%	0.80%
Other entertainments	0.08%	0.15%	0.95%	0.12%
Other non-food cultivation	0.00%	0.14%	59.10%	0.01%
Airplane repair	0.11%	0.14%	69.82%	0.05%
Other food cultivation	0.00%	0.14%	94.66%	0.00%
Residential building construction (non-wooden)	0.06%	0.14%	0.00%	1.08%
Textile clothes	0.11%	0.14%	33.89%	0.24%
Private non-profit entity for households (excl. those listed otherwise) *	0.03%	0.14%	0.01%	0.33%
Newspapers	0.10%	0.14%	0.02%	0.27%
Postal service	0.07%	0.14%	1.48%	0.22%
School education (national and public) **	0.09%	0.13%	0.00%	1.63%
Travel and other transportation related services	0.10%	0.13%	38.44%	0.11%
Other stock raising	0.09%	0.13%	29.81%	0.01%
Automobile repairs	0.10%	0.13%	0.00%	0.70%
Seeds and saplings	0.05%	0.13%	31.35%	0.01%
Telecommunication facility construction	0.07%	0.12%	0.00%	0.15%
Wheat etc.	0.03%	0.12%	50.57%	0.01%
Other office services	0.08%	0.11%	6.07%	1.46%
Chicken eggs	0.05%	0.11%	0.10%	0.05%
Electric measuring instruments	0.09%	0.11%	55.50%	0.16%
Publishing	0.06%	0.11%	3.25%	0.24%
Tatami mats, straw products	0.05%	0.11%	9.20%	0.01%
Potatoes	0.02%	0.11%	0.18%	0.03%
Photography businesses	0.05%	0.10%	1.78%	0.11%
Rental car businesses	0.02%	0.10%	0.00%	0.17%
Performance groups	0.08%	0.10%	9.97%	0.06%
Packing	0.06%	0.09%	0.00%	0.13%
Information services	0.07%	0.09%	4.43%	1.47%
Animal feed cultivation	0.02%	0.09%	24.70%	0.02%
Legal, financial, and accounting services	0.01%	0.08%	7.92%	0.28%
Non-residential building construction (wooden)	0.05%	0.08%	0.00%	0.08%

Name of Industry Sector	NVAS	MVAS	Trade Intensity	Share in domestic production
Residential home building (wooden)	0.05%	0.08%	0.00%	1.24%
Television and radio sets	0.04%	0.08%	50.59%	0.07%
Mobile telecommunication	0.05%	0.08%	0.02%	0.60%
Wholesale	0.04%	0.08%	8.40%	6.32%
Property insurance	0.05%	0.07%	3.90%	0.34%
Other water supply related service	0.02%	0.07%	54.97%	0.01%
Humanity research institutes (industrial)	0.05%	0.06%	8.74%	0.00%
humanity research institutes (non-profit) *	0.01%	0.06%	0.00%	0.00%
Fruits	0.00%	0.06%	19.50%	0.10%
Building services	0.01%	0.05%	0.00%	0.44%
House lease and rents	0.01%	0.05%	0.03%	1.27%
Sugar-making plant cultivation	0.00%	0.05%	0.00%	0.01%
Life insurance	0.03%	0.05%	1.53%	0.85%
News supply, private detective agencies	0.03%	0.05%	6.95%	0.09%
Beans	0.00%	0.04%	60.26%	0.01%
Financial services	0.03%	0.04%	1.90%	2.79%
Tobacco	0.02%	0.03%	16.64%	0.32%
Rental and lease services (excl. rental cars)	0.02%	0.03%	2.27%	1.15%
Forestation	0.00%	0.03%	0.00%	0.09%
Butchers (incl. chicken processing)	0.02%	0.02%	41.70%	0.16%
Worker dispatch services	0.00%	0.01%	0.01%	0.17%
Crops for drink-making	0.00%	0.01%	44.59%	0.01%
Iron scraps	0.00%	0.00%	0.00%	0.00%
Non-ferrous metal scraps	0.00%	0.00%	0.00%	0.00%
House lease and rents (rent for belonging)	0.00%	0.00%	0.00%	4.59%
In-house transportation (passenger cars)	0.00%	0.00%	0.00%	0.63%
In-house transportation (cargo trucks)	0.00%	0.00%	0.00%	0.39%
Office supplies	0.00%	0.00%	0.00%	0.19%
Crude steel (converter)	0.61%	-0.85%	0.00%	0.22%

Note: * - Public service producers, ** - Private non-profit household service producers
no * - Industries

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