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A Comparative Study on the Environmental Impact of Korea-Japan Free Trade

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Foreword

Since the emergence of multilateral trade system fostered by the GATT and the WTO, the world economy has changed profoundly, accompanied by substantial environmental degradation. It is understood in general that economic growth driven by trade liberalization may speed up the process of environmental degradation unless sufficient environmental flanking measures are put in place.

In parallel with the trade liberalization under the current multilateral trade system, the number of regional or bilateral trade agreements is continuously increasing all over the world. With its ratification of the first free trade agreement with Chile, Korea joined the main stream of trade liberalization with regional trade agreement. Korea is engaging in the intergovernmental negotiations with Japan and Singapore, and proceeding joint studies with ASEAN, EFTA(European Free Trade Association), and Mexico.

The need for Korea to ensure the mutual supportiveness between trade and environment is more pressing today than ever before. For this, we need to understand first of all the exact linkage between trade and environmental and to count on more constructive and rigorous way of approach including variety of quantitative analysis methodology. While a great deal of induced environmental impacts can be learned by careful sectoral quantitative study, this approach could overlook important interlankages between sectors and trade partners, so-called general equilibrium effects.

The current study based on a computable general equilibrium model linked with air pollution emission module analyzes the environmental impact of trade liberalization between Korea and Japan. It was planned and implemented by the joint research group composed of experts in the Korea Environment Institute in Korea, the Institute for Global Environmental Strategy and the National Institute for Environmental Studies in Japan.

Comparative analysis of industry and bilateral trade structure between Korea and Japan revealed the economic rationale of Korea-Japan Free trade Agreement. The air pollution inventories of Korea and Japan was made as a background of environmental impact analysis. The induced air pollution effects from structural change in trade specialization was estimated based on the free trade simulation using a standard GTAP computable general equilibrium model.

This kind of quantitative approach, in spite of intrinsic weakness resulting from data deficiency, seems very useful to understand the trade and environment linkage in a specific trade liberalization case study from which lots of policy implications could be learned.

Finally, I would like to thanks Dr. Sang In Kang and Mr. Jae Joon Kim of KEI for their efforts. My special thanks goes to Dr. Tae Young Jung in IGES and Dr. Toshihiko Masui and Dr. Junichi Fujino for their excellent contribution to this study. Please consider that opinions expressed here are the author's and do not necessarily represent the official view of KEI.

December 2004.

Korea Environment Institute
President
Suh-Sung YOON, Ph.D.

Abstract

Since the World Summit on Sustainable Development(WSSD) in 2002 endorsed the importance of mutual supportiveness between environmental protection and promotion of sustainable development under the open and non-discriminatory multilateral trading system, the environmental impacts of trade liberalization have become a theme of heated debate at diverse global, regional and national fora focusing on trade and environment.

Having finished its own environmental impact assessment of the current multilateral trade negotiation under the DDA(Doha Development Agenda) in WTO, Korea is now implementing a series of quantitative analysis on the environmental impacts of a free trade agreement. Japan is also trying to introduce an environmental review process in its free trade agreement policy, after having concluded its first free trade agreement with Singapore.

The current study on the environmental impact of trade liberalization between Korea and Japan has been implemented by the joint expert meeting composed of experts in the Korea Environment Institute, Institute for Global Environmental Strategies and the National Institute for Environmental Studies in Japan.

The joint expert meeting shared the view that environmental review on the FTA would be very important in designing flanking environmental policies and measures to realize mutual supportiveness of trade and environment, and decided to implement a comparative study on the air pollution impact resulting from a free trade agreement between Korea and Japan.

In the study, a comparative analysis of industry and bilateral trade structure between Korea and Japan was made as a background of environmental impact

analysis. The air pollution inventories of Korea and Japan based on the Korean I-O table classification were harmonized and compared. The intertemporal change in industrial emission structure between 1995 and 2000 showed that there had been an important technological progress in managing air pollution.

The air pollution effect was calculated by combining emission coefficient per unit of production and output change after free trade. The emission coefficient per unit of production was obtained from the related energy consumption survey. In general, the emission coefficient of Japan is lower than that of Korea for a given industry, which reveals a inter-industrial difference in emission coefficient for a given air pollutant in a country. These two kinds of difference were supposed to play a key role in determining aggregated air pollution impact of industrial output change after trade liberalization. The output change by industry after free trade was calculated from the free trade simulation using a standard computable general equilibrium model developed by GTAP. The standard CGE model could be characterized by comparative static type and perfect competitive market assumption.

The result showed that free trade between Korea and Japan can mitigate air pollution, and economic gains from trade represented by +1.17% and +0.21% increase of GDP respectively. After free trade, the specialization structure of Korea and Japan moved to less pollution intensive one, and the mitigation of air pollution in Japan revealed less important than that of Korea. This results might show one of the interesting cases that the free trade and environmental protection could be mutually supportive.

But the generalization of the result obtained by the current study needs much precaution. The simulation result from CGE type model is highly dependant on the value of various elasticities not always estimated econometrically but sometimes chosen arbitrary by researchers. The second limit of the current study is that it used a multi-regional general equilibrium model and could not consider the detailed national information which can be more useful in a two-country general equilibrium model combining two individual national general equilibrium models. The comparative static structure of the model put also certain limit on analysis capacity related to the induced technology transfer or progress after free trade.

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I. Introduction

Globalization has led to accelerated growth of world economy. However, economic growth has been accompanied by environmental degradation such as global warming, deforestation, depletion of the ozone layer, and so on.

Since the World Summit on Sustainable Development in 2002 endorsed the importance of mutual supportiveness between environmental protection and promotion of sustainable development under the open and non-discriminatory multilateral trading system, the environmental impacts of trade liberalization have become one of the heated agenda at global, regional and national level.

In understanding overall linkage between trade and environment, we need to recognize that trade is not the major factor which causes the environmental degradation. The relation between trade and environment depends on the specialization structure and the inter-industrial difference in induced environmental impacts from output change. It is generally accepted that, without appropriate environmental policy intervention, the economic growth driven by trade liberalization may speed up the environmental degradation. But in the long run, international trade could contribute to the environmental protection by facilitating the worldwide diffusion of environment-friendly technologies and goods. It means that we cannot establish a general conclusion on whether trade liberalization brings a positive environmental impact or not. So, there are more and more multilateral, regional, or bilateral trade liberalization negotiations dealing with various trade and environmental issues to make free trade systems be supportive to environmental protection. And this is the reason why the WTO Ministerial Declaration recommends conducting environmental impact assessments of trade policies at national level.

Next figure shows the overall linkage of trade and environment which forms a base of sustainable development.

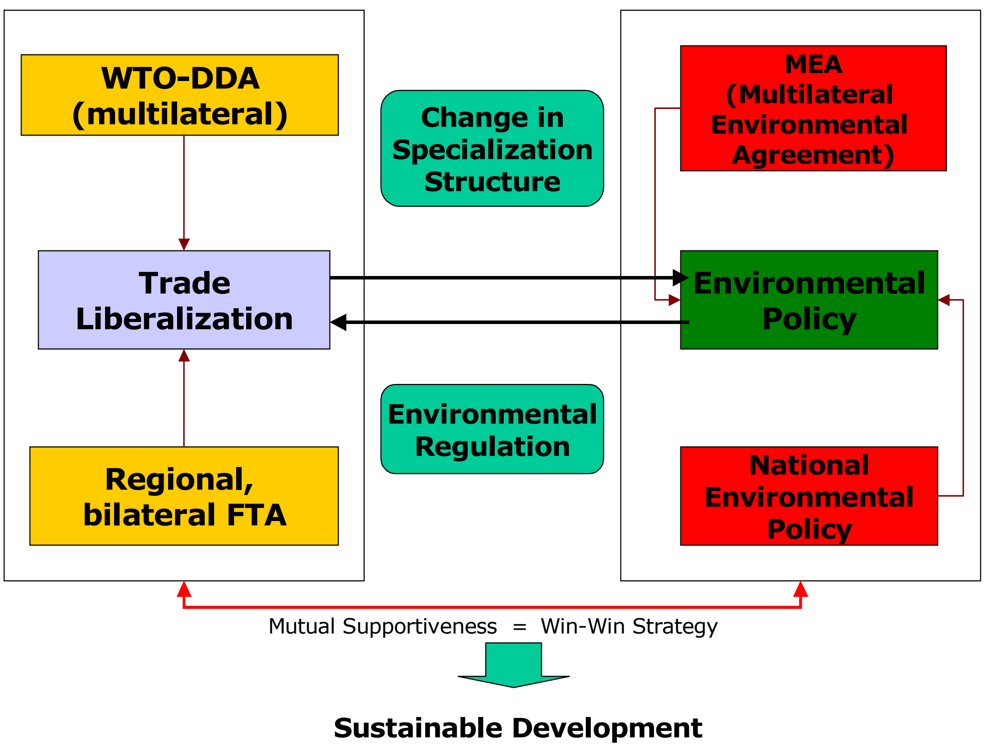

Figure Ⅰ-1. Diagram of trade and environment linkage

In parallel with the trade liberalization under the GATT multilateral trade system, the number of regional or bilateral trade agreements is continuously increasing all over the world. The rush to conclude regional trade agreements has gained further momentum since 1995, the inauguration year of the WTO. The WTO reports that the total number of notified regional trade agreements in force as of

May 2003 amounts to 184.

The WTO Annual Report 2003 observed that most of its members are now a party to at least one regional free trade agreement and many to several. And the upward surge in regional trade agreements was most strongly felt in the Asia Pacific region, where countries long in favor of multilateral-only liberalization have whole-heartedly embraced the regional option.

II. FTA Policy in Korea

1. Overview

Korea and Japan, with the entry into force of the Free Trade Agreement(FTA) with Chile and with Singapore respectively, became the latest regional trade agreement converts among the WTO members.

The FTA between Korea and Chile entered into force on April 1st, 2004. The Korea-Chile FTA is expected to lead to a rapid increase in the exportation of Korean industrial products to Chile[1]. The removal of tariffs from major Korean export items to Chile, such as automobiles and cellular phones, is expected to restore the market power of such Korean product, which had been weakened by the delayed ratification of the Korea-Chile FTA.

The ratification of Korea's first FTA has demonstrated Korea's commitment to trade liberalization and market opening, and established international credibility that will reinforce Korea's pursuit of FTAs with other countries. It has also opened doors for Korea to advance into the era of FTAs, by making smooth progress in the on-going intergovernmental negotiations with Japan and Singapore, and the joint study with ASEAN[2], EFTA[3](European Free Trade Association), and Mexico[4].

As the importance of FTA policy increased, the Ministry of Foreign Affairs and

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1) Jeung and Lee (2000)

2) See http:// http://www.mofat.go.kr/en/eco/e_fta.mof

3) The 1st Korea-EFTA Joint Study Group Meeting was held on Aug 11th~13th, 2004 at the EFTA secretariat in Genova to examine the FTA between Korea and the EFTA, which is composed of four-member states including Switzerland, Norway, Iceland, and Lichtenstein..

4) The 1st Korea-Mexico Joint Study Group Meeting was held on Otc 25th~26th, 2004 in Seoul.

Trade(MOFAT) reported during the State Council meeting held March 9th 2004 its plans to establish 『Guidelines on Procedures for conclusion of FTA』. As the absence of guidelines on the procedures for concluding FTAs has raised transparency and credibility issues, the MOFAT has worked towards the establishment of these guidelines to effectively gather the opinions of interested groups during the process of FTA negotiations and forged a national consensus on the promotion of FTAs.

The guidelines establish a system for the conclusion of FTAs that will enhance efficiency in the implementation of FTA policies. The guidelines designate the 「Economic Ministers' Meeting」 as the executive decision-making body, and stipulate the composition and management of the 「FTA Promotion Committee」, which will assume practical responsibilities for the conclusion of FTAs, the 「FTA Task Force」, and the 「FTA Partner Review Board」.

The guidelines will establish standard procedures for the conclusion of FTAs, which will enhance transparency and credibility in the process of concluding FTAs. Moreover, it will make possible a multi-track approach to FTA negotiations, and are also expected to consolidate national support for FTAs through public promotion and the gathering of opinions. MOFAT plans to produce a draft guideline in the near future through consultations with relevant governmental institutions, and will finalize the establishment of these guidelines in the very near future[5].

5) See Http://www.mofat.go.kr/en/eco/e_econew_view.mof/ipage=2&seq_no=2011&b_code=efta&num=18&p=7&TOTAL_ROW=35&searchtype=&search=

Table II-1. FTA agenda in Korea

Country	State
Chile	Dec. 1999 - Negotiation started Dec. 2003 - Korea-Chile FTA signed July. 2003 - Submitted to the National Assembly for ratification April 1. 2004 - Korea-Chile FTA entered into force June. 2004 - 1st Korea-Chile FTC(Free Trade Commission) held
Japan	July. 2002 - Korea-Japan joint study group established Oct. 2003 - Joint study concluded Dec. 2003 - 1st Round of Negotiation started. June. 2004 - 4th Round of Negotiation Nov. 2004 - 6th Round of Negotiation
Singapore	Nov. 2002 - Korea-Singapore joint study group established Oct. 2003 - Joint study concluded Jan. 2004 - 1st Round of Negotiation started. July. 2004 - 4th Round of Negotiation Oct. 2004 - 5th Round of Negotiation Oct. 2004 - The working-level Meeting for Korea-Singapore FTA
ASEAN	April. 2004 - Launching of the Korea-ASEAN FTA export group meeting July. 2004 - 4th Korea-ASEAN exports group meeting held. Aug. 2004 - 5th Korea-ASEAN exports group meeting held.
EFTA	Aug. 2004 - 1st Korea-EFTA joint study Oct. 2004 - 2nd Round of Korea-EFTA experts group meeting held.
Mexico	Oct. 2004 - 1st meeting of the Korea-Mexico joint experts group

1) Source: rearranged from http://www.mofat.go.kr/en/eco/e_fta.mof

2. Korea-Japan FTA progress

2.1 Joint Study Group

In July 2002, Korea and Japan established a Joint Study Group, composed of representatives from the government, business and academia of both countries, to appraise the possibility of setting up the Korea-Japan FTA. This Joint study continued for 17 months to review the economic effects of Korea-Japan FTA, basic principle of Korea-Japan FTA and its scope, such as liberalization and facilitation, cooperation, and dispute settlement.

This group reviewed across-the-board range of issues for the possible scope of the negotiations. After intensive discussions over eight meetings, the Joint Study Group concluded that the Korea-Japan FTA would bring forth mutual benefits by creating a win-win situation for both countries. To maximize the benefits, the Joint Study Group accentuated that the Korea-Japan FTA should be firmly built on the principles of comprehensiveness, substantial liberalization, enhancement of mutual benefits and consistency with WTO rules and regulations.

The Joint Study Group has now completed its work and recommends that[6]:

1. The Republic of Korea and Japan enter into negotiations at an early date with a view to conclude the Korea-Japan FTA within a reasonable period of time
2. Both governments would forge a comprehensive FTA that would bring about mutual benefits and greater efficiency, and eventually lead to further economic development in both economies.
3. Taking into account the importance of NTMs on the Korea-Japan FTA and the overall economic relationship between the two countries, the works on NTMs should be continued under the FTA negotiation framework as one of the

6) Korea-Japan FTA Joint Study Group Report, 2003, MOFAT.

sub-groups.

4. The business sectors in both countries actively utilize the Korea-Japan FTA in facilitating restructuring and strengthening of their competitiveness, and further expand bilateral cooperation by pursuing strategic alliances taking the opportunity of the Korea-Japan FTA and revitalizing various existing business-to-business fora.
5. Both governments take full account of the views of business sector in the negotiations for the Korea-Japan FTA.
6. The academic sectors of both countries continuously carry out relevant studies with a view to giving advice to respective governments on various aspects of the Korea-Japan FTA as well as presenting a vision for the future of both economies and the bilateral relationship between them.
7. In addition to the suggestions above, the government, the businessmen, and the members of academia of both countries collectively exert efforts in promoting public awareness of the Korea-Japan FTA and generating support for the Korea-Japan FTA among the peoples of Korea and Japan. So the formal negotiations would be launched soon and successfully concluded in time.

2.2 Negotiations

After the Korea-Japan joint study was completed, the round of Korea-Japan FTA negotiations have been in progress. There were six rounds of Korea-Japan FTA negotiations by present time since the 1st round of negotiation has begun in Dec 2003.[7]

7) For more details,
See http://www.mofat.go.kr/en/eco/e_fta.mof

At the second round of Korea Japan FTA, both countries discussed major issues through the five negotiating groups on ① Trade in Goods, ② Non-tariff measure, ③ Investment and trade in services, ④ Other trade related issues such as government procurement, competition policy, intellectual property rights, and ⑤ Cooperation.

Both sides reaffirmed the basic principles which are to promote comprehensive liberalization in the trade of goods and services for expansion of trade and investment between the two countries and to seek measure to maximize the benefits of the FTA, such as the establishment of preferential rule of origin for preventing circumvention and the simplification of customs procedures.

In the area of non-tariff measure, both sides concurred to keep up with consultations and proceed with discussions based on concrete examples in the future. They concurred to create and promote joint projects to achieve substantial economic integration and maximize the effects of the FTA. Also, both sides agreed to establish a mutual recognition negotiating group for mutual recognition of technical regulations of conformity assessment countries.

The third round of Korea Japan FTA is a full-fledged round because they started negotiations based on the text of the agreement, as the both sides have exchanged draft texts on April 16th 2004.

Both sides proceeded with negotiations based on the draft texts[8)] exchanged prior to the negotiations, in the seven main areas of ① Trade in goods, ② Non-tariff measure, ③ Investment and trade in services, ④ Other trade related issue ⑤ Mutual recognition, ⑥ Dispute settlement, ⑦ Cooperation.

8) The Korean draft text included a number of provisions on SPS, government procurement, mutual recognition and non tariff measures in accordance with the objective of the bilateral FTA, which is to achieve a grater degree of liberalization and cooperation.

At its fourth round, the two countries reaffirmed the basic principle of concluding a comprehensive and high-level FTA, and held discussions with the six negotiating groups including trade in goods and services on the major issue in the FTA negotiations based on the draft text of the agreement.

Korea actively raised issues of concern such as Non-Tariff Measure(NTM), Mutual Recognition Agreement(MRA) and government procurement, and Japan showed interest in intellectual property rights. The two countries also exchanged general views on when to exchange the tariff concession schedules and the level of offers.

Recently, Korea and Japan held the 6th round of negotiations for the Korea-Japan FTA from November 1~3, 2004 in Tokyo. Through seven working-group negotiations, both countries continued the process of drawing up the consolidated text which has been in progress since the two sides exchanged their own versions of the draft agreements with each other at the 3rd round. Furthermore, the two countries decided to continue negotiations on the tariff elimination schedule for goods, which is the core of an FTA.

III. EIA on Korea-Japan FTA

1. EIA Joint Study Group in Japan[9)]

From the fiscal year of 2000 to 2001, the Ministry of the Environment commissioned the Mitsubishi Research Institute, Inc. to conduct a survey work on the environmental impact assessments in trade liberalization. Following this, in the considerations in 2002, the Study Group on Environment and Economic Partnership Agreements/Free Trade Agreements was newly established in the Mitsubishi Research Institute to work out a guideline on EPAs/FTAs with a case study. This guideline summarizes the results of such considerations.

The environmental impact assessment procedure of this Guideline consists of each of the following stages: screening, scoping, impact assessments, and preventive and mitigating measures. Public-sector involvement should be introduced as the proper procedures in the various stages of environmental impact assessments.

Screening is a process to select EPAs/FTAs where impact assessments should be applied. Specifically, it is a process that categorizes trade liberalization, and narrows down the areas with a great need of environmental impact assessments considering the extent of their environmental impact. The overall situation of trade and environment in Japan and its partner countries (region) will be compiled. Second, scoping is a process of establishing the scope of considerations and selecting issues without being limited to the examination of impact assessment methods and items. Based on the screening results, the assessment items and

9) This part is written by Dr Jung and Ms Kimura in IGES.

assessment methods in impact assessment will be narrowed down. Third, based on available economic and environmental data, methods (including VI quantitative model analysis) that should be used in impact assessments will be considered. Both qualitative and quantitative analyses will be made using these methods and the impact assessment will be conducted. Fourth, taking into account environmental friendliness in past trade liberalization, considerations will be made of the details of the concept of the preventive and mitigating measures.

Hypothetical Japan-Korea EPA/FTA was considered in the case study. This case study was conducted subject to this Guideline. In the screening stage, two types of screening sheet were created and the areas with a great need for environmental impact assessments were selected. A screening sheet, "Details of the EPA/FTA Discussed at the Joint Study Group", includes items that consider whether they need to be incorporated into the text of the agreement (status). Furthermore, a screening sheet, "the Relationship Between Trade Liberalization and Environmental Impacts", includes items that consider clarifying the differences in the environmental policy situation in Japan and Korea.

Second, understanding the basic situation is a process of qualitatively organizing environmental impacts that a bilateral EPA/FTA may cause, based on the basic information on the economy and environment of Japan and Korea, which will contribute to the selection of content for which there should be prioritized considerations in environmental impact assessments. Scoping sheets on the economic, environmental and social situation contributing to impact assessments were prepared, and the items contributing to the establishment of impact assessment methods, items and scope of consideration and narrowing down the issues were extracted. Third, impact assessments of economic, environment and social were conducted by utilizing qualitative and quantitative methods, including the international input-output analysis and the AIM/CGE[10)] model analysis. The

AIM/CGE model takes a macro perspective, namely, a closed model focusing on global equilibrium, while input-output analysis takes a micro perspective, an open model focusing on Japan and Korea.

According to the impact assessment, the conclusion of the Japan-Korea EPA/FTA will contribute to the expansion of economic activity in both Japan and Korea. However, the results show that the EPA/FTA will have a different impact on exports and imports as well as production volume in each industry in both countries. The impact on the environment is expected to steadily increase as a result of the expansion of economic activity. However, the growth rate of the environmental pressure will be lower than that of economic activity, and from a macro-level perspective, it is presumed that the spread of environment-friendly technology and structural changes aimed at becoming energy-efficient industries will be promoted. This trend became even more apparent through the international input-output analysis, which showed the relationship between the rate of change in CO_2 emissions and SO_2 emissions and economic growth rate. However, if the expansion of the environmental pressure is to be suppressed as much as possible while maintaining or increasing economic activity, it is necessary to consider measures to counterbalance the expansion of the environmental pressure arising from the expansion of economic activities.

Finally, considerations were given to three aspects: efforts in the industrial sectors, support in the policy and systemic aspects, and efforts in bilateral negotiation.

10) AIM/CGE is a general equilibrium model focused on energy sectors to analyze the relationship between emissions and international trade. The Asia Pacific Integrated Model(AIM) is a set of computer simulation models developed by the National Institute for Environmental Studies in Japan(http://www-iam.nies.go.jp/aim/AIM_datalib/Aimbook/1_overview.pdf).

2. EIA of FTA in Korea[11)]

Having finished its own environmental impact assessment of the current multilateral trade negotiation under the DDA in WTO, Korea is now implementing a series of quantitative analyses on the environmental impacts of a free trade agreement.

In the previous studies, it was shown that from the trade and environment linkage point of view, a quantitative approach to the environmental impact of free trade agreement provides decision-makers with more helpful policy reference than a qualitative analysis.

Last year, a quantitative analysis using standard multi-region computable general equilibrium model was implemented. The analysis was based on the Global Trade Analysis Project(GTAP) to estimate at first the aggregated and sectoral economic effects of Korea-Japan free trade agreement.

The study calculated emission coefficients per output in different industrial sectors and disposal costs of major air pollutants from the sectoral pollution and abatement costs inventory in Korea, and obtained the aggregated disposal costs of air pollution induced by the free trade agreement between Korea and Japan[12)].

The current comparative study on the environmental impact of trade liberalization between Korea and Japan has been implemented by the joint expert meeting composed of experts in the Korea Environment Institute in Korea, Institute for Global Environmental Strategies[13)] and the National Institute for Environmental Studies[14)] in Japan.

The joint expert meeting shared the view that environmental review on the FTA

11) EIA of FTA in Korea is implemented by the Korea Environment Institute since 2003.
12) A quantitative analysis of the environmental costs induced by Korea- Japan free trade, 2003, KEI.
13) Tae yong Jung, IGES
14) T. Masui, J. Fujino, NIES

would be very important in designing and flanking environmental policy and measures to realize mutual supportiveness of trade and environment, and decided to implement a comparative study on the air pollution impact resulting from a free trade agreement between Korea and Japan.

In this study, a comparative analysis of industry and bilateral trade structure between Korea and Japan was made as a background of environmental impact analysis. The air pollution inventories of Korea and Japan were harmonized based on the Korean I-O table and compared. The intertemporal change in industrial emission structure between 1995 and 2000 showed that there had been an important technological progress in managing air pollution.

The air pollution effect was calculated by combining emission coefficient per unit of production and output change after free trade. The emission coefficient per unit of production was obtained from the related energy census. In general, the emission coefficient of Japan is higher than that of Korea for a given industry. There revealed an interindustrial difference in emission coefficient for a given air pollutant in a country. These two kinds of difference were supposed to play a key role in determining aggregated air pollution impact of industrial output change after trade liberalization. The output change by industry after free trade was calculated from the free trade simulation using a standard computable general equilibrium model developed by GTAP. The standard CGE model could be characterized by comparative static and perfect competition assumption.

IV. Empirical Results

1. Data, Model and Simulation

1.1 Data

To analyze the air pollution effect of Korea-Japan FTA, we used a standard multi region computable general equilibrium model based on the GTAP ver. 5 and the emission coefficient of the three major air pollutants for each countries. The reference year of the analysis is 1995. The reason why we took 1995 as the reference year in spite of more up-to date data set in both countries is that the available GTAP ver. 5 is based on 1995 I-O tables for each country.

We took the trade balance data compiled by the Office of Customs Administration in Korea and Ministry of Finance in Japan respectively and compared the balance of payments and bilateral trade flows between Korea and Japan.

In order to compare the pollution effect in Korea with that of Japan, we employed Japanese air emission intensity data as well as Korean air emission intensity data. We employed direct air pollutant emission coefficient per unit of output as an indicator of environmental performance which links industrial production with production-induced air pollution. Then the direct air pollutant emission coefficient was calculated for each of the three selected air pollutants including Nox, Sox, and PM_{10} in industry by industry.

We calculated and compared also the emission factor of 1995 and that of 2000 to see the progress of environmental performance between 1995 and 2000 in Korea.

The updated emission factor was obtained from the energy consumption survey in 2002. As the updated emission factor of Japan was not available, we could not evaluate the environmental performance progress in Japan in the same period. Detailed data compilation method is explained in the relevant sections of the chapter.

1.2 Model

The economic and trade impact of the Korea-Japan FTA was assessed based on the GTAP standard multi-regional CGE model.

In the model, final goods are produced by Leontief production technology using composite good of production factors and intermediate goods in Armington composite(equation IV-1). GTAP-CGE allows more flexibility in modeling production technology. One can adopt Cobb-Douglas production technology for example. But Cobb-Douglas production function seems more suitable for long-run effect model than in comparative static model. The composite factor goods are produced by Constant Elasticity of Substitution(CES) technology using land, labor and capital. Armington goods are produced by CES technology with domestic and imported composite goods. Imported composite goods are generated by CES technology using each regional goods.

Following equations shows the systematic behavioral relationships among producer, government, consumer, and market in standard GTAP-CGE model. And Figure IV-1 shows the analytical diagram linking free trade, economic changes and environmental impacts[15] used in our model.

15) The diagram was used in "A quantitative analysis of the environmental costs induced by Korea Japan free trade", 2003, KEI.

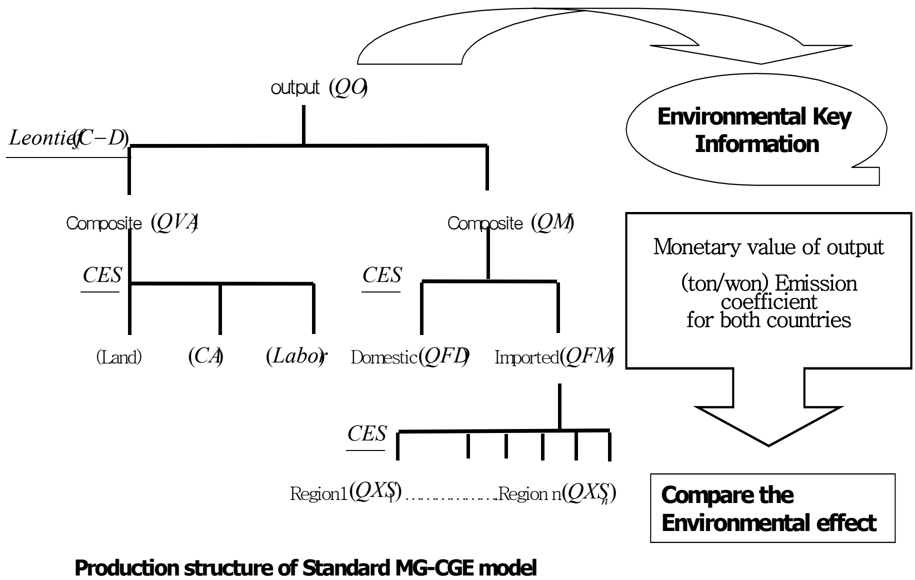

Figure IV-1. Diagram of the analytical framework

Production sector

final good i in region r

$$qo_i(r) = Leontief(\; qva_i(r),\quad x_{ij}(r)) + s_i(r)\; qva_i(r) \qquad \text{IV-1}$$

$x_{ij}(r)$: intermediate input j to industry i in region r

$s_i(r)$: scale parameter of industry i in region r

$qva_i(r)$: production factor input of industry i in region r

Each firm determines the intermediate demand of domestic good and imported good under the given producer price conditions.

intermediate input of domestic good j of industry i in region r

$$dx_{ij}(r) = x_{ij}(r) + \sigma_j^D [\, p_{ij}(r) - pdx_{ij}(r)] \qquad \text{IV-2}$$

σ_j^D: price elasticity of the intermediate demand j in region r

$p_{ij}(r)$: production price of the demand of composite good j in industry i of region r

$pdx_{ij}(r)$: production price of domestic composite good j demanded by industry i in region r

intermediate input of imported good j of industry i in region r

$$mx_{ij}(r) = x_{ij}(r) + \sigma_j^D [\, p_{ij}(r) - pmx_{ij}(r)] \qquad \text{IV-3}$$

$pmx_{ij}(r)$: production price for imported good j of industry i in region r

The producer price of intermediate demand is calculated by weighted average of imported good and domestic good as it is in IV-4.

production price of intermediate good j of industry i in region r

$$p_{ij}(r) = amx_{ij}\, pmx_{ij}(r) + (1 - amx_{ij})\, pdx_{ij}(r) \qquad \text{IV-4}$$

amx_{ij}: proportion of input for imported intermediate good j in total intermediate input of industry i

$pdx_{i,j}(r)$: price of domestic intermediate good j of industry i in region r

For a given industry i, the volume of export from region r to s is determined by the imported price and the total import of the region s.

quantity of export in industry i from region r to s

$$xx_{i,s}(r) = m_i(s) + \sigma_i^M [\, pm_i(s) - pms_{i,r}(s)] \qquad \textbf{IV-5}$$

$m_i(s)$: quantity of import for industry i of region s

σ_i^M: elasticity of substitution of commodity i for imported goods

$pm_i(s)$: import price of the good i of region s (weighted average price)

$pms_{i,r}(s)$: import price of good i from r to s

Each industrial demand of production factor by region is determined as it is presented in the equation IV-6. The value added price of industry is calculated as weighted average of expenditure on each production factor.

input of production factor k of industry i in region r

$$qva_i(k,r) = qva_i(r) - \sigma_v(k) [\, pva_i(k,r) - pva_i(r)] \qquad \textbf{IV-6}$$

$\sigma_v(k)$: elasticity of substitution among production factors

$pva_i(k,r)$: price of production factor k of industry i in region r

$pva_i(r)$: value added price of industry i in region r (weighted average price of the proportion of factor input)

value added price of industry i in region r

$$pva_i(r) = \sum_k ava_i(k,r) \times pva_i(k,r) \qquad \textbf{IV-7}$$

$ava_i(k,r)$: proportion of production factor k in total factor expenditure of industry i, region r

Consumption sector

The welfare level of each regional economy is constructed by weighted average of consumption and saving.

welfare of region r

$$u(r)=\sum_i \beta_i(r)\times \Phi_i(r), \quad \text{IV-8}$$

$\Phi_i(r); up(r),\ ug(r), save(r)$

$\beta_i(r)$: each proportion of private and government consumption, and saving in total expenditure to industry i in region r $(\therefore \sum_i \beta_i(r)=1)$

Consumer is supposed to decide the quantity of consumption between domestic and imported good to maximize household utility under the given composite consumption price.

private consumption for domestic good i in region r

$$dc_i(r)= cp_i(r)+\sigma_i^C[pc_i(r)-pdc_i(r)] \quad \text{IV-9}$$

$cp_i(r)$: consumption for the good i of region r

σ_i^C : elasticity of substitution for private consumption good i

$pc_i(r)$: consumption price for good i of region r

$pdc_i(r)$: consumption price for domestic good i of region r

private consumption for imported good i in region r

$$mc_i(r)= cp_i(r)+\sigma_i^C[pc_i(r)-pmc_i(r)] \quad \text{IV-10}$$

$pmc_i(r)$: private consumption price for imported good i in region r

private consumption price for composite consumption good i in region r

$$pc_i(r) = \theta mc_i(r) \times pmc_i(r) + [1 - \theta mc_i(r)]\, pdc_i(r) \qquad \text{IV-11}$$

$\theta mc_i(r)$: private consumption proportion for imported good in total private consumption of industry i in region r

Therefore, the quantity of composite consumption depends on income elasticity of consumption good and price elasticity of private sector.

quantity of private consumption for good i in region r

$$cp_i(r) = \sum_k ep_{i,k}(r) \times pc_k(r) + ey_i(r) \times yp(r) \qquad \text{IV-12}$$

$ep_{i,k}(r)$: price elasticity for consumption good (i, k) in region r

$ey_i(r)$: income elasticity of for consumption good i of region r

Price sector

In the GTAP CGE model, the price variables are used to consider market based policy measures. The equation IV-13 shows how consumption and production price is linked to tariff and tax. The import price in region r is the sum of import tariff and international price of imported good.

import price of the good i from s to r

$$pms_{i,s}(r) = tms_{i,s}(r) + pcif_{i,s}(r) \qquad \text{IV-13}$$

$tms_{i,s}(r)$: import tariff of imported good i from s to r

$pcif_{i,s}(r)$: international price of imported good i from s to r

The import price index of each region is calculated as weighted average for import proportion of each country.

weighted average import price of good i in region r

$$pm_i(r)=\sum_s \gamma m_{i,s}(r)\times pms_{i,s}(r) \qquad \text{IV-14}$$

$\gamma m_{i,s}(r)$: proportion of import from region s in total import for good i in region r

The demand price of intermediate imported good of each regional industry is produced by summing import price index with tariff for producer.

price of demand for import good j in industry i, region r

$$pmx_{ij}(r)= pm_i(r)+ tmx_{i,j}(r) \qquad \text{IV-15}$$

$tmx_{i,j}(r)$: import tariff for good j of industry i in region r

The demand price of domestic good of each regional industry is calculated by summing producer price with domestic tax.

price for domestic good j of industry i in region r

$$pdx_{ij}(r)=p_i(r)+tdx_{i,j}(r) \qquad \text{IV-16}$$

$p_i(r)$: production price of industry i in region r

$tdx_{i,j}(r)$: tax for intermediate good j of industry i in region r

The private consumption price of imported good is summed with import price index and import tariff. Also, the consumption price for domestic good can be represented by summing production price with domestic consumption tax.

private consumption price for imported good i in region r

$$pmc_i(r) = pm_i(r) + tpm_i(r) \qquad \text{IV-17}$$

$tpm_i(r)$: import tariff for household consumption good i in region r

private consumption price for domestic good i of region r

$$pdc_i(r) = p_i(r) + tdc_i(r) \qquad \text{IV-18}$$

$tdc_i(r)$: tax for domestic consumed good i of household in region r

The general equilibrium is a composite of individual factor and commodity market equilibrium. The equilibrium price is determined by marginal price under the assumption of perfect competition. In the case of imperfect competition with fixed cost, average cost pricing mechanism is applied and total profit of all market converges to zero. As the policy effect in a typical CGE model is represented by the percentage change of relative price and quantity, we took the consumer price index weighted by the proportion of consumption expenditure.

Market equilibrium

Factor market equilibrium condition

total input of production factor in region r

$$qva(r) = \sum_j qva_j(r) \qquad \text{IV-19}$$

Commodity market equilibrium condition

equilibrium condition for commodity i in region r

$$qo_i(r) = dc_i(r) + dx_i(r) + \sum_s xx_{i,s}(r) \qquad \text{IV-20}$$

equilibrium condition for imported commodity i in region r

$$m_i(r) = mc_i(r) + \sum_j mx_{ij}(r) \qquad \text{IV-21}$$

Price condition for equilibrium

equilibrium price

$$p_i(r) = mc_i(r) \quad (= ac_i(r),\ imperfect\ competetion) \qquad \text{IV-22}$$

$mc_i(r)$: marginal price, $ac_i(r)$: average price

basic price: comsumer price index

$$pc(r) = \sum_i \theta c_i(r) \times pc_i(r) \qquad \text{IV-23}$$

$\theta c_i(r)$: proportion of household expenditure for industry i in region r

In the analysis, a regional economy is composed of 26 sectors. Table IV-1 shows GTAP sectoral aggregation corresponding to Korean industrial classification used in I-O table. As to the commodity concordance between the GTAP sectoral classification and the Korea I-O table, we made reference to the chapter 11.E of GTAP 5 documentation[16].

16) See the chapter 11.E Korea, GTAP 5 documentation, JongHwan Ko and Inkyo Cheong, 2002.

Table IV-1. Sectoral aggregation by Korea I-O classification

GTAP code	industry sectors
1 AG_FI_FO	▪ Agriculture, forestry and fisheries
2 Mining	▪ Mining and quarrying
3 FPWP	▪ Food, beverages and tobacco
4 PFB_TEX	▪ Textile - Fiber
5 WAP	▪ Wearing apparels, apparel accessories and other fabricated textile product
6 LEA	▪ Leather and fur products
7 LUM	▪ Wood and wooden products
8 PPP	▪ Pulp, paper, printing, publishing and reproduction
9 P_C	▪ Petroleum and coal products
10 CRP	▪ Chemicals and allied products
11 NMM	▪ Nonmetallic mineral products
12 I_S_NFM	▪ Primary metal products
13 FMP	▪ Fabricated metal products
14 OME	▪ General machinery, equipment(electronics, etc) and precision instrument
15 ELE	▪ TV, radio, communication, computer and other office equipment
16 MVN	▪ Motor vehicles and parts
17 OTN	▪ Ship building, repairing and other transportation equipment
18 OMF	▪ Furniture and other manufactured products
19 ELY	▪ Electric services
20 GDT_WTR	▪ Gas and water supply
21 CONS	▪ Construction
22 TRD	▪ Wholesale, retail trade, eating, drinking place and hotel
23 OTP_WA	▪ Transportation and warehousing
24 CMN	▪ Communications and broadcasting
25 OFI_ISR	▪ Finance and insurance
26 Others	▪ Other services

Table IV-2. Aggregated elasticity of substitution based on GTAP

sectors	ESUBD[a]	ESUBM[b]	ESUBVA[b]
1 AG_FI_FO	2.41	4.66	0.23
2 Mining	2.8	5.6	0.2
3 FPWP	2.39	4.71	1.12
4 PFB_TEX	2.2	4.4	1.16
5 WAP	4.4	8.8	1.26
6 LEA	4.4	8.8	1.26
7 LUM	2.8	5.6	1.26
8 PPP	1.8	3.6	1.26
9 P_C	1.9	3.8	1.26
10 CRP	1.9	3.8	1.26
11 NMM	2.8	5.6	1.26
12 I_S_NFM	2.8	5.6	1.26
13 FMP	2.8	5.6	1.26
14 OME	2.8	5.6	1.26
15 ELE	2.8	5.6	1.26
16 MVH	5.2	10.4	1.26
17 OTN	5.2	10.4	1.26
18 OMF	2.8	5.6	1.26
19 ELY	2.8	5.6	1.26
20 GDT_WTR	2.8	5.6	1.26
21 CONS	1.9	3.8	1.4
22 TRD	1.9	3.8	1.68
23 OTP_WA	1.9	3.8	1.68
24 CMN	1.9	3.8	1.26
25 OFI_ISR	1.9	3.8	1.26
26 Others	1.9	3.8	1.26

a) Value-Added, b) Domestic/Imported, c) Sourcing of imports

CGE model is highly dependant on the value of elasticities linked to different type of production and consumption functions. In the study, standard GTAP behavioral parameters, such as Armington parameter, value-added parameter, and others[17] based on CES function were used.

17) For the income and price elasticities of demand, see Hertel (1997, pp129~139)

Consumer behavior in GTAP is assumed to follow the Constant Difference Elasticity(CDE) function. In fact, CES function is a special case of the CDE function. We accepted this basic assumption of the standard GTAP CGE model.

As the value of CDE parameter was not estimated for each individual country in GTAP, the use of CDE function may cause some bias to the simulation result in the study. As the primary objective of the study is to assess environmental impact of free trade, we did not deal with the issues related to the estimation of parameters of a specific functional form. This is why we took a standard static GTAP model in the study.

1.3 Simulation

In the standard GTAP CGE model, trade barriers are represented as taxes on imports and exports between two regional markets. In the simulation, we assumed that free trade agreement between Korea and Japan results in the elimination of bilateral import tax. This corresponds to remove ad-valorem import tariffs and tariff equivalents of bilateral nontariff barriers between Korea and Japan.[18)]

Then, we calculate the changes in trade flows and domestic output.[19)] The emission change of air pollution after free trade is calculated by multiplying the change of output and emission factor per unit of output by industry and pollutant type.

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18) As to the experiment used here, we made reference to the chapter 9 of "Global Trade Analysis: Modeling and Applications" edited by Thomas W. Hertel in 1997.

19) Before the free trade simulation, we should have employed a preliminary shock to the model to update the change of industrial structure between 1995 and 2000 or the implementation of Uruguay Round phase outs, which may not have been complete in 1995. This is not done here. As a result, the reported results may give the Korea-Japan FTA credit which is partially due to the structural changes or UR commitments.

The equilibrium was obtained from the GTAP standard multi-regional general equilibrium closure. The standard general equilibrium closure allows capturing the substitution effect in production and consumption and the resulting changes in trade flows and values. In the closure, the allocation of investment is arranged by a global banker and it is fixed.

As the experiment used in the study assumes the complete removal of ad valorem import tariff and tariff equivalents of bilateral non-tariff barriers between Korea and Japan, the simulation result should be interpreted as an upper bound of the free trade agreement effect on each of the national economy in a comparative static model.[20)]

20) See p. 242, "Global Trade Analysis: Modeling and Applications", Thomas W. Hertel, 1997.

2. Comparison of Economic Structure

2.1 Domestic Industry Structure

To compare the industry structure of the two countries, we reorganized the Japanese I-O industrial classification according to the Korean I-O sectors fitted with those of GTAP ver5.

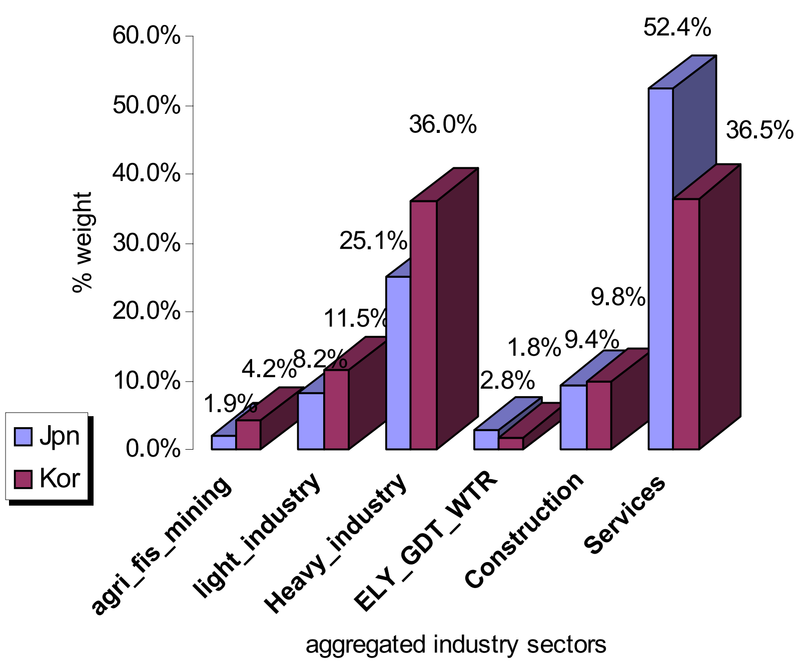

Figure IV-2. Industry structure of Korea and Japan in 1995

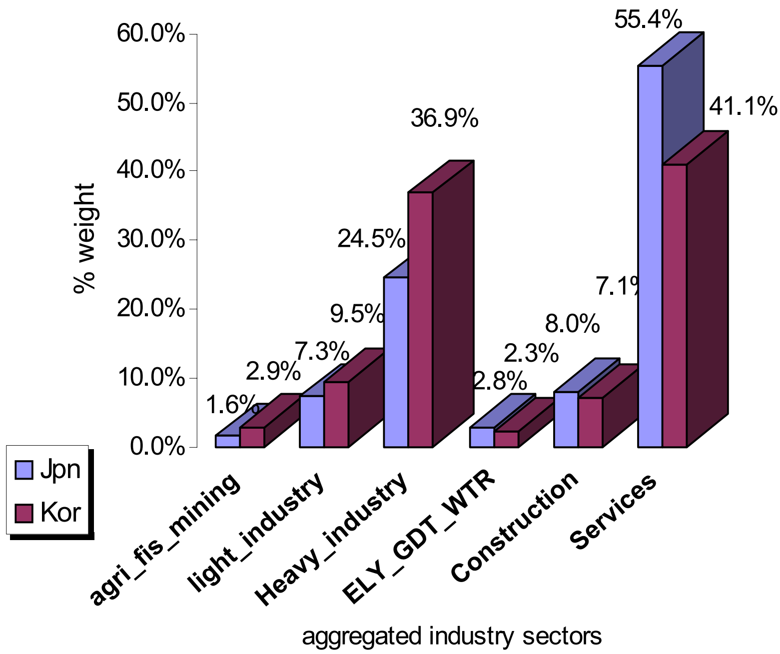

Figure IV-3. Industry structure of Korea and Japan in 2000

Figure IV-2 and IV-3 shows the comparison of Japanese and Korean industrial structure in 1995 and 2000 respectively. The original 26 industry sectors were aggregated into 6 sectors: agri_fi_for_mining, Light industry, Heavy industry, Ely_GDT_Wtr, Construction and Service[21].

For both countries, 'Heavy Industry' and 'Services' are the largest economic activities. The share of 'Agri_Fi_For_Mining' and 'Light industries' in the total output of Korea is larger than that of Japan in 1995. The same situation was observed in 2000 also.

The share of 'Services' sector in Japan representing more than a half of total Japanese industrial output is bigger than that of Korea. Considering that the share

21) For the detail of 26 sectoral comparison, see Table A1-1 and A1-2 in Annex 1.

of the services sector in the national economy is relatively high in most developed countries, we observe Japan has advanced industrial structure than Korea.

In general, the change of industrial structure seems more important in Korea than in Japan. In Korea, the share of light industry production in total industrial production decreased between 1995 and 2000 even if the volume itself increased in the same period. This means that the growth rate of light industry is much smaller than that of heavy industry and services. Electronic equipments such as semiconductor, communication equipment and services have shown remarkable growth as they are most competitive in the world market as well as the domestic market since mid 1990s. Especially, the electronic products such as Integrated Circuit(IC), TV, personal computer and audio-visual and digital equipments became the major export sector in recording approximately 500% increase between 1995 and 2000. Table A1-1 and 2 of Annex1 shows the details of this change.

The structural change of Japanese industry seems modest compared to the case of Korea. Japanese economy is highly concentrated in service sectors. The share of services in total industrial production increased from 52% in 1995 to 55% in 2000. The volume as well as the share of light industry production including textile, leather, and wood products decreased[22].

2.2 Bilateral Trade Flow

The volume of bilateral trade between Korea and Japan has steadily increased over the years and reached its peak in the year 2000 and 2003 by registering over 52 billion US dollars. As we see in Table IV-2, the Korean import is highly concentrated on the products coming from Japan. The size of export has been

22) For the detail, see Table A1-2 in the Annex1

constantly decreasing since 1990, showing the diversification of Korean export destination.

Table IV-3. Change of trade flows in Korea

(unit = US million $)

year	export			import		
	A=total export (rate of increase)	B=export to Japan (rate of increase)	B/A	C=total import (rate of increase)	D=import from Japan (rate of increase)	D/C
1990	65,016	12,638	19.4%	69,844	18,574	26.6%
1991	71,870 (10.5%)	12,356 (-2.2%)	17.2%	81,525 (16.7%)	21,120 (13.7%)	25.9%
1992	76,632 (6.6%)	11,599 (-6.1%)	15.1%	81,775 (0.3%)	19,458 (-7.9%)	23.8%
1993	82,236 (7.3%)	11,564 (-0.3%)	14.1%	83,800 (2.5%)	20,016 (2.9%)	23.9%
1994	96,013 (16.8%)	13,523 (16.9%)	14.1%	102,348 (22.1%)	25,390 (26.9%)	24.8%
1995	125,058 (30.3%)	17,051 (26.1%)	13.6%	135,119 (32.0%)	32,622 (28.5%)	24.1%
1996	129,715 (3.7%)	15,767 (-7.5%)	12.2%	150,339 (11.3%)	31,449 (-3.6%)	20.9%
1997	136,164 (5.0%)	14,771 (-6.3%)	10.8%	144,616 (-3.8%)	27,907 (-11.3%)	19.3%
1998	132,313 (-2.8%)	12,238 (-17.2%)	9.2%	93,282 (-35.5%)	16,840 (-39.7%)	18.1%
1999	143,685 (8.6%)	15,862 (29.6%)	11.0%	119,752 (28.4%)	24,142 (43.4%)	20.2%
2000	172,268 (19.9%)	20,466 (29.0%)	11.9%	160,481 (34.0%)	31,828 (31.8%)	19.8%
2001	150,439 (-12.7%)	16,506 (-19.4%)	11.0%	141,098 (-12.1%)	26,633 (-16.3%)	18.9%
2002	162,471 (8.0%)	15,143 (-8.3%)	9.3%	152,126 (7.8%)	29,856 (12.1%)	19.6%
2003	193,817 (19.3%)	17,276 (14.1%)	8.9%	178,827 (17.6%)	36,313 (21.6%)	20.3%

1) Data source: The Office of Customs Administration, Korea

Table IV-4. Change of trade flows in Japan

(unit = US million $)

year	export			import		
	A=total export (rate of increase)	B=export to Korea (rate of increase)	B/A	C=total import (rate of increase)	D=import from Korea (rate of increase)	D/C
1990	285,693	17,352	6.1%	233,307	11,643	5.0%
1991	314,149 (10.0%)	20,055 (15.6%)	6.4%	236,578 (1.4%)	12,332 (5.9%)	5.2%
1992	339,294 (8.0%)	17,775 (-11.4%)	5.2%	232,921 (-1.5%)	11,563 (-6.2%)	5.0%
1993	360,237 (6.2%)	19,031 (7.1%)	5.3%	240,380 (3.2%)	11,625 (0.5%)	4.8%
1994	394,598 (9.5%)	24,256 (27.5%)	6.1%	273,841 (13.9%)	13,445 (15.7%)	4.9%
1995	441,959 (12.0%)	31,157 (28.5%)	7.0%	335,732 (22.6%)	17,263 (28.4%)	5.1%
1996	412,917 (-6.6%)	29,469 (-5.4%)	7.1%	350,719 (4.5%)	16,019 (-7.2%)	4.6%
1997	423,038 (2.5%)	26,188 (-11.1%)	6.2%	339,992 (-3.1%)	14,640 (-8.6%)	4.3%
1998	385,368 (-8.9%)	15,253 (-41.8%)	4.0%	278,905 (-18.0%)	12,002 (-18.0%)	4.3%
1999	415,735 (7.9%)	22,788 (49.4%)	5.5%	308,368 (10.6%)	15,951 (32.9%)	5.2%
2000	481,131 (15.7%)	30,819 (35.2%)	6.4%	381,319 (23.7%)	20,536 (28.7%)	5.4%
2001	404,954 (-15.8%)	25,398 (-17.6%)	6.3%	350,687 (-8.0%)	17,266 (-15.9%)	4.9%
2002	414,847 (2.4%)	28,441 (12.0%)	6.9%	336,179 (-4.1%)	15,419 (-10.7%)	4.6%

1) Data source: Korea-Japan Free Trade Agreement, Joint Study Group Report, raw **data** from Trade Statistics, Ministry of Finance, Japan

Table IV-3 and IV-4 show that the trade flow of Japan is more stable than that of Korea. The weight of export and import with Korea in total trade has stagnated around 6% and 5% respectively since 1990. The total volume of trade is about 2 times higher than the Korean trade volume. We note that Korea records an important trade deficit with Japan. Annual deficit is more than 10 billion US dollars since 1994. The imports of general machinery and parts are responsible for the deficit.[23] All these indicate that Japan is one of the most important trade partners of Korea.

Figure IV-4. Trade balance of Korea with Japan

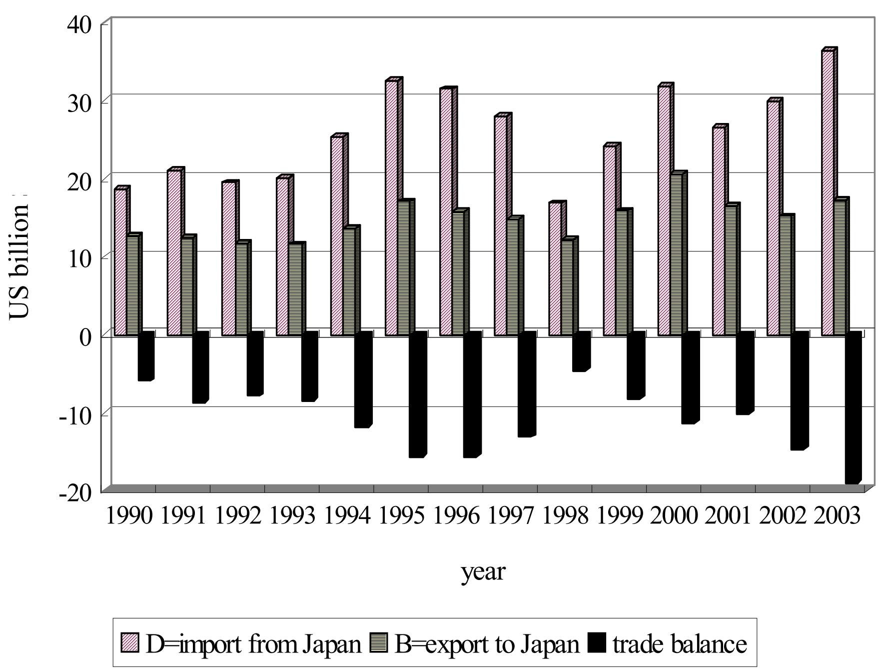

Figure IV-4 shows the change of trade volume and balance of Korea with Japan

23) See Kang and Kim(2003).

since 1990. The deficit of trade balance becomes more and more important over the years. This means that the deficit in trade balance might be the most sensitive issue in the Korea-Japan free trade agreement negotiation.

Figure IV-5 presents the change of Japanese trade surplus with Korea and the share of that in the total trade surplus of Japan. In early 1990s, the share of trade surplus in bilateral trade rested around 10% of total trade surplus.

Except for the period of recent financial crisis, the share of bilateral trade surplus shows steadily increasing trend. This means that the bilateral trade between Korea and Japan is more favorable to Japan than to Korea. Japanese active stance in the current free trade agreement negotiation can be explained partly by this surplus trend in bilateral trade.

Figure IV-5 Trade balance of Japan

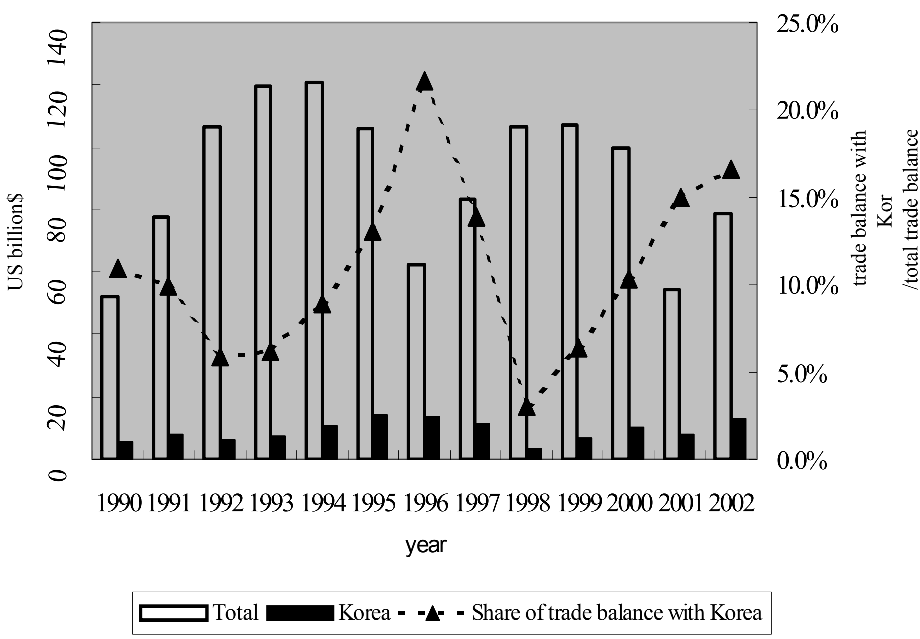

Table IV-5. Bilateral import tax rates by sectors and regions

(unit: %)

tms*	from Jpn to Kor	from Kor to Jan
AG_FI_FO	29.0	13.6
Mining	2.6	0
FPWP	44.6	42.1
PFB_TEX	8.0	9.1
WAP	8.0	12.3
LEA	6.1	14.5
LUM	7.8	1.2
PPP	6.3	2.1
P_C	6.7	3.4
CRP	7.7	2.6
NMM	7.5	0.8
I_S_NFM	7.2	2.3
FMP	8.0	1.3
OME	7.9	0.2
ELE	8.0	0
MVH	8.0	0
OTN	2.8	0
OMF	6.8	2.6
ELY	0	0
GDT_WTR	0	0
CONS	0	0
TRD	0	0
OTP_WA	0	0
CMN	0	0
OFI_ISR	0	0
Others	0.3	0

*tms[i,r,s]: import tax on good i imported from region r to s

Table IV-5 and IV-6 show the structure of import tariffs calculated in GTAP ver 5 by industry sectors and regions, sources and destinations respectively. The value presents ad valorem % rate for goods as well as services. What Table IV-5 presents is that the import protection in agriculture, fishing, forest, food industry of Korea is relatively higher than that in Japan. Import tax of Japan is higher than that of

Korea in textile and wearing appeal industry. This means that the elimination of bilateral import tax gives greater export increase to Korea than Japan. However, Korea keeps relatively higher import tax than Japan in most of Heavy industry sectors. In the experiment of free trade simulation, we eliminated all of import tax on tradeable goods between Korea and Japan. As this would be an extreme case which Korea-Japan free trade agreement achieves, the results show the upper bound of what can be expected.

Table IV-6 shows that Japan and Korea keep relatively lower barrier in their bilateral trade in manufacturing industry compared to that with other trade partners. This means a close economic relations between Korea and Japan which provide a good starting point for the Korea-Japan free trade agreement.

As the Korean import barrier with Japan is higher than that of Japan with Korea, the impact of tariff liberalization would be more important in Korea than in Japan.

Table IV-6. Bilateral tariff rates by source and destination

(unit:%)

destination / source	rTMS	NAFTA	EU	Kor	Jpn	Chn	Oth_ASIA	ROW
NAFTA	AG_FD*	14	17.9	11.9	11.8	10.1	12.5	15.9
	RE_MA_O**	0.1	2.3	3.2	2.5	5.9	3.6	2.5
EU	AG_FD	19.3	0	30.2	31.7	18.5	22	22
	RE_MA_O	2	0	3.7	3.6	5.2	3.8	2.1
Kor	AG_FD	88.1	36	0	48.9	162.9	35	63.8
	RE_MA_O	5.4	5.2	1.7	7.5	7	5.3	4.2
Jpn	AG_FD	63.2	64.5	42.9	0	44.5	44.2	61.8
	RE_MA_O	1	1.3	2.6	0	5.1	1.4	-0.1
Chn	AG_FD	57.8	41.2	25.6	23.7	0	31.4	36.1
	RE_MA_O	9.5	10.2	16.4	15.1	0	14.8	5.3
Oth_ASIA	AG_FD	10.7	14.2	16.4	10.5	9.4	18	14.1
	RE_MA_O	3.5	5.7	7.4	7	6.8	4.9	7.5
ROW	AG_FD	29.4	43.6	27.4	37.6	24.2	25.9	28.2
	RE_MA_O	7	7.7	11.3	8.4	12.9	6	6.9

*AG_FD: agriculture, food industry

**RE_MA_O: resources, manufacturing, and others

3. Environmental Performance

3.1 Data

In the previous study, we used Korean air pollutant emission accounts in 1995 to see the linkage between industrial production and air pollution. Emission coefficient was calculated as a volume of emission per unit output. The raw data was retrieved from Korean I-O tables in 1995 and Energy Census compiled by the industry. The aggregation of air pollution coefficient was then readjusted to match the GTAP product classification.

After a free trade simulation between Korea and Japan, the analysis of induced air pollution effect and its disposal costs in Korea was made. The environmental impact in Japan was not dealt with in the analysis.

This year, using compiled Japanese air emission coefficient per unit of output,[24] we could compare environmental performances of Korea and Japan and their industrial emission structure.

We used Japanese air pollutant sector-wise emission intensity calculated per unit of output. The emission intensity counts only direct emission effect of industrial production. It is different from the embodied emission intensity which considers both direct and indirect emission effect. Detailed sector-wise emission intensities are presented in the Annex 2.

We calculated also updated sectoral emission coefficient in Korea based on Energy Census in 2001, which is compiled once for every 3 years. Comparison of the two sets of sector-wise emission intensity shows us the change of environmental performance in air pollution in Korea. As the Japanese data for recent years was not available, we could not compare the environmental

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24) See Table A2-2, A2-3 in Annex 2.

performance change in Japan in the study.

Japanese sector-wise intensity was readjusted to be matched with GTAP. Being summed up as weighted average, the emission coefficients of 93 industries were aggregated into 26 sectoral coefficients.

3.2 Environmental Performance Progress in Korea

To analyze sectoral environmental performance progress in air pollution in Korea, we compared the emission coefficients in 1995 and 2000 calculated based on sectoral energy consumption survey data compiled by energy source and use. The compiled data covers the sectors such as agriculture, fishing, mining manufacturing, and construction, transportation, commercial and public-services, households, and buildings.

In the process of recompilation adjusted to our analysis, we didn't consider some sub-sectors, heating for home and building sector for example. And emissions from non-industry combustion were not taken into account. For this reason, the total aggregated estimation might be an underestimate compared to the value of total emission in the official data presented for example in the Environmental Statistics Yearbook.[25)]

Energy sources considered in the study were differentiated as coal(6), petroleum(10), gas, electricity, steam, and others.[26)] The sectoral division of this data follows the Korea Standard Industrial Classification(KSIC) which is different

25) We can propose some view for solving this kind of estimation problem. If this data, the energy consumption data, is provided by commodity base like I-O table, then we can get and make out easily the energy consumption data by industry sectors.

26) Briquette, Dom. Anthracite, Imp. Anticite, Bituminous, Brown coal, Cokes includes Coal, and Petroleum includes Gasoline, Kerosene, Diesel, Bunker A,B,C, Naphtha, jet oil, Propane, Butane. There exist also Gas by pipeline, Electricity, Steam, and Others.

from the sectoral classification in I-O table. We needed to readjust the difference in classification.

The detailed recompiling process by activities is based on the NIER methodology presented in Annex 4.[27] and summed up below.

■ Industry sectors

total emission(ton/year) = emission coefficient(kg/kl, kg/ton, kg/10^3m^3) × yearly energy consumption(kl, ton, kg/10^3m^3/year) × unit conversion factors

■ Transportation sectors

total emission(ton/year) = a number of car registration × a distance covered in a day by a car(km/a num of car × day) × emission coefficient(g/km) × 365day/year × unit conversion factors

Based on this, we calculated the emission coefficients in 1995 and 2000, and presented them in Table IV-7.

The compilation was made for only two types of air pollutant: PM10 and Nox. We observed that environmental performance in air pollution improved in the majority of sectors with some exceptions marked by shaded cells in Table IV-7.

The gray cells in Table IV-7 represent the sectors of which the emission intensity increases between 1995 and 2000. We observed that oil use in these sectors increased more than the output growth in the energy consumption survey in 2001.

The improvement of emission intensity in other sectors is supposed to come from the change of energy consumption pattern and technological progress in energy use.

27) Original emission factor was taken from the related publications of NIER and KEI.

Table IV-7. Change of emission intensity: 1995-2000

(unit: ton/million won)

sectors	1995			2000		
	sox	nox	tsp	nox	2000-1995	PM_{10}
1 AG_FI_FO	0.0014610	0.0005050	0.0000990	0.0003544	-0.0001506	0.0008585
2 Mining	0.0002840	0.0003600	0.0001900	0.0001784	-0.0001816	0.0005357
3 FPWP	0.0013432	0.0003437	0.0001073	0.0001053	-0.0002384	0.0000456
4 PFB_TEX	0.0026410	0.0005230	0.0002320	0.0002502	-0.0002728	0.0000539
5 WAP	0.0001500	0.0000630	0.0000150	0.0000045	-0.0000585	0.0000012
6 LEA	0.0016760	0.0003500	0.0001210	0.0000406	-0.0003094	0.0000091
7 LUM	0.0006230	0.0001590	0.0000550	0.0002249	0.0000659	0.0000563
8 PPP	0.0028385	0.0005042	0.0002175	0.0003720	-0.0001323	0.0001636
9 P_C	0.0122800	0.0020290	0.0009230	0.0003647	-0.0016643	0.0000666
10 CRP	0.0017593	0.0004756	0.0002113	0.0002672	-0.0002084	0.0002670
11 NMM	0.0058090	0.0038490	0.0017760	0.0028071	-0.0010419	0.0109064
12 I_S_NFM	0.0074010	0.0060440	0.0029130	0.0025235	-0.0035205	0.0128206
13 FMP	0.0003010	0.0001010	0.0000230	0.0000521	-0.0000489	0.0000082
14 OME	0.0000641	0.0000245	0.0000058	0.0000124	-0.0000121	0.0000035
15 ELE	0.0004720	0.0000951	0.0000348	0.0000066	-0.0000886	0.0000002
16 MVN	0.0003080	0.0000670	0.0000230	0.0000194	-0.0000476	0.0000012
17 OTN	0.0000160	0.0000050	0.0000010	0.0000199	0.0000149	0.0000056
18 OMF	0.0001600	0.0001000	0.0000190	0.0000094	-0.0000906	0.0000207
19 ELY	0.0293290	0.0119270	0.0119730	0.0170574	0.0051304	0.0806504
20 GDT_WTR	0.0014210	0.0028620	0.0001340	0.0027268	-0.0001352	0.0000763
21 CONS	0.0000960	0.0000480	0.0000080	0.0000268	-0.0000212	0.0000025
22 TRD	0.0003103	0.0000921	0.0000205	0.0000521	-0.0000400	0.0000314
23 OTP_WA	0.0083150	0.0032690	0.0005540	0.0093051	0.0060361	0.0004587
24 CMN	0.0000400	0.0000120	0.0000020	0.0000059	-0.0000061	0.0000006
25 OFI_ISR	0.0000310	0.0000140	0.0000010	0.0000054	-0.0000086	0.0000010
26 Others	0.0001066	0.0000261	0.0000177	0.0000164	-0.0000097	0.0000054

Table IV-8 shows the change of energy consumption structure since 1992. The share of the gas and electricity increased steadily with the share of oil decreasing.

Table IV-8. Change of energy consumption structure in Korea

(unit: %)

year	Coal	Oil	Gas	Electricity	Others
1992	4.6	44.0	17.9	33.3	0.3
1995	0.2	39.3	20.6	39.4	0.4
1998	0.2	28.5	26.3	44.6	0.4
2001	0.2	22.1	21.0	56.3	0.4

3.3 Comparative Environmental Performance in Air Pollution

Table IV-9 shows aggregated emission coefficients in 1995 for Japan and Korea. The emission coefficient in Table IV-9 has the same denomination, million of US dollars. Japanese yen and Korean won were converted to US dollar for the comparison of environmental performance on a common basis.[28] We used also PPP rate as a complementary measure appropriate to real economy. The cross rate between Korea and Japan in PPP is much smaller than nominal cross exchange rate. This means that the comparison of environmental performance based on nominal exchange rate would overestimate the relative environmental performance of Japan compared to Korea.[29]

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28) In the previous study analyzing disposal cost effect of induced air pollution after free trade, we used average exchange rate won/dollar at 2000. In this study we applied the closing rate of exchange at 1995 in both countries.

29) See Table A2-6 in Annex 2

Table IV-9. Aggregated emission intensity

(unit = emission ton/US million ton**)

sectors	Korea			Japan		
	sox	nox	tsp	sox	nox	spm
1 AG_FI_FO	1.13330	0.39173	0.07679	0.80464	1.45323	0.23312
2 Mining	0.22030	0.27925	0.14738	0.09056	0.37583	0.02315
3 FPWP	1.04196	0.26663	0.08325	0.13043	0.05163	0.00890
4 PFB_TEX	2.04862	0.40569	0.17996	0.37736	0.24238	0.03857
5 WAP	0.11636	0.04887	0.01164	0.03397	0.04153	0.00444
6 LEA	1.30007	0.27150	0.09386	0.07825	0.03701	0.00635
7 LUM	0.48326	0.12334	0.04266	0.03917	0.06225	0.01212
8 PPP	2.20182	0.39114	0.16872	0.23470	0.17688	0.04626
9 P_C	9.52560	1.57390	0.71597	0.46616	0.53299	0.03992
10 CRP	1.36472	0.36894	0.16394	0.22337	0.20669	0.02665
11 NMM	4.50604	2.98567	1.37764	0.35260	1.84559	0.09785
12 I_S_NFM	5.74096	4.68833	2.25961	0.31333	0.40173	0.04635
13 FMP	0.23349	0.07835	0.01784	0.02138	0.05172	0.00473
14 OME	0.04974	0.01901	0.00447	0.01097	0.02260	0.00261
15 ELE	0.36616	0.07380	0.02703	0.01076	0.01617	0.00107
16 MVN	0.23892	0.05197	0.01784	0.01031	0.02216	0.00259
17 OTN	0.01241	0.00388	0.00078	0.04049	0.03663	0.00552
18 OMF	0.12411	0.07757	0.01474	0.02906	0.03183	0.00529
19 ELY	22.75051	9.25177	9.28746	1.35583	1.58414	0.15211
20 GDT_WTR	1.10227	2.22005	0.10394	0.26894	0.27413	0.22459
21 CONS	0.07447	0.03723	0.00621	0.01499	0.16249	0.01524
22 TRD	0.24073	0.07147	0.01588	0.02891	0.02105	0.00194
23 OTP_WA	6.44995	2.53576	0.42974	2.00863	4.38110	0.29383
24 CMN	0.03103	0.00931	0.00155	0.00951	0.02554	0.00170
25 OFI_ISR	0.02405	0.01086	0.00078	0.00079	0.00383	0.00029
26 Others	0.08268	0.02024	0.01374	0.02730	0.03920	0.00472

**exchange rate: Korea - 775.7K-won/US$, Japan - 103.4 J-Yen/US$, closing exchange rate at 1995

We see that the value of Japanese emission intensity is lower than that of Korea. Environmental performance in air pollution management in Japan seems better than Korea in general. But for certain sectors shaded in Table IV-9: In Agriculture and Fishery and Mining, Japanese emission intensities are higher than those of Korea. This comes from the fact that the energy use in Japanese fishery industry and marine transportation services depends highly on Bunker oil, especially the Bunker C oil.

Table IV-10 and VI-11 present top five emission intensity industries for both countries in Sox and Nox emission respectively.[30)] The shaded cell in the tables marks a common pollution intensive sector in both Korea and Japan. We see then there is a little difference in inter-industrial emission intensity structure between the two countries. This structural difference plays an important role in determining sectoral and aggregated air pollution emission impact resulting from the change of specialization structure after free trade simulation in the study.

Table IV-10. Top five Sox emission intensive sectors

(unit = emission ton/US million $)

KOREA		JAPAN	
19 ELY	22.75051	23 OTP_WA	1.87503
9 P_C	9.52560	19 ELY	1.84775
23 OTP_WA	6.44995	1 AG_FI_FO	1.17574
12 I_S_NFM	5.74096	9 P_C	1.13365
11 NMM	4.50604	4 PFB_TEX	0.98595

30) In case of pm, it should be estimated for Korea in the near future. Particulate Matter is closely related to the human health such as respiratory disease, premature mortality etc. We leave it as a future study area.

Table IV-11. Top five Nox emission intensive sectors

(unit = emission ton/US million $)

KOREA		JAPAN	
19 ELY	9.25177	23 OTP_WA	4.38110
12 I_S_NFM	4.68833	11 NMM	1.84559
11 NMM	2.98567	19 ELY	1.58414
23 OTP_WA	2.53576	1 AG_FI_FO	1.45323
20 GDT_WTR	2.22005	9 P_C	0.53299

4. Free Trade Simulation

4.1 Macroeconomic Impacts

After a free trade simulation which eliminates the price differences between Korea and Japan for a given product, we observe that the free trade gives gains from trade to both Japan and Korea. Table IV-12 presents the summary of the effects of Korea Japan FTA on some selected macroeconomic variables.

Table IV-12. Economic impact of Korea-Japan free trade

(unit = %, US million $)

	pgdp*	qgdp**	vgdp***	u	y	tot	EV
Korea	0.90	0.274	1.17	0.52	1.31	0.36	2026.39
Japan	0.21	-0.002	0.21	0.07	0.21	0.26	2502.44

1) *pgdp-price index of GDP, **qgdp- quantity index of GDP, ***vgdp- value of GDP
2) u - per capita utility from aggregated household utility
3) y - regional household income
4) tot - terms of trade[31)]
5) EV - Equivalent Variation

In terms of GDP, our free trade simulation shows an increase equal to 1.17% of GDP in Korea, which is mainly due to price effects. In consumption side, per capita utility from household and household income increase by 0.52% and 1.31% respectively. The monetary value of these total social welfare change(EV) is estimated around 2,026 million US dollars and it is smaller in Korea than in Japan.

Table IV-13 shows the change by various expenditure sides. Evidently, export and import expenditure shows most important percentage change after free trade

31) $tot(r) = psw(r) - pdw(r)$, where psw is the price index received for tradable produced in region r and pdw is the price index paid for tradable used in region r.

simulation.

Table IV-13. Change of expenditures after Korea-Japan free trade

	consumption	investment	government	exports	import	gdp expenditure
Korea	1.31%	1.57%	1.31%	3.39%	4.06%	1.18%
Japan	0.21%	0.32%	0.21%	0.90%	1.36%	0.21%

We observe in Figure IV-6 that the output of agriculture, fishery, construction and most of light industry in Korea increases.[32)]

However, the change in Japan is relatively modest and shows a different feature which seems complementary to that of Korea. This shows that free trade results in more enhanced specialization structure in both countries.

We note that this result is based on the GTAP ver 5 of which the reference year is 1995. Considering intertemporal evolution of industrial structure of both countries, it is certain that we need much precaution in interpreting this structural change as it would be at present. The share of heavy industry and service sectors would increase substantially since 1995 especially in Korea. In spite of all these limits, we can say that free trade would result in important economic and structural change both in Korea and Japan, from which non-negligible induced environmental impact would result.

32) The details of 26 sectoral output change are presented in Table A1-3 of Annex 1.

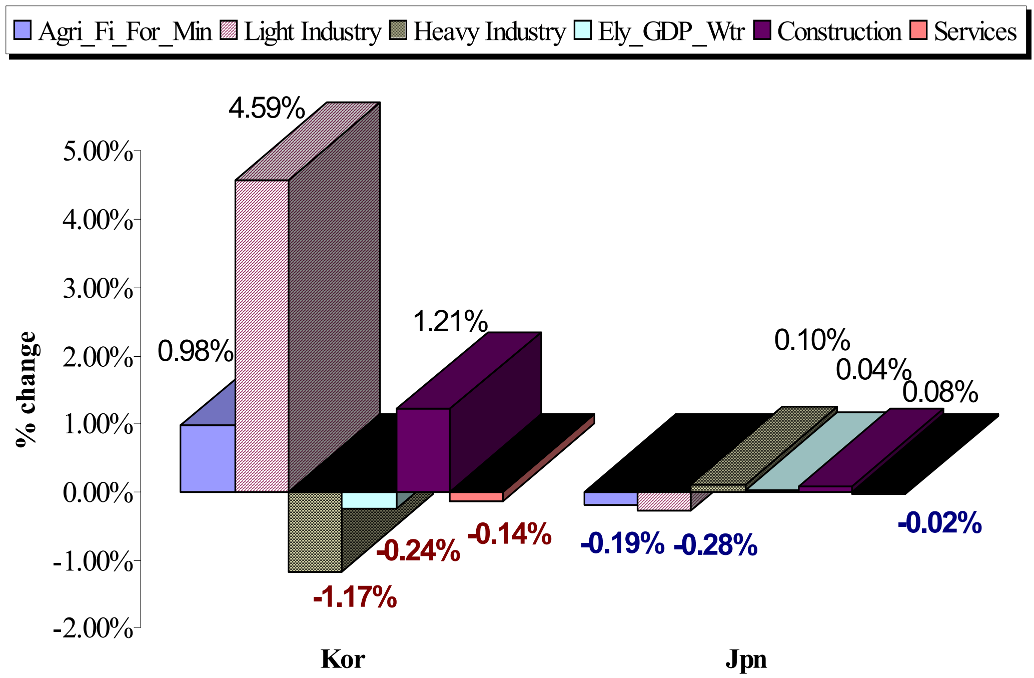

Figure IV-6. Change in production after Korea-Japan free trade

4.2 Changes in Trade Flow

With Korea-Japan free trade simulation, we observe that the total trade balance in both countries are getting worse, even though the bilateral trade volume itself increases.

Table IV-14 Change of aggregated trade flow in Korea and Japan

(unit: weight value, %)

aggregated sectors	Korea				Japan			
	import*		export**		import		export	
AG_FI_FO_Min	1433.98	4.34%	156.89	23.89%	155.77	0.20%	126.66	18.75%
Light Industry	1332.16	8.04%	5501.12	25.02%	3283.99	3.47%	1127.73	9.24%
Heavy Industry	4178.65	4.16%	83.56	0.08%	1440.97	0.94%	2911.60	0.70%
ELY_GDT_Wtr	2.03	2.94%	-0.41	-5.63%	3.57	0.84%	-1.34	-1.70%
CONS	1.22	1.72%	-1.84	-3.55%	41.45	0.60%	-68.67	-1.03%
Services	315.69	1.35%	-831.88	-2.69%	468.29	0.51%	-596.26	-0.83%

* qim value: aggregated imports in Korea and Japan, market price weight

** qxw value: aggregated exports of sectors from Region, fob weight

Table IV-14 shows the percentage increase of Korean export in Agricultural and Light industry product is more important than that of Japan. But the export of Japan in Heavy industry increases more than that of Korea. As a whole, the amplitude of sectoral export and import changes shows a similar pattern in both countries.

From Table IV-14 and IV-15, we know that the trade deficit deteriorated more in Korea than the decrease of Japanese trade surplus, as the growth of import from Japan to Korea was more important than the export increase from Korea to Japan. The increase of trade volume was more important in highly protected sectors such as light industries than in other sectors for which the protection was less important. The terms of trade improved in both countries after free trade, as the export price increased in opposite to the decrease of import price.[33)]

33) See Annex 3. for the detail of change in trade variables.

Table IV-15. Change of bilateral trade flow from Korea to Japan

(unit = US million $, %)

Aggregated sectors	export	import	balance of trade
Agri_Fi_For_Min	618.29 (46.69%)	200.01 (179.96%)	418.28 (19.49%)
Light Industry	9102.73 (200.80%)	2219.86 (118.54%)	6882.87 (242.37%)
Heavy Industry	11322.44 (6.15%)	33173.26 (34.77%)	-21850.82 (56.65%)
Ely_GDP_Wtr	0.97 (-5.11%)	1.39 (1.15%)	-0.42 (19.30%)
Construction	1.76 (-3.07%)	1.54 (0.55%)	0.22 (-22.52%)
Services	988.86 (-3.58%)	1362.15 (0.37%)	-373.30 (12.61%)

Table IV-15 shows aggregated sectoral change in bilateral trade flow from Korea to Japan. We observe that Korean export concentrated more in agriculture, fishery, forestry and light industry. But the import of heavy industry product from Japan increased substantially with amplified sectoral trade deficit equal to 21,850 million US dollars.[34] This type of industrial specialization resulted in trade induced environmental impact in the free trade simulation.

In sum, it seems that Korea gains more than Japan after free trade in overall macroeconomic view point. But the trade deficit in Korea and the economic performance in heavy industry group in general may rise as a potential obstacle to overcome in the Korea Japan free trade agreement negotiation. Industries in Korea are concerned about the increase of import from Japan in electrical parts, equipment and machinery sectors which are regarded as strategic industrial sectors.

34) Heavy industry in this case includes most of manufactures such as semiconductor and part, electronic equipment and part, automobile and parts etc.

4.3 Air pollution Impacts of Korea-Japan Free Trade

Finally we calculated, based on the observed output change after free trade simulation, the induced air pollution impact by air pollutant type[35].

Table IV-16 shows that the total air pollutant emission decreases in both countries. The grey cells in Table IV-16 represent the sectors of which the pollutant emission decreases after free trade simulation. The change of air pollutant emission is closely linked to the output change presented in Figure IV-6. The direction of change in air pollution emission and that in output are the same across the two countries, even though the magnitude of change in air pollution emission is difference because of the differentiation[36] of the sectoral emission intensity in the two countries.

It was estimated that the total emission ton of air pollution in Korea decreased in spite of the slight increase of the volume total of output equal to 0.187% after free trade. This result comes from the fact that the pollution reduction in shrinking sectors was more important than the pollution increase in expanding sectors, and means that the output structure of Korea became less pollution intensive, as the specialization of Korean industry concentrated in less pollution intensive industries.

In sum, we can expect from this simulation result that Korea-Japan free trade is not against to the air quality management in both countries. This result can be interpreted as an empirical evidence of win-win situation meaning that trade and environment would be mutually supportive. But we can not conclude that a free trade gives improved quality of environment in general, as the result depends highly on the values of behavioral parameters included in the simulation model and the change in specialization structure of participating countries.

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35) The emission change in 26 industry sectors by three types of air pollutant; Sox, Nox, and TSP is presented in Table A2-7 of Annex 2.

36) For the detail in sector-wise emission intensity, see section 3.2

Table IV-16. Change of emission after Korea-Japan FTA

(unit = ton, %)

Aggregated sectors	Korea			Japan		
	Sox	Nox	TSP	Sox	Nox	Spm
Agri_Fi_For_Min	469.73	150.09	23.83	-211.16	-379.50	-61.20
	1.20%	1.05%	0.77%	-0.22%	-0.21%	-0.22%
Light Industry	5,284.81	1,307.87	418.65	-202.26	-98.21	-16.74
	3.37%	3.88%	3.28%	-0.21%	-0.17%	-0.13%
Heavy Industry	-5,909.42	-4,837.68	-2,301.40	537.91	1,011.01	89.00
	-0.84%	-1.36%	-1.37%	0.25%	0.28%	0.28%
Ely_GDP_Wtr	-1,120.34	-450.66	-458.32	102.03	119.46	10.26
	-0.27%	-0.27%	-0.28%	0.04%	0.04%	0.03%
Construction	79.51	39.76	6.63	8.68	94.09	8.82
	1.21%	1.21%	1.21%	0.08%	0.08%	0.08%
Services	-1,636.80	-642.04	-111.11	-790.24	-1,721.11	-116.36
	-0.52%	-0.53%	-0.49%	-0.08%	-0.09%	-0.09%
total	-2,832.50	-4,432.67	-2,421.74	-555.04	-974.26	-86.22
	-0.17%	-0.64%	-0.65%	-0.03%	-0.03%	-0.03%

V. Conclusion

The current study on the environmental impact of trade liberalization between Korea and Japan has been implemented by the joint expert meeting composed of experts in the Korea Environment Institute in Korea, and Institute for Global Environmental Strategy and the National Institute for Environmental Studies in Japan.

The joint expert meeting shared the view that environmental review on the FTA would be very important in designing flanking environmental policy and measures to realize mutual supportiveness of trade and environment, and decided to implement a comparative study on the air pollution impact resulting from a free trade agreement between Korea and Japan.

In the study, a comparative analysis of industry and bilateral trade structure between Korea and Japan was made as a background of environmental impact analysis. The air pollution inventories of Korea and Japan based on the Korean I-O tables classification were harmonized and compared. The intertemporal change in industrial emission structure between 1995 and 2000 showed that there had been an important technological progress in managing air pollution.

The air pollution effect was calculated by combining emission coefficient per unit of production and output change after free trade. The emission coefficient per unit of production was obtained from the related energy consumption survey. In general, the emission coefficient of Japan is lower than that of Korea for a given industry. There revealed a interindustrial difference in emission coefficient for a given air pollutant in a country. These two kinds of difference were supposed to play a key role in determining aggregated air pollution impact of industrial output change after trade liberalization. The output change by industry after free trade was calculated from the free trade simulation using a standard computable general equilibrium model developed by GTAP. The standard CGE model could be characterized by comparative static and perfect competition assumption

In terms of GDP, our free trade simulation shows an increase equal to 1.17% of GDP in Korea, which is mainly due to price effects. In consumption side, per capita utility from households and household income increase by 0.52% and 1.31% respectively. The monetary value of these total social welfare change(EV) is estimated around 2,026 million US dollars and it is smaller in Korea than Japan.

We observe that the total trade balance in both countries are getting worse, even though the bilateral trade volume itself increases. With free trade, Korean export became concentrated more in agriculture, fishery, forestry and light industry. But the import of heavy industry product from Japan increased substantially with amplified sectoral trade deficit equal to 21,850 million US dollars. It seems that Korea gains more than Japan after free trade in overall macroeconomic viewpoint. But the trade deficit in Korea and the economic performance in heavy industry group in general may rise as a potential obstacle to overcome in the Korea-Japan free trade agreement negotiation. Industrials in Korea worry much about the increase of import from Japan in electrical parts, equipment and machinery sectors, regarded as strategic industrial sectors.

We found that the total air pollutant emission decreases in both countries after free trade. The results showed that the total emission ton of air pollution in Korea decreased in spite of the slight increase of the volume of total output equal to 0.187% after free trade. This results may come from the fact that the pollution reduction in shrinking sectors was more important than the pollution increase in expanding sectors, and means that the output structure of Korea became less pollution intensive, as the specialization of Korean industry concentrated in less pollution intensive industries.

In sum, the simulation result showed that Korea and Japan can get a mitigation of air pollution after free trade as well as economic gains from trade. These results might show one of the interesting cases that the free trade and environmental protection could be mutually supportive.

But there exist certain limits of the study. At first, we should be attentive to conclude that the free trade gives improved quality of environment in general. The result depends highly on the specific value of behavioral elasticity parameters included in the model. In case that the value of these elasticities are not estimated econometrically but chosen arbitrarily, there will be a certain limit in explaining what will happen after free trade.

The second limit of the current study is that it used a multi-regional general equilibrium model and could not consider the detailed national informations which can be more useful in a two-country model combining two individual national general equilibrium models. The comparative static structure of the model put also certain limit on analytic capacity in related to the induced technology transfer or progress after free trade. These can be included in main research topics of next studies.

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Annex 1. Industry structure for Korea and Japan

Table A1-1. Industrial sectoral change of Korea

(unit: 10billion won, %)

sectors	output		% change	% weight	
	1995	2000		1995	2000
1 AG_FI_FO	31942	38287	19.9%	3.8%	2.7%
2 Mining	3256	2648	-18.7%	0.4%	0.2%
3 FPWP	41910	59086	41.0%	5.0%	4.2%
4 PFB_TEX	14122	20668	46.4%	1.7%	1.5%
5 WAP	15032	20514	36.5%	1.8%	1.5%
6 LEA	5583	5689	1.9%	0.7%	0.4%
7 LUM	3467	3424	-1.2%	0.4%	0.2%
8 PPP	17214	23336	35.6%	2.0%	1.7%
9 P_C	18611	53148	185.6%	2.2%	3.8%
10 CRP	53766	88627	64.8%	6.4%	6.4%
11 NMM	15881	17173	8.1%	1.9%	1.2%
12 I_S_NFM	41796	57689	38.0%	5.0%	4.1%
13 FMP	16395	21007	28.1%	1.9%	1.5%
14 OME	78132	57443	-26.5%	9.3%	4.1%
15 ELE	22293	134920	505.2%	2.6%	9.7%
16 MVN	39610	58853	48.6%	4.7%	4.2%
17 OTN	9108	15760	73.0%	1.1%	1.1%
18 OMF	7954	10004	25.8%	0.9%	0.7%
19 ELY	11484	20623	79.6%	1.4%	1.5%
20 GDT_WTR	3586	10865	203.0%	0.4%	0.8%
21 CONS	82508	99269	20.3%	9.8%	7.1%
22 TRD	56607	110988	96.1%	6.7%	8.0%
23 OTP_WA	33320	51161	53.5%	4.0%	3.7%
24 CMN	11869	33891	185.5%	1.4%	2.4%
25 OFI_ISR	32283	63435	96.5%	3.8%	4.5%
26 Others	173790	314417	80.9%	20.6%	22.5%
Total	843513	1395927	65.5%	100%	100%

Table A1-2. Industrial sectoral change of Japan

(unit: 10billion yen, %)

sectors	output		% change	% weight	
	1995	2000		1995	2000
1 AG_FI_FO	15818	14370	-9.2%	1.7%	1.5%
2 Mining	1660	1379	-16.9%	0.2%	0.1%
3 FPWP	38857	38925	0.2%	4.1%	4.1%
4 PFB_TEX	4069	2855	-29.8%	0.4%	0.3%
5 WAP	7095	4238	-40.3%	0.8%	0.4%
6 LEA	934	665	-28.8%	0.1%	0.1%
7 LUM	4492	3161	-29.6%	0.5%	0.3%
8 PPP	21593	20747	-3.9%	2.3%	2.2%
9 P_C	10493	12983	23.7%	1.1%	1.4%
10 CRP	39108	39343	0.6%	4.2%	4.1%
11 NMM	9696	8369	-13.7%	1.0%	0.9%
12 I_S_NFM	26436	23297	-11.9%	2.8%	2.4%
13 FMP	15708	13452	-14.4%	1.7%	1.4%
14 OME	49178	47512	-3.4%	5.2%	4.9%
15 ELE	33494	38417	14.7%	3.6%	4.0%
16 MVN	36964	37276	0.8%	3.9%	3.9%
17 OTN	4892	5391	10.2%	0.5%	0.6%
18 OMF	9512	9688	1.8%	1.0%	1.0%
19 ELY	16738	16737	0.0%	1.8%	1.7%
20 GDT_WTR	9726	10267	5.6%	1.0%	1.1%
21 CONS	88149	77311	-12.3%	9.4%	8.0%
22 TRD	132221	128215	-3.0%	14.1%	13.3%
23 OTP_WA	50114	47907	-4.4%	5.3%	5.0%
24 CMN	14763	22139	50.0%	1.6%	2.3%
25 OFI_ISR	36335	38149	5.0%	3.9%	4.0%
26 Others	259056	296093	14.3%	27.6%	30.8%
Total	939096	960886	2.3%	100%	100%

Table A1-3. Change in sectoral output after Korea-Japan free trade

(Unit: %)

qo*	Kor	Jpn	qo	Kor	Jpn
1. AG_FI_FO	1.25	-0.22	13.FMP	-0.47	0.12
2. Mining	-1.80	0.07	14.OME	-2.95	0.67
3. FPWP	7.70	-0.36	15.ELE	1.03	0.09
4. PFB_TEX	0.58	-0.07	16.MVH	-1.63	-0.69
5. WAP	5.27	-0.54	17.OTN	-2.19	-1.10
6. LEA	13.38	-2.07	18.OMF	-0.68	-0.02
7. LUM	-0.52	-0.09	19.ELY	-0.28	0.05
8. PPP	-0.17	-0.03	20.GDT_WTR	0.20	-0.03
9. P_C	0.41	-0.09	21.CONS	1.21	0.08
10.CRP	-0.78	0.20	22.TRD	0.12	0.02
11.NMM	-1.21	0.31	23.OTP_WA	-0.57	-0.09
12.I_S_NFM	-1.74	0.50	24.CMN	-0.27	-0.04
13.FMP	-0.47	0.12	25.OFI_ISR	-0.10	-0.04

*qo :industry output of commodities

Annex 2. Emission intensity data for Korea and Japan

Table A2-1. Sectoral air pollutants emission intensity in Korea, 1995

(Unit = emission ton/million K-won, 1995)

Aggregated industry sectors(38)	Sox	CO	Nox	TSP	HC
Agriculture, forestry, and fishe	0.0014610	0.0001780	0.0005050	0.0000990	0.0000190
Mining and quarrying	0.0002840	0.0004450	0.0003600	0.0001900	0.0000620
Food and beverages	0.0014130	0.0000800	0.0003640	0.0001130	0.0000080
Tobacco	0.0004050	0.0000130	0.0000710	0.0000310	0.0000020
Fiber	0.0026410	0.0000670	0.0005230	0.0002320	0.0000080
Wearing apparels and other fabricated textile product	0.0001500	0.0000660	0.0000630	0.0000150	0.0000090
Leather and fur products	0.0016760	0.0000970	0.0003500	0.0001210	0.0000120
Wood and wooden products	0.0006230	0.0001100	0.0001590	0.0000550	0.0000150
Pulp and paper	0.0047060	0.0001100	0.0008110	0.0003580	0.0000120
Printing, Publishing and reprod	0.0000670	0.0000620	0.0000490	0.0000090	0.0000090
Coal, Petroleum products	0.0122800	0.0001980	0.0020290	0.0009230	0.0000190
Chemical products	0.0020700	0.0000520	0.0005770	0.0002590	0.0000060
Plastic and Rubber products	0.0007400	0.0000370	0.0001430	0.0000550	0.0000040
Non metalic mineral products	0.0058090	0.0002390	0.0038490	0.0017760	0.0000310
Primary metal products	0.0074010	0.0002120	0.0060440	0.0029130	0.0000270
Febricated metal products	0.0003010	0.0000750	0.0001010	0.0000230	0.0000100
General machinery and equipment	0.0000650	0.0000410	0.0000380	0.0000070	0.0000060
Electronic and machinery component	0.0000600	0.0000080	0.0000170	0.0000050	0.0000010
computer and Office	0.0000240	0.0000080	0.0000090	0.0000020	0.0000010
radio, television and communication products	0.0007470	0.0000370	0.0001480	0.0000550	0.0000050
Precision instruments	0.0001110	0.0000260	0.0000380	0.0000080	0.0000030
Motor vehicles	0.0003080	0.0000200	0.0000670	0.0000230	0.0000030
Ship and other transportation equipment	0.0000160	0.0000030	0.0000050	0.0000010	0.0000000
Furniture and other manufacturing products	0.0001600	0.0001040	0.0001000	0.0000190	0.0000150
Electricity	0.0293290	0.0021720	0.0119270	0.0119730	0.0001720
Gas and Water supply	0.0014210	0.0002400	0.0028620	0.0001340	0.0000320
Construction	0.0000960	0.0000390	0.0000480	0.0000080	0.0000050
Wholesale and retail trade	0.0000610	0.0000040	0.0000240	0.0000050	0.0000010
Eating, drinking and lodging services	0.0017370	0.0000930	0.0004820	0.0001090	0.0000100
Transportation and warehousing	0.0083150	0.0020730	0.0032690	0.0005540	0.0004980
Communication and broadcasting	0.0000400	0.0000020	0.0000120	0.0000020	0.0000000
Finance and insurance	0.0000310	0.0000020	0.0000140	0.0000010	0.0000000
Real estate and rental, business services	0.0000040	0.0000000	0.0000010	0.0000000	0.0000000
Public administration and defending services	0.0003710	0.0000160	0.0000870	0.0000210	0.0000010
Educational and research services	0.0000500	0.0000020	0.0000160	0.0000040	0.0000000
Medical and Health services	0.0002350	0.0000090	0.0000600	0.0001400	0.0000010
Culture and recreational services	0.0001230	0.0000060	0.0000290	0.0000120	0.0000010
Other services	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

Data source: A study on Environmental Pollution Accounting, 1998, Kim and Choi, KEI

Table A2-2. Sectoral air pollutants emission intensity in Korea, 2000

(Unit = emission ton/million K-won, 2000)

Num	sectors	Nox	PM10
1	Agriculture	0.0001779	0.0009493
2	Fishery	0.0017563	0.0001373
3	Mining and quarrying	0.0001784	0.0005357
4	Food and Beverages	0.0001116	0.0000487
5	tobacco	0.0000171	0.0000024
6	Texile	0.0002502	0.0000539
7	Wearing Apparel	0.0000045	0.0000012
8	Leather, luggage	0.0000406	0.0000091
9	Wood	0.0002249	0.0000563
10	Pulp and Paper	0.0006383	0.0002805
11	Publishing, Printing	0.0000104	0.0000050
12	Refined petroleum products	0.0003647	0.0000666
13	chemical	0.0003327	0.0003548
14	Rubber, Plastic	0.0000781	0.0000133
15	Non-metallic minerals	0.0028071	0.0109064
16	Basic Metal	0.0025235	0.0128206
17	Fabricated metal products	0.0000521	0.0000082
18	Machinery	0.0000124	0.0000035
19	Computers	0.0000037	0.0000001
20	Electrical machinery	0.0000045	0.0000002
21	TV, Communication	0.0000152	0.0000004
22	Medical, precision	0.0000027	0.0000001
23	Motor of vehicles	0.0000194	0.0000012
24	Other transport equipment	0.0000199	0.0000056
25	Furniture and others	0.0000094	0.0000207
26	Recycling	not available	not available
27	construction	0.0000268	0.0000025
28	Transportation services	0.0109479	0.0005281
29	Trs related services	0.0000242	0.0000670
30	wholesale and Retail	0.0000223	0.0000239
31	Hotel and Restaurants	0.0001028	0.0000440
32	Post and Telecommunications	0.0000059	0.0000006
33	Finance and insurance	0.0000054	0.0000010
34	Real Estate	0.0000009	0.0000003
35	Rental and others	0.0000061	0.0000003
36	Business activities	0.0000039	0.0000001
37	R & D	0.0000068	0.0000003
38	Public Ad	0.0000134	0.0000015
39	Education	0.0000305	0.0000023
40	Human Health	0.0000168	0.0000005
41	Social work	0.0000377	0.0003420
42	Movie, theater, etc act	0.0000225	0.0000009
43	sports and other acts	0.0000231	0.0000018
44	waste water, waste disposal	0.0000056	0.0000003
45	other repair and private services	0.0000535	0.0000109
46	Electricity	0.0170574	0.0806504
47	Gas	0.0036749	0.0000546
48	Steam and Hot Water	0.0024890	0.0002972
49	Water	0.0000105	0.0000003

Table A2-3. Direct Nox emission intensity in Japan[37)]

(Unit = emission kg/million J-Yen, 1995)

Sector number	Item on producer price basis	kg-NOx/ Million yen
1	Agriculture for crops	2.566684
2	Livestock and sericulture	0.209169
3	Agricultural services	1.136605
4	Silviculture	4.338165
5	Fisheries	84.018818
6	Metal ores	3.206911
7	Non-metal ores	3.967985
8	Coal mining	1.248089
9	Crude petroleum and natural gas	0.292218
10	Food	0.561456
11	Drinks	0.473352
12	Feeds and organic fertilizers	0.453204
13	Tabacco	0.092516
14	Fabric	2.344148
15	Wearing apparel and textile products	0.401692
16	Timber and wooden products	0.601983
17	Wooden furniture and accessories	0.286883
18	Pulp and paper	6.206087
19	Converted paper products	0.414720
20	Publishing and printing	0.143830
21	Chemical fertilizer	8.242755
22	Industrial inorganic chemicals	7.630659
23	Industrial organic chemicals	4.956036
24	Resin	3.174246
25	Chemical fiber	4.662774
26	Medicaments	0.181930
27	Final chemical products	0.791175
28	Petroleum refinery products	2.870306
29	Coal products	21.666640
30	Plastic products	0.578620

1) Data: Dr. Fujino, NIES, Japan

37) Japanese's data in related analysis were made by Dr. Hujino and Dr. Masui in NIES and Dr. Jung in IGES. This work is jointly conducted by KEI in Korea and IGES and NIES in Japan.

continue...

Sector number	Item on producer price basis	kg-NOx/ Million yen
31	Rubber products	1.055986
32	Leather and fur products	0.357950
33	Glass and glass products	16.461587
34	Cement and cement products	26.739637
35	Pottery, china and earthenware	4.592753
36	Miscellaneous ceramic, stone and clay products	5.355607
37	Pig iron and crude steel	12.702648
38	Steel	1.651192
39	Cast and forges products(iron)	1.667610
40	Non-ferrous metals	5.962153
41	Non-ferrous metal products	0.996675
42	Metal products for construction and architecture	0.633943
43	Other metal products	0.407276
44	General industrial machinery	0.300010
45	Special industrial machinery	0.265903
46	Other general machines and parts	0.370952
47	Office machine and machinery for service industry	0.135712
48	Household electric appliances	0.075262
49	Electric and communication equipment	0.156594
50	Industrial heavy electrical equipment	0.149011
51	Other electrical equipment	0.226035
52	Passenger cars	0.214349
53	Steel ships and repair	0.240613
54	Other transportation equipment and repair	0.445712
55	Precision instruments	0.146995
56	Musical instruments	0.322560
57	Construction	0.241564
58	Repair of construction	0.538924
59	Civil engineering and construction	3.254998
60	Electric power	15.320543

continue...

Sector number	Item on producer price basis	kg-NOx/ Million yen
61	Gas, steam and hot water supply	0.724123
62	Water supply	1.137335
63	Other sanitary services	6.171724
64	Trade	0.125100
65	Financial service and insurance	0.037034
66	Real estate agencies, managers and rent	0.212372
67	House rent	0.041733
68	Railway transport	0.289141
69	Road transport	20.564531
70	Transport by private motor cars	30.819322
71	Water transport	297.617258
72	Air transport	39.308470
73	Freight forwarding	5.772658
74	Storage facility service	0.262705
75	Services relating to transport	0.415562
76	Telecommunication	0.217172
77	Broadcasting	0.381576
78	Public administration	0.710235
79	Education	0.629202
80	Research institute	0.509858
81	Medical service and health	0.566848
82	Social security	0.283514
83	Private non-profit organization service	0.380962
84	Advertising agencies and information service	0.107666
85	Goods renting leasing	0.164532
86	Car and machine repairing	0.279333
87	Other business services	0.171181
88	Amusement and recreation services	0.602235
89	Eating and drinking places	0.469806
90	Hotel and other lodging places	0.479317
91	Other personal services	0.586255
92	Office supplies	0.000000
93	Activities not elsewhere classified	1.654108

Table A2-4. Direct SOx emission intensity in Japan

(Unit = emission kg/million J-Yen, 1995)

Sector number	Item on producer price basis	kg-SOx/ Million yen
1	Agriculture for crops	1.423732
2	Livestock and sericulture	0.032858
3	Agricultural services	0.160110
4	Silviculture	1.294684
5	Fisheries	47.456832
6	Metal ores	1.870925
7	Non-metal ores	0.910302
8	Coal mining	0.851442
9	Crude petroleum and natural gas	0.113200
10	Food	1.375882
11	Drinks	1.343923
12	Feeds and organic fertilizers	0.991467
13	Tabacco	0.181169
14	Fabric	3.649545
15	Wearing apparel and textile products	0.328515
16	Timber and wooden products	0.378817
17	Wooden furniture and accessories	0.217033
18	Pulp and paper	8.087416
19	Converted paper products	1.190829
20	Publishing and printing	0.046538
21	Chemical fertilizer	1.526026
22	Industrial inorganic chemicals	8.435422
23	Industrial organic chemicals	5.003675
24	Resin	2.881855
25	Chemical fiber	7.776678
26	Medicaments	0.105001
27	Final chemical products	1.181709
28	Petroleum refinery products	2.973607
29	Coal products	15.601622
30	Plastic products	0.734941

1) Data: Dr. Fujino, NIES, Japan

continue

Sector number	Item on producer price basis	kg-SOx/ Million yen
31	Rubber products	1.597604
32	Leather and fur products	0.756794
33	Glass and glass products	5.488321
34	Cement and cement products	2.835221
35	Pottery, china and earthenware	2.087615
36	Miscellaneous ceramic, stone and clay products	3.629080
37	Pig iron and crude steel	7.408984
38	Steel	0.864042
39	Cast and forges products(iron)	4.540717
40	Non-ferrous metals	7.353047
41	Non-ferrous metal products	0.884745
42	Metal products for construction and architecture	0.284238
43	Other metal products	0.152986
44	General industrial machinery	0.139521
45	Special industrial machinery	0.122698
46	Other general machines and parts	0.151592
47	Office machine and machinery for service industry	0.063840
48	Household electric appliances	0.040471
49	Electric and communication equipment	0.104430
50	Industrial heavy electrical equipment	0.083803
51	Other electrical equipment	0.112825
52	Passenger cars	0.099685
53	Steel ships and repair	0.114210
54	Other transportation equipment and repair	0.614828
55	Precision instruments	0.101876
56	Musical instruments	0.325847
57	Construction	0.051487
58	Repair of construction	0.133486
59	Civil engineering and construction	0.250358
60	Electric power	13.112434

continue

Sector number	Item on producer price basis	kg-SOx/ Million yen
61	Gas, steam and hot water supply	0.667445
62	Water supply	4.470391
63	Other sanitary services	1.142046
64	Trade	0.318987
65	Financial service and insurance	0.007622
66	Real estate agencies, managers and rent	0.148626
67	House rent	0.030282
68	Railway transport	0.252323
69	Road transport	2.063629
70	Transport by private motor cars	4.105892
71	Water transport	196.072286
72	Air transport	0.128390
73	Freight forwarding	0.581958
74	Storage facility service	0.055674
75	Services relating to transport	0.118873
76	Telecommunication	0.053439
77	Broadcasting	0.265846
78	Public administration	0.616676
79	Education	0.410643
80	Research institute	0.402340
81	Medical service and health	0.541438
82	Social security	0.013998
83	Private non-profit organization service	0.258674
84	Advertising agencies and information service	0.180512
85	Goods renting leasing	0.054093
86	Car and machine repairing	0.018218
87	Other business services	0.070124
88	Amusement and recreation services	0.390166
89	Eating and drinking places	0.131378
90	Hotel and other lodging places	0.187946
91	Other personal services	0.274125
92	Office supplies	0.000000
93	Activities not elsewhere classified	0.760572

Table A2-5. Direct Spm emission intensity in Japan

(Unit = emission kg/million J-Yen, 1995)

Sector number	Item on producer price basis	kg-SPM/ Million yen
1	Agriculture for crops	1.763403
2	Livestock and sericulture	0.014566
3	Agricultural services	8.241328
4	Silviculture	0.334699
5	Fisheries	6.408176
6	Metal ores	0.258890
7	Non-metal ores	0.239395
8	Coal mining	0.144724
9	Crude petroleum and natural gas	0.026581
10	Food	0.095617
11	Drinks	0.086729
12	Feeds and organic fertilizers	0.067999
13	Tabacco	0.015625
14	Fabric	0.373064
15	Wearing apparel and textile products	0.042910
16	Timber and wooden products	0.117185
17	Wooden furniture and accessories	0.077733
18	Pulp and paper	1.705446
19	Converted paper products	0.066014
20	Publishing and printing	0.015009
21	Chemical fertilizer	1.051135
22	Industrial inorganic chemicals	1.223029
23	Industrial organic chemicals	0.516879
24	Resin	0.393453
25	Chemical fiber	0.630738
26	Medicaments	0.025566
27	Final chemical products	0.122182
28	Petroleum refinery products	0.288651
29	Coal products	1.090343
30	Plastic products	0.087044

1) Data: Dr. Fujino, NIES, Japan

continue...

Sector number	Item on producer price basis	kg-SPM/ Million yen
31	Rubber products	0.171389
32	Leather and fur products	0.061438
33	Glass and glass products	0.827048
34	Cement and cement products	1.154954
35	Pottery, china and earthenware	0.613716
36	Miscellaneous ceramic, stone and clay products	0.733844
37	Pig iron and crude steel	1.270420
38	Steel	0.200308
39	Cast and forges products(iron)	0.457159
40	Non-ferrous metals	0.518705
41	Non-ferrous metal products	0.125798
42	Metal products for construction and architecture	0.055091
43	Other metal products	0.039264
44	General industrial machinery	0.042383
45	Special industrial machinery	0.033943
46	Other general machines and parts	0.047758
47	Office machine and machinery for service industry	0.017169
48	Household electric appliances	0.006257
49	Electric and communication equipment	0.010214
50	Industrial heavy electrical equipment	0.011462
51	Other electrical equipment	0.018880
52	Passenger cars	0.025059
53	Steel ships and repair	0.041398
54	Other transportation equipment and repair	0.062948
55	Precision instruments	0.009551
56	Musical instruments	0.032639
57	Construction	0.085953
58	Repair of construction	0.140408
59	Civil engineering and construction	0.216387
60	Electric power	1.471110

continue

Sector number	Item on producer price basis	kg-SPM/ Million yen
61	Gas, steam and hot water supply	0.078135
62	Water supply	0.358588
63	Other sanitary services	6.245901
64	Trade	0.014403
65	Financial service and insurance	0.002773
66	Real estate agencies, managers and rent	0.022875
67	House rent	0.005071
68	Railway transport	0.115429
69	Road transport	2.367084
70	Transport by private motor cars	3.444888
71	Water transport	13.117777
72	Air transport	2.412043
73	Freight forwarding	0.662577
74	Storage facility service	0.027817
75	Services relating to transport	0.044922
76	Telecommunication	0.014747
77	Broadcasting	0.023831
78	Public administration	0.068673
79	Education	0.086879
80	Research institute	0.133038
81	Medical service and health	0.070400
82	Social security	0.020540
83	Private non-profit organization service	0.043492
84	Advertising agencies and information service	0.012485
85	Goods renting leasing	0.016709
86	Car and machine repairing	0.025616
87	Other business services	0.020369
88	Amusement and recreation services	0.056536
89	Eating and drinking places	0.033144
90	Hotel and other lodging places	0.034548
91	Other personal services	0.084298
92	Office supplies	0.000000
93	Activities not elsewhere classified	0.137703

Table A2-6. Direct emission intensity based on PPPs

(unit = emission ton/mil ppp*)

sectors	Korea			Japan		
	sox	nox	tsp	sox	nox	spm
1 AG_FI_FO	1.00809	0.34845	0.06831	1.36961	2.47358	0.39681
2 Mining	0.19596	0.24840	0.13110	0.15414	0.63971	0.03941
3 FPWP	0.92684	0.23717	0.07405	0.22201	0.08788	0.01514
4 PFB_TEX	1.82229	0.36087	0.16008	0.64232	0.41257	0.06566
5 WAP	0.10350	0.04347	0.01035	0.05782	0.07070	0.00755
6 LEA	1.15644	0.24150	0.08349	0.13320	0.06300	0.01081
7 LUM	0.42987	0.10971	0.03795	0.06667	0.10595	0.02062
8 PPP	1.95856	0.34793	0.15008	0.39948	0.30107	0.07874
9 P_C	8.47320	1.40001	0.63687	0.79346	0.90722	0.06795
10 CRP	1.21394	0.32818	0.14583	0.38021	0.35181	0.04536
11 NMM	4.00821	2.65581	1.22544	0.60017	3.14143	0.16655
12 I_S_NFM	5.10669	4.17036	2.00997	0.53333	0.68380	0.07889
13 FMP	0.20769	0.06969	0.01587	0.03640	0.08804	0.00805
14 OME	0.04424	0.01691	0.00398	0.01867	0.03847	0.00445
15 ELE	0.32571	0.06564	0.02404	0.01832	0.02752	0.00182
16 MVN	0.21252	0.04623	0.01587	0.01754	0.03773	0.00441
17 OTN	0.01104	0.00345	0.00069	0.06892	0.06235	0.00939
18 OMF	0.11040	0.06900	0.01311	0.04947	0.05419	0.00901
19 ELY	20.23701	8.22963	8.26137	2.30779	2.69642	0.25892
20 GDT_WTR	0.98049	1.97478	0.09246	0.45777	0.46660	0.38228
21 CONS	0.06624	0.03312	0.00552	0.02552	0.27657	0.02593
22 TRD	0.21413	0.06357	0.01413	0.04920	0.03583	0.00329
23 OTP_WA	5.73735	2.25561	0.38226	3.41894	7.45720	0.50013
24 CMN	0.02760	0.00828	0.00138	0.01619	0.04347	0.00289
25 OFI_ISR	0.02139	0.00966	0.00069	0.00134	0.00652	0.00049
26 Others	0.07354	0.01801	0.01222	0.04647	0.06673	0.00803

*PPP per US$ - 690(Korea), 176(Japan), OECD statistics

Table A2-7. Air pollution impact of Korea-Japan free trade

(unit: ton)

Sectors	KOR			JPN		
	Sox	Nox	TSP	Sox	Nox	Spm
1. AG_FI_FO	483.05	166.97	32.73	-211.95	-382.80	-61.41
2. Mining	-13.31	-16.88	-8.91	0.80	3.30	0.20
3. FPWP	4,070.70	1,041.65	325.25	-155.69	-61.63	-10.62
4. PFB_TEX	283.04	56.05	24.86	-9.97	-6.41	-1.02
5. WAP	65.32	27.43	6.53	-11.17	-13.66	-1.46
6. LEA	952.55	198.92	68.77	-12.89	-6.10	-1.05
7. LUM	-9.97	-2.54	-0.88	-1.16	-1.84	-0.36
8. PPP	-76.80	-13.64	-5.88	-11.38	-8.57	-2.24
9. P_C	868.16	143.44	65.25	-24.21	-27.68	-2.07
10.CRP	-667.02	-180.32	-80.13	132.32	122.44	15.79
11.NMM	-945.37	-626.39	-289.03	89.52	468.56	24.84
12.I_S_NFM	-5,047.05	-4,121.65	-1,986.49	351.24	450.33	51.95
13.FMP	-19.29	-6.47	-1.47	3.28	7.93	0.72
14.OME	-111.12	-42.46	-9.99	23.88	49.22	5.69
15.ELE	205.06	41.33	15.14	4.12	6.19	0.41
16.MVH	-182.69	-39.74	-13.64	-22.23	-47.80	-5.59
17.OTN	-3.03	-0.95	-0.19	-19.62	-17.75	-2.67
18.OMF	-7.16	-4.48	-0.85	-0.38	-0.41	-0.07
19.ELY	-1,123.42	-456.85	-458.61	103.68	121.14	11.63
20.GDT_WTR	3.08	6.19	0.29	-1.65	-1.68	-1.38
21.CONS	79.51	39.76	6.63	8.68	94.09	8.82
22.TRD	17.95	5.33	1.18	4.66	3.40	0.31
23.OTP_WA	-1,631.51	-641.42	-108.70	-781.11	-1,703.72	-114.26
24.CMN	-1.15	-0.34	-0.06	-0.49	-1.32	-0.09
25.OFI_ISR	-0.92	-0.42	-0.03	-0.11	-0.51	-0.04
26.Others	-21.09	-5.16	-3.50	-13.20	-18.95	-2.28
total	-2,832.51	-4,432.65	-2,421.74	-555.03	-974.25	-86.22

Annex 3. Comparison of Environmental Markets

1. Korea

Table A3-1. Total EPER in Korea, 2002

(unit = billion K-won)

year	Investment expenditure	Internal current expenditure	Reciepts from byproducts	abater expenditure	weigh (%)t	Subsidy/ Transfers	Fees/ Purchases	Revenues	Financing Expenditure
Ambient Air and Climate	985	1,327	28	2,284	16.8 %	0	46	46	2,284
Wastewater	3,202	2,210	13	5,399	39.7 %	0	1,456	1,456	5,399
Waste	763	3,381	413	3,732	27.4 %	0	2,429	2,429	3,732
Remediateion of Soil, Groundwater and Surface Water	156	243	1	398	2.9%	1	18	18	399
Noise and Vibration	107	65	0	172	1.3%	0	3	3	172
Biodiversity and Landscape	428	369	0	796	5.9%	1	27	27	797
Radiation	23	83	0	105	0.8%	0	21	21	105
Research and Development	193	120	0	313	2.3%	0	0	0	313
Others	94	323	7	410	3.0%	2	21	21	412
Total	5,951	8,120	463	13,609	100.0 %	4	4,021	4,021	13,613

Data source: Economic Statistics System, The Bank of Korea,

Table A3-2. EPER in public sector

year	Investment expenditure	Internal current expenditure	Reciepts from byproducts	abater expenditure	weight (%)	Subsidy/ Transfers	Fees/ Purchases	Revenues	Financing Expenditure
Ambient Air and Climate	9	47	0	55	0.9%	-287	0	0	-232
Wastewater	2,379	426	0	2,805	44.0%	-374	345	732	2,044
Waste	451	1,462	43	1,870	29.4%	-59	725	560	1,975
Remediateion of Soil, Groundwater and Surface Water	141	148	0	289	4.5%	-196	4	8	90
Noise and Vibration	50	8	0	58	0.9%	0	0	0	58
Biodiversity and Landscape	428	368	0	796	12.5%	-71	1	26	699
Radiation	11	66	0	77	1.2%	-134	2	19	-74
Research and Development	96	112	0	208	3.3%	0	0	0	208
Others	28	184	0	211	3.3%	-113	1	7	93
Total	3,592	2,821	43	6,370	100.0%	-1,235	1,078	1,352	4,861

Table A3-3. EPER in business sector

year	Investment expenditure	Internal current expenditure	Reciepts from byproducts	abater expenditure	weight (%)	Subsidy/ Transfers	Fees/ Purchases	Revenues	Financing Expenditure
Ambient Air and Climate	973	1,052	28	1,996	46.1%	209	39	0	2,245
Wastewater	761	866	13	1,614	37.3%	374	722	0	2,710
Waste	152	411	369	193	4.5%	59	1,141	0	1,393
Remediateion of Soil, Groundwater and Surface Water	14	87	1	100	2.3%	101	13	0	214
Noise and Vibration	57	55	0	112	2.6%	0	3	0	115
Biodiversity and Landscape	0	0	0	0	0.0%	71	0	0	71
Radiation	12	15	0	26	0.6%	134	19	0	180
Research and Development	98	7	0	105	2.4%	0	0	0	105
Others	65	128	7	186	4.3%	115	20	0	321
Total	2,131	2,620	419	4,332	100.0%	1,065	1,956	0	7,353

Table A3-4. EPER in private sector

year	Investment expenditure	Internal current expenditure	Reciepts from byproducts	abater expenditure	weight (%)	Subsidy/ Transfers	Fees/ Purchases	Revenues	Financing Expenditure
Ambient Air and Climate	0	191	0	191	36.4%	78	6	0	274
Wastewater	0	334	0	334	63.6%	0	372	0	705
Waste	0	0	0	0	0.0%	0	518	0	518
Remediateion of Soil, Groundwater and Surface Water	0	0	0	0	0.0%	95	0	0	95
Noise and Vibration	0	0	0	0	0.0%	0	0	0	0
Biodiversity and Landscape	0	0	0	0	0.0%	0	26	0	26
Radiation	0	0	0	0	0.0%	0	0	0	0
Research and Development	0	0	0	0	0.0%	0	0	0	0
Others	0	0	0	0	0.0%	0	0	0	0
Total	0	525	0	525	100.0%	173	922	0	1,619

Table A3-5. EPER in Specialized producers sector

year	Investment expenditure	Internal current expenditure	Reciepts from byproducts	abater expenditure	weight (%)	Subsidy/ Transfers	Fees/ Purchases	Revenues	Financing Expenditure
Ambient Air and Climate	4	37	0	41	1.7%	0	1	46	-4
Wastewater	62	584	0	646	27.1%	0	18	724	-60
Waste	160	1,509	0	1,668	70.0%	0	46	1,869	-155
Remediateion of Soil, Groundwater and Surface Water	1	8	0	9	0.4%	0	0	10	-1
Noise and Vibration	0	3	0	3	0.1%	0	0	3	0
Biodiversity and Landscape	0	0	0	0	0.0%	0	0	1	0
Radiation	0	2	0	2	0.1%	0	0	2	0
Research and Development	0	0	0	0	0.0%	0	0	0	0
Others	1	12	0	13	0.5%	0	0	14	-1
Total	228	2,154	0	2,383	100.0%	0	66	2,670	-221

2. Japan

The Japanese environmental market has experienced exceptional growth, maintaining the average annual growth rate of 14.3% during the period of 1994-2000, reaching a scale of 21,619 billion Yen in 2000[38]. This trend made Japanese market the second largest one in the world after USA. However, the growth rate of Japanese market is declining, as the market gets mature. Even though the current trend of dramatic growth of the market seems to be disappeared, it is expected that Japanese environmental market will grow as highly as other developed countries during the 2000s, because Japanese government is currently taking active measures for environmental conservation such as the measure to raise the recycling rate to 90% by 2010.

Ministry of Environment(MOE) in Japan has given the priority to the waste policy such as the expansion of the disposal facility (e.g. incinerators) in the past under the assumption that the total amount of waste would dramatically increase. However, the supply-centered policies have faced the residents' strong resistance concerning the location of the new waste disposal facility or incinerator. Furthermore, the pollution of Dioxin, which result from incineration, has threatened public health.

As the problems associated with the waste management get aggravated and "Sustainable Development" gets the priority as a new paradigm, MOE in Japan starts to change the incineration-focusing policy into environmentally sound one. MOE in Japan is currently taking the active measures to establish the foundation for Sustainable Development, reexamining overall policies and switching over the

38) Ministry of Environment, Japan

direction of policies. MOE in Japan started to reinforce the incentives and support measures as one of the measures for activate recycling activities.

Japanese government also enacts the laws to impose obligations upon the agents of respect economic stages (e.g. production, distribution and consumption) in order to secure the effectiveness of policies. Especially, they are focusing on the support for the development of new technology, which would actually contribute to saving resources by activating recycling activities. That is because the technology that can be put to the practical use in the market will contribute to accomplishing the national goal associated with resource recycling.

Table A3-6. Prospect on environmental market in Japan

(unit = 100 million Yen)

Classifications	1997	weight(%)	2010	weight(%)
A. pollution management group	142,140	57.45%	188,430	47.29%
1. Manufacturing Pollution abatement and control equipments	13,475	5.45%	17,860	4.48%
air pollution control	3,052	1.23%	3,660	0.92%
water disposal	9,824	3.97%	10,828	2.72%
waste disposal	89	0.04%	387	0.10%
Remediation and cleanup for soil, water quality	15	0.01%	2,408	0.60%
Noise and vibration abatement	142	0.06%	104	0.03%
Environmental Monitoring, analysis and assessment	352	0.14%	473	0.12%
2. Services	86,098	34.80%	103,607	26.00%
air pollution control				
water disposal	9,569	3.87%	12,111	3.04%
waste disposal	73,904	29.87%	85,202	21.38%
Remediation and cleanup for soil, water quality	356	0.14%	3,225	0.81%
analysis, collecting data, Monitoring and assessment	2,197	0.89%	2,186	0.55%
supply of education, training and information services	21	0.01%	348	0.09%
Others	51	0.02%	534	0.13%
3. Build and install facilities	42,567	17.20%	66,964	16.81%
air pollution control			59	0.01%
water disposal	33,942	13.72%	57,884	14.53%
waste disposal	7,196	2.91%	6,421	1.61%
Noise and vibration abatement	1,429	0.58%	2,599	0.65%
B. Cleaner production and technologies group	2,256	0.91%	5,464	1.37%
cleaner/resource efficiency technologies and processes				
cleaner/resource efficient products	2,256	0.91%	2,964	0.74%
C. Resource management group	103,031	41.64%	207,049	51.96%
Water supply]	288	0.12%	1,051	0.26%
recycled materials	37,451	15.14%	88,506	22.21%
renewable energy plant	1,690	0.68%	7,109	1.78%
Heat/energy savings and menagement	7,560	3.06%	24,949	6.26%
Others	56,041	22.65%	85,434	21.44%
(protection of nature, ecosystems etc)				
Total	247,426	100.00%	398,443	100.00%

1) Data source: The prospect of Environmental industry, Konetic report, 2004,

http://www.konetic.or.kr/konetic_report , The perspectives of environmental market of Japan are based on this policy tendency. As shown in Table 3A-6, the environmental market is expected to maintain the average annual growth rate of 3.6% from 1999 to 2010. Japan Machinery Federation expected the growth rate of 4.7%. Ministry of Environment expected the growth rate of 4.7%. This report analyzed the growth rates based on the expectation of MOE in Japan, whose items are classified with OECD standard s[39].

According to the expectation of MOE in Japan, the average annual growth rate is expected to be 7% for cleaner production and technologies from 1997 to 2010, which is twice as much as the total environmental market. This expectation is attributed to the dramatic growth of the market for the development of resource-efficient technologies and processes in 2010s, which has not existed in the past.

Resource management sector is also expected to grow rapidly, showing the prospect of the average annual growth rate of 5.5%. In particular, the annual average growth rate is expected to be 11% for the production of renewable energy and the construction of facilities for water supply. And the average annual growth rate is expected to be respectively 9.6% and 6.8% for heat/energy saving and management and resource recycling sector.

The annual average growth rate is expected to be 2.2% for pollution management sector, which is much lower than that of total environmental market. This lower growth rate is attributed to the prospect that the growth rate will be only 2.2% and

39) OECD, Oct. 2000, Environmental Goods and Services: An Assessment of the Environmental, Economic and Development Benefits of Future Global Trade Liberalization, COM/TD/ENV(2000)86/Final.

1.4% for prevention facility of pollution (e.g. prevention facility of air pollution, waste water treatment facility, treatment & disposal of waste). However, the average annual growth rate for industry sector of constructing those facilities is expected to be 3.5%. Reflecting the result of these expectations, the market share of pollution management sector, which represented the largest share (57.4%) of environmental market in 1997 will decline to 47.3% in 2010. On the other hand, the market share of resource management sector will increase from 41.6% to 52.0% during the same period. The market share of clean sector is also expected to increase from 0.9% to 1.4%.

Annex 4. Detailed Trade effects on K-J FTA

Table A4-1. Bilateral trade effects of Korea-Japn FTA

(unit = US million $, %)

qxs[*,Kor,*]**	export		import		Balance of Trade	
1. AG_FI_FO	593.7313	50.4%	172.8059	262.4%	420.9254	21.3%
2. Mining	24.5569	-7.9%	27.1994	14.5%	-2.6425	-190.7%
3. FPWP	5529.8794	347.4%	1060.1511	448.7%	4469.7283	328.6%
4. PFB_TEX	1068.7366	41.0%	729.4901	38.7%	339.2465	46.3%
5. WAP	1216.7787	155.1%	94.9633	94.6%	1121.8154	162.0%
6. LEA	1107.1345	189.4%	62.1974	76.1%	1044.9371	201.0%
7. LUM	107.2431	3.9%	61.9943	50.4%	45.2488	-27.1%
8. PPP	72.9575	5.1%	211.0622	23.4%	-138.1047	35.8%
9. P_C	1536.1088	11.3%	115.4024	26.9%	1420.7064	10.2%
10.CRP	1389.4004	9.1%	4876.5605	23.8%	-3487.1601	30.9%
11.NMM	262.9008	0.5%	1176.7118	35.6%	-913.811	50.7%
12.I_S_NFM	2141.1797	12.2%	3774.2656	36.2%	-1633.0859	89.4%
13.FMP	402.9312	4.9%	625.6871	40.6%	-222.7559	265.6%
14.OME	1647.6935	0.0%	13742.5273	33.9%	-12094.8338	40.4%
15.ELE	3414.8611	2.9%	7086.0522	36.6%	-3671.1911	96.7%
16.MVH	112.016	-2.6%	1178.9224	92.4%	-1066.9064	114.4%
17.OTN	32.7127	-3.0%	137.3828	30.3%	-104.6701	46.0%
18.OMF	382.6368	11.6%	459.7524	37.6%	-77.1156	-968.9%
19.ELY	0	0	0	0	0	0
20.GDT_WTR	0.9666	-5.1%	1.3857	1.1%	-0.4191	19.3%
21.CONS	1.7615	-3.1%	1.5403	0.6%	0.2212	-22.5%
22.TRD	67.2421	-4.2%	100.4428	1.2%	-33.2007	14.2%
23.OTP_WA	474.2988	-3.0%	952.2695	0.0%	-477.9707	3.2%
24.CMN	54.0643	-3.8%	55.2272	-0.3%	-1.1629	-246.0%
25.OFI_ISR	128.4222	-4.5%	27.7122	1.2%	100.71	-5.9%
26.Others	264.8315	-4.0%	226.5028	1.5%	38.3287	-27.3%
total	22035.046	45.5%	36958.2087	36.6%	-14923.1627	25.2%

** qxs[*,Kor,*]: exports sales of commodity * from Korea to destination *

Table A4-2. Total export effects in Korea and Japan from K-J FTA

(unit = US million $, %)

variable	qxw(change)		pxw change	
sectors	Korea	Japan	Kor	Jpn
1. AG_FI_FO	760.86 (27.0%)	613.29 (25.7%)	4.7%	0.1%
2. Mining	52.87 (-8.2%)	188.84 (0.7%)	1.7%	0.2%
3. FPWP	6452.73 (187.8%)	3687.28 (31.5%)	1.9%	0.0%
4. PFB_TEX	14105.58 (0.4%)	7756.71 (2.3%)	0.4%	0.1%
5. WAP	3393.14 (21.8%)	1083.92 (2.9%)	0.6%	0.1%
6. LEA	3199.41 (24.8%)	341.4 (8.2%)	0.5%	0.0%
7. LUM	341.33 (-1.2%)	464.2 (3.7%)	0.6%	0.1%
8. PPP	1828.13 (-2.5%)	2925.67 (0.6%)	0.8%	0.2%
9. P_C	4123.13 (3.4%)	1220.58 (1.6%)	0.2%	0.1%
10.CRP	13902.53 (-0.1%)	41830.11 (1.6%)	0.2%	0.2%
11.NMM	947.23 (-3.2%)	6999.99 (3.5%)	0.9%	0.2%
12.I_S_NFM	10193.77 (1.5%)	22900.92 (3.7%)	0.1%	0.2%
13.FMP	2668.56 (-2.0%)	7117.13 (1.3%)	0.5%	0.2%
14.OME	16656.34 (-1.8%)	129140.3 (1.6%)	0.3%	0.2%
15.ELE	39182.47 (2.3%)	106600.44 (0.5%)	-0.4%	0.2%
16.MVH	10962.83 (-3.4%)	74145.52 (-1.5%)	0.3%	0.2%
17.OTN	6456.59 (-3.2%)	16846.04 (-2.1%)	0.3%	0.2%
18.OMF	2059.02 (-1.3%)	7676.48 (0.4%)	0.7%	0.2%
19.ELY	0.05 (0.0%)	0.32 (0.0%)	0.8%	0.2%
20.GDT_WTR	6.66 (-5.7%)	76.74 (-1.7%)	1.0%	0.2%
21.CONS	49.69 (-3.6%)	6589.54 (-1.0%)	0.9%	0.2%
22.TRD	2213.33 (-4.7%)	5872.78 (-1.0%)	1.2%	0.2%
23.OTP_WA	17451.93 (-1.3%)	42832.34 (-0.6%)	0.9%	0.2%
24.CMN	757.61 (-4.3%)	2054.84 (-1.1%)	1.1%	0.3%
25.OFI_ISR	979.48 (-4.9%)	4514.31 (-1.2%)	1.3%	0.3%
26.Others	8677.85 (-4.5%)	16297.93 (-1.1%)	1.2%	0.3%

Table A4-3. Total import effects in Korea and Japan from K-J FTA

(unit = US million $, %)

variable	qim(change)				pim change	
sectors	Korea		Japan		Korea	Japan
1. AG_FI_FO	11909.462	(13.0%)	29973.41	(0.4%)	-0.4%	-0.3%
2. Mining	22577.164	(0.3%)	49833.188	(0.1%)	-0.1%	-0.1%
3. FPWP	7448.95	(14.2%)	49861.684	(4.9%)	-3.5%	-2.5%
4. PFB_TEX	5227.787	(4.2%)	11788.746	(1.2%)	-1.1%	-0.8%
5. WAP	1791.458	(4.0%)	14522.535	(3.3%)	-0.4%	-0.8%
6. LEA	1436.12	(7.3%)	7017.572	(4.3%)	-0.3%	-1.5%
7. LUM	2004.182	(1.3%)	14835.224	(0.4%)	-0.3%	-0.1%
8. PPP	2155.701	(2.3%)	4791.215	(0.5%)	-0.7%	-0.1%
9. P_C	3865.397	(0.3%)	8723.524	(1.0%)	-0.3%	-0.7%
10.CRP	15188.81	(3.2%)	27445.395	(0.7%)	-2.4%	-0.2%
11.NMM	3153.062	(7.2%)	5547.371	(0.8%)	-2.7%	-0.1%
12.I_S_NFM	18293.723	(1.3%)	17626.811	(1.6%)	-1.4%	-0.3%
13.FMP	1798.525	(7.2%)	3995.622	(1.0%)	-2.6%	-0.2%
14.OME	30730.627	(6.6%)	37955.383	(0.9%)	-3.3%	-0.1%
15.ELE	20650.207	(3.4%)	40856.293	(0.9%)	-2.5%	-0.1%
16.MVH	3475.534	(11.3%)	11747.97	(1.3%)	-2.2%	-0.1%
17.OTN	3423.509	(1.8%)	6177.257	(0.8%)	-0.2%	-0.1%
18.OMF	1863.996	(5.1%)	9955.073	(0.9%)	-1.6%	-0.2%
19.ELY	0.011	(10.0%)	0.002	(0.0%)	-0.1%	-0.1%
20.GDT_WTR	71.015	(2.9%)	427.162	(0.8%)	-0.1%	-0.1%
21.CONS	72.243	(1.7%)	6959.167	(0.6%)	-0.1%	-0.1%
22.TRD	1969.081	(2.2%)	8755.581	(0.5%)	-0.1%	-0.1%
23.OTP_WA	9961.456	(1.1%)	43300.484	(0.4%)	0.0%	-0.1%
24.CMN	912.284	(0.8%)	2604.092	(0.5%)	-0.1%	-0.1%
25.OFI_ISR	518.57	(2.4%)	9702.244	(0.5%)	-0.1%	-0.1%
26.Others	10355.806	(1.4%)	28654.949	(0.6%)	-0.1%	-0.1%

국문요약(Abstract in Korean)

환경과 무역연계에 관한 통합적 접근은 무역자유화가 지방(local), 국가(national), 지역(regional), 지구(global) 환경에 어떠한 파급효과를 가져오는가 또는 환경정책 및 규제가 국제무역 특히 개도국 및 최빈국의 선진국 시장접근에 미치는 영향은 어떤 것인가에 관한 의문에서 출발하며, 환경과 무역의 연계문제를 다루는 국제통상협상의 주요 쟁점을 구성한다.

지난 2003년 9월 멕시코 칸쿤에서 개최된 제5차 세계무역기구(WTO) 각료회의에서 도하개발아젠다(DDA) 무역자유화협상과 관련된 주요 쟁점에 대한 중간평가는 예상된 성과를 도출하지 못하였다. 이에 따라 다자간 무역자유화 협상에 상당한 난항이 예상되는 시점에서, 다자간 자유무역협상의 중요한 보완수단으로 인식되어온 양자 혹은 지역국가간의 자유무역협정(FTA)에 대한 관심이 크게 대두되고 있다.

지역, 양자간 자유무역협정은 상품 혹은 서비스부문의 교역자유화는 물론 직접투자, 무역원활화, 인력이동 등 보다 심화된 교역장벽 제거를 통해 협정 당사국간의 경제통합 정도를 높일 수 있다는 장점이 있다. 반면, 각 국이 독자적인 국내 환경정책목표달성을 위해 설정한 환경규제 기준 및 정책의 차이는 종종 국가 간 교역에 상당한 실질적 교역장벽으로 작용하는 경우가 발생한다. 따라서 환경규범, 규제기준 및 환경정책협력의 강화를 통한 교역장벽 해소는 주요한 지역자유무역협정의 구성요소로 인식되어야 한다. 이를 위해서는 협상 혹은 환경부문을 담당하는 정부부처를 중심으로 진행 중인 자유무역협정 논의과정에서 적절한 환경성 검토가 이루어질 수 있는 제도적 장치를 마련해야 한다.

또한 자유무역협정을 통한 국가간 교역확대 및 경제통합의 진전은 당사국 국가경제의 생산, 소비, 자원이용의 변화에 따라 상당한 환경파급효과를 유발할 수 있으며, 궁극적으로 환경오염, 생태계 파괴, 자원고갈의 원인이 될 수 있다. 자유무역협정에 따른 환경파급효과를 정확히 예측하고 부정적 환경효과를 최소화하기 위한 정책대안

을 모색하며, 발생하는 환경문제를 비용 효과적으로 해결할 수 있도록 환경기술 혹은 환경정책부문의 협력수요를 발굴하는 정성 및 정량적 분석체계수립이 요구된다.

자유무역협정의 환경성 평가는 무역협상과 함께 시작되는 것이 바람직하며, 평가에는 협상의 초기단계에서 예측 가능한 환경성 평가결과와 함께 협정이 가져올 부정적인 환경효과에 대한 대응조치 등이 포함되어야 한다. 또한 환경영향평가를 수행하는 실무자가 자유무역협정의 협상과정에 참여하는 것이 중요하다. 이는 단계별 협상을 통해 진행되는 자유무역협정의 각 협상단계를 이해하고 그 과정에서 얻어지는 협상정보를 환경영향평가에 통합하는 장점을 가져다준다.

최근 관심을 모으는 전략적 환경영향평가를 무역자유화의 환경성 평가에 적용할 경우, 충분한 정보를 구비한 협상자, 중앙정부나 지방정부 등 다양한 관리기관의 참여, 전문가, 환경관련 NGOs, 시민과 경영단체의 참여가 특히 중요해진다. 환경적 측면의 정보를 공유한 전문가, 환경단체, 시민, 경영단체 등과 다양한 영역의 참여는 이들이 가진 양자무역 및 환경과 관련된 정보를 효율적으로 이용할 수 있게 해주며, 평가의 각 단계에서 일반시민의 의견을 수렴할 수 있도록 하는 장점을 제공한다.

자유무역협정의 환경성 평가는 경제성 평가와 연계되어 진행되는 것이 바람직하다. 자유무역협정에 따른 무역자유화가 재화와 서비스의 교역에 직접적으로 영향을 미치는 관세의 철폐나 저감은 물론 비관세장벽의 감소를 의미하며, 무역자유화의 환경영향 또한 이러한 경제적 교역여건의 변화로 인한 무역흐름의 변화에 의존한다는 점에서 환경성 평가와 경제성 평가는 병행되어야 한다.

우리나라는 지난 2004년 4월 칠레와의 FTA 발효로 일본에 이어 자유무역협정 체결국 대열에 합류하였다. 또한 기존협상대상국인 일본 및 싱가포르 외에 EFTA 와 멕시코 등 새로운 FTA 협상대상국을 선정하고 현재 협상 및 공동연구가 진행 중이다.

일본과의 FTA협상은 지난 2002년 이후 일본과의 본격적인 자유무역협상이 시작된 이래, 2004년 11월 현재까지 6차 협상이 진행되었으며, 실무자 논의 및 대책회의가 지속되고 있다. 일본은 싱가포르와의 자유무역협상 체결 이후 환경성평가에 대한 작업을 진행하고 있으며, 우리나라도 이에 대한 대책을 강구하고 있는 실정이다.

본 연구는 2003년 연구에서 제안했던 국가 간 자유무역협정의 경제, 무역, 환경 등

의 효과를 통합하여 정량적으로 추정하고 양국 간 비교 연구하는 것을 목적으로 하였다. 일반적인 글로벌 모형에서의 정량적 분석절차는 먼저, 관세 및 비관세장벽의 제거 혹은 감축으로 인해 생산 활동의 변화와 재화 및 서비스 교역량의 변화를 파악하고, 다음으로 생산 활동의 변화에 따라 재화와 서비스의 소비가 증가한 경우 예상되는 환경적 위험에 대한 평가를 진행하며, 마지막으로 환경적 위험을 저감하는 충분한 정책대안에 대한 연구가 이루어지는 순서로 구성된다.

무역협정형태의 무역자유화는 분석에 사용된 모형의 경제변수들을 통해 표현될 수 있으며, 이들 경제변수들의 상호관계에 대한 정량분석을 통해 환경·경제적 파급효과가 계량화된다. 따라서 교역당사국간의 자유교역에 따른 환경파급효과 추정작업에는 먼저 교역에 따른 재화와 용역의 흐름은 교역당사국의 비교우위구조에 의해 결정되고 교역방향에 따라 당사국내 산업생산구조의 변화가 유발되는 경제적 분석이 선행된다. 이어 이 같은 생산활동의 변화에 따른 환경적 외부성(externality)을 추정하는데, 생산구조의 변화가 유발하는 환경효과를 분석하기 위한 산업별 환경오염유발강도에 대한 추정이 선행되고 이는 국내경제를 대상으로 특정 산업의 생산 활동과 관련된 환경적 외부효과를 검증하는 작업을 포함한다.

본 연구에서는 자유무역협정의 환경파급효과를 정량적으로 추정하기 위한 분석모형으로 기본적인 GTAP-CGE 모형을 이용하였다. 양국의 산업구조를 비교하기위해 각각 1995년과 2000년의 투입산출표(IO table) 자료를 바탕으로 본 연구의 산업구분별 자료를 작성하였다. 또한 한국과 일본의 산업별 배출집약도를 나타내는 계수를 수집하여 본 연구의 분석목적에 맞게 재배열하였으며, 우리나라의 경우 2000년 기준의 산업별 배출계수를 에너지 총조사 보고서에 기반하여 재 추정해 보았다.

양국 산업구조를 비교해보면, 일본은 서비스업 비중이 약간 증가하였을 뿐 1995년과 비교해 여전히 서비스 중심의 산업구조를 이루고 있다. 한국은 중공업부문의 제조업과 서비스업 비중이 일본에 비해 크게 증가하였고, 일본과 같은 서비스 분야로 산업의 비중이 커가고 있음을 관찰하였다. 양국간의 비교에서는 건설업 비중이 양국모두 다소 감소하였고, 한국에서의 농림수산업 분야 비중이 일본의 그것보다 크게 나타났다. 전체적으로 양국의 경제규모를 비교해서 산업구조 변화를 보면 1995년과 크게

달라지지 않았음을 확인할 수 있으며, 우리나라의 변화가 일본에 비해 컸음을 관찰하였다.

한・일간 교역구조를 살펴본 결과, 우리나라의 대일 수출은 경, 중공업에 다양하게 분포되어 있는데 반해 수입은 중공업 및 대형 장비산업 등에 편중되어 있음을 알 수 있었다. 또한 대외교역에서 일본에 대한 수출비중은 꾸준히 감소하고 있으나 수입은 지속적으로 유지 및 확대되고, 특정부문에 편중되어 있어서 심각한 무역불균형이 존재함을 확인할 수 있다.

환경효과를 분석하기 위한 양국 대기오염물질의 산업별 배출집약도를 비교해 보면, 대부분 산업에서 우리나라가 일본에 비해 단위배출수준이 높은 것으로 나타났다. 그러나 에너지 사용비중이 훨씬 높은 일본의 선박산업 부문 또는 농림수산광업, 수송서비스, 그리고 건설업 등에서 Nox의 단위배출수준이 우리나라에 비해 높게 나타났다. 전체적인 1995년의 단위배출계수 값도 한국은 산업별 편차가 약 100배까지 보이고 있으나, 일본은 대부분 안정적인 것으로 나타났다.

우리나라의 2000년 기준으로 재 추정된 배출계수와 기존의 값을 비교해 보면 대부분의 산업에서 배출계수 값이 감소하였음을 알 수 있다. 그러나 목재 및 목제품, 자동차를 제외한 수송산업, 전력산업, 그리고 수송서비스 산업 등은 ‘95년에 비해 단위배출수준이 높은 것으로 나타났다.

완전한 자유무역을 가정한 한・일 FTA 모의분석 결과, 한・일 양국의 GDP는 각각 1.17% 및 0.21% 증가하는 것으로 나타났으며, 유발된 대기오염 변화율은 GDP변화율에 비해 낮은 것으로 예측되었다.

경제적 효과에서는 우리나라의 생산량은 증가하나 일본은 극소지만 감소하는 값이 추정되었다. 또한 일본과의 무역구조에 큰 변화가 없으며, 전체적인 무역수지가 개선되더라도 오히려 일본과의 무역적자는 더 심해지는 것으로 나타났다.

이러한 경제적 효과는 양국의 정형화된 교역구조에서 기인한다고 판단된다. 즉, 일본으로부터 수입이 최종생산 증가를 유발하고 그것이 다시 우리나라 전체 교역구조에 영향을 주는 것으로 파악되며, 상대적으로 일본은 우리나라와의 교역비중이 작으므로 그 효과가 적은 것으로 나타났다.

환경적인 부분에서 양국의 대기오염은 감소하는 것으로 추정되었다. 특히 우리나라는 오염집약적 산업의 생산이 줄고 일본으로 부터의 수입이 이를 대체하여 다른 오염효과가 작은 산업으로의 생산 유발효과가 일본보다 큰 것이 반영되었고, 일본은 전체적인 산출 감소량이 오염배출감소를 유발한 것으로 파악된다. 물론 이러한 면은 양국의 1995년 산업구조를 가정한 상태에서 이루어진 것임을 고려해야 할 것이다.

분석과정에서 양국의 교역구조가 상이하고, 환경오염물질의 배출량에서도 산업별로 차이가 있으므로, 자유무역의 환경오염유발효과 예측에 상당한 주의가 요구됨을 알 수 있었다. 자유무역은 당사국의 교역조건 및 산업구조 변화여부에 따라 특정 산업에 환경오염을 편중시킬 수 있으며, 한일 양국의 교역구조 및 산업특화, 그리고 경쟁력 등의 변화가 경제부문 및 환경에 동시에 영향을 줄 수 있을 것으로 예상된다.

본 연구에서는 완전경쟁모형을 가정하여 정태비교분석을 실시하였으며, 규모의 경제 및 자본축적효과 등은 고려하지 않았다. 또한 기준년의 기술수준에 변화가 없다고 가정하였으며, 모형에 적용한 환경오염유발모듈은 경제적 효과와 외생적으로 결합된 형태이다. 따라서 경제부문과의 상호 피드백 및 성장효과를 파악할 수 없다는 단점이 있으며, 또한 통계자료 및 산업분류상의 제약으로 모든 환경오염물질의 배출에 미치는 효과를 고려하지 못하고 주요 대기오염물질에 한정하여 분석하였다.

이 같은 제약에도 불구하고 본 연구는 자유무역협정의 환경파급효과를 추정하는데 있어 다지역 다재화 일반균형모형을 이용하여 산업별 경제적 파급효과에 연계된 환경파급효과를 정량분석하고, 양국의 산업별 단위 배출계수자료를 토대로 환경오염유발효과를 추정・비교하였다는 성과를 얻었다고 할 수 있다. 본 연구에서는 2000년 기준 일본 자료가 획득되지 않았는데, 이는 추후 보완할 것이며, GTAP자료의 업데이트와 함께 최신의 산업구조 및 교역효과를 반영한 양국간 비교연구가 될 수 있을 것으로 예상된다.

또한 국내 환경정책의 효과를 반영할 수 있는 분석도구로써 양국의 개별적 일국모형을 구축하고 대기오염물질 외에 폐기물 흐름자료 등을 반영한 통합모형을 구축하여 비교하는 것을 다음과제로 제안하며, 본 연구를 결론짓도록 하겠다.

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