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Eco-labelling, Environment, and International Trade*

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1 Introduction

In recent years, great concern for environment has been growing. Protection of environment is one of the main issues discussed around the world. Eco-labeling programs are a set of measures to protect environment, though there are other kinds of measures such as taxes, subsidies, and standards. In the past decade, eco-labelling programs have been disseminated since Germany first introduced the eco-label called "Blue Angel" in 1977. Now more than 26 countries/regions, including developing countries such as India, Brazil, and Zimbabwe, introduce similar programs. A non-profit association of eco-labelling organizations around the world was also founded in 1994. It is the global eco-labelling network (GEN).[1] The purpose of the association is "to improve, promote, and develop the eco-labelling of products and services". These facts reveal that eco-labelling is expected as one of the effective measures to protect environment.[2]

The eco-labelling programs provide consumers with the information on environmental burdens of products. They will affect the behavior of consumers, in particular, who are aware of the importance of environment. Those consumers tend to purchase environmentally preferable products, which can be identified through the eco-label on the products. Thus, the eco-labelling programs will increase a demand for environmentally preferable products, and will change the resource allocation so as to protect environment. The diffusion of the eco-labelling programs in many countries, however, raises new questions related to their effectiveness and trade effects.

First, the effects of the eco-labelling programs are not so apparent. They affect the resource allocation indirectly through a change in the consumer's behavior. Some consumers are very conscious of environment, but others are not. The consumers' sensitiveness to environment is essential for the eco-labelling programs to be effective.

Moreover, the eco-label is awarded to a restricted number or percentage of the firms in a voluntary schemes of the eco-labelling. Since an introduction of the eco-labelling programs

[1] http://www.gen.gr.jp/whats.html

[2] There are many international organizations that discuss eco-labelling programs themselves, or thier relation to international trade. The organizations include the WTO, the OECD, the Codex Alimentarius Comission, the International Trade Center (ITC), the United Nations Conference on Trade and Development (UNCTAD), the United Nations Environment Programme (UNEP), the United Nations Industrial Development Organization (UNIDO), and the International Organization for Standardization (ISO).

may bene¯t to a small number of ¯rms who attained the label, it may change the ¯rms' power of price control, or the market structure. Then, we cannot simply predict the e®ects of the eco-labelling on resource allocation and welfare, assuming a competitive market.

Secondly, most eco-labelling programs are established independently in each country. The criteria of awarding eco-labels are usually developed and adopted by domestic parties. Then, the criteria may be determined, intentionally or unintentionally, in favor of domestic ¯rms. If domestic ¯rms can take the eco-label easier than foreign ¯rms due to the criteria, it may cause undesirable trade e®ects or trade frictions.

In this respect, transparency is said to be very important to avoid unnecessary international frictions. Colombia, Pakistan, Hong Kong China, Korea and others said that "the key way to minimize the negative trade e®ects of eco-labelling is to ensure transparency in the processing and application of eco-labels, that interested parties could participate in their development" (CTE Bulletin 23). Eco-labelling procedures tend to be open to public participation, such as environmentalist, consumers, industry, trade unions, and foreign interest groups. For example, in Japanese eco-labelling scheme, called Eco-Mark, there is 60 day public review process.

Mutual recognition of criteria may also reconcile the di®erence in the country-based criteria. "The concept of equivalencies in the context of eco-labelling implies that when comparable environmental objectives can be achieved in di®erent ways, taking into account the speci¯c environmental conditions of each country, di®erent criteria can be accepted as a basis for awarding eco-labels (Zarrilli, Jha, and Vossenaar (1997))". If both the importing country and the exporting country have their own eco-labelling schemes and they accepted di®erent criteria each other, it is called mutual recognition. Analyzing of environmental criteria leading to mutual recognition is one of the purposes of GEN. This issue has also been discussed in the Committee of Trade and Environment (CTE) of the WTO.[3]

Finally, the use of Life-Cycle Approaches (LCA) in eco-labelling programs is to evaluate the overall environmental e®ects of products, but it may also cause trade e®ects. The key feature of LCA is to take into consideration of all life stages of the product, called 'cradle to grave' approach. Generally life cycle assessment covers the ¯ve phases of the life cycle of products: (1) acquisition of raw materials, (2) process and production, (3) distribution,

[3]See CTE Bulletin 8.

(4) use, (5) disposal. International Organization for Standardization (ISO) started to make international guidelines of LCA and almost all of the work has been completed. (ISO 1997, 1998, 2000a, 2000b, 2000,c) LCA may in theory be an ideal way to assess the overall environmental e®ects of products.

In terms of practical use, however, there are a lot of di±culties.[4] First, there does not exist any clear methodology for LCA. Even experts and scientists cannot identify the clear boundary of the phase of life cycle, and the accurate impacts in each life phase. This fact makes the decision making under the in°uence of lobbying activities. Second, it is di±cult for LCA to take into account of non-environmental factors such as resource allocation. Therefore, an introduction of eco-labelling schemes based on LCA leads to ine±cient resource allocations and the degradation of environment. Third, the public may be irritated if new LCA is developed and the criteria of eco-labelling programs change frequently.

Moreover, the eco-labelling programs based on LCA give rise to international trade issue. In an open economy a producing country (exporting country) is often di®erent from a consuming country (importing country). However, the use of LCA in eco-labelling schemes theoretically considers all life stages including acquisition of raw materials, production of materials, and fabrication of products. In the absence of international methodologies and standards "LCA systems could deliberately and unwittingly become barriers to the entry of foreign products"[5], since the eco-labelling schemes may re°ect the environmental conditions and preferences of the importing country.

This aspect of eco-labelling programs is also discussed in relation to the Agreement on Technical Barriers to Trade (TBT Agreement) at the WTO. Both developed countries and developing countries have argued whether eco-labelling schemes fall under the TBT Agreement. This issue has become complicated due to LCA. As for the product related PPMs, countries have already reached an agreement that they are covered by the TBT Agreement. However, they have not yet agreed whether the non-product related PPMs fall under the TBT Agreement.

In connection with the point above, the concept of 'like product' is also in dispute. If the

[4]For example, they cannot know how long consumers use the products, and how they dispose of the products. For a detailed explanation, see Scarlett and Morris (1996), and Neitzel (1997).

[5]CTE Bulletin 6.

TBT Agreement allows for the concept of 'like product' to be extended to cover non-product related PPMs, exporting countries may not be able to set environmental standards based on their own environmental preferences, but have to adjust their standards to those of importing countries. Therefore many developing countries have objected non-product related PPMs to be allowed by the TBT Agreement.

At the present stage, the full use of LCA cannot be realistic, even impossible. "The most interesting use of LCA is for the identi¯cation of signi¯cant environmental impacts in the various phases of the life cycle in order to guide the development of criteria that mirrors those impacts" (Neitzel 1997, p.242).

We have brie°y stated some real issues regarding the eco-labelling schemes, but we can hardly ¯nd a rigorous analysis on the e®ects of them. Some exceptions include the followings. OECD (1997) investigated practical e®ects of eco-labelling schemes operating in OECD countries, and Zarrilli, Jha and Vossenaar (1997) surveyed the general issues on eco-labelling and international trade and referred to each eco-labelling program.

The purpose of this paper is to discuss the e®ectiveness of eco-labelling schemes and their impacts on international trade issues descriptively, and to present a simple theoretical model of eco-labelling schemes in an international economy. First, we describe the e®ects of eco-labelling schemes on consumer's behavior, environment, international trade, and investment. Then, we set up a simple international oligopoly model with eco-lalels. The eco-labelling scheme is assumed to be voluntary, and may discriminate against foreign producers. We will analyze the e®ects of an introduction of domestic, or foreign eco-labelling programs on pro¯ts of the ¯rms and environment. We also refer to the issue of recognition of foreign eco-labelling schemes. We have obtained rather diversi¯ed results even if we construct a simple model. The results depend, in particular, on a change in competitive pressure in the market and the origin of the environmental damages.

The rest of the paper is organized as follows. Section 2 considers pros and cons of eco-labelling schemes and mutual recognition in terms of the e®ect on consumers' behavior. The e®ects of eco-labelling programs on environment and international trade are described in section 3 and 4, respectively.. In section 5, we explain the e®ects on investment in environment sound technology (EST) by ¯rms. In section 6, we present a simple model to analyze the e®ects of eco-labelling in an international setting. Section 7 provides some

concluding remarks.

2 The E®ects on Consumers' Behavior

The purpose of eco-labelling schemes is to in°uence consumers' behavior by awarding eco-labels to environmentally preferable products and services. In another words it is to induce consumers' to buy products which have less negative impacts on environment than other products. The eco-labelling schemes, however, have the intended e®ects as well as unintended side-e®ects. In this section we provides a brief review of those e®ects and extend them to the case of mutual recognition.

First, we look into the intended e®ects. Consumers have actually changed their behavior toward environmental friendly consumption. We can infer whether eco-labelling programs have changed consumers' behavior or not from the change of market share of labeled products and unlabeled products. The share of labeled products has increased since an introduction of eco-labelling schemes in many countries. 'Blue Angel' in Germany supports the statement. "for recycled paper products, an increase in market share of eco-labeled products was observed as follows: in 1993, 64 percent for sanitary paper products compared to 32 percent in1986; and respectively 24 percent for administrative paper products compared to 13 percent" (OECD (1997) p.53). Moreover, for varnishes and coatings, market shares of unlabeled products have fallen.

It should be noted that the small share of labeled products does not necessarily mean the failure of the eco-labelling scheme. The criteria for awarding eco-labels have been revised at intervals. For example, in Eco-Mark in Japan, the criteria for load stabilizing devices for energy conservation was abolished and the criteria for paper for communication was revised in May 2000. Some eco-labelling schemes may set the criteria so that the share of labeled products is small to induce ¯rms to compete for labels.

Second, eco-labelling schemes make consumers more environmental conscious. If eco-labelling schemes did not exist, consumers could not know the information on environmentally unfriendly products, and therefore they could not know how their consumption damaged the environment.

Let us turn to the negative e®ects of eco-labelling programs. First, consumers may be

confused since there are many kinds of eco-labels.. The oversupply of eco-labels hinders consumers from consuming environmentally friendly products. According to a continuously conducted poll in Germany, the share of people who consider the Blue Angel in purchasing products has decreased. A 1990 survey carried out for Tesco, a British market chain, may be another example of the confusion of consumers, in which only about 10 percent of consumers bought labeled products although about 50 percent of consumers said that they were willing to pay extra for labeled-products. Neitzel (1998) noted that "the Blue Angel program has to accept the competition raised by other environmentally-related labeling activities. This "labeling market" should be evaluated and compared by independent bodies. | the only solutions how to solve confusion are well prepared information campaigns to achieve correct understanding."

Second negative e®ect is that consumers are skeptical of environmental claims on the eco-labellings in general, which is another explanation for the survey quoted above. As mentioned in the introduction of this paper, almost all of eco-labelling schemes have not been able to take into consideration the non-product related PPMs. Consumers know this fact and question eco-labels. If non-product related PPMs in eco-labelling are not used "it may be very di±cult to convince the public about the life cycle approach of a particular scheme" (gate magazine 98/2, p.4).

Third, "consumers may use labeled products without the necessary care to avoid environmental e®ects in the use phase" (Neitzel (1998), p.15). Consumers may not understand the meaning of eco-labels completely. Eco-labels are awarded, taking some life stages into account. Therefore, if consumers use and dispose of the labeled products that are environmentally unfriendly, the eco-labelling schemes may be counterproductive.

Therefore, we cannot tell de¯nitely whether the original purpose of eco-labelling schemes has been attained or not since there are both positive and negative e®ects. There are some factors to make eco-labelling schemes function properly.

The ¯rst factor is consumer information campaign or consumer education. Neitzel (1997) emphasized the importance of this scheme by taking up an example of campaigns on how to wash environmentally sound. From this campaign it is clear that the campaigns a®ect consumers' behavior. Nitzel (1997) concluded that "the future review of environmental labeling criteria programs shall include improved and optimized consumer information and

tools on how to wash environmentally sound". In Japan, many institutions, such as Hyogo Environmental Advancement Association , have campaigned for the consumption of labeled products.

The second factor is retailers or "professional purchaser (Neitzel 1998, p12)". Eco-labelling does not a®ect consumers' behavior directly. However, eco-labels may a®ect them signi¯cantly when retailers want to stock products with eco-labels (OECD 1997, p6).

The third factor is government procurement. According to OECD (1997), total public sector procurement in Canada is more than $75 billion per year. In US and Japan, governments, institutions, and universities have been important sources for labeled products. Since the amount of government procurement, including local governments, is very large, their behavior a®ects the share of labeled products.

It may be di±cult for eco-labelling programs by itself to change consumers' behavior towards the purchasing of environmentally friendly products. However, if other schemes, such as educational program, consumer campaign, and government procurement, are concurrent with eco-labelling schemes, they work as intended.

Let us extend these e®ects into the mutual recognition. If mutual recognition is established between two countries, the share of the products awarded eco-labelling will increase in the importing country since eco-labels are a±xed to imported products which did not used to be. This gives rise to a price e®ect: "Egypt noted that mutual recognition could, for example, result in an integration of markets and the establishment of a lower equilibrium price for the labeled product. This would encourage environmentally motivated consumers to switch from unlabeled goods and generate a positive income e®ect in developing countries, thus increasing their capability to improve the environment" (WTO/CTE Bulletin No.6, p.8). Because of the increase of labeled products and the fall in the price consumers buy more labeled products. They may also become more environment conscious since they are able to acquire the information on the environment of the exporting countries.

On the other hand, consumers may be confused and become skeptical more than before since the two or more di®erent criteria are determined that they are equivalent. Or they may use and dispose the labeled products with less care than before since the labeled products in the market increase, which leads to consumers' mistake that products in the category become more environmentally friendly.

The point is that the mutual recognition also has both positive and negative e®ects. Therefore it is very important that eco-labelling schemes are enforced with other appropriate schemes as mentioned above.

3 The E®ects on Environment

In this section we concentrate on the e®ect of introduction of eco-labelling schemes and mutual recognition of them on the environment. According to a survey conducted by the Federal Environmental Agency of Germany, 56 % of companies of 296 are of the opinion that the "Blue Angel" is "very bene¯cial" or "bene¯cial" to the environment. However, OECD (1997) noted that "most eco-labelling programs are relatively recent and their environmental e®ectiveness has not been evaluated. Also, the environmental bene¯t of eco-labelled products is di±cult to di®erentiate from the environmental bene¯t achieved though other environmental measures" (p.38).

Only with respect to certain products it is possible to estimate the e®ect of eco-labelling schemes. For example, in Nordic Swan program an estimation conducted in 1995 showed that "the eco-labelling of ¯ne paper had resulted in an 11 percent reduction in sulphur emissions from Swedish pulp and paper mills, a 21 percent reduction in COD emissions and a 50 percent reduction in AOX emissions" (OECD (1997) p.48).

We can infer the e®ects by analogy with the e®ects on consumers' behavior although accurate evaluation of eco-labelling schemes will depend on many surveys carried out in the future. If consumers can know the accurate impact on the environment by consuming the products and change their behavior in favor of environment by the introduction of a eco-labelling scheme, eco-labellings are useful schemes for conservation. However, if consumers are confused and become skeptical because of the increase of the number of eco-labelling schemes, they deteriorate the environment rather than conserve.

A similar analogy holds on the e®ect of mutual recognition. Moreover, we should not overlook another essential point to mutual recognition, which is related to LCA. Generally the existing eco-labelling schemes have excluded only the non-product related PPMs. Hence they cannot re°ect the impacts both in the acquisition and the production phases. This incomplete consideration of LCA in conjunction with mutual recognition may expand the

negative e®ects. On the other hand, if each eco-labelling scheme takes into consideration the environmental impacts which cannot be identi¯ed in the product itself based on its own damages and preferences, mutual recognition works in favor of the environment, since the eco-labelling schemes give proper incentives for the environment to producers both in exporting and importing countries. The standardization of LCA has almost completed in ISO although Neitzel (1998) pointed out that the lack of standardization tools made it di±cult to recognize mutually.

4 The e®ects on International Trade

WTO members have discussed the trade e®ects of eco-labelling schemes at CTE meetings. They have focused on whether eco-labelling schemes give rise to technical barriers to trade (TBT) or not.

Canada, the EC, Argentina, India, the ASEAN countries, the United States and others noted that "the recent increase in the use of eco-labelling schemes raised concerns about transparency, unfair burdens and high competitive costs on foreign producers of like products | eco-labelling schemes could lead to protectionist abuse" (CTE Bulletin No.6, p.6). On March 1998, Colombia presented a document (WTO (1998c)), which showed that some environmental measures adopted by particular developed countries, such as eco-labelling or packaging regulations, have negative e®ects on its exports in spite of the introduction of strict environmental standard in Colombia. Moreover, Colombia insisted that "despite this e®ort towards environmental protection, Colombia's °ower sector had encountered di±culties with market access due to the fact that private organizations in certain importing countries had promoted a campaign to denigrate Colombian °owers" (CTE Bulletin No.23, p.6). Colombia proved those e®ect using data which compared the percentage change in volume of °ower exports to whole world with that to Germany (WTO (1998c), p7). Korea, Pakistan, and Egypt also noted that in some cases developing country exporters must bear "5 to 20 per cent of additional costs on exported products (CTE Bulletin No.23, p7)" in the existence of an eco-labelling scheme in the importing country.

OECD (1997) mentioned four possible points on whether circumstances potentially leading to trade concerns exist "in the absence of evidence of speci¯c trade e®ects (p.38)".

(1) The number of eco-labels developed for product groups of particular export interest to developing countries

(2) Whether the eco-label criteria developed are based on criteria related to the production, use or disposal phase of the product, since trade concerns have emerged largely because eco-label criteria are increasingly based on life-cycle analysis and more speci¯cally production related criteria

(3) The proportion of eco-labelled products manufactured or produced in foreign countries and in particular developing countries

(4) The proportion of foreign licensees which have obtained an eco-label for their products.

Take the Blue Angel for example. The criteria of the Blue Angel does not generally include the non-product related PPMs. Moreover, foreign producers form about 13 per cent of the total of producers awarded the label. This number underestimates the actual ratio of foreign producers since there exist cases in which domestic retail chains apply for the label to foreign products they import. Thus, at the present stage, the ¯rst point can be considered as the best explanation for elo-labelling schemes having the negative trade e®ects.

The industries which raise concerns about trade e®ects are textile and paper products. The EU eco-label criteria for textile industries include the environmental impacts from the use of pesticides in the growing cotton, harmful process during the production of polyester and the use of harmful substances during the processing, making up and ¯nishing of products. It is di±cult for producers in developing countries to comply with these criteria. The criteria for paper products in several eco-labelling schemes include the requirements on the ratio of recycled paper, and that of renewable resources, which can be technical trade barriers.

The key point is to what extent the criteria are based on LCA. If the criteria include the environmental impacts in acquisition and production phases, they can easily become points in dispute. The reason is that, though the environmental impacts from the same production method are di®erent between the exporting country and the importing country, which leads to the di®erence of the strictness of environmental standards, the criteria usually re°ect the impact in the importing country. Scarlett and Morris (1996) referred to this fact and attributed it to political processes, in which stakeholders in the importing country have advantage of those in the exporting country.

Now turn to the e®ects of mutual recognition. There are two positive e®ects. First, if

mutual recognition is established between countries, the cost of complying with the criteria falls, since the cost of meeting the different criteria necessitated by different schemes is likely higher than that of meeting only one set of criteria.

Second, mutual recognition is established with the full LCA, it achieves efficient resource allocation. The reason is as follows: with the full LCA the environmental impacts in acquisition and production phases not in the importing country but in the exporting country are respected.

Although mutual recognition in all categories between any two eco-labelling schemes cannot be attained in a short term, there are two substitutes: first, as in the case of Nordic Swan, which is an eco-labelling program common to Sweden, Norway, Finland, and Iceland, the criteria should be set so that a product is awarded the label if the way of producing the product complies with all relevant provisions in the legislation/laws of the place/country of production, since those laws reflect the preference of the environment in the place/country. Second, as noted by Neitzel (1998), the criteria should include the requirements on non-product related PPMs according to specific international, or regional agreed certification systems, only if they are available. Sustainable forest certification organized by Forest Stewardship Council, Codex Alimentarius complete texts on food labeling are among them.

'Prisoners' dilemma' result is worth mentioning, although it is not a problem specific to eco-labelling schemes. If one eco-labelling scheme respects another scheme by mutual recognition, they may compete in loosening their criteria on non-product related PPMs. In this case, the second effect reduces, or even nullified.

5 The effects on Investment

We may also consider positive effect and negative effects of the introduction of eco-labeling schemes on investment in EST.

The positive effect is as follows: the producers with labeled products profit more than those with unlabeled products since the eco-label puts a premium on the products. This market condition gives rise to the competition for eco-labels.. Producers have to invest more in EST to put eco-label on their products. According to the survey in Germany in 1998, "76 % of companies believe that the eco-label has increased competition for environmental

innovation in their branch (Neitzel (1998), p12)".

On the other hand, "technical options and innovations, which may be a breakthrough for future developments, and which may require support from labeling activities, may be restricted by LCA because of status-quo scenarios and present data (Neitzel (1997), p.242). Moreover, when new criteria are being developed, producers of eco-labeled products may "try to ensure that criteria favor the current technology (Scarlett and Morris (1997), p.32)" they have which also distort the direction of innovation.

In terms of international aspect, there are two factors to distort the innovation: one is about transparency and one is non-product related PPMs. The decision making process in not transparent, it costs much time and money for the producers in the exporting country to collect the information, which hinder them from investing in EST. Furthermore, if it is very difficult for the producers to comply with the criteria on the non-product related PPMs, they may also give up innovating.

Mutual recognition accelerates the positive effect since potential entrants to the market of labeled products increase, and reduce the negative effect in terms of international aspect, since the producers can collect the information and comply with non-product related PPMs more easily.

One point should be noted on mutual recognition. As GEN (1997) pointed out, mutual recognition is attained more easily when "the exporting country's environmental criteria are similar to the importing country's program requirements". We may say that the more similar technologies the two countries have, the similar requirements the eco-labelling schemes of those countries become. Therefore technology transfer from developed countries to developing countries plays an important role in mutual recognition. At CTE meetings, several countries have pointed out this point. For example, Egypt recommended that "developing countries should be provided with technical assistance to improve environmental performance (CTE Bulletin No.23)".

6 A Theoretical Analysis of Eco-labelling

In this section, we build a simple international oligopoly model that can specifically take account of the following characteristics of eco-labelling:

- Eco-labelling is voluntary and open to any producers.
- Eco-labelling may discriminate against foreign producers.
- Eco-labelling a®ects consumers' behavior.

We are particularly interested in the e®ects on the domestic economy of the introduction of eco-labelling and the domestic recognition of the foreign eco-label.

We begin with the case where there is no eco-labelling. This case is referred to as Case 0. To avoid unnecessary complication, we impose several assumptions. There are n^d domestic ¯rms and n^f foreign ¯rms. All ¯rms are identical and the numbers of ¯rms are ¯xed. Those ¯rms produce a homogeneous good with the constant marginal cost (MC) which is assumed to be zero. The production (or consumption) emits pollution that is proportional to the output (or consumption) level and damages environment. Both domestic and foreign ¯rms can abate the emission by incurring an extra MC. This MC is related to the emission level. The higher the MC is, the lower the emission level per unit. There are two segmented markets, domestic and foreign. To mainly focus on the domestic market, however, we assume that the domestic market is supplied by both domestic and foreign ¯rms, while the foreign market is supplied by the only foreign ¯rms. The ¯rms compete in quantities with Cournot conjecture in each market.

The inverse demand function of the domestic markets is given by[6]

$$P = 1 - X; \tag{1}$$

where P and X are, respectively, the price and the total demand. Variable pro¯ts from the domestic market for the domestic ¯rm (¯rm d) and the foreign ¯rm (¯rm f) are, respectively, given by

$$\pi^d = Px^d; \quad \pi^f = Px^f; \tag{2}$$

where x^i is the supply of ¯rm i $(i = d; f)$.

We can easily ¯nd the Cournot equilibrium in the domestic market:[7]

$$x_0^d = x_0^f = \frac{1}{n^d + n^f + 1}; \quad P_0 = \frac{1}{n^d + n^f + 1}; \quad \pi_0^d = \pi_0^f = \frac{1}{(n^d + n^f + 1)^2}: \tag{3}$$

[6] The essence of the main results will not change even if the demand is not linear.
[7] Subscript j denotes Case j in the following.

In the following, we consider three cases to examine the effects of eco-labelling on the domestic economy. In Case 1, the only domestic country introduces eco-labelling. In Case 2, both countries independently establish eco-labelling systems. In Case 3, the domestic country recognizes the foreign eco-label which is not recognized in Case 2.

In Case 1, eco-labelling is introduced in the domestic country alone. The domestic government sets a certain target level of emission per unit. Those firms which intend to obtain the eco-label have to incur an extra MC, c^d, to attain the target level. To capture the feature of discrimination against foreign producers, however, we assume that the eco-labelling is available to the only domestic firms. It is also assumed that any firm can produce only one type of good, i.e., either the labelled good or the unlabeled good.[8]

To reflect the effect of eco-labelling on consumers' behavior, we assume that once the eco-labelling is introduced, consumers are decomposed into two groups: those who consume the only labelled good (and never consume the unlabeled good anymore) and those who are indifferent between the labelled and unlabeled goods.[9] The share of the former consumers is γ, which is assumed to be constant.[10] That is, the domestic inverse demand for the labelled good and that for the unlabeled good are, respectively, given by[11]

$$P^l = 1 - \frac{X^l}{\gamma}; \quad P^u = 1 - \frac{X^u}{1-\gamma}: \tag{4}$$

In the following analysis, we focus on the parameter values under which $P^l > P^u$ always holds.

To capture the voluntary feature of eco-labelling, we assume that the number of domestic firms that obtain eco-labeling, n^{dl}, is endogenously determined such that the profits are equalized among the domestic firms. The profits of the domestic firm with the label are given by

$$\pi^{dl} = (P^l - c^d)x^{dl} \tag{5}$$

[8] This may be because of the presence of fixed costs.

[9] Mattoo and Singh (1994) also impose the same assumption in their analysis.

[10] It is of interest to examine the relationship between c^d and γ. This question is dealt with in Abe, Higashida and Ishikawa (2000).

[11] Superscripts l and u, respectively, denote \with" and \without" the eco-label in the following.

The domestic equilibrium in Case 1 is as follows:[12]

$$x_1^{dl} = \frac{¸(1 - c^d)}{n_1^{dl} + 1}; \quad P_1^{l} = \frac{1 + n_1^{dl} c^d}{n_1^{dl} + 1}; \quad ¼_1^{dl} = \frac{¸(1 - c^d)^2}{(n_1^{dl} + 1)^2}; \tag{6}$$

$$x_1^{du} = x_1^{f} = \frac{1 - ¸}{n_1^{du} + n^f + 1}; \quad P_1^{u} = \frac{1}{n_1^{du} + n^f + 1}; \quad ¼_1^{du} = ¼_1^{f} = \frac{1 - ¸}{(n_1^{du} + n^f + 1)^2}: \tag{7}$$

Speci¯cally, we consider two cases. One is the case where the domestic ¯rms are divided into two groups, those with the eco-label and those without the eco-label. The other is the case where all domestic ¯rms obtain the eco-label.[13] We have

$$¼_1^{dl} = \frac{¸(1 - c^d)^2}{(n_1^{dl} + 1)^2} = \frac{(1 - ¸)}{(n_1^{du} + n^f + 1)^2} = ¼_1^{du} = ¼_1^{f} \tag{8}$$

in the former case and

$$¼_1^{d} = \frac{¸(1 - c^d)^2}{(n^d + 1)^2} > \frac{1 - ¸}{(n^f + 1)^2} = ¼_1^{f} \tag{9}$$

in the latter.

The domestic prices of both labelled and unlabeled goods are higher than the domestic price without eco-labelling. With respect to the e®ect on pro¯ts, the following three cases could arise.

- All ¯rms lose from domestic eco-labelling.

  With $n^d = n^f = 10$, $¸ = 0{:}5$, and $c^d = 0{:}533333$,

  $n_1^{dl} = 6$ and $¼_0^{i} = 0{:}0022675 > 0{:}00222222 = ¼_1^{dl} = ¼_1^{du} = ¼_1^{f}$.

- All ¯rms gain from domestic eco-labelling.

  With $n^d = n^f = 10$, $¸ = 0{:}5$, and $c^d = 0{:}166667$,

  $n_1^{dl} = 9$ and $¼_0^{i} = 0{:}0022675 < 0{:}00347222 = ¼_1^{dl} = ¼_1^{du} = ¼_1^{f}$.

- The domestic ¯rms gain while the foreign ¯rms lose.[14]

  With $n^d = n^f = 10$, $¸ = 0{:}8$, and $c^d = 0{:}25$,

  $n^{dl} = 10$ and $¼_1^{f} = 0{:}0016528 < ¼_0^{i} = 0{:}0022675 < ¼_1^{dl} = 0{:}003719$.

[12] In fact, the domestic eco-labelling does not a®ect the foreign market at all in this case, because the two markets are segmented and MCs are constant.

[13] No domestic ¯rm may have an incentive to obtain the eco-label. Since this case is not interesting, we do not deal with this case.

[14] With $n^d = n^f = 10$, $¸ = 0{:}8$, and $c^d = 0{:}5$, we have $n_1^{dl} = 10$ and $¼_0^{i} = 0{:}0022675 > 0{:}0016528 = ¼_1^{dl} = ¼_1^{f}$. Thus, if $c^d < 0{:}5$, then $n^d = n_1^{dl}$ and $¼_1^{dl} > ¼_1^{f}$.

The reason why three cases are possible is that the domestic eco-labelling leads to two opposing effects on the profits. It makes the market that each firm faces smaller but the competitive pressure weaker. It should be noted that although the foreign firm cannot obtain the domestic eco-label, the foreign firm could benefit from the domestic eco-labelling system.

We now consider the effect of the domestic eco-labelling system on the environmental damage. Since we are primarily concerned with the domestic economy, we focus on the local pollution.[15] When the pollution is emitted during production, the total emission in the domestic country is given by

$$E^p = \phi(0)n^{du}x^{du} + \phi(c^d)n^{dl}x^{dl}; \quad \phi'(\cdot) < 0; \tag{10}$$

where ϕ measures the level of emission per unit of production. ϕ decreases as the MC of abatement rises. When it is emitted during consumption, on the other hand, the total emission is given by[16]

$$E^c = \psi(0)(n^{du}x^{du} + n^{fu}x^{fu}) + \psi(c^d)n^{dl}x^{dl} + \psi(c^f)n^{fl}x^{fl}; \quad \psi'(\cdot) < 0: \tag{11}$$

where ψ measures the level of emission per unit of consumption.

Since the domestic prices of both labelled and unlabeled goods are higher than the domestic price without eco-labelling (i.e. $P_0 < P_1^u > P_1^l$), $E_0^c > E_1^c$ clearly holds. However, whether E^p lowers or not is ambiguous. For example, suppose that $n^d = n^f = 10$, $\gamma = 0{:}8$, and $c^d = 0{:}25$. As we have seen above, all domestic firms obtain the label in this case (i.e. $n_1^{dl} = n^d = 10$). Then $E_0^p = \phi(0)n_0^d x_0^d = \phi(0) \pounds 0{:}4761904$ and $E_1^p = \phi(0{:}25)n_1^d x_1^{dl} = \phi(0{:}25) \pounds 0{:}545454$. If $\phi(0)$ and $\phi(0{:}25)$ are close enough, thus, $E_0^p < E_1^p$ holds. Although all domestic firms produce the labelled good, the domestic eco-labelling system makes the total domestic emission higher.[17] This is because the emission per unit of production becomes less but the total production becomes larger. This case is likely to arise when c^d is small and γ is large.

Proposition 1 Suppose that the only domestic country introduces eco-labelling. All domestic consumers face the higher prices. The foreign firm does not necessarily lose. All firms

[15] It is possible to take account of the transboundary pollution. In this case, however, the degree of damages caused by the foreign pollution is crucial for the result.

[16] c^f will be defined later.

[17] The total world emission becomes less, because the domestic eco-labelling system does not affect the foreign market.

could gain or lose at the same time. The foreign firms alone hurt only if all domestic firms obtain the label. The domestic emission is mitigated if the pollution is emitted during consumption but may be magnified if it is emitted during production.

We next consider Case 2 where the foreign country also introduces the eco-labelling system. To obtain the foreign eco-label, the foreign firm has to incur an extra MC, c^f. However, the foreign eco-label is not recognized in the domestic country. That is, the domestic consumers cannot distinguish the foreign labelled good from the foreign unlabeled good and hence regard the foreign labelled good as the unlabeled good. We assume $c^d = c^f + c$ for simplicity.

The domestic equilibrium is given by

$$x_2^{dl} = \frac{\alpha(1-c)}{n_2^{dl}+1}; \quad P_2^{l} = \frac{1+n_2^{dl}c}{n_2^{dl}+1}; \quad \pi_2^{dl} = \frac{\alpha(1-c)^2}{(n_2^{dl}+1)^2}; \tag{12}$$

$$x_2^{fl} = \frac{(1-\alpha)\{1-(n_2^{du}+n_2^{fu}+1)c\}}{n_2^{du}+n^f+1}; \; x_2^{du} = x_2^{fu} = \frac{(1-\alpha)(1+n_2^{fl}c)}{n_2^{du}+n^f+1}; \; P_2^{u} = \frac{1+n_2^{fl}c}{n_2^{du}+n^f+1}; \tag{13}$$

$$\pi_2^{fl} = \frac{(1-\alpha)\{1-(n_2^{du}+n_2^{fu}+1)c\}^2}{(n_2^{du}+n^f+1)^2}; \quad \pi_2^{du} = \pi_2^{fu} = \frac{(1-\alpha)(1+n_2^{fl}c)^2}{(n_2^{du}+n^f+1)^2}. \tag{14}$$

To make a comparison between Case 1 and Case 2, suppose $n_1^{dl} = n_2^{dl}$ for the moment. We have two cases: one is the case with $n_1^{dl} < n^d$ and the other is the case with $n_1^{dl} = n^d$. In the former case, we have $\pi_1^{du} < \pi_2^{du}$, because those foreign firms that obtain the foreign eco-label have to incur the higher MC to produce the labelled good. That is, the foreign eco-labelling system affects not only the competition in the foreign markets but also that in the domestic markets.

As a result, n^{dl} falls (i.e., $n_1^{dl} > n_2^{dl}$). This, in turn, raises the price of the domestic labelled good and decreases its total supply. It should be noted that the supply and profits of each domestic firm which still obtains the eco-label rise. As all domestic firms obtain the same profits, π^{du} and hence π^{fu} actually increase. The price of the unlabeled good becomes higher. E^c is reduced. This reduction is due to not only the decreases in the demands for both goods but also the supply of the foreign good with the foreign eco-label. Since $n^{dl}x^{dl}$ falls and $n^{du}x^{du}$ rises, E^p is likely to increase.

When $n_1^{dl} = n^d$ initially holds, n^{dl} may or may not fall. If it falls, the effects are the same as the case with $n_1^{dl} < n^d$. If n^{dl} does not alter, there is no effect on the domestic market of the labelled good. With respect to the market of the unlabeled good, P^u and ϕ^{fu} rise and ϕ^{fl} falls. E^c lowers but E^p does not change.

Proposition 2 Suppose that the foreign country also introduces the eco-labelling system, which is not recognized by the domestic country. Then ϕ^{fu} increases but ϕ^{fl} decreases. n^{dl} either decreases or remains unchanged. When n^{dl} falls, all domestic firms gain and the domestic emission decreases if the pollution is emitted during consumption but is likely to increase if it is emitted during production. When n^{dl} remains constant, the profits of all domestic firms remain unchanged and the domestic emission falls if the pollution is emitted during consumption but does not alter if it is emitted during production.

We next consider Case 3 where the domestic country recognized the foreign eco-label. We assume for simplicity that n^{fl} remains to be constant (i.e. $n_2^{fl} = n_3^{fl} = n^{fl}$).[18] Then the equilibrium in Case 3 is given by

$$x_3^{dl} = x^{fl} = \frac{\gamma(1-c)}{n_3^{dl} + n^{fl} + 1}; \; P_3^l = \frac{1 + (n_3^{dl} + n^{fl})c}{n_3^{dl} + n^{fl} + 1}; \; \phi_3^{dl} = \phi^{fl} = \frac{\gamma(1-c)^2}{(n_3^{dl} + n^{fl} + 1)^2}; \quad (15)$$

$$x_3^{du} = x^{fu} = \frac{1-\gamma}{n_3^{du} + n^{fu} + 1}; \; P_3^u = \frac{1}{n_3^{du} + n^{fu} + 1}; \; \phi_3^{du} = \phi^{fu} = \frac{1-\gamma}{(n_3^{du} + n^{fu} + 1)^2}: \quad (16)$$

To compare Case 3 with Case 2, suppose $n_3^{dl} = n_2^{dl}$ for the moment. ϕ^{du} and ϕ^{fu} rise but ϕ^{dl} falls, because the total number of firms in the domestic market of the labelled good increases and that of the unlabeled good decreases.

Again, we examine the two case: $n_2^{dl} < n^d$ and $n_2^{dl} = n^d$. With $n_2^{dl} < n^d$, n^{dl} clearly falls. We first show

Lemma 3 If $n_2^{dl} \geq n^{fl}$, then the decrease in n^{dl}, $-\Delta n^{dl}$, is less than n^{fl}.

Proof: Suppose in contradiction that $-\Delta n^{dl} \geq n^{fl}$. Then $\phi_3^{dl} \geq \phi_2^{dl}$ and $\phi_3^{du} < \phi_2^{du}$ hold, because the domestic firm does not need to incur c anymore when it decides not to obtain the label. Since $\phi_2^{dl} = \phi_2^{du}$ and $\phi_3^{dl} = \phi_3^{du}$ hold in equilibrium, this is contradiction. (Q.E.D.)

[18] This could be the case if the domestic markets are very small relative to the foreign ones. Even if n^{fl} is endogenously determined, the essence of the following analysis will not change.

The lemma implies $n_3^{dl} + n^{fl} > n_2^{dl}$. Thus, $¼_3^{dl} = ¼_3^{du} = ¼_3^{fu} < ¼_2^{du} = ¼_2^{dl} = ¼_2^{fu}$ holds. The e®ect on $¼^{fl}$ is not clear. Both P^l and P^u fall. E^c becomes higher, but E^p may or may not become higher.

It should be noted that if n_2^d n^{fl}, the domestic labelled good may completely be replaced by the foreign one, i.e., $n_3^{dl} = 0$ may hold. The larger n^{fl} is, the more likely this is to occur. If this is the case, P^l decreases while P^u may increase. When it does increase, $¼^{du}$ and $¼^{fu}$ also increase. The e®ect on E^p is ambiguous. E^c increases if P^u does not rise but may decrease if P^u rises.

With $n_2^{dl} = n^d$, the recognition of the foreign label may not decrease n^{dl}. If this is the case, P^l falls but P^u rises. The recognition reduces $¼^{dl}$ but raise $¼^{fu}$. Since the output of each domestic ¯rm lowers, E^p falls. The e®ect on E^c is not clear.

Proposition 4 Suppose that the domestic country now recognizes the foreign eco-label which it has not recognized. The price of the labelled good falls. n^{dl} either decreases or does not change. With $n_3^{dl} = 0$, the e®ects on the pro¯ts and emission level are ambiguous. With $0 < n_3^{dl} < n^d$, the domestic ¯rms lose and the domestic emission rises if it is emitted during consumption. With $n_3^{dl} = n^d$, the domestic ¯rms lose and the domestic emission falls if it is emitted during production.

We can easily compare Case 1 with Case 3. This corresponds to the situation in which the domestic country recognizes the foreign eco-label as soon as it is established. Again, n^{dl} either decreases or does not change. The following three cases are possible. First, $n_3^{dl} + n^{fl} = n_1^{dl}$ holds if n^{fl} $n_1^{dl} < n^d$. That is, the number of the foreign ¯rm that obtain the eco-label is equal to that of the domestic ¯rm that stops obtaining the eco-label. If this does not hold, $¼_3^{dl} = ¼_3^{du}$ does not hold, either. With $n_3^{dl} + n^{fl} = n_1^{dl}$, the foreign eco-labelling does not a®ect the prices and pro¯ts in both markets. Although E^c is not a®ected at all, E^p obviously goes up.

Second, if $n_1^{dl} < n^d$ and $n_1^{dl} < n^{fl}$, then $n_3^{dl} = 0$. In this case, the price of the labelled good falls while that of the unlabeled good rises. Although no domestic ¯rm obtains the label, the domestic ¯rms gain. The e®ect on the emission is ambiguous whether the pollution is emitted during consumption or production.

Lastly, n^{dl} may remain unchanged with $n_1^{dl} = n^d$. In this case, the price of the labelled good falls but that of the unlabeled good rises. The domestic ¯rms lose. Since the output of each domestic ¯rm lowers, E^p falls. The e®ect on E^c is not clear.

Proposition 5 Suppose that the domestic country recognizes the foreign eco-label once it is established. n^{dl} either decreases or does not alter. With $n_3^{dl} = 0$, the price of the labelled good falls, the price of the unlabeled good rises, the domestic ¯rms gain, but the e®ect on the domestic emission is ambiguous. With $0 < n_3^{dl} < n^d$, there are no e®ects on the prices and pro¯ts at all. The domestic emission does not alter if it is emitted during consumption but rises if it is emitted during production. With $n_3^{dl} = n^d$, the domestic ¯rms lose and the domestic emission lowers if it is emitted during production.

7 Concluding Remark

In this paper, we have described various e®ects of eco-labelling programs in terms of their e®ectiveness and their relation to international trade. Furthermore, using a simple international oligopoly model, we have examined the e®ects of eco-labelling on the domestic economy. We have particularly incorporated some of the signi¯cant features of eco-labelling into the model. It has been shown that the e®ects of eco-labelling on the domestic emission crucially depend on whether the pollution is emitted during production or consumption. In particular, the introduction of eco-labelling or the recognition of the foreign eco-label could increase the local emission. Moreover, even if the foreign ¯rms cannot obtain the domestic eco-label, this does not necessarily mean that the foreign ¯rms lose from it.

In this study, we consider a situation where the domestic country establishes the eco-labelling system before the foreign country does. One may think of other situations. However, we can now easily examine other cases, since we have provided the basic intuitions.

References

Abe, K., K. Higashida, and J. Ishikawa, 2000, \Eco-labelling under International Oligopoly", mimeo.

GEN, 1999, GEN discussion paper on enhanced co-operation, GEN.

Mattoo, A., and H. V. Singh, 1994, \Eco-labelling: Policy Considerations", Kyklos 47, 53-65.

Neitzel, H., 1997, LCA and ecolabelling: application of life cycle assessment in environmental labeling, German experiences,

Neitzel, H., 1998 a, 20 years of experiences of the German environmental labeling scheme: "Blue Angel", Updated version of a presentation, given at the Consumer's Choice Council Conference "Labelling for a sustainable and just world", 24-25, Washington, DC.

Neitzel, H., 1998 b, Applying non-product related criteria in eco-labelling: some controversies and experiences, Gate magazine 98/2.

OECD, 1997, Eco-labelling: Actual e®ects of selected programs, OCDE/GD(97)105.OECD.

Scarlett, L., and J. Morris, 1996, Green groceries: consumers, product labels and the environment, Publication by Reason Public Policy Institute (http://www.rppi.org/)

WTO, 1995, CTE Bulletin No.6.

WTO, 1996 a, CTE Bulletin No.8.

WTO, 1996 b, CTE Bulletin No.11.

WTO, 1997, Eco-labelling: overview of current work in various international fora, WT/CTE/W/45, WTO.

WTO, 1998 a, CTE Bulletin No.18.

WTO, 1998 b, CTE Bulletin No.23.

WTO, 1998 c, Environmental labels and market access: case study on the Colombian °owergrowing industry, WT/CTE/W/76, G/TBT/W/60 (Colombia).

Zarrilli, S., V. Jha, and R. Vossenaar, 1997, Eco-labelling and international trade, MacMillan Press, London.