A Framework for the Environmental Assessment of the NAFTA

JeongDai Kim
(jdkim@utdallas.edu)

School of Social Sciences
University of Texas at Dallas

ABSTRACT

This paper provides an overview of the issues involved in modeling the environmental effect of the NAFTA with dynamic general equilibrium approach (DCGE). Given most approaches so far regarding the NAFTA and environment are journalistic discourses or anecdotal reports, the environmental assessment of the NAFTA with DCGE approach still need to explore many unprecedented problems. First, the study needs to identify the way to incorporate the income effect, environmental effect and their interactions in a model. Second, the DCGE approach requires the methodological robustness on how the various level of pollutions – local, regional (= transboundary) and global range of pollutions can be incorporated in multi-regional DCGE model. Third, given anticipatory behavior the starting point of the NAFTA should be considered as a part of sensitivity test.

As a natural extension of discussions about each of problems above, I try to locate the above problems in the conceptual flow of DCGE approach so that hopefully I can illustrate how the problems are related not only to each other but also to other general equilibrium concepts. The conceptual clarification and understanding of environmental variables in DCGE modeling will contribute to the advance of systematic analysis of the environmental effect of the trade liberalization in general and the NAFTA in particular.

1. INTRODUCTION

This paper suggests a framework to assess the environmental effect of the North American Free Trade Agreement (NAFTA) in the context of dynamic general equilibrium approach. While journalistic and anecdotal discourses are readily available, the comprehensive assessment for the environmental effect of the NAFTA has been rarely documented. For instance, among the papers presented in the first symposium on the linkages between trade and environment held in October 11-12, 2000 by the Commission for the Environment Cooperation (CEC) under the NAFTA regime, only Reinert and Roland-Holst (2000) reported the preliminary results for the industrial pollution impacts of the liberalization in tariffs and non-tariffs barriers under NAFTA. Even that study only deals with the effect of trade liberalization, leaving out the effect of environmental provisions including the side accord.

To be a comprehensive assessment, the model should incorporate the regional trade liberalization and environmental provisions[1] together. Under the assumption that the trade agreement increases economic activities, the trade agreement may increase the pollution through the increased economic activities. However, if the increased economic activities have positive impact on income, the concern about the environment may also become stronger (income effect). Based on the environmental concerns, each country decides the level of environmental regulations or taxations. On the other hand, these domestic polices are conditioned by the NAFTA environmental provisions. The

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[1] Explicitly or implicitly, there have been a few perspectives on the environmental provisions in the NAFTA. First, they are by-products of NAFTA negotiation and the actual effect, by their design, is marginal. Second, they are forms of non-tariff barrier, which protect job transfer and capital exodus, especially from the U.S. to Mexico. Third, they actually protect environmental degradation by monitoring and supervising the enforcement of the environmental law and the environmental effect of trade and production in each member country.

provisions are believed to floor the minimum level, which, in turn, affects other economic activities. As a result, the equilibrium could end up with either aggravated pollution problem or the environment cleaner than before the trade agreement being implemented. But the linkage between the regional trade agreement (RTA) and income, as well as between income and environmental concerns has never arrived an agreement in economic researches.

Section two provides an overview of literature on the linkages between regional trade liberalization and welfare, and between trade and environment. At the end of Section two, a conceptual flow chart will be presented as a synthesis of the literature. Section three discusses the NAFTA regimes focusing on the main elements that should be considered in general equilibrium modeling. Section four concludes this paper with discussions on the equilibrium concepts and calibration methods.

2. TRADE LIBERALIZATION, WELFARE, AND ENVIRONMENT

David Ricardo's comparative advantage theory and Adam Smith's illustration of pin production had backed the argument that trade improves the efficiency and welfare, which means not only fewer resource usage, less waste production and, thus, less emission of the pollution than in the case of the same amount of total production without trade but also the more production of welfare that may be used for cleaning the environment. Thus, the environmental regulations might paradoxically block out the opportunity to improve the environment as well as the welfare by distorting the trade condition.

When the general argument above goes down to the RTA system where groups of counties are preferential to members and discriminative to non-members, the question evolves from the comparison of autarky with trade to the comparison of the various forms of trade system – CU vs. FTA or RTA vs. WTO. But the question still is whether or not an RTA can create more welfare and efficiency and whether or not an RTA affects the environment through the income effect as well as through the changes in economic activities. The former does not take account of the environmental effect but is about whether or not an RTA actually brings any changes in the level or to the distribution of the welfare among the signatory countries and the rest of the world. The latter is whether or not RTA causes the changes in the total and the distribution of the pollution among countries.

2.1 Welfare Effect: Vinerian and 'New' Trade Theory

Srinivasan (1998), Panagariya (1998), and Bhagwati and Panagariya(1996) have maintained the idea of Viner (1950) that the welfare change in participating RTAs depends on the relative size of trade creation and trade diversion.[2] When the rest of the world is the least-cost supplier and faces constant costs, an RTA with the supplier who faces high and increasing costs can only divert trade. As a result, the liberalizing country loses because the reduction of tariff revenue is greater than the welfare gain from RTA compared to pre-RTA participation. On the other hand, if the customs union member is the least and the constant-cost supplier, RTA participation improves welfare in the

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[2] Trade creation is a shift in product origin from a high-cost domestic producer to a lower-cost member producer. Trade diversion is a shift in product origin from a low-cost nonmember to a high-cost member producer.

liberalizing country since it benefits from reduced price while it still yield tariff revenue from non-member countries.

However, Panagariya (1998) excludes the latter case in his model, arguing that usually the rest of the world is constant-cost supplier not the member country of an RTA. As a result, an RTA, e.g., the NAFTA ends up with the welfare loss for the country with high initial tariffs, e.g. Mexico. In other words, Panagariya treats it as an exogenous factor determined by the modeler whether or not the member country is the constant-cost supplier, and the answer to the question whether or not an RTA results in welfare gain is mainly driven exogenously not in endogenous manner. Therefore, in this sort of model, what matters is the magnitude of trade diversion instead of allowing the trade creation as well as the trade diversion.

De Melo et al. (1993) endogenize the 'constant-cost supplier' and set up a model that allows both trade creation and trade diversion. In his model, the country that lowers its barriers against a trade partner faces a new domestic price, which is lower than the tariff-inclusive mark-up over the constant cost supplier (the rest of the world) but higher than the free trade price. In this setting, the gains from an RTA becomes greater as the initial tariff on a given sector is higher, the post-RTA tariff on non-union countries is lower, and the complementarity in import demands between the union partner is higher. This implies that there are large gains from an RTA between developed and developing countries – such as the U.S. and Mexico – which have different factor endowments. According to De Rosa (1998), who utilizes Meade's model that allows both international and domestic relative prices to adjust in a general equilibrium framework, if a country entering an RTA increases imports from all sources, its welfare will improve. Robinson

(1999) interprets De Rosa's point as "the formation of an RTA in an environment of continuing multilateral liberalization may well have different welfare implications than forming an RTA in an increasingly protectionist environment." But De Rosa's application of Meade's model simply confirms that lowering import barriers improves the welfare in static & partial equilibrium model, which, in turn, comes back to the importance of multilateralism rather than the efficiency of RTA.

A group of researchers depart from the Vinerian – trade creation vs. trade diversion – framework. They claim that Vinerian approach is inappropriate by pointing out the features of 'new' regionalism – not much of trade liberalization but rather deep integration such as capital liberalization and even currency unionization. Also, this group has employed Computable General Equilibrium (CGE) models to take account of market structure, i.e., imperfect competition, and trade externalities such as increasing returns to scale or the efficiency improvement, which have been ignored in partial equilibrium model such as Vinerian approach.

At the early stage of international trade modeling, static CGE models were the main tools. Especially early NAFTA analyses with CGE, inherited from the analyses of U.S.-Canada FTA by Harris (1984), and Brown and Stern (1989), stressed sectoral details but ignored dynamic phenomena that involve labor force adjustment and capital flows, which are crucial in assessing the impact of NAFTA. First, static models set the world supply of capital to the level available in pre-RTA state. Thus, welfare gain, which is at the heart of trade diversion vs. trade creation framework, from capital movement is considered only through the reallocation of capital, ignoring the efficiency effect of capital accumulation. Second, related to the first, static models have difficulty in dealing

with the international trade of financial assets. Because the NAFTA involves one large economy (U.S.) and two small economies, the changes of the returns to scale and market size are crucial for both of Canada and Mexico, and for Mexico with lower per worker production, the trend of capital flow is also crucial. The effort to capture the trend of market structure and capital flow typically emerged from the dynamic computable general equilibrium (DCGE) model because a DCGE allows the update of capital accumulation and the change of market structure.

The research on RTAs that explicitly considers the change of capital flow, labor adjustment, the change of market structure (competition), and technology effects (returns of scale) has been termed 'new trade theory' (Robinson and Thierfelder 1999). New trade theory assumes that participating in RTAs encourages more competition and permits firms to pursue economies of more efficient specialization and location of capitals. Robinson and Thierfelder (1999) characterize the new trade theory as Smithian approach in the sense that it argues the increase of trade does not necessarily occur in sectors where factor proportions are different among countries (Ricardian approach), but efficiency gains from increased trade in RTAs arise from the economies of scale in more efficient specialization (division of labor, e.g., pin production in Smith's example). Kehoe (1995), and Kouparitsas(1997) incorporate dynamic elements, and demonstrate that the overall result of the simulations with DCGE models shows that all three member countries of the NAFTA stand to gain from it.

In addition to the advantage of DCGE that captures the features of 'new' regionalism, it can also report the 'path' of adjustment to the shock. But as to that 'path' in open economy, there have been two unsolved anomalies between the theory and the

data as Kehoe (1995) conceptualizes them as the quantity anomaly and the price variability anomaly. The quantity anomaly is the discrepancy between the theories assuming the cross-country consumption correlation is higher than cross-country output and the actual data indicating the opposite. The price variability anomaly is that the terms of trade are more volatile in the data than the theory suggests. These anomalies have not been successfully compromised in DCGE model even after all the works by Hess and Shin(1997), Baxter and Jermann (1997), and Stockman and Tesar (1995).

2.2 Environmental Effect – Composition, Scale and Technical Change

Grossman and Krueger (1991, 1993) suggest decomposing the environmental impact of trade into three interacting elements — a composition effect, a scale effect, and a technique effect. The composition effect is a specialization effect so that each country can gain efficient production in a smaller range of production compared to the pre-trade liberalization. The net effect on the local environment can be either positive or negative, depending on the specialized production sector's pollution intensity. The scale effect is the change of the pollution level caused by the change in overall economic activities affected by the trade liberalization. According to the Vinerians, the scale effect is not always positive, considering the trade diversion. The technique effect is the reduction of pollution per unit production under the new environmental standard corresponding to the changes in income level.

Martin (1999) adds the policy interaction and the technology transfer to the considerations of Grossman and Krueger so that models should consider: 1. the impact of trade liberalization on the total output and composition of the output, 2. the impact on the

costs of abatement, 3. the impacts through technology transfer, and   4. regulatory policy interactions.   The technique effect in Grossman and Krueger is analogous to the cost abatement effect in Martin, but the cost abatement effect is not pre-assumed to come from the changes in the preference for the environment as Grossman and Krueger do. Martin stresses the identification of policy instruments that affect the impact of RTAs not only because various trade policies have differentiated the impact on the sectoral outputs that affect the environment but also because recent RTAs accompany the provisions for investment and technology transfer that affect the capital movement and, ultimately, the environment.

Copeland and Taylor (1994) incorporate the decomposed elements in their North-South model.   In the model, there are two countries – North (developed countries) and South (developing countries), and a range of goods with inherently different pollution intensities.   The model assumes that pollution problems are local, that is, there is no transboundary effect, and that both governments exercise pollution taxes in order to control the pollution: North sets higher tax rates backed by the preference for the cleanness, which is induced by higher incomes. South has lower tax rates because the preference for the clean environment is weaker than in North.   In the model, the composition effect mitigates pollution in North and increases it in South because of the higher standard in North and the lower standard in South.   The polluting industries contract in North and expand in South unless South and North have balanced growth so that the environmental standard rises in tandem and the industrial composition remains unchanged. The scale effect and the technique effect cancel each other. The study shows that the technique effect could neutralize the scale effect in North.   But it cannot

neutralize both of composition and scale effects in South that has comparative advantages due to lax environmental standards. One of the key findings of the study is that the total pollution can be decreased if South grows faster than North, and increased if North grows faster than South. Therefore, trade liberalization that leads to fast growth of South can be beneficial to the global environment. But the locality of pollution assumed in the study does not provide any intuition about the global nature of some pollutants such as CO_2, transboundary gases or particles.

Copeland and Taylor (1995) present another model that takes the environment at a global scale. They assume that the emissions of CO_2 are limited by self-imposed national quotas with nationally tradable emissions permits. In this setting, the trade liberalization between North and South induce the polluting industries in South and clean industries in North (composition effect). Consequently the market price of pollution permits will fall in North and rise in South since less polluting industries in North do not have to use the permits so much as polluting industries in South. The optimal response of South to the change in the market price of the pollution permits is to increase the number of permits to accommodate the more polluting composition of the national output. Likewise, North's best choice is to call in some of the emissions permits at home in order to offset the effects of South on the global environment. But unless the offset is 100 per cent, the trade equilibrium will be higher emissions in the global scale than before the trade liberalization.

Chichilnistky (1994) argues that property rights have been neglected in the literature on the economics of environment and trade. If environmental externalities can be solved by establishing the property rights for the environment as the Coase theorem

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(1960) points out, the stricter standard for the environment in developed countries may come from the well-defined property rights, and lax standards in South may boil down to the poorly defined property rights. Chichilnisky shows that the different degree of the property rights among identical regions can create a trade flow based on comparative advantages over the polluting industries. South is assumed to have a comparative advantage in natural resource extraction because of ill-defined property rights and is specialized in resource-intensive goods to a greater extent that it would have been, otherwise.

The arguments of Copeland and Taylor (1994, 1995), and Chichilnisky (1994) are based on the comparative advantage theory in explaining the trade. According to them, the difference in the environmental standards generates the comparative advantages in the less polluting industries in North and the more polluting industries in South, *ceteris paribus*. But the comparative advantage in actual trade is not determined solely by environmental standards. The classical theory of trade focuses on the labor-capital ratio, and the developed countries are assumed to be abundant in capital compared to the developing countries. Thus, if the capital-intensive industries are more likely to produce the pollution, their arguments can be supported only when the pollution-abatement costs reverse the comparative advantage between North and South, but it is questionable. (Nordstrom and Vaughan 1999)

Next, their model analyzes the simplified North-South situation and the only difference between North and South is in environmental standards. But in the context of the RTAs, the model should be able to distinguish the impact on the signatory countries and on the rest of the world. For instance, countries are not equally ready to control the

various gases with equal weight. Even the developed countries may be less willing to pay the abatement costs for the gases that reach a global scale such as carbon dioxide (CO_2), compared to other gases such as sulphur dioxide (SO_2) and nitrogen oxide (NO_x) that are directly harmful to the host country and the close neighborhood countries. Thus, even though the signatory countries maintain the high standard for the regional environment, it is still possible that an RTA produces more global gases than would produce without the RTA. To assess this problem, it is necessary to utilize a global model that includes not only the signatory countries but also the other countries (or the rest of the world).

2.3 Framework of the System

As a summary of above discussions the linkages of RTA to welfare and environment, Figure 1 captures the conceptual relationships in a systematic way.

Despite the discussions that the settlement of an international agreement is contingent on the political economy of each country, the trade agreement is treated as exogenous since this study is not about the motivation of the trade agreement but the impact of it. In addition, given that purpose, the endogenous elements are not critical unless the agreement is re-negotiated in the course of implementation.[3] Once a trade agreement becomes effective that deals with the labor and environment standards, the schedule of the tariff and non-tariff barrier reduction, and the change of the investment
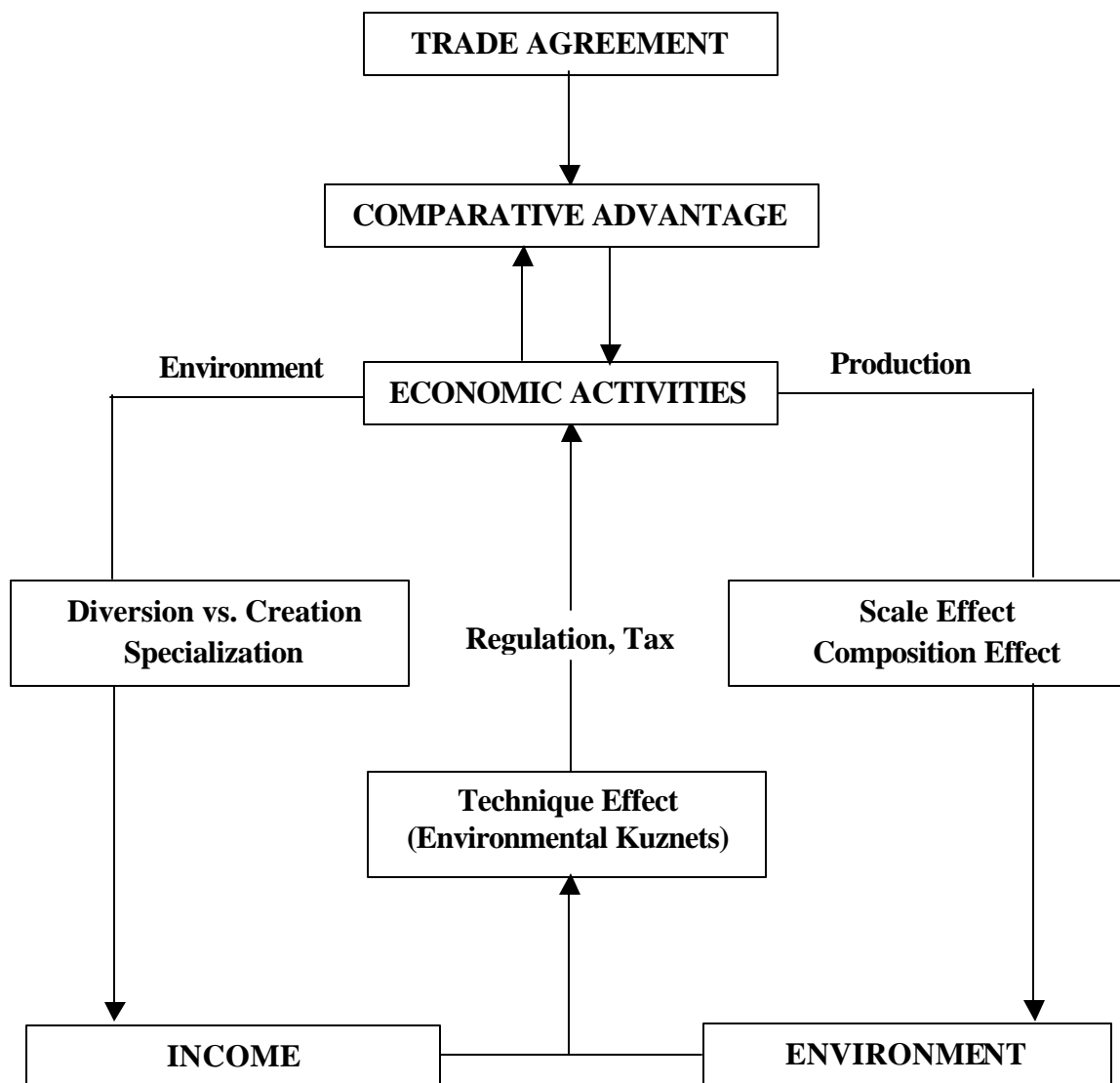
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[3] In a microscopic sense, this is not an accurate statement because each member country might choose a specific path, e.g., a tariff reduction schedule allowed in the agreement, or re-interpret the agreement itself corresponding to its political economy, which involves more complicated dynamic process. But it is out of the scope in this study.

and technology transfer routines, it changes the terms of trade and investment that have an influence on the comparative advantage of each country and each sector.

Figure 1

Conceptual Framework of the System

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                    ┌──────────────────────────┐
                    │    TRADE AGREEMENT       │
                    └──────────────────────────┘
                                 │
                                 ▼
                    ┌──────────────────────────┐
                    │  COMPARATIVE ADVANTAGE   │
                    └──────────────────────────┘
                             ▲    │
                             │    ▼
  Environment      ┌──────────────────────────┐      Production
   ──────────────  │   ECONOMIC ACTIVITIES    │  ──────────────
  │                └──────────────────────────┘                │
  │                            ▲                                │
  │                            │                                │
┌─────────────────┐    Regulation, Tax     ┌─────────────────────┐
│ Diversion vs.   │           │            │   Scale Effect      │
│ Creation        │           │            │   Composition Effect│
│ Specialization  │           │            │                     │
└─────────────────┘           │            └─────────────────────┘
  │                ┌──────────────────────────┐                  │
  │                │   Technique Effect       │                  │
  │                │ (Environmental Kuznets)  │                  │
  │                └──────────────────────────┘                  │
  │                            ▲                                  │
  ▼                            │                                  ▼
┌─────────────┐         ┌──────┴──────┐          ┌──────────────────┐
│   INCOME    │─────────┤             ├──────────│  ENVIRONMENT     │
└─────────────┘                                  └──────────────────┘
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The changes in the comparative advantages affect the foreign trade – export and import of goods, the location of investment (capital movement) and the technology transfer. All these economic activities can be summed up to the production and environment aspects as indicated by the left and right arrows in Figure 1. The effect of the changes in comparative advantage does not necessarily lead to an increase in trade or welfare of each member country. First of all, the variation across the industrial sectors may or may not increase the total trade even though each country becomes more specialized in narrower range of products. Second, although the total trade increases because of the trade agreement, it does not necessarily mean the increase in welfare as argued by Vinerians. An RTA may have greater trade diversion than trade creation.

Horizontally, the scale effect corresponds to trade diversion or trade creation at the level of total production and its growth, while the composition effect corresponds to the specialization and the location of investment at sectoral level. But these horizontal correspondences hold only on the given technique effect that regulates the introduction of clean technologies based on the environmental preference driven by the income level. Since it comes through the changes in regulations and environmental standards, the technique effect has an influence not only on economic activities such as production but also on the comparative advantages. Also, note that domestic and international politics are involved with the technique effect through the changes in regulations and environmental standards, although the political elements are not modeled in this study.

The systematic framework depicted in Figure 1 provides a conceptual basis in modeling the environmental effect of RTA. But for the frame work to be utilized in

NAFTA models, the specific features of the NAFTA should be additionally considered, which is the main focus of the next section.

3. THE NAFTA SPECIFICS

3.1 Tariffs and Non-tariff Trade Barrier (NTB) Reduction Schedule under NAFTA

NAFTA represents a regime of North American integration as well as an agreement that is a part of NAFTA regime. NAFTA regime is composed of three trinational (Canada, Mexico, and the U.S.) and one binational agreements – North American Free Trade Agreement (NAFTA), the North American Agreement for Labor Cooperation (NAALC), the North American Agreement for Environmental Cooperation (NAAEC), and the Agreement for Border Environment Cooperation and North American Development Bank between Mexico and the U.S. All four agreements became effective on January 1, 1994, and initiated the first regional trade agreement with explicitly incorporated environmental concerns. According to the agreement, five supranational institutions were established -- the Commission for Free Trade (CFT), the Commission for Labor Cooperation (CLC), the Commission for Environmental Cooperation (CEC), the Border Environment Cooperation Commission (BECC), and the North American Development Bank (NADB).

The main focus of NAFTA regime is to remove not only tariffs but also non-tariff barriers through domestic rules of each country. Over 15 year period, all tariffs, except for diary, eggs, poultry and some items in sugar, are phased out at varying rates among industries and signatory countries. In implementing the schedule, supranational

institutions do not have any enforcement power, but monitor and recommend the NAFTA rules. This is one of significant differences from European Union (EU) where signatory countries follow the supranational bureaucratic system. Also, unlike EU, a Customs Union by which signatory countries charges a common set of tariffs to the rest of the world, the NAFTA is a Free Trade Area (FTA) that allows the mutual free trade among signatory countries but lacks a common tariff system for the rest of the world.

In modeling perspective, the first issue is the time we claim as the 'starting' point of the NAFTA. Even though the regime became in effect on January 1, 1994, considering anticipatory behavior, researches take various starting points between 1990 to 1993. But no study takes the starting point as a part of sensitivity test. Second, one of the advantages of DCGE over static CGE is its capacity to model the tariff phase-out schedule. But non-tariff barriers (NTBs) are much more complicate since many NTBs are industry specific, their administration is diffused across a variety of government departments and agencies, and it cannot be measured in a regular basis. Thus, NTBs are transformed to tariff equivalence and assumed to be phased out with the same rate of tariff reduction in the industry.

3.2 Environmental Provisions in NAFTA main text

In the main text of the NAFTA agreement there are provisions regarding environmental protection. Article 104 provides partial protection for the three other major environmental treaties -- Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, and the Montreal Protocol ozone

treaty -- in the case of the NAFTA conflicting with them. Article 1114 is called the protection from competitive deregulation, because it discourages the parties from deregulating the environmental standards in order to attract the investment. It states, "... it is inappropriate to encourage investment by relaxing domestic health, safety or environmental measures. Accordingly, a party should not…or should not offer to...lower standards to attract investment." This measure was aimed at stopping competitive deregulation, even though it was not mandatory.

In the main text of the NAFTA agreement, there are also environment-related provisions. Domestic laws including domestic environmental laws are protected by 'Sanitary and Phytosanitary Measures' (chapter7B) and 'Standards Related Measures' (chapter 9). Especially, Article 754 and Article 904 describe the right of each country to choose its own level of protection in the areas related to safety, the protection of human, animal and plant life and health, the environment, and consumers, and measures to ensure their enforcement or implementation. But the level of protection is not used for the discrimination against imported products, and should not create an unnecessary obstacle or restriction to trade between parties.

Even though the NAFTA main text contains environmental provisions, there is neither plan of implementation nor detailed enforcement provisions for them. The environmental side accord is often assumed to provide the path to implementation.

3.3 Environmental Side Agreement

The North American Agreement on Environmental Cooperation (NAAEC) is composed of a preamble and 51 articles divided into seven parts. From modeling

perspective, the core of this agreement is part five: Consultation and Resolution of Disputes. Under Part V, there are three provisions to resolve environmental disputes: (1) investigations of controversial issues initiated by the Secretariat under Article 13, (2) submissions by non-governmental organizations (NGOs) and individuals under Article 14 and 15, and (3) governmental initiated consultations regarding enforcement.

The Secretariat has the authority under Article 13 of the NAAEC to investigate and develop recommendations on controversial environmental matters that are of broad importance to the region. However, Article 13 studies cannot address issues involving whether a party has failed to enforce its environmental laws and regulations.

Under Article 14, any person or nongovernmental organization can submit a complaint to the Secretariat that the government of another party fails to enforce its trade-related environmental laws. Following specified criteria and guidelines, the secretariat would then consider how to proceed. After all the processes, if the government still takes no measure to correct the violation, a fine could be imposed on the offending government up to 0.007 percent of total trade in goods between the Parties during the most recent year for which data are available. (Annex 34 of the environmental side accord). In the eventuality that this government continued neither to enforce its environmental laws nor pay the fine, it could be subjected to a limited suspension of NAFTA's trade benefits.
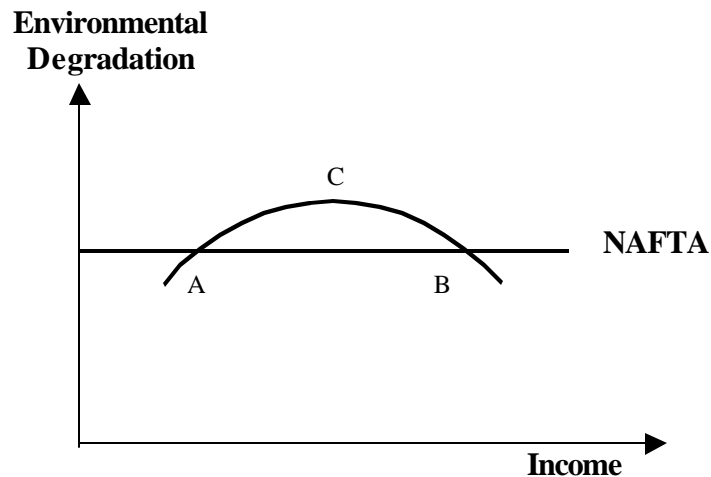
3.4 Modeling Environmental Provisions

The core of environmental provisions in NAFTA is the prevension of competitive deregulations, which designates the environmental standard of each country in 1994 as

the minimum floor.   Related to the environmental Kuznets curve (Stern et al. 1996),

Figure 2 shows the possible role of the provisions.

Figure 2

**<u>Environmental Kuznets Curve and NAFTA</u>**

Suppose the inversed U shape curve is an environmental Kuznets curve, which

depicts the equilibrium path.   Note the environmental provision set each country's 1994

environmental standard as a floor.   The straight line in the Figure indicates a possible

environmental standard floor.   Unless the country is at the worst environmental situation

(C in Figure 2), the signatory country is at either at A or B in 1994 and the floor would

become a constraint as income grows (at A) or decreases (at B).   This constraint does not

limit the total amount of pollution emission but it is a regulatory floor.

Another implication of the Kuzenets curve is that the higher the representative household income, the higher the marginal rate of substitution of non-environmental good for environmental good[4] as shown in Figure 3.

Figure 3

The Existence of Kuznets Curve and Indifference Curve
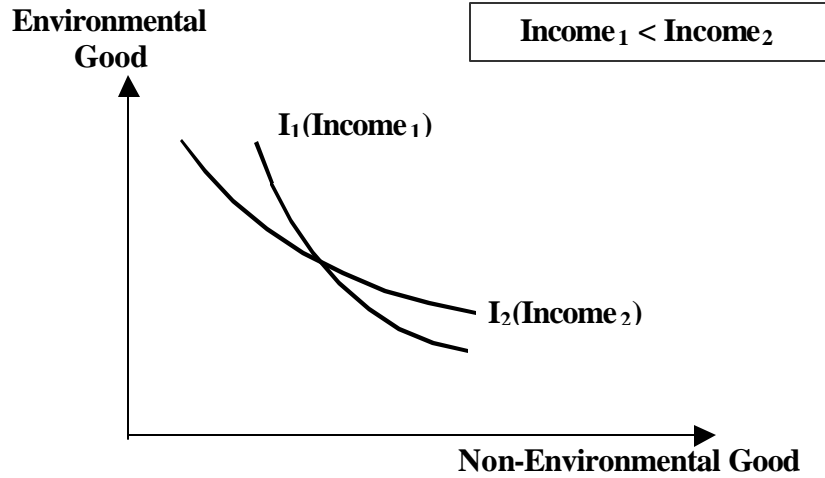
To utilize this implication in representative household's utility function, suppose the utility function is given as:

$$U = \sum_{t=0}^{\infty} \boldsymbol{b}^t U(c_t, h_t)$$

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[4] Environmental good is defined as the environmental benefit, which is the negative of the pollution.

where b^t, c_t and h_t are a subject rate of time discount ($0 < b < 1$), consumption and leisure, respectively. Consumption is aggregated with a constant elasticity of substitution $1/\eta$ so that,

$$c_t = (wc_t^{1-h} + (1-w)e_t^{1-h})^{\frac{1}{1-h}}$$

where c_t is consumption of non-environmental (durable and nondurable) goods, e_t, environmental goods, w proportion for c_t . Then, the benchmark value of η is lower in high income country then in low income county.

3.4 Border Environment Commission and North American Development Bank

In October 1993, to strengthen bilateral cooperation along their border, Mexico and the United States entered into the "Agreement Between the Government of the United States of America and the Government of the United Mexico States Concerning the Establishment of a Border Environment Commission and a North American Development Bank. This bilateral agreement is a solution for the earlier border plans as well as a response to the environmentalist demands conditioned to the NAFTA support. The Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADB) are supposed to provide additional ways for two governments to solve the border environmental problem between the U.S. and Mexico with more concrete funding and work plan.

3.5 Levels of Pollutions and Roles of BECC and NADB

There are three levels of pollutions with respect to their range of effect. Local pollutants do not cross over the country boundary so that they can be considered as a country-wide public good but they are not a significant agenda in international trade agreement (e.g., particles). There are two levels of transboundary pollutants. Regional pollutants actually cross the country boundaries but are not significant in global scale (e.g., acid rain in EU or Canada-U.S boundary) while Global pollutants draws global concerns (e.g., Freon gas, CO2).

Figure 4

Roles of BECC and NADB
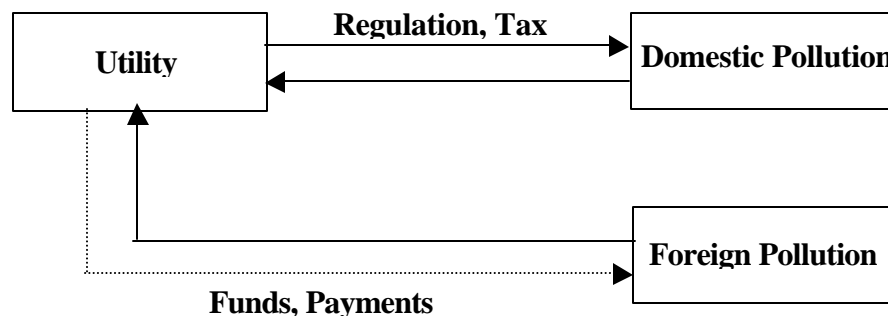
The environmental provisions in NAFTA main text and side accord do not recognize the pollution with regard to the level of effect range but concerns mainly about the competitive deregulations, while BEEC is about boundary pollutions. But the model that

takes account of the utility of pollution should also incorporate the domestic and transboundary pollutions separately so that $e_t := e_{dt} + \delta e_{ft}$, where e_{dt} is domestic environmental goods, e_{ft} is foreign environmental goods, and δ is diffusion coefficient.

Then, the model using the assumption that domestic environmental regulations are backed by the marginal utility of pollution should be refined further. Even though the marginal utility is affected by the foreign transboundary pollution as well, there is no inherent mechanism of regulating the foreign pollution unless the international agreement is endogenized (above figure). In such a system, the growing disutility for the pollution, even it is because of increasing foreign transboundary pollution, results in strengthening the domestic regulations only. But the Border Environmental Cooperation Commission (BEEC) and the North American Development Bank (NADB) play a role in transfering the reaction of domestic household's utility to foreign pollution. By providing the environmental cleaning fund through BEEC and NADB, one country can react to the other member country's pollution. For instance, the U.S may supply fund to clean the Mexican pollution as long as the payment is less than the cost for cleaning the domestic environment to improve the same level of utility. This mechanism can explain why developed countries provide funds for cleaning the pollution in developing countries or preserving the forests (e.g., Amazon forest). Thus, in general equilibrium model, we need to put a fund transfer system based on the willingness to pay to the foreign transboundary pollution. Domestic household first, compare the costs for unit domestic and diffused foreign pollution abatement, and decide whether to pay tax for domestic environment or transfer for foreign environment.

3.6 Model Structure

Figure 5 puts together the discussions in Section 2 and 3 – modeling frame of RTA in general and the specifics of NAFTA.[5] The NAFTA main text is considered for the scheduled liberalization of tariffs, NTBs and investment, while the environmental provisions are considered as a standard floor that prevents the competitive deregulation.

As to number of regions in the model, the question boils down to how to specify the rest of the world (ROW). One possibility is to specify each of all countries so that there is no 'ROW' residual. Although this specification is superior in the sense that the model can show the NAFTA effect on each country, the model will become enormous in its size and data intensive. Second possibility is to specify the ROW as a quasi-country. The advantages of this specification are: First, since the U.S. economy has a significant influence on the rest of the world, it is not realistic to assume the ROW as an exogenous factor that does not have feedback relationship with the U.S. economy. Second, fully specifying the ROW can ensure endogenous determination of all prices and quantities (Kouparitsas 1997). But the way to define the behavior of the ROW cannot avoid arbitrary speculations. The actual model will be between the full specification of all countries and one ROW specification. One household represents one country, living infinitely and maximizing its expected lifetime utility. The household is assumed to have a fixed amount of time per period that is divided into leisure and labor time. The utility of each household is the function of leisure, consumption of environmental and other goods. Environment is not tradable but because of the global nature of some gases, domestic environment is affected by the productions in the neighborhood countries.

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[5] The model of Kouparitsas (1997, 2000, 2001) is a basis for this figure.

Figure 5

Model Structure
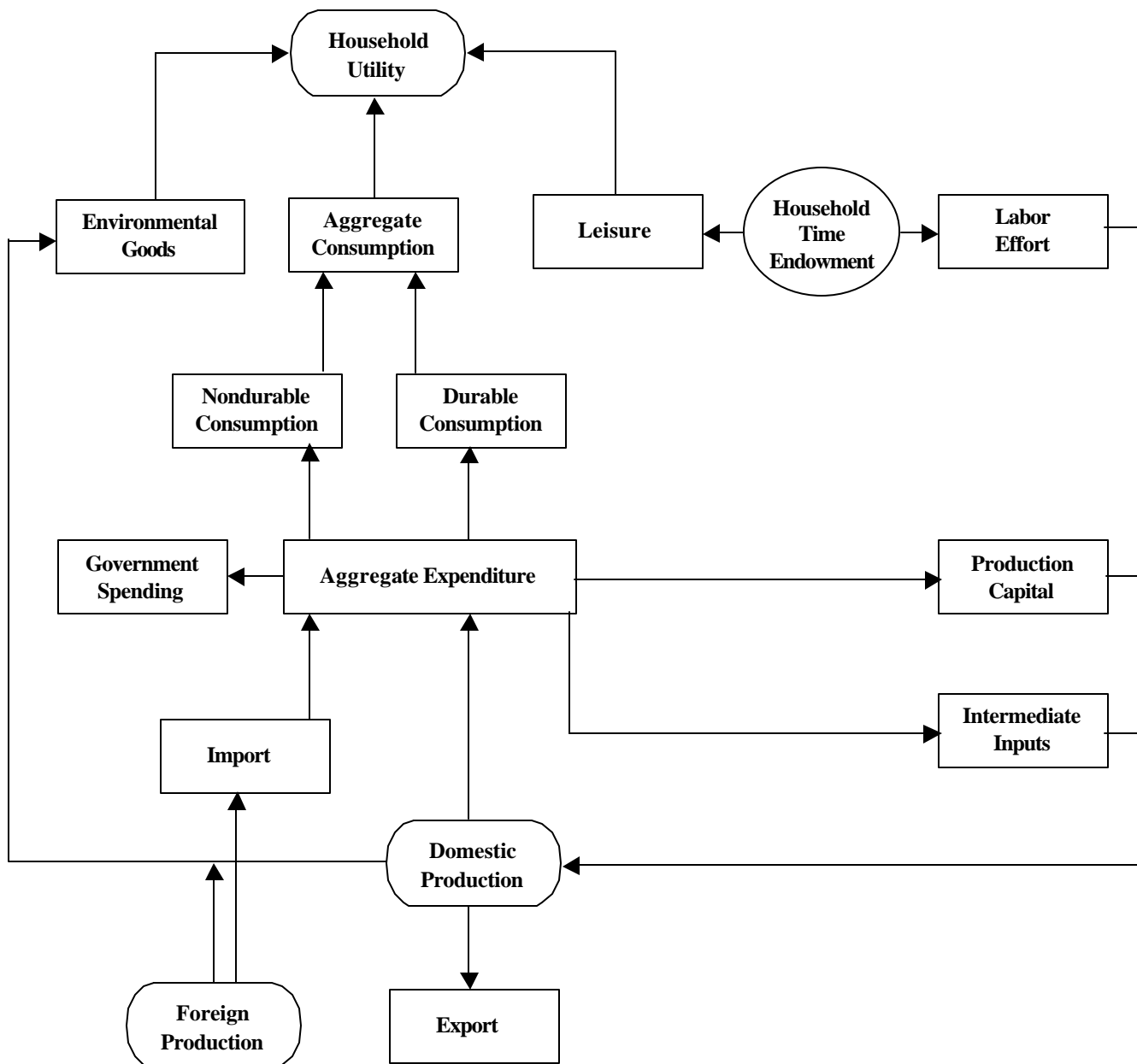
Output in all sectors is described by a production function that has two basic inputs – intermediate and value-added parts (labor and capital). Labor power is considered as immobile internationally. The expenditure is composed of three categories – investment, consumption, and government expenditure. Investment is the expenditure either for the intermediate goods or for the durable capital goods such as household durable services and the composite of equipment or structures. Capital is mobile between sectors within and across the countries with adjustment cost.

4. Conclusion - Equilibrium Concepts

The DCGE model is known to satisfy the existence (of equilibrium) condition with CES class of utility and production functions. Actually, preliminary forms of functions could be extracted from the previous studies that utilize the CES functions such as McKibbin and Vines (2000), Kouparitsas(2001), Backus, Kehoe and Kydland (1992, 1993, 1994, 1995), and King, Plosser and Rebelo(1988).

As equilibrium conditions, zero profit, income balance and market clearance are commonly employed. But once the environmental good is introduced, the model requires another condition. As discussed in Section 3, the environmental good has a diffusion effect over the country boundary. Although the diffusion coefficient (δ) less than one rules out 'pure' characteristics, it should be considered as a public good, which needs a equilibrium condition. One possible choice is Lindahl condition[6] so that at equilibrium a household's marginal willingness to pay equals to the contribution from the household.

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[6] Instead of Lindahl condition, we may employ Samuelson equilibrium concept to compare the coordinative characteristics of two equilibrium concepts with the other conditions.

But the question remains unsolved whether or not this new condition can coexist with the other conditions, confirming the existence of unique equilibrium. Although Dakhlia (1997) proposes a testing technique for a unique equilibrium and Berliant and Dakhlia (1997) introduce a method of sensitivity analysis in the presence of multiple equilibria, still public good is not included in their test technique. At this point, finding equilibrium seems to rely on *ad hoc* constraints and 'learning by doing' trials.

Second, as a calibration strategy, the methods suggested by Baxter and Crucini (1995), and King, Plosser and Rebelo(1988) fit DCGE model calibration. They provide the log-linear approximation technique and typical method of solving dynamic trade models.

Finally, the pollution coefficient and the diffusion coefficient can be obtained from IOE with environmental account or other studies, e.g., Grossman and Krueger (1995) and the tariff-equivalent NTB estimates from Roland-Holst, Reinert, and Shiells (1992).

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