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Rethinking the Relationship between International Trade and Environment: Thailand as a Case Study

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Abstract

Theoretically, international trade raises questions about environmental impact, especially in developing countries. Thailand has used trade policy as an instrument for boosting economic growth. Trade expansion may induce an environmental degradation in Thailand. This study employs the Computable General Equilibrium (CGE) analysis to measure the impacts of trade reforms on the environment of Thailand. Results show that trade reform is good for economic growth but not favorable to the environment. An environmental regulation should be concerned with mitigating environmental degradation. A combined policy between trade reform and moderate environmental tax is a favorable solution both for economic and environment. However, the policy should be enforced with adequate consideration. Too strict environmental policy may lead to economic contraction.

Keywords: International Trade, Environment, Thailand

1. Introduction

1.1. International Trade and the Environment

Theoretically, international trade enlarges markets and enhances the efficiency of resource allocation, which in turn boosts economic growth. Other benefits such as poverty reduction and income distribution improvement are also often experienced. As a result, many countries promote trade policies, particularly free trade, as instruments for boosting economic growth. However, in the beginning, the impact of international trade in other dimensions such as social, environment, etc. was not much emphasized.

Global awareness of international trade and environmental concerns were beginning interested at the United Nations Stockholm Conference on Development in 1972 and the Earth Summit in

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1992 (Jayadevappa & Chhatre 2000). A concern on this topic raised rapidly in the 1990s. It was an important issue widely discussed during the Uruguay round (GATT) and the Doha round of the World Trade Organization (WTO). International trade has been questioned regarding its environmental impacts, particularly in developing countries. With weak environmental policies, free trade may promote growth that is amenable to pollution-intensive industries that destroy local environments. It is a result of relocation of pollution-intensive production from tightly regulated countries to countries with lax environmental regulations. This situation is called "Pollution Haven."

Theoretically, the impact of trade liberalization on the environment can be decomposed as three determinants; a scale effect, a technique effect, and a composition effect (Grossman & Krueger 1991; Copeland & Taylor 1994; Dean 2002). In sum, the scale effect is measured as an increase in pollution that would be generated if an economic activity enlarges. At the same time, economic growth raises real income, it induces demand for a clean environment from consumers and encourages firms to shift toward cleaner production processes. This is referred to as the technique effect and usually contributes to positive benefits for environmental quality. The third effect, the composition effect, is a change in the production structure. Specifically, it is a change in the share of output of each sector in total production. Since each production sector pollutes differently, changing in the level of its production will change the level of pollution. In other word, the composition effect is a change in share of pollution-intensive production in overall domestic production. Composition effect is emphasized as an important determinant of the relationship between international trade and environment by many researchers. It can be an advantage or a detriment effect to the environment depending on how change of production structure of each country after freer trade.

Composition effect involves with country's degree of openness and its comparative advantage (Managi, Hibiki, & Tsurumi 2008). The comparative advantage may be determined by the difference in resource abundance (the capital-labour endowments or the KLE) or the asymmetry in the degree of environmental regulation (the pollution haven hypothesis or the PHH). The KLE theory proposes that comparative advantage of each country is different due to dissimilar in the resource endowment. A country with capital-abundant will specialize in the capital-intensive product while the country with labour abundant will specialize in the labour-intensive product. A capital intensive industry is typically regarded as a dirty industry or a pollution-intensive industry in the viewpoint of environmentalist. Therefore, if the KLE theory is applied, it can be forecasted that freer trade will induce developed country (capital-abundant country) to specialize in pollution-intensive industry and lead developing country (labour-abundant country) to specialize in less pollution-intensive industry.

For the latter one, the degree of environmental regulation is internalized in the cost of production (i.e. pollution abatement cost). Then country has comparatively lax environmental standards have the comparative advantage in pollution-intensive industry since lax environment regulation leads to lower cost of production comparing with country with strict environmental policy, ceteris paribus (Grossman

& Krueger 1991; Antweiler, Copeland, & Taylor 2001; Managi et al. 2008). With this knowledge, environmental regulation is an important factor for freer trade. Freer trade may harm the environment if there are no appropriate environmental policies put in place.

Overall, the net of these effects may be positive or negative. The technique effect may offset negative impacts from the scale effect, but the composition effect can contribute to either negative or positive effects and needs to be of concern to researchers and policymakers.

This study will analyse the impacts of trade reform on environmental quality of Thailand with a focus on environmental policy. Trade reforms are postulated as the import tariff is zero for all commodities. Results are expected to contribute benefits both in terms of verifying the relationship of trade and environment and proposing appropriate policy for Thailand.

This paper is organized as follows. Section 1 presents background of this study including; summarizes conceptual idea, revisits previous related studies, and provides background of trade and environment in Thailand. Section 2 shows the methodology and data used in this study. Section 3 presents results and discussions of the study. Section 4 presents conclusions and policy implications. The last section, section 5, presents limitations and suggestions for future studies.

1.2. Review of Related Literatures

The discussions on the linkage between environmental quality and trade have a long history, both theoretically and empirically. Many theoretical concepts have been proposed but, among of them, the popular ideas to debate on this concern are based on the KLE theory and the PHH, as mentioned earlier. Grossman and Krueger (1991) developed a useful knowledge to explain this issue. They decomposed effect of freer trade on the environment into three main effects; the scale, the composition and the technique effects; and tested with available data. The finding was that the effect of trade on pollution was determined by a difference in factor abundance, as said in the KLE theory. Copeland and Taylor (1994) further developed the model that focusing on North-South trade. They pointed out that the North (developed country) tended to specialize in cleaner goods after trade with the South (developing country). Antweiler et al. (2001) introduced a comprehensive model that the three effects were clarified. Cole and Elliott (2003) extended the idea of Antweiler et al. (2001) and proposed that environmental regulation determines the composition effect.

A growing number of empirical works is increasing showing the evidence supporting both sides; positive impacts and the negative impacts of international trade on the environment. For example, studies of China (Dean 2002), Mexico (Jenkins 2003) and India (Mukhopadhyay & Chakraborty 2005) found that trade liberalization is good for the environment, whereas studies of Argentina (Jenkins 2003), Brazil (Jenkins 2003), Vietnam (Jha & Mani 2006) and Nigeria (Feridun, Ayadi, & Balouga 2006) showed that freer trade damages the environment.

Beghin et al. (1997) proposed an importance of a coordinating policy between trade and environmental reforms. Their statement is supported by plentiful empirical evidence (see O'Ryan et al. (2005), Dessus and Bussolo (1998), Al-Amin et al. (2008)).

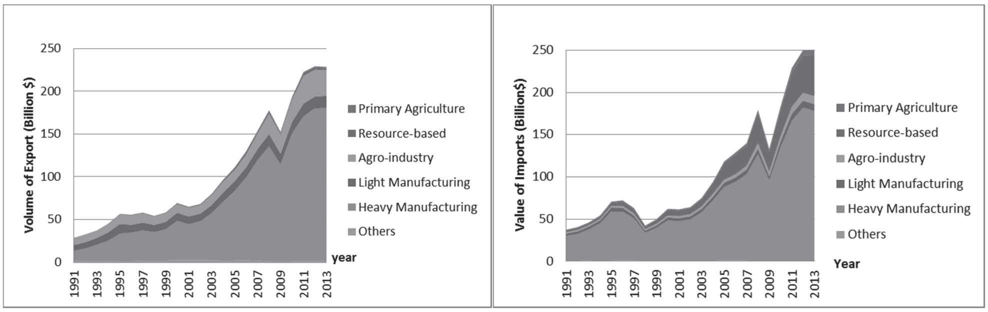
For the study on impact of international trade on environmental quality in Thailand, there is only limited empirical evidence available. Mukhopadhyay (2006) proposed that trading with OECD destroyed the environment of Thailand. Thailand increasingly exported dirty goods and imported clean goods. Li (2005) simulated impacts of tariff reduction on the environment of Thailand. She found that trade liberalization had a negative impact on the environment, but its effect was trivial. Energy taxes were proposed to apply together to protect the environment.

Debates on previous literatures give knowledge that it remains no common conclusion on the effects of trade on the environment. For instance, the impact of trade reform on the environment in developing countries is varying across country and sometimes different from theoretical hypothesis. Therefore, this topic remains important and debatable.

1.3. International trade and the Environment in Thailand

For Thailand, international trade has played an important role for a long history. During the national second development plan (1967–1971), Thai government promoted import-substitution strategy as an engine of economic growth. In 1980s, the Thai government implemented sets of export promotion policies, for example, tax and tariff rebates. Also, Thailand joined several multilateral and bilateral trade liberalization agreements. Series of export-led-growth measures and freer trade strategies within the said period led to an impressive GDP growth.

Figure 1 Thailand Export and Import Structures



Source: Ministry of commerce, Thailand

The importance of international trade on Thai economy is confirmed by an increase of shares of exports and imports in GDP. The share of exports and imports in GDP rise from about 30% in 1980s to about 70% in 2000s[1]. Figure 1 shows that, In 1990s, agro-industry, light manufacturing and heavy manufacturing are major export sectors. Thailand's export is growing towards heavy manufacturing sector. For an import, Thailand's major import sector is heavy manufacturing especially machinery products, but import of resource-based sector continuously expands from an increase in import of crude oil as an input of petroleum refinery. An expansion of heavy manufacturing sector may bring about questions on its environmental impacts.

During that rapid growth period, the government policy mainly focused on raising national income and accelerating economic growth. Environmental issue was not much underlined. In Thailand, there are two main environmental laws including the enhancement and conservation of National Environmental Quality Act, B. E. 2535, and Article 67 of the Thai Constitution. Under the first, the Environmental Quality Board was established. The Environmental Quality Board has powers and duties in submitting policy and governing agencies related to environmental quality management. For the latter, Article 67 of the Thai Constitution stipulates that for large-scale development projects, environmental impact assessments must be conducted before projects start. With these laws, environmental standards are set such as water quality standard (2009), air quality and noise standards (2007) and soil quality standard (2004).

Overall, environmental quality in Thailand is regulated by command and control measures, not market-based instruments. However, the rapid growth of environmental awareness both on a global community and national level raises pressure to Thailand. Thailand desires to move its development goal from economic growth toward sustainable development. Sustainable development has been promoted as a development goal since the 9th National Economic and Social Development plan (2002–2009), but no practical measures regarding environmental quality have been implemented. The 11th National Economic and Social Development plan (2012–2016) highlights the need for the country to transit to a green economy and a society that is environmentally friendly. A key measure is encouraging green production and consumption that leads to Greenhouse Gas (GHG) emission reduction. In order to reach this goal, Thailand is currently working on the Financial Measures for Environment Act[2]. Under this law, emission charges for some pollution such as wastewater and air pollution will be levied.

2. Methodology

This study has two steps of analysis. In the first step, the Computable General Equilibrium (CGE) analysis was applied to simulate impacts of trade reform and other four scenarios. The second step utilized results from CGE to calculate environmental impacts that are defined as levels of Greenhouse Gas (GHG) emission.

2.1. A CGE Model

In order to measure the impact of trade reform on Thailand's environment, at the start, this study used the Standard Computable General Equilibrium model of the International Food Policy Research Institute (IFPRI) by Lofgren et al. (2001). This model is a comparative static general equilibrium model with perfect competition market and constant return to scale (CRTS) technology assumption.

The model includes the following elements: production (activities and commodities), factor input, institutions (household, government, and enterprise), and savings-investments (S-I), tax elements and the rest of the world. A producer is assumed to maximize profit by choosing a combination of intermediate inputs and primary factors. The substitution among intermediate inputs is assumed to follow the Leontief specification while primary factors can be substituted with Constant Elasticity of Substitution. Model closures for macroeconomic balances selected by this study are flexible government savings and the exchange rate, fixed direct tax rate and foreign savings, and investment-driven closure. These closures are chosen based on the assumption that the Thai economy is a small and open economy. The Consumer Price Index (CPI) is chosen to be numeraire.

To calibrate the model, the General Algebraic Modeling System (GAMS), a software for mathematical programming and optimization, is used with the Social Accounting Matrix (SAM) of Thailand extracted from the database of the Global Trade Analysis Project (GTAP) version 8, following the method of McDonald and Thierfelder (2004). Thailand's data from GTAP 8 is settled based on Thailand's 2005 Input-Output table of the National Economic and Social Development Board (NESDB) and Macroeconomic data of 2004 and 2007.

Raw data acquired from this method was from a Global SAM which required additional treatment to reduce it to Thailand's SAM, which its elements reconcile with the IFPRI's CGE model, a pool of income in the GTAP model (payment to/from "Regional Household,") is disaggregated. An "Enterprise" institution is founded. A transfer between domestic institutions is established by referring to transfer to total income proportion from Thailand's SAM 1998 by Li (2002).

Production factors in this SAM are labor, capital, natural resources, and land. Labor is classified by skill types and sectors. Labor is classified as unskilled agricultural labor, skilled agricultural labor, unskilled non-agricultural labor, and skilled non-agricultural labor. Capital is classified by sectors. So it is divided by non-agricultural capital and agricultural capital. An assumption for factor market is that all types of labors are fully employed and mobile, but capital, natural resources and land are fully employed and activity-specific. The set of elasticity used in the model is taken from GTAP8.

There are 36 sectors in Thailand's SAM which consists of four primary agricultural sectors, six resource-based sectors, four agro-industry sectors, four light manufacturing sectors, eight heavy manufacturing sectors, three utility sectors, six service sectors, and a transportation sector.

The simulation scenarios are designed as follows. Trade reform is defined as import tariff is set to be zero. Environmental policy schemes are designed by referring previous literatures and an on-progress Thailand's Financial Measures for Environment Act[3]. I set environmental policy as two scenarios, lax environmental tax with 500 Thai Baht per ton of carbon-dioxide equivalent[4] (tCo2eq) of emission and strict environmental tax with 2,500 Thai Baht per tCo2eq of emission. The base year reveals the benchmark scenario in the absence of trade reforms and any environmental policies.

There are five scenarios in this study. *Scenario 1* is a simulation of trade reform policy implemented without any other complimentary environmental policy. *Scenario 2* is a simulation of lax environmental tax without trade reform. *Scenario 3* is a simulation of strict environmental tax without trade reform. *Scenario 4* addresses trade reforms with lax environmental tax simultaneously. *Scenario 5* considers both trade reform and strict environmental tax. Simulation scenarios are concluded in Table 1.

Table 1 Simulation Design

	Without Environmental tax	Lax Environmental Tax	Strict Environmental Tax
Without Trade reform	Base Case	Scenario 2	Scenario 3
With Trade reform	Scenario 1	Scenario 4	Scenario 5

Source: Author

The CGE model will be calibrated for simulations under all the scenarios, and their results will be compared with those in the base case. In theory, after the trade reform, domestic prices of imported goods decline. For demand side, demand for imported goods increases while demand for domestic goods[5] decreases. The size of the change depends on their marginal rate of substitution. For supply side, tariff removal leads to a reduction in production costs, and then supply of domestic goods would increase. A total change in domestic production depends on the net effect of these demand and supply impacts. It is often the case that a sufficient expansion in exports due to improved price competitiveness in those expanding sectors is necessary to compensate for the losses in production made in import competing sectors. As a result of all above adjustments, a production structure, imports and exports of the country will also change. A change in production structure leads to a change in returns to production factors, household income and consumption. Finally, Gross Domestic Production (GDP) will change as well. For the larger positive impact of trade reform, the more flexible factor markets and resource shifts from shrinking to expanding sectors are called for. Assumptions on the marginal rates of substitution between domestic and imported products and rigidities in factor mobility are thus crucial among other parameters.

2.2. Environmental Analysis

Results of the CGE analysis will be used to calculate environmental impacts, which proxies by level of Green House Gas (GHG) emission. GHG is a prominent indicator of air pollution. Other types of pollution such as soil degradation, land degradation and wastewater are not considered in this study due to a lack of data. GHG emission levels in all scenarios will be figured with respect to GHG sectoral emission intensity conducted by Limmeechokchai and Suksuntornsiri (2007).[6] Three types of GHG, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), following the revised 1996 Intergovernmental Panel on Climate Change (IPCC) guidelines, and energy use are used to calculate

GHG intensity.

To analyze environmental impacts of trade reform, the scale effects and the composition effects will be calculated by method presented by Strutt and Anderson (2000). Unfortunately, due to a limitation of data, a technology effects[7] associated with technology advancement will not be considered. I assume that producers cannot upgrade their technology in the short-run. Therefore, this study will modify the method of Strutt and Anderson (2000) with major concerns on the scale and composition effects. Total change in GHG emission (E) is the summation of changes in emission from each sector (E_j).

$$E = \sum_{j=1}^{36} E_j$$

Where $E_j = S_j + C_j$

j denotes the production sector in the model. S_j and C_j represent the scale effects (SE) and the composition effects (CE) respectively. The overall emission level of each sector is the sum of scale and composition effects. Scale and composition effects are calculated as follows:

$$S_j = \theta_j * g * X_j$$
$$C_j = \theta_j * (x_j - g) * X_j$$

Scale effect of sector j is computed by the product of the initial output level of sector j (X_j) and emission intensity (θ_j) and the overall growth rate of real output (g). x_j stands for the proportional change of output in each sector. Scale effect indicates a change in emission from a change in economic activity due to trade reform with no concern for any transformation in production structure. Composition effect, by contrast, measures the effect from production structure change while maintaining output level at the same level as before trade reform.

3. Results of the Study

This section discusses results from the CGE simulation and environmental analysis. It can be divided into four sub-sections. Section 3.1 reviews results from scenario 1. Section 3.2 explains results from scenario 2 and 3. Findings from scenario 4 and 5 are discussed in section 3.3. In each section, the discussion includes impacts on macroeconomic variables (Table 2), sectoral impacts (Table 3) and GHG emissions (Table 4). Later I summarize all results in section 3.4.

3.1. Impacts of Trade Reform (Scenario 1)

The first discussion addresses impacts of trade reform without any environmental policies enforced. Before looking at impacts on the environment, this study starts with a discussion on Thailand tariff structure before trade reform (see Appendix). Tariff structure is calculated based on Thailand's SAM. In general, Thailand's manufacturing sectors are protected by import tariff. I find that manufacturing

Table 2　Macroeconomic Impacts

	BASE (Bill. Baht)	Scenario 1 (%Ch.)	Scenario 2 (%Ch.)	Scenario 3 (%Ch.)	Scenario4 (%Ch.)	Scenario 5 (%Ch.)
GDP	9829.61	1.14	−0.05	−2.61	1.07	−1.73
Real GDP	9829.61	0.32	−0.10	−3.12	0.22	−2.86
Absorption	8643.02	0.67	−0.16	−3.76	0.48	−3.37
Private Con.	4998.14	0.67	−0.21	−7.15	0.48	−6.50
Fixed Inv.	2477.53	−0.67	1.30	9.88	0.57	8.53
Gov. Con.	1167.35	3.46	−3.06	−18.17	0.32	−15.17
Exports	7132.30	7.29	0.11	3.06	7.40	10.31
Imports	−5945.71	7.82	− 0.02	2.52	7.81	10.34
Net Ind. Tax	882.51	−36.11	57.94	316.22	22.95	284.53
Price Index	1.00	1.07	0.31	5.05	1.34	5.92
Welfare		0.55	−0.21	−6.68	0.35	−6.14

Source: Simulation Results

Table 3　Sectoral Outputs

Sector	BASE (Bill. Baht)	Scenario 1 (%Ch.)	Scenario 2 (%Ch.)	Scenario 3 (%Ch.)	Scenario 4 (%Ch.)	Scenario 5 (%Ch.)
Total	22727.57	0.04	− 0.44	− 3.42	− 0.40	− 3.32
Primary Agriculture						
Crops	333.09	− 0.10	− 0.01	0.47	− 0.10	0.38
Vegetable and Fruit	372.89	0.15	0.06	0.14	0.21	0.29
Sugar cane	43.30	0.96	− 0.39	− 2.85	0.59	− 1.81
Livestocks	201.89	− 0.36	− 0.07	− 1.08	− 0.43	− 1.46
Resource-based						
Forestry	45.47	− 2.21	0.84	4.81	− 1.32	2.89
Fishing	177.41	− 0.13	− 0.03	− 0.47	− 0.15	− 0.57
Coal	21.76	− 0.05	− 0.11	− 2.42	− 0.17	− 2.60
Oil	194.32	− 0.01	0.15	1.14	0.13	1.06
Gas	69.97	0.01	0.13	0.67	0.14	0.62
Mining	145.87	− 0.06	− 0.22	− 2.80	− 0.29	− 2.92
Agro-industry						
Meat Products	223.25	− 0.73	0.11	− 0.10	− 0.62	− 0.81
Food Products	1091.63	1.83	− 0.39	− 2.31	1.48	− 0.37
Dairy products	73.68	− 2.89	− 0.27	− 3.48	− 3.20	− 6.71
Beverages and Tobacco	227.46	− 6.68	0.43	0.01	− 6.30	− 6.81
Light Manufacturing						
Textile and Apparel	890.85	0.18	− 0.41	− 4.78	− 0.18	− 4.43
Leather products	191.19	− 0.32	1.04	7.74	0.84	8.38
Wood products	223.07	− 0.38	1.72	11.55	1.38	11.32
Paper and publishing	262.07	− 0.85	− 0.31	− 2.87	− 1.19	− 4.09
Heavy Manufacturing						
Petroleum and coal	1127.90	− 1.53	− 2.49	− 15.21	− 4.03	− 16.65

Sector	BASE (Bill. Baht)	Scenario 1 (%Ch.)	Scenario 2 (%Ch.)	Scenario 3 (%Ch.)	Scenario 4 (%Ch.)	Scenario 5 (%Ch.)
Chemical, rubber, plastic	1661.95	0.47	−0.39	−1.85	0.13	−1.13
Non-Metal Product	374.26	−2.23	−5.06	−40.50	−7.52	−44.34
Metal Product	747.68	0.37	−6.00	−42.53	−5.57	−41.74
Transport equipment	1429.49	−1.48	−0.13	0.94	−1.56	−0.13
Electronic equipment	1767.99	2.56	0.13	2.95	2.80	6.21
Machinery	1514.35	1.70	1.02	6.22	2.82	8.70
Manufacturing n.c.e.	445.47	−10.47	0.22	2.27	−10.42	−9.34
Utilities						
Electricity	464.42	0.04	−2.60	−27.65	−2.52	−27.37
Gas manufac.	278.16	0.00	−2.01	−21.93	−1.98	−21.75
Water	57.13	−0.06	−0.28	−5.42	−0.34	−5.46
Transportation	1292.56	2.02	−4.12	−22.33	−2.20	−20.81
Services						
Construction	860.59	0.24	−0.25	−1.78	0.00	−1.44
Trade&Financial Service	3861.40	−0.16	1.15	5.74	0.96	5.31
Communication	298.05	−0.21	0.75	3.08	0.51	2.67
Recreation	429.83	0.55	0.32	−1.40	0.89	−0.83
Public Services	1182.93	−0.13	0.60	3.06	0.46	2.81
Dwellings	144.26	−0.03	0.04	0.16	0.02	0.12

Source: Simulation Results

Table 4 GHG Emissions

	Base	Scenario 1 (%Ch.)			Scenario 2 (%Ch.)			Scenario 3 (%Ch.)			Scenario 4 (%Ch.)			Scenario 5 (%Ch.)		
	(MtCO2)	Total	SE	CE	Total	SE	CE	Total	SE	CE	Total	SE	CE	Total	SE	CE
Total Economy	1039.08	0.09	0.04	0.06	−1.74	−0.44	−1.29	−13.06	−3.42	−9.64	−1.65	−0.40	−1.25	−13.00	−3.32	−9.68
Primary Agriculture	14.82	−0.05	0.04	−0.09	−0.01	−0.44	0.43	−0.22	−3.42	3.19	−0.07	−0.40	0.33	−0.28	−3.32	3.04
Resource-Based	30.13	−0.09	0.04	−0.13	−0.03	−0.44	0.42	−0.74	−3.42	2.68	−0.13	−0.40	0.27	−0.86	−3.32	2.46
Agro-Industry	53.84	0.51	0.04	0.48	−0.25	−0.44	0.20	−1.91	−3.42	1.51	0.28	−0.40	0.68	−1.34	−3.32	1.97
Light Manufacturing	66.65	−0.12	0.04	−0.16	−0.08	−0.44	0.36	−1.93	−3.42	1.48	−0.17	−0.40	0.23	−1.93	−3.32	1.39
Heavy Manufacturing	442.16	−0.44	0.04	−0.47	−2.19	−0.44	−1.74	−15.50	−3.42	−12.09	−2.62	−0.40	−2.22	−15.93	−3.32	−12.61
Utilities	144.73	0.04	0.04	0.00	−2.52	−0.44	−2.08	−26.95	−3.42	−23.53	−2.46	−0.40	−2.06	−26.69	−3.32	−23.37
Transportation	129.53	2.02	0.04	1.98	−4.12	−0.44	−3.68	−22.33	−3.42	−18.91	−2.20	−0.40	−1.80	−20.81	−3.32	−17.49
Services	157.22	0.04	0.04	0.00	0.51	−0.44	0.96	2.12	−3.42	5.54	0.54	−0.40	0.94	2.07	−3.32	5.39
Polluting industry	644.39	0.27	0.04	0.23	−2.86	−0.44	−2.41	−21.40	−3.42	−17.98	−2.61	−0.40	−2.21	−21.28	−3.32	−17.96
Non-Polluting industry	394.69	−0.20	0.04	−0.23	0.09	−0.44	0.54	0.55	−3.42	3.97	−0.08	−0.40	0.32	0.51	−3.32	3.83

Source: Author's calculation from simulation Results

n.e.c.[8] sector has highest tariff, follow by beverage and tobacco sector. Primary agricultural and agro-industry sectors are also protected by tariff to some extent.

Impacts of trade reform on the overall economy are presented in Table 2. CGE results show that trade reform generates an increase in exports, imports and GDP. GDP increases by 1.14% from the base level due to a large expansion in trade volume, 7.29% in exports and 7.82% in imports. The result follows basic international trade theory: when tariff, which is a distortion, is removed, resource allocation will be more efficient. Welfare, measured by equivalent variation (EV)[9], also increases.

After trade reform, sectors can be "winners" or "losers". In this study, I consider "winners" as sectors with an increase in their production (or production expansion). "Losers" are sectors that contract after trade reform. Results of trade reform at sectoral level are presented in Table 3. The results reveal that most of the winners are in an industrial side (such as food manufacturing, the electronic equipment and the machinery sector). Transportation sector also enlarges. As mention earlier, a net change in sector's production depends on changes in demand and supply of imports and domestic goods, which rely on several factors. For example, the expansion of a food industry is from an increase in supply from a lower cost of production. Intermediate input prices used in food industry decline after trade reform.[10] Therefore, there is an increase in production in this sector, and this situation dominates sector's contraction from an increase in import goods. For the losing sectors, domestic production in sectors carried high tariffs before trade reform (such as beverage and tobacco) declines since it loose trade protection.

For environmental impacts, as presented in Table 4, overall GHG emission increased after trade reform (0.09%). A scale effect (SE) shows an increase of GHG emission deriving from economic expansion after trade equals 0.04%. A composition effect (CE) of relative expansion of polluting industries also shows a positive number (0.23%). It can be explained that, after trade reform, Thailand's environmental quality degraded, since an increase in GHG emission comes from polluting industries.[11] In other words, the production structure of Thailand after trade reform shifted towards polluting industries.

Note that the main source of increase in GHG emission is the transportation sector. Trade reforms enlarge economic activities that lead to an increase in the demand for transportation service. With GHG emission intensity, the transport sector is considered as a polluting industry. Its GHG emission intensity is 100.21 tCo2eq, while an average emission intensity of overall sectors is 45.43 tCo2eq. However, to receive benefits from economic growth, an increase in GHG emission from a widening of the transportation sector may be unavoidable since it closely relates with an expansion of the economy.

3.2. Impacts of Environmental Tax (Scenario 2 and 3)

This section discusses results of scenarios 2 and 3 that are environmental taxation without trade reform. In scenario 2, each sector is imposed lax environmental tax which is equal to 500 Baht/tCo2eq. This tax is collected based on the emission intensity of each sector.[13] Then sector that emits at high intensity of GHG is enforced high tax respectively, for example, 14.42% environmental tax rate for the electricity sector, 10.39% for non-metal product sector and 5% for a transportation sector (See Appendix).

When lax environmental policy is implemented (Scenario 2), GDP decreases by a small amount, and welfare also declines (see Table 2). These findings are predictable. Environmental tax is a distortion that increases production cost and cause economic contraction. At sectoral level (Table 3), since the environmental tax rate is connected to levels of GHG emission, sectors with high intensity of emission are confronted with high tax rate compared to other sectors and in turn transmit into their production cost that finally result in a decline in production. For example, the transportation sector, metal and non-metal sectors shrink around 5%. Conversely, sectors that emit low intensity of GHG such as forestry and service sectors expanded. These changes in sectoral outputs lead to a change in overall GHG emission of Thailand. In sum, the GHG emission (Table 4) decreased 1.74% from the level in the baseline. The result also shows a contraction in the polluting industry (CE equal to −2.41%) and an expansion in non-polluting industry (CE equal to 0.54%).

For strict environmental tax (Scenario 3), each sector is imposed strict environmental tax which is equal to 2500 Baht/tCo2eq. From Table 2, it is shown GDP significantly drops by 2.61%. Welfare decreases about 6.68%. Strict environmental tax leads to noticeable economic contraction because it puts very high pressure on production costs. For sectoral impacts, as shown in Table 3, sectors with high environmental tax rate contract to a large extent. For instance, metal and non-metal sectors diminish approximately 40%. Transportation, electricity, and gas manufacturing sectors shrink to about 20%.

However, strict environmental tax shows a significant success in GHG emission control. GHG emission declines notably by 13.06% (Table 4), which is the greatest reduction compared to other scenarios. This GHG reduction comes from a tightening in economic activity (scale effect), which leads to −3.42% in GHG emission, and a decrease of GHG level results in a change in production structure toward non-polluting industry (composition effect), which equal to −9.64% reduction in GHG emission. In summary, it shows that strict environmental policy succeeds in promoting non-polluting sectors although an economy will suffer a contraction.

3.3. Impacts of Trade Reform and Environmental Tax (Scenario 4 and 5)

These experiments aim to explore mixed policy between trade reform and environmental tax. Scenario 4 and 5 examine impacts of trade reform on the environment when environmental tax is introduced. Scenario 4 is a combination of trade reform and lax environmental tax. Scenario 5 is a coordination of trade reform and strict environmental tax.

Starting with scenario 4, when lax environmental tax is enforced with trade reform, macroeconomic index (Table 2) of this scenario shows similar effects to Scenario 1. GDP increases by 1.07% that indicates benefits from freer trade dominate economic contraction from environmental regulations. Trade volume expands, and welfare also increases. However, there is a different in production structure (Table 3). In contrast to scenario 1, the transportation sector cannot be considered a “winner” because the sector contracts. It refer that gains from tariff removal are offset by rising costs associated with environmental policy.

As a result, for environmental impacts, the GHG emission declines after this combined policy (scenario 4) is introduced. GHG emission declines by 1.65% compared to that in the baseline scenario (see Table 4). Both scale and composition effects show negative sign that reveals that GHG emission decreases. Accordingly, the level of emission in the economy does not go as high as scenario 1. Compared with scenario 1 where trade reform generates pollution, the results show that such pollution can be reduced if environmental regulation is put in place.

An increase in GDP and a reduction in GHG emission as outcomes of the combination policy make the policy desirable. The combined policy lets the country simultaneously enjoy benefits from economic growth while preserving environmental quality.

When strict environmental tax is introduced together with trade reform (Scenario 5), the gain from trade is superseded by the contraction of the economy from strict environmental tax. As in Table 2, GDP falls by 1.73%, and welfare also decreases. For environmental impact (Table 4), overall GHG emission greatly goes down (13.00%). Similar to scenario 3, scenario 5 is effective for GHG mitigation but raises a question on its economic impact.

These two scenarios highlight the importance of the degree of environmental regulation as a determinant of the benefits from international trade. Strong environmental policy will be suitable for protecting the local environment, but the country cannot utilize benefits from trade liberalization.

Also note that the degree of the initial tariff is important. If an initial tariff is small (country's trade policy is close to free trade), environmental policy will play a crucial role in changes in production structure, economic and environmental impacts.

3.4. Discussion and Summary of the Results

According to the theoretical discussion, international trade brings about an expansion of the economy, in particular, economic growth. Still, the country may have to accept environmental degradation at the same time. A summary of the relationship between GDP (as a proxy of economic impact) and GHG emission (as a proxy of environmental effect) is shown in Table 5.

Table 5 Summary of Total GHG Emission and GDP under Different Policy Schemes

	GDP Billion Baht (%Ch.)	Real GDP Billion Baht (%Ch.)	GHG Emission MtCo2eq (%Ch.)
Base	9829.61	9829.61	1039.08
Scenario1	9942.00	9861.43	1040.03
	(1.14)	(0.32)	(0.09)
Scenario2	9824.64	9819.80	1021.03
	−(0.05)	−(0.10)	−(1.74)
Scenario3	9572.94	9523.27	903.38
	− (2.61)	− (3.12)	− (13.06)
Scenario4	9935.09	9851.47	1021.92
	(1.07)	(0.22)	− (1.65)
Scenario5	9659.30	9549.01	903.99
	− (1.73)	− (2.86)	− (13.00)

Source: Author

The result confirms the above statement of the linkage between trade and the environment. Thailand receives economic benefits from freer trade while it has to accept environmental degradation. When tariffs are removed, GHG emission increases from 1039.08 Million tCo2eq to 1040.03 Million tCo2eq. An increase in GHG emission is an environmental cost of trade reform. However, when environmental policy is put in place, the relationship between trade and environmental quality is not necessarily negative. In this study, scenario 4 (a combination of trade reform and lax environmental tax) is preferable. It increases GDP by 1.07% from the baseline and reduces GHG emission 1.65% at the same time.

4. Conclusion and Policy Implication

This section concludes with the results of the study. There are five important issues that will be addressed.

First, for Thailand, trade reform itself is not good for the environment. It shifts economic structure toward polluting industry. When it is implemented without any other complementary environmental policy, Thailand will gain benefits from an increase in GDP but have to accept more pollution due to rising GHG emissions. Without any environmental protection measure, Thailand may be a pollution haven. Hence, environmental regulations should be concerned with protection against environmental degradation.

Second, the results show that there exists an appropriate policy from which Thailand can utilize benefits from trade without environmental damage. In this study, the coordinating policy between trade reform and lax environmental tax (scenario 4) leads to that consequence. Policymakers can ensure

Thailand, by introducing this policy, can pursue development without environmental degradation.

Third, the degree of regulation should be emphasized. A combined policy of environmental tax and trade reform should be done carefully. Too strict an environmental tax may lead to economic contraction.

Fourth, as the results show, trade reform can be an instrument for enhancing economic growth, it implies that if Thailand is obligated to perform environmental tax in the future (for instance, environmental measures forced by the United Nations Framework Convention on Climate Change [UNFCCC]), the country should enforce it together with trade reform policy. Mixed policy will be more beneficial to the economy than enforcing environmental tax alone.

Fifth, the results show that the sector that contributes most to GHG emission after trade reform is the transportation sector. However, transportation service is linked to other economic activities. Tax policy for this sector should be introduced with this consideration. Other policies that do not obstruct its activity but can reduce GHG emissions, such as renewable energy subsidy, may be implemented.

5. Limitations and Suggestions for Further Research

A limitation of this study mostly derives from the limitation of data and the difficulty of structuring the model. Firstly, the model is conducted under several assumptions. Some assumptions of the model may not well explain the real situation, such as perfect competition in the goods market and full employment condition on the factor market. These assumptions should be modified in the future research. Besides, some key assumptions need to be more considered. The first concern is the Leontief specification in utilizing intermediate inputs that do not allow substitution among input uses when their relative prices change. So producer cannot substitute between polluting and non-polluting inputs. The second concern is the consumption pattern of institutions does not change after the price of goods and their income change. This assumption may differ from economic theory that consumers tend to demand environmental-friendly goods when their income increases. The third concern is the technology changes which should be contained in the model. This limitation may lead to a biased result towards negative effects. Results of environmental impacts in this study may overestimate.

Another limitation is a limitation of the environmental data. This study cannot analyze the impact of trade on other types of pollution, such as water and soil. In reality, these types of pollution affect the standard of living, health, and welfare and should be emphasized.

Finally, to contribute more knowledge, a study on ecological footprint should be addressed in the future study. International trade can be identified by nation's ecological footprint, which results in lower emission and natural resource use at the global level.

Notes

1 Ministry of Commerce (2014)

2 In Financial Measures for Environment Act (On progress), an emission charge is expected to be 2,500 Baht/ton of air pollution (75$/year)

3 Data as at July 2014

4 A carbon dioxide equivalent is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential (European Union, 2013)

5 Domestic goods mean domestically produced goods, which then can be sold locally or export.

6 GHG intensity is calculated for final consumptions. See Limmeechokchai and Suksuntornsiri (2007b)

7 “Technology effect” defined in the model of Strutt and Anderson (2000) is closely to the term “Technique effect” that mentioned in Grossman & Krueger (1991), Copeland, & Taylor (1994), Antweiler et al. (2001). Technology effect focuses on environmental improvement from transfer of environmental friendly technology after freer trade while technique effect emphasizes on environmental improvement from rising demand for environmental standard as a result of an increase in income.

8 Manufacturing n.e.c. includes; scientific equipment, photographic & optical goods, watches and clocks, jewelry & related articles, recreational and athletic equipment, etc.

9 A change in welfare is measured by a percentage change in equivalent variation from consumption value at the base case.

10 Main inputs used in food product sector are from sectors following; dairy products (23.45%), food product (13.07%), livestock (8.80%). Prices of goods of these sector change −3.12%, −3.24%, −1.90%, respectively. Data is available upon request.

11 In this study, polluting industry is defined that an industry that its emission intensity is higher than average. Polluting industries include fishing, mining, textile and apparel, paper and publishing, chemical rubber and plastic, non-metal product, metal product, electricity, construction, transportation.

12 Data of sectoral emission is available upon request.

13 Environmental tax is converted as an ad-valorem tax so as to include it in the model. See McDougall (1993) and Wattanakuljarus (2011) for more details.

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APPENDIX
Tariff, Emission Intensity and Environmental Tax Rate

Sector	Import Tariff Rate	GHG Intensity (TonCo2/MB)	Lax Environmental Tax rate (at 500 B/tCo2eq)	Strict Environmental Tax rate (at 2500 B/tCo2eq)
Primary Agriculture				
Crops	10.87	13.64	0.68	3.41
Vegetable and Fruit	15.09	14.25	0.71	3.56
Sugar cane	0.00	10.87	0.54	2.72
Livestocks	4.60	22.27	1.11	5.57
Resource-based				
Forestry	4.75	8.16	0.41	2.04
Fishing	6.86	60.42	3.02	15.11
Coal	0.79	40.19	2.01	10.05
Oil	0.00	33.71	1.69	8.43
Gas	0.01	33.71	1.69	8.43
Mining	1.00	63.42	3.17	15.86
Agro-industry				
Meat Products	15.60	25.55	1.28	6.39
Food Products	10.72	36.95	1.85	9.24
Dairy products	9.33	35.36	1.77	8.84
Beverages and Tobacco	42.60	22.84	1.14	5.71
Light Manufacturing				
Textile and Apparel	9.49	46.60	2.33	11.65
Leather products	13.73	30.05	1.50	7.51
Wood products	8.70	25.10	1.26	6.28
Paper and publishing	4.88	52.61	2.63	13.15
Heavy Manufacturing				
Petroleum and coal	7.84	28.48	1.42	7.12
Chemical, rubber, plastic	8.63	54.27	2.71	13.57
Non-Metal Product	12.19	207.79	10.39	51.95
Metal Product	4.04	110.41	5.52	27.60
Transport equipment	18.60	35.28	1.76	8.82
Electronic equipment	1.75	34.24	1.71	8.56
Machinery	5.10	20.85	1.04	5.21
Manufacturing n.c.e.	55.26	38.10	1.91	9.53
Utilities				
Electricity		288.41	14.42	72.10
Gas manufac.		30.26	1.51	7.57
Water		41.45	2.07	10.36
Transportation		100.21	5.01	25.05
Services				
Construction		64.06	3.20	16.01
Trade&Financial Service		17.25	0.86	4.31
Communication		8.46	0.42	2.12
Recreation		29.59	1.48	7.40
Public Services		16.41	0.82	4.10
Dwellings		5.86	0.29	1.47

Source: Author calculates import tariff from SAM. Emission intensity is from Limmeechokchai and Suksuntornsiri (2007b). Environmental tax is calculated by author.