Economy-wide Impact of a Carbon Tax in ASEAN

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Abstract

The establishment of an ASEAN Economic Community in 2015 has been on the agenda for quite some time. One issue that has recently emerged is the climate change issue in which each member of ASEAN needs to respond. The main goal of this paper is to analyze the benefits and losses of cooperation among ASEAN members in mitigating their CO_2 emission, particularly by implementing a uniform carbon tax across ASEAN. To achieve this goal, this paper develops a multi-country computable general equilibrium (CGE) for ASEAN, known as the Inter-Regional System of Analysis for ASEAN (IRSA-ASEAN) model. This paper finds that the implementation of a carbon tax scenario is an effective means of reducing carbon emissions in the region. However, this environmental gain could come at a cost in terms of gross domestic product (GDP) contraction and reduction in social welfare, i.e. household income. Nevertheless, Indonesia and Vietnam can still gain from the implementation of a carbon tax depending on how revenues generated from the carbon tax are redistributed.

1. Introduction

The world has now moved beyond the conventional view that economic growth objectives are incompatible with environmental objectives. Left unaddressed, climate change represents a serious threat to economic wellbeing. Central to such principles is the appropriate pricing of carbon and ensuring that climate change mitigation policies across the board are both effective and economically efficient (Ministry of Finance, 2009).

As such, this paper analyzes the impact of implementing a carbon tax, or a levy on CO_2 emission, in Southeast Asia, namely Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam. As of 2010, these are the six of the ten member countries of the regional cooperation known as the Association of Southeast Asian Nations (ASEAN).[1] This paper utilizes the Inter-Regional System Analysis for ASEAN (IRSA-ASEAN) multi-country computable general equilibrium (CGE) model

[1] Brunei Darussalam, Cambodia, Lao PDR, and Myanmar are not included in the model due to severe lack of data.

to look at the economy-wide impact of implementing such a tax in terms of environmental improvement, economic growth, and income equity.

The rest of this paper is organized as follows. Section 2 provides a brief review of the IRSA-ASEAN model, including its construction method and dataset. Section 3 presents the results and analysis of using the IRSA-ASEAN model to simulate various policy scenarios with regard to the implementation of a carbon tax in the region. Lastly, section 4 provides a summary and conclusion for this paper.

2. The IRSA-ASEAN Model

The IRSA-ASEAN model is a multi-country CGE model that bears similarities with the Inter-Regional System of Analysis for Indonesia Five Regions (IRSA-Indonesia5) developed by Resosudarmo *et al*. (2008). However numerous features of this model stem from other developments in CGE modeling over the last 20 years; some of these sources of inspiration are direct and easily identified, including one of the first CGE models for Indonesia by Lewis (1991), GTAP model (Hertel, 1997), and Globe model (McDonald *et al*., 2007).

The IRSA-ASEAN model itself is a multi-country model that solves at the country level, meaning that optimizations are done at the country level. This approach allows price as well as quantities to vary independently by countries, which means that variation in price as well as in quantity of each country can be observed using this model. This approach enables the user of the model to observe the impact of a specific shock in a country to other countries, the whole ASEAN economy, and the country itself.

INSERT FIGURE 1 HERE

Figure 1 shows the basic flow of commodities and production structures in each country. *XTOT(i,d)* is output, *XINT_S(c,i,d)* is the intermediate good, and *XPRIM(i,d)* is the primary input. Meanwhile, *XTRAD_R(c,d)* is the domestic[2] demand composite, *XD_S(c,d)* is the domestic and import[3] demand composite, and *XFAC(f,i,d)* is the demand for factor of production. The following defines the subscript notations:

- *c* commodity;
- *d* destination of commodity in domestic country;
- *f* factors of productions, labors, and capital;
- *h* households;
- *i* industry;

[2] Note that the word "domestic" composite here refers to goods from within the country and within ASEAN.
[3] The word "import" refers to extra-ASEAN imports.

r source of commodity in domestic country; and

s source of commodity, composite between domestic country and import.

Note that *XEXP(c,r)* represents exports to the rest of the world, while the term *XIMP(c,d)* refers to imports from the rest of the world. Meanwhile, XHOU_S(c,h,d) represents household demand, XGOV_S(c,d) represents government demand, and XINV_S(c,d) represents investment demand. Also note that indirect taxes affect production output while import taxes affect the composite demand.

Another highlight to the IRSA-ASEAN model deals with the issue of "double-dividend". Although the IRSA-ASEAN model can be used for a wide-range of policy simulations, e.g. trade and fiscal simulations, the main motivation to their development is to assess the economic impact of environment-related policies, e.g. carbon tax. As such, the IRSA-ASEAN model takes a step further with regards to the issue of environment by allowing for the possibility of the double-dividend hypothesis.

In the IRSA-ASEAN model, aside from the usual increase in government expenditure due to revenue generated from the newly existing carbon tax, there are two other alternatives in which the government may use the revenue to obtain a double-dividend. First, government may directly transfer part, or the entirety, of the revenue obtained from the carbon tax to households in order to increase social welfare; and/or second, the government may use the revenue to cut production taxes to generate a less distortionary tax system. These alternatives are represented by the yellow line in Figure 1.

For empirical results, the IRSA-ASEAN model uses the Social Accounting Matrix for ASEAN (ASEAN-SAM) which has been calibrated from the input-output (I-O)-based Global Trade Analysis Project (GTAP) version 7 Data Base. The database uses a common reference year of 2004 and a common currency of USD million for all six countries in the region. The database has been heavily modified using various country-specific dataset, e.g. social accounting matrices and household income/expenditure surveys, so as to provide greater insight and flexibility for policy analysis.

Detailed list of sets for the ASEAN-SAM can be seen in Table 1. Table 2 shows some macro variables from the resulting ASEAN-SAM.

INSERT TABLE 1 AND TABLE 2 HERE

3. Policy Scenarios and Results

With regards to policy scenarios, this study focuses on the economic impact of carbon tax policies. The simulations of the model are basically grouped into two scenarios based on how each is implemented, namely symmetric and asymmetric policies. A symmetric policy simply means that the chosen policy is implemented across the board in all six countries. In contrast, an asymmetric policy means that the chosen policy is only implemented in one or few countries. Two additional scenarios are also included, which assume 10 percent efficiency gain of coal use and 10 percent efficiency gain of oil use symmetrically.

Aside from the broad scenarios mentioned previously, there are four variants to the policy that are explored as well. The first variant assumes that the government retains all the revenue generated and thereby increases its consumption proportionally where the total increase equals the carbon tax revenue. The second variant assumes that the government redistributes some of the revenue back to households in the form of a direct cash transfer to improve social welfare. The government only redistributes cash to those of low income households in both rural and urban areas. The third variant assumes that the government uses part of the carbon tax revenue to reduce other distortionary taxes in order to achieve a double dividend. The fourth variant combines the second and third variants. Lastly, the carbon tax itself is set at USD 20 per ton of CO_2 emissions following the much cited work of Frankhauser (1992) fossil fuel usage, i.e. coal, petroleum products, and gas.

<u>Scenario 1: Symmetrical Carbon Tax Policies</u>

A USD 20 per ton of CO_2 emissions tax in all six countries:

1a. Each government retains all carbon tax revenue to increase its consumption;

1b. Each government retains 75 percent of the revenue to increase its consumption and redistributes 25 percent back to low-income households in both rural and urban areas in the form of cash transfers. Shares between rural and urban areas are determined based on poverty incidences;

1c. Each government retains 75 percent of the revenue to increase its consumption and redistributes 25 percent to the industries in the form of a subsidy proportional to the industrial size; and

1d. Each government retains 75 percent of the revenue to increase its consumption and redistributes 12.5 percent to households as well as 12.5 percent to the industries in the form of a subsidy proportional to the industrial size.

<u>Scenario 2: Asymmetrical Carbon Tax Policies</u>

A USD 20 per ton of CO_2 emissions tax in Indonesia:

2a. Indonesian government retains all carbon tax revenue to increase its consumption;

2b. Indonesian government retains 75 percent of the revenue to increase its consumption and redistributes 25 percent back to low-income households in both rural and urban areas in the form of cash transfers. Shares between rural and urban areas are determined based on poverty incidences;

2c. Indonesian government retains 75 percent of the revenue to increase its consumption and redistributes 25 percent to the industries in the form of a subsidy proportional to the industrial size; and

2d. Indonesian government retains 75 percent of the revenue to increase its consumption and redistributes 12.5 percent to households as well as 12.5 percent to the industries in the form of a subsidy proportional to the industrial size.

Scenario 3: Symmetrical Carbon Tax Policies

A USD 20 per ton of CO_2 emissions tax with 10 percent efficiency gain in the use of coal in all six countries. The four variants remain the same.

Scenario 4: Symmetrical Carbon Tax Policies

A USD 20 per ton of CO_2 emissions tax with 10 percent efficiency gain in the use of oil in all six countries. The four variants remain the same.

Note that fuels here do not refer to crude oil but refers to petroleum products. Also, Oil and Gas as defined in Lee (2008) are assumed to be used solely as feedstock such that they do not emit CO_2. As such, bear in mind that the carbon tax is imposed only on three products, namely coal, petroleum products, and gas.

Also, Scenario 3 to Scenario 4 will not be discussed in details as they simply reinforce the results from Scenario 1 and Scenario 2. The results for the last four scenarios are included in the Appendix to show the robustness and consistency of the results as well as provide policy alternatives for the implementation of a carbon tax. As such, Table 3 shows the results of Scenario 1, a symmetric carbon taxation at USD 20 per ton of CO_2 emissions. Few thing to bear in mind include changes in GDP are “real” as they are calculated at original prices and sectoral changes make up the overall change in GDP.

INSERT TABLE 3 HERE

With the exception of Vietnam, implementing a carbon tax with any variants reduces carbon emissions. However, in some cases, this gain for the environment comes at a cost in terms of contraction in the GDP as well as household income reduction. Redistributing revenue generated to low-income households appears to alleviate the cost associated with the rising price of energy; but this comes at a cost in terms of greater GDP reduction, or lower GDP growth in some cases.

More interestingly is how a carbon tax affects each country differently. Determining which countries stand to gain the most from a carbon tax scheme is not as clear cut as expected as it really depends on how the revenue generated will be redistributed. For Indonesia, a carbon tax has an adverse effect on the economy. However, should the revenue be redistributed back to the industry, Indonesia actually has a chance to gain from implementing such a scheme. In fact, redistributing the revenue back to the industry has a positive effect in terms of rising household income better than a direct transfer to low-income households.

Malaysia and Singapore, on the other hand, exhibit a similar pattern to each other that is in opposite to the Indonesian pattern. Although beneficial in terms of environmental improvement, the cost comes at a contraction to their respective economy. In few words, Malaysia and Singapore almost have no other incentive for implementing a carbon tax in their countries aside from environmental gain.

For Philippines, the pattern is somewhat different in which the best outcome for the country comes from the government keeping all the revenues for itself. Although redistributing some of the revenue gained back to low-income households will not hurt the economy as much either. This is consistent as Philippines does not subsidize its energy sector. As such, it can be assumed that this sector is already running as efficiently as possible. Introducing too many changes to this sector actually creates distortion to the economy that would have an adverse effect to its economy. Thailand exhibits a similar pattern as Philippines although in a lesser extent.

Vietnam is actually the country that would most likely gain from implementing a carbon tax. In all simulations, the net outcome is positive. This might not reflect so much on Vietnamese efficiency as it does on Vietnamese economic development. In terms of economic development, Vietnam is relatively lagging behind the other countries, however, this actually creates a situation in which Vietnam's economy has more room to grow and gain from a carbon tax scheme that is not enjoyed by the other countries. Admittedly, the household income gain in the third variant might seem somewhat exaggerated. However, this does not change the fact that Vietnam consistently gain from implementing a carbon tax scheme in all simulations.

INSERT TABLE 4 HERE

Table 4 on the other hand, shows that Indonesia could still actually gain from implementing a carbon tax unilaterally. This has a serious policy implication for Indonesia as it shows that Indonesia can gain or lose from implementing a carbon tax regardless of whether the other countries do so or not. The more important question for Indonesia is how it chooses to redistribute the income. In this regard, the greatest benefit from implementing a carbon tax scheme in the country arises when Indonesia redistributes the income back to the industrial sector, which would in turn make its industrial sector more competitive despite the added new tax.

INSERT TABLE 5 AND TABLE 6 HERE

In Table 5 to Table 6, technological changes are introduced in the form of efficiency gain in coal and petroleum products usage of 10 percent. These technological improvements are introduced to compensate the lack of intermediate input substitution in the model due to the technical limitation of GAMS[4]. In reality, these technological improvements can be seen as an industrial response to the implementation of a carbon tax in which now industries have an incentive to reduce their usage of coal and petroleum products while maintaining the same amount of output, i.e. efficiency gain. Obviously, the results show that such improvements will have positive effects to the economy.

As such, the question of implementing a carbon tax in ASEAN is no longer a question of whether it should be implemented or not; but a question of how to implement such a scheme to obtain the most benefit in terms of environmental improvement, economic growth, and equity.

4. Conclusion

The main goal of this paper is to understand the impact of coordinated and non-coordinated carbon tax policies on the economy and environmental performance of each country within ASEAN. This question is a relevant one, since, first, though it has been slow, the establishment of ASEAN community will most likely be happening soon in which synchronization of various policies will be required; and, second, some of the ASEAN countries are among the top polluters of CO_2 emission, such that they have to react soon to control their emission.

To be able to answer the above question, this paper builds a multi-country CGE model for ASEAN, known as the IRSA-ASEAN. Before doing so, this paper constructs the ASEAN-SAM as the main dataset for the CGE. This ASEAN-SAM is one of the first comprehensive data systems available for ASEAN, and hence the IRSA-ASEAN becomes one of the more comprehensive economic models for the region. There are several weaknesses of the data system and model built in this paper. The two most important ones are as follows. First, it is that the accuracy of the ASEAN SAM is debatable, mainly due to the uncertainty on the reliability of some of its data sources. For example it remains to be seen how reliable are information available for Vietnam in GTAP version 7 or in any statistical data system. Second, parameters utilized in this CGE do not come from rigorous estimation works

[4] Generalized Algebraic Modeling System (GAMS) is a programming tool used to run the IRSA-ASEAN model.

due to the unavailability of those works. There are many CGE models for Indonesia, some of which have produced reliable analysis, and so adopting parameters from those models is most likely to be appropriate. However, this is not true for other ASEAN countries. Hence, it remains to be seen the quality of parameters adopted in the CGE for this paper.

Taking into account those weaknesses, several conclusions, however, still can be drawn. First, in general, a carbon tax is an effective way of reducing carbon emissions. For most ASEAN countries, even if the revenues from this tax are recycled back to the economy, it does not seem to induce a rebound effect, i.e. more use of energy and so more emission, as can be seen in Table 5 and Table 6.

Second, it is not obvious that ASEAN countries could always expect a double-dividend phenomenon to happen when they implement a combination of carbon tax and recycling policy. It is quite likely that implementing a carbon tax will contract the economies of these countries. Recycling the carbon tax revenue, though it is of outmost importance in terms of softening the impact of this policy on economic growth and household incomes, does not always induce a double dividend phenomenon. Some of the main reasons for this are as follows. Current effective tax rates for the higher polluter countries, namely Indonesia and Vietnam, have been relatively low. And so, there is much room to reduce other taxes to compensate the effects of carbon tax policy.

Third, as each country responds differently to the implementation of a carbon tax, particularly with regards to the revenue re-distribution, an across the board implementation will create “winners” and “losers”. Indonesia gain could, though not always, reap the greatest benefit by implementing a carbon tax and redistributing the revenue back to the economy. Malaysia and Singapore, on the other hand, are the likely “losers” as the implementation of a carbon tax creates an additional distortionary tax with the only possible gain in terms of environmental improvement. Philippines and Thailand stand to gain depending what the respective government does with the revenue, albeit the gains are not as clear. Vietnam is a potential “winner”, although this would more likely reflect the development level of Vietnam, which has more growth potential compared to the other countries, as to the efficiency of its economy.

Fourth, efficiency gain as a response from the industrial sector might alleviate the adverse effects of the additional tax as well. Finally, for Indonesia, which is the highest CO_2 emission among ASEAN members and so is required to response soon, whether other countries in the region implement a carbon tax or not, it does not change outcomes by much. And so, waiting for such a regional cooperation to happen is unnecessary and domestic considerations should be put first.

References

Omitted due to length limitation, but available upon request.

Figure 1. Production Structure of the IRSA -ASEAN Model

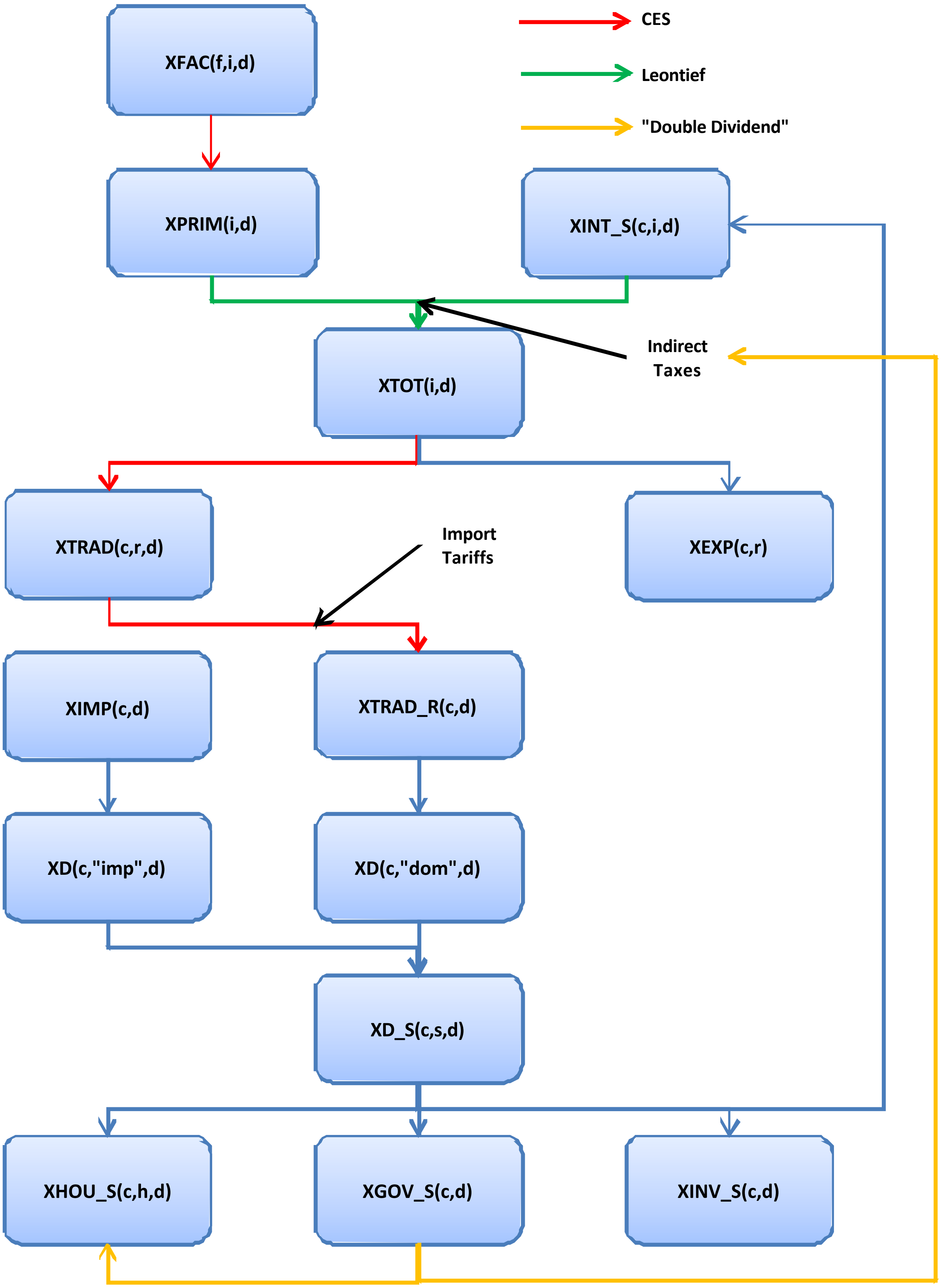

Table 1. List of Sets

Production Sectors

Agriculture
Farming
Forestry
Fishing
Coal
Oil
Gas
Minerals *nec*
Food and beverages
Textile and leather products
Wood and paper products
Petroleum and coal products
Chemical, rubber, and plastic products
Mineral products *nec*
Metal products
Manufacturing
Electricity
Gas manufacture distribution
Water
Construction
Trade
Transportation
Communication
Financial services
Public administration, defense, health, and education
Dwellings and other services

Regions

Indonesia
Malaysia
Philippines
Singapore
Thailand
Vietnam
Rest of the World

Factors

Unskilled Labor
Skilled Labor
Land
Natural resources
Capital

Institutions

Rural-Low Household
Rural-High Household
Urban-Low Household
Urban-High Household
Corporate
Government

Other Accounts

Indirect Tax
Import Tax
Saving-Investment

Table 2. Selected Indicators and Initial Values

	IDN	MYS	PHL	SGP	THA	VNM
Macroeconomic Indicators						
(in USD million)						
Private Consumption	174,751	37,373	58,936	55,286	86,874	29,139
Government Consumption	20,035	11,641	8,754	13,911	16,129	2,798
Fixed Investment	49,317	17,316	14,118	31,396	40,344	15,073
Export	89,212	154,873	51,491	168,038	121,174	32,660
Import	78,612	106,302	48,822	161,818	102,823	36,643
Gross Domestic Product	254,703	114,901	84,476	106,813	161,698	43,027
Sectoral Disaggregation						
(in USD million)						
Agriculture	33,917	6,299	10,004	304	13,590	6,405
Manufacture	96,033	72,203	31,414	29,220	68,253	22,935
Service	124,752	36,397	43,059	77,289	79,855	13,687
Average Income per Capita						
(in USD)						
Rural-Low	460	1,225	215		634	212
Rural-High	1,857	3,506	1,375		1,531	549
Urban-Low	627	1,432	220	10,031	1,194	175
Urban-High	2,812	7,052	2,514	30,785	5,447	1,389
CO_2 Emission	357,387	145,012	76,641	40,838	216,977	86,708
(in Kiloton)						

Source: GTAP Version 7 Data Base and authors' calculation.

Table 3. Simulation Results of Scenario 1

	CO_2	Real GDP	Sectoral Change (%)			Household Income (%)			
	%	%	Agri.	Manuf.	Serv.	Rural-Low	Urban-Low	Rural-High	Urban-High
Simulation 1a									
Indonesia	-7.59	-0.41	-0.54	-2.16	0.96	-3.53	-3.49	-3.06	-0.99
Malaysia	-8.53	-0.95	-0.34	-1.40	-0.17	-2.12	-2.09	-1.92	-1.92
Philippines	-4.66	0.59	-0.09	-0.42	1.49	-0.86	-0.33	-0.29	0.09
Singapore	-2.05	-0.22	-0.04	-0.73	-0.02		-0.60		-0.81
Thailand	-4.40	0.02	-0.32	-1.54	1.42	-1.12	-0.28	-1.11	-0.37
Vietnam	-6.29	0.57	-0.39	-1.33	4.21	-0.37	0.87	-0.08	1.78
Simulation 1b									
Indonesia	-7.70	-0.76	-0.50	-2.16	0.24	-0.62	-2.40	-3.41	-1.87
Malaysia	-8.45	-1.16	-0.24	-1.37	-0.90	5.95	-1.47	-2.32	-2.32
Philippines	-4.65	0.34	-0.04	-0.40	0.96	5.55	0.66	-0.56	-0.26
Singapore	-2.05	-0.30	-0.03	-0.73	-0.13		0.09		-0.92
Thailand	-4.44	-0.30	-0.26	-1.51	0.72	3.19	0.48	-1.53	-1.08
Vietnam	-6.25	0.23	-0.20	-1.23	2.88	3.81	2.68	-0.31	1.13
Simulation 1c									
Indonesia	-5.18	1.61	0.46	0.56	2.73	1.66	1.88	2.43	4.20
Malaysia	-9.44	-2.01	-0.64	-1.98	-2.30	-5.65	-5.34	-4.02	-4.02
Philippines	-7.81	-4.74	-3.11	-5.32	-4.70	-17.73	-16.07	-15.75	-14.50
Singapore	-4.62	-3.31	-0.65	-3.14	-3.39		-6.82		-6.58
Thailand	-6.66	-2.64	-1.40	-3.37	-2.22	-10.91	-9.48	-10.36	-8.60
Vietnam	4.71	7.99	2.74	6.12	13.57	34.86	33.23	38.40	34.95
Simulation 1d									
Indonesia	-6.33	0.53	0.04	-0.69	1.61	0.80	0.01	-0.23	1.40
Malaysia	-8.95	-1.59	-0.44	-1.68	-1.61	0.12	-3.42	-3.18	-3.17
Philippines	-6.23	-2.20	-1.50	-2.87	-1.88	-6.40	-7.93	-8.36	-7.56
Singapore	-3.35	-1.82	-0.33	-1.94	-1.78		-3.42		-3.79
Thailand	-5.55	-1.47	-0.82	-2.44	-0.76	-3.96	-4.57	-6.01	-4.90
Vietnam	-0.47	4.72	1.98	2.94	8.99	19.15	17.85	18.53	17.81

Table 4. Simulation Results of Scenario 2

	CO_2	Real GDP	Sectoral Change (%)			Household Income (%)			
	%	%	Agri.	Manuf.	Serv.	Rural-Low	Urban-Low	Rural-High	Urban-High
Simulation 2a									
Indonesia	-7.08	0.05	-0.34	-1.70	1.49	-2.27	-2.21	-1.82	0.16
Malaysia	0.01	-0.01	*	-0.01	*	-0.02	-0.02	-0.02	-0.02
Philippines	*	*	*	*	*	-0.01	-0.01	-0.01	-0.01
Singapore	-0.03	*	*	0.01	*		-0.02		-0.07
Thailand	*	-0.01	*	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
Vietnam	-0.13	-0.12	-0.05	-0.10	-0.17	-0.34	-0.27	-0.39	-0.29
Simulation 2b									
Indonesia	-7.19	-0.30	-0.30	-1.69	0.77	0.65	-1.11	-2.15	-0.70
Malaysia	0.01	-0.01	*	-0.01	*	-0.02	-0.02	-0.02	-0.02
Philippines	*	*	*	*	*	-0.01	-0.01	-0.01	-0.01
Singapore	-0.03	*	*	*	-0.01		-0.02		-0.07
Thailand	*	-0.01	*	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
Vietnam	-0.13	-0.12	-0.05	-0.10	-0.18	-0.34	-0.27	-0.39	-0.29
Simulation 2c									
Indonesia	-6.93	*	-0.21	-1.05	0.88	-2.78	-2.68	-2.04	0.05
Malaysia	0.01	-0.01	*	-0.01	*	-0.02	-0.02	-0.01	-0.01
Philippines	*	*	*	*	*	-0.01	-0.01	-0.01	*
Singapore	-0.03	*	*	0.02	*		-0.01		-0.05
Thailand	*	-0.01	*	-0.01	*	-0.02	-0.02	-0.02	-0.01
Vietnam	-0.13	-0.11	-0.05	-0.10	-0.17	-0.33	-0.26	-0.37	-0.28
Simulation 2d									
Indonesia	-7.06	-0.15	-0.25	-1.37	0.83	-1.06	-1.89	-2.10	-0.33
Malaysia	0.01	-0.01	*	-0.01	*	-0.02	-0.02	-0.01	-0.01
Philippines	*	*	*	*	*	-0.01	-0.01	-0.01	-0.01
Singapore	-0.03	*	*	0.01	*		-0.02		-0.06
Thailand	*	-0.01	*	-0.01	*	-0.02	-0.02	-0.02	-0.02
Vietnam	-0.13	-0.11	-0.05	-0.10	-0.17	-0.34	-0.27	-0.38	-0.28

*Note: * - negligible value.*

Table 5. Simulation Results of Scenario 3

	CO_2	Real GDP	Sectoral Change (%)			Household Income (%)			
	%	%	Agri.	Manuf.	Serv.	Rural-Low	Urban-Low	Rural-High	Urban-High
Simulation 3a									
Indonesia	-8.29	-0.29	-0.47	-2.03	1.10	-3.32	-3.28	-2.85	-0.80
Malaysia	-9.11	-0.85	-0.29	-1.31	-0.05	-2.02	-1.97	-1.80	-1.80
Philippines	-5.91	0.66	-0.03	-0.36	1.57	-0.63	-0.14	-0.13	0.22
Singapore	-2.04	-0.21	-0.04	-0.72	-0.02		-0.59		-0.79
Thailand	-4.93	0.15	-0.26	-1.40	1.56	-0.94	-0.07	-0.91	-0.14
Vietnam	-7.66	0.74	-0.26	-1.17	4.41	-0.48	0.83	-0.29	1.71
Simulation 3b									
Indonesia	-8.40	-0.64	-0.43	-2.03	0.38	-0.44	-2.20	-3.20	-1.67
Malaysia	-9.03	-1.06	-0.19	-1.28	-0.78	6.01	-1.36	-2.19	-2.20
Philippines	-5.90	0.41	0.02	-0.34	1.04	5.69	0.84	-0.40	-0.12
Singapore	-2.04	-0.29	-0.03	-0.72	-0.13		0.10		-0.90
Thailand	-4.96	-0.17	-0.21	-1.37	0.86	3.35	0.68	-1.33	-0.85
Vietnam	-7.62	0.40	-0.07	-1.07	3.09	3.64	2.61	-0.52	1.06
Simulation 3c									
Indonesia	-5.82	1.80	0.55	0.76	2.95	2.08	2.31	2.85	4.58
Malaysia	-10.00	-1.90	-0.59	-1.88	-2.17	-5.52	-5.21	-3.89	-3.88
Philippines	-9.01	-4.60	-3.00	-5.19	-4.55	-17.32	-15.71	-15.42	-14.20
Singapore	-4.61	-3.30	-0.65	-3.12	-3.38		-6.80		-6.56
Thailand	-7.19	-2.51	-1.33	-3.24	-2.08	-10.70	-9.26	-10.14	-8.36
Vietnam	3.12	8.13	2.77	6.31	13.70	33.80	32.56	36.95	34.16
Simulation 3d									
Indonesia	-7.01	0.68	0.11	-0.54	1.77	1.08	0.30	0.06	1.68
Malaysia	-9.52	-1.48	-0.39	-1.58	-1.48	0.21	-3.30	-3.05	-3.05
Philippines	-7.45	-2.10	-1.41	-2.77	-1.77	-6.12	-7.66	-8.10	-7.34
Singapore	-3.34	-1.81	-0.33	-1.93	-1.77		-3.40		-3.78
Thailand	-6.07	-1.34	-0.76	-2.31	-0.62	-3.78	-4.36	-5.80	-4.66
Vietnam	-1.99	4.86	2.06	3.08	9.14	18.59	17.50	17.79	17.41

Table 6. Simulation Results of Scenario 4

	CO_2	Real GDP	Sectoral Change (%)			Household Income (%)			
	%	%	Agri.	Manuf.	Serv.	Rural-Low	Urban-Low	Rural-High	Urban-High
Simulation 4a									
Indonesia	-12.49	1.10	0.37	-0.78	2.74	-1.44	-1.40	-0.93	1.19
Malaysia	-13.28	0.51	0.47	-0.23	2.00	-0.74	-0.66	-0.32	-0.32
Philippines	-10.58	1.34	0.50	0.08	2.46	0.32	0.79	0.76	1.10
Singapore	-9.96	0.91	0.51	0.51	1.06		0.53		0.37
Thailand	-9.80	1.53	0.96	-0.50	3.36	-0.19	1.23	0.18	1.74
Vietnam	-10.73	1.99	0.71	*	5.93	0.85	1.83	1.07	2.67
Simulation 4b									
Indonesia	-12.59	0.77	0.40	-0.78	2.06	1.31	-0.37	-1.27	0.35
Malaysia	-13.20	0.32	0.57	-0.20	1.30	6.92	-0.08	-0.70	-0.70
Philippines	-10.57	1.10	0.54	0.10	1.96	6.33	1.72	0.51	0.77
Singapore	-9.96	0.83	0.52	0.51	0.96		1.16		0.26
Thailand	-9.82	1.22	1.02	-0.47	2.70	3.87	1.95	-0.22	1.06
Vietnam	-10.69	1.66	0.89	0.10	4.64	4.82	3.55	0.85	2.04
Simulation 4c									
Indonesia	-10.42	2.98	1.28	1.75	4.39	3.38	3.59	4.18	6.03
Malaysia	-14.10	-0.50	0.18	-0.79	-0.06	-4.11	-3.78	-2.35	-2.34
Philippines	-13.39	-3.70	-2.31	-4.53	-3.42	-15.72	-14.18	-13.93	-12.76
Singapore	-12.14	-1.98	-0.04	-1.73	-2.08		-5.27		-5.02
Thailand	-11.87	-1.04	-0.04	-2.26	-0.16	-9.53	-7.60	-8.68	-6.22
Vietnam	-0.56	9.53	3.79	7.50	15.61	35.63	33.61	39.01	35.21
Simulation 4d									
Indonesia	-11.40	1.97	0.89	0.58	3.34	2.62	1.87	1.70	3.42
Malaysia	-13.65	-0.10	0.38	-0.50	0.62	1.37	-1.94	-1.53	-1.53
Philippines	-11.98	-1.30	-0.81	-2.22	-0.74	-4.97	-6.44	-6.89	-6.15
Singapore	-11.06	-0.58	0.25	-0.61	-0.58		-2.10		-2.42
Thailand	-10.84	0.09	0.50	-1.36	1.26	-2.92	-2.89	-4.51	-2.63
Vietnam	-5.38	6.16	3.01	4.25	10.83	19.98	18.43	19.36	18.36

*Note: * - negligible value.*