Full Report

An Analytical Study of Effects of Trade Liberalization on Natural Resources and Environment of Thailand

Khin Maung Nyunt

This research was made possible by the financial support of the National Research Council of Thailand

Mae Fah Luang University/Thai Government
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EXECUTIVE SUMMARY

The present study provides an analytical assessment of trade and environment linkages and their impacts on natural resources and environment of Thailand. The objectives of the research study are to (i) investigate linkages between livelihoods and natural resource-use by analyzing the current utilization rates, associated values and the dynamics of household resource-use; (ii) to examine whether trade results in environmental degradation; (iii) to explore the effect of trade liberalization; (iv) to investigate macroeconomic impacts of environmental trade policies and the welfare implications of Thailand; (v) to investigate the factors determining trade, growth and environment of Thailand based on the integrated assessment; and (vi) to enhance national capacity of Thailand, in particular, to respond effectively the challenging opportunity emerged from the trade, environment, employment and industry.

The research study contains two main parts. First, the present research investigates the effect of trade related policy on natural resource-use in relation to agriculture, forestry, fishery and water resources. Second, it seeks to investigate the effects of various trade and environmental policy scenarios on the economic sectors applying computational general equilibrium (CGE) model. The complementary policy in favor of environment, enhanced competitiveness and sustainable development of Thailand are discussed.

In the first part of micro-level households' resource-use, the study examines broad changes in resource-use based on 213 households in four villages in Chiang Rai Province.

In observing the environmental effects of human activity, the study applies the "Driving Force–State–Response" (DSR) framework employed by the United Nations Commission on Sustainable Development.

The indicators for impact assessment are constructed based on livelihoods, characterizing the rural economy and natural resource-use in relation to agriculture, forestry, fishery and water resources in four villages locating near forests in Chiang Rai Province. This analysis attempts to ascertain the significance of natural resource utilization in the region for rural livelihoods, forest-use in the regional and national economies. It is anticipated that a robust analytical framework for this indicator dataset will enable effective policy implementation. The major economic activities in these villages are agriculture, livestock keeping and fishing. Crop farming constitutes mainly subsistence agriculture. Most of the available arable lands are currently cultivated land and irrigated land.

On land-use pattern of the households under surveys, agricultural land shows 54% of total land in the village, followed by property land 42% as shown in Ban Rong Hai. However, households do not own forest and property lands. Similarly households in Bang Pong Kong do not hold forest land, property land, but agriculture land constitutes 60.9% of total land in the village. The livelihood patters and employment status in these villages for the purpose of observing pressures on resource-use. Number of person with employment in Ban Saew indicates the lowest ratio of 54.6%, while such ratio for Ban Sobyod indicates the highest ratio of 73%. The ratio reflects about 60% each in Ban Pong Rong and Ban Maengern. On household access to health, about 94% to 100% of households in these villages are able to access health services.

The structure of environmental risks associated with natural disaster under survey is reported in Table 3.4. Drought and flood are major risks faced in Ban Sobyod and Ban Mae Khom. In contrast, about 47% of respondents state that there exist drought in the village, while about 42% indicates forest fire in Pa Ka. Soil collapse situation presents the largest risk in Ban Pa Ka and San Ton Pao compared to other two villages under study as shown in Table 3.4.

The effect of trade related policy on natural resource use, in particular, in agriculture and forestry sector, five policy simulations are performed using CGE model in this research as follows:

Simulation 1 (SIM1): 5% tariff cut in agriculture and forestry imports (trade liberalization),

Simulation 2 (SIM1): 20% increase in agriculture and forestry exports,

Simulation 3 (SIM3): 250% increase in capital,

Simulation 4 (SIM4): 300% increase in production tax on industry and

Simulation 5 (SIM5): 200% increase in commodity tax on industry.

In each policy simulation, nine types of effects such as effects on public final consumption of commodity, domestic demand for commodity locally produced, supply of commodity by sector to the domestic market, quantity of product exported by each sector, GDP at market prices, final demand of commodity for investment purposes, demand for type of capital by industry, demand for type of labor by industry, and consumer price stability.

The impacts of each simulation are compared with ones under ‘Base’ scenario focusing on agriculture including forestry sector. In brief, all simulation exercises except

SIM2 (export tax on agriculture including forestry), lead to a decline in public consumption of agriculture and forestry products. A negative effect (-41% decrease) in domestic demand for agriculture and forest products is found under SIM2. On the supply effect, SIM2 provides a negative effect (-40% decline) in agriculture and forest production. The negative effects (about 95% to 100% decline) in exports are found in all policy simulations. On investment effect by sector, SIM1 (trade liberalization) and SIM2 offers positive effects. SIM1 also provides a positive employment effect, i.e. 140% increase in employment in agriculture and forestry sector. The welfare in the context of GDP also increases by 21% and 6% under SIM1 and SIM6 (commodity tax) respectively indicating that the tariff liberalization of forestry import generates better scenario compared to the production tax (SIM5) and commodity tax (SIM6). The use of production tax and commodity tax enable to reduce or control over public consumption in agriculture and forest products at the expense of national welfare.

In brief, in selecting policy alternatives to meet simultaneously couples of objectives such as welfare and price stability, the desirable policy alternatives can be exercised using this framework. Similar reasoning can be applied in selecting policy alternatives to meet couples of objectives such as trade objective and environmental objectives in the integrated framework.

ABSTRACT

The present research seeks to examine the impact of trade liberalization on the natural resources and environment of Thailand based on micro-level household survey and macro level analysis. This study contains two main parts. First, it investigates the effect of trade related policy on natural resource-use in relation to agriculture, forestry, fishery and water resources. The analysis applies "Driving Force – State – Response" (DSR) model in order to establish better linkages between livelihoods and natural resource conservation. This study analyses the current utilization rates and associated values and investigates the dynamics of household forest-use based on 213 households in four villages in Chiang Rai Province. Second, it seeks to investigate the effects of various trade and environmental policy scenarios on the economic sectors focusing on natural resource and environment applying computational general equilibrium (CGE) model. The complementary policy in favor of environment, enhanced competitiveness and sustainable development of Thailand are examined. In selecting policy alternatives to meet simultaneously couples of objectives such as welfare, price stability and the environmental policy alternatives can be applied in the integrated framework as employed in this research.

Key words: Drivers-Pressure-State-Response model, CGE, trade liberalization, environmental regulation and eradication of poverty.

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Chapter 1

Introduction

The trade liberalization policies and agreements are based primarily on an assessment of regulatory effects including product process, standards, economic instruments and subsidies, etc. On the basis of such regulatory framework, complementary mechanisms can be developed for the re-enforcement of environmental regulations, levying taxes or charges to contribute to a green growth. The present study aims to provide an analytical assessment of trade and environment issues and their impacts on natural resources in relation to agriculture, forestry, fishery and water resources of Thailand. It also attempts to seek complementary policies in favor of environment and enhance competitiveness and sassed sustainable development of Thailand.

This research begins with the related baseline environmental conditions of Thailand. Subsequently to examine broad changes in resource-use at selected village level due to the trade liberalization. Next, the effects of various trade and environmental policy scenarios on the economic sectors are analyzed focusing on natural resources and environment. Moreover, alternative measures are devised to enhance positive environmental effects in the long run and reduce potential negative environmental effects. The findings of research advocate different policy responses, including: (i) modification of some aspects of the trade policy;(ii) inclusion of environmental safeguards in the trade liberalization; and (iii) implementation of a complementary environmental mechanism to integrate the trade policy.

In micro-level study, households' resource-use surveys are conducted to examine the effect of trade liberalization on natural resource use based on household resource use patterns and their perception on environmental impacts. Major causes of environmental degradation problems focusing on (a) the existence of polluting production and certain kinds of consumption, (b) the use of strategic environmental trade policy such as pollution tax, and (c) the presence of policy failures due to the subsidies for polluting and resource- degrading activities such as subsidies to agriculture is examined.

The research under national level study attempts to compare and contrast the current status of development of trade and environmental impacts, in particular, impact on allocation of natural resources: land, labor and capital embodied in the production of traded-goods.

The trade barriers that generally contribute to poor environmental policy are explored and the effective environment and trade policy and measures are investigated. It also attempts to measure the effect of environmental regulations on the competitiveness in the certain industries. It finally discusses public policy in trade and environment, and an empirical study of the impact of trade liberalization on agricultural, forestry and macroeconomic performances of Thailand.

1.1 Objectives

The objectives of the research study are to (i) investigate linkages between livelihoods and natural resource-use by analyzing the current utilization rates, associated values and the dynamics of household resource-use; (ii) to examine whether trade results in environmental degradation; (iii) to explore the effect of trade liberalization; (iv) to

investigate macroeconomic impacts of environmental trade policies and the welfare implications of Thailand, (v) to investigate the factors determining trade, growth and environment of Thailand based on the integrated assessment, and (vi) to enhance national capacity of Thailand, in particular, to respond effectively the challenging opportunity emerged from the trade, environment, employment and industry.

1.2 Scope, Method of Study and Statement of Problem

The research study contains two main parts. First, the present research investigates the effect of trade related policy on natural resource-use in relation to agriculture, forestry, fishery and water resources. Second, it seeks to investigate the effects of various trade and environmental policy scenarios on the economic sectors applying computational general equilibrium (CGE) model. The complementary policy in favor of environment, enhanced competitiveness and sustainable development of Thailand are examined.

However, the present research employs by reconciling of trade theory, field surveys and econometrics technique, bridges the gap in study in this area. This research covers the analysis of public policy issues on the impact of trade liberalization on environment as well as the effect of environment policy upon the trade of Thailand. Finally empirical study of effect of trade on natural resources is investigated applying relatively robust methodology as mentioned above.

Statements of the Research Problem in this study are identified as follows:

(i) To examine the trade related policies and environmental regulations which influence the environment of Thailand by developing trade and environment indicators.

(ii) To examine the simultaneous impact of trade liberalization on agricultural, forestry and macroeconomic performances applying recent development in trade-environment research.

(iii) To measure the magnitude and direction of trade-related environmental effects that Thailand may face among five commonly defined effects viz.: product effects, technology effects i.e. changes in factor demand, economy of scale effects, structural effects and regulatory effects.

In light of sustainable development through international trade of Thailand, it is crucial to review the potential impact of trade liberalization on the environment, which would contribute to effective public policy in environmental management.

1.3 Literature Review

In analyzing the impact of international trade upon the environment, there exists primarily three main impacts: the natural resource effects, pollution effects, and health and safety affects. The present research focuses extensively on the first category. In addition, the issues in trade and environment research can be classified as follows: (a) the nature of macroeconomic impacts, (b) patterns of trade and comparative advantage, (c) terms of trade, (d) patterns of production and consumption, (e) linkages between trade, environment and the economy, (f) pollution redeployment to developing countries, (g) environmental degradation, (h) factor rewards and (i) the “Driving Force – State – Response” (DSR) model.

To achieve these goals the various methodologies have been applied recently in the literature and these approaches can be summarized as follows: (a) computable general

equilibrium models, (b) international trade models, (c) input-output models, (d) welfare analysis models, (e) game theoretic models, (f) optimization models, (g) spatial geographic information system (GIS) models, and (h) econometric models.

The insightful surveys of the empirical literature on this issue can be seen in the recent studies of Dean (1992), Ulph (1994), van Beers and van den Bergh (1996), and Xing and Kolstad (1996). In particular, the studies on natural resources and trade have been undertaken by Puttock and Sabourin (1992) and Park and Labys (1999). There are two general approaches to the integration of trade and environment. The first allows the trade possibilities into the standard closed-economy model of resource use to determine whether the results obtained from the closed economy carry-over to the open economy. The second approach introduces natural resources in a standard trade model to determine how these affect trade and whether standard trade theory explains the effects on the environment.

However, the issues toward linkages between trade and the global environment remain heavily disputable as can be seen in the studies of Grossman and Krueger (1993), World Bank (1992), Bhagwati (1993), Daly (1993a,b), Chichilnisky (1994), Copeland and Taylor (1997), Perroni and Wigle Taylor (1994), and Lopez (1994). In the debate over the environmental consequences of free trade, Bhagwati (1993) and Daly (1993a) argue that both trade and environmental protection can be advanced by imaginative solutions. Even growth enables governments to tax and to raise resources for objectives such as pollution abatement and the general protection of the environment. Moreover, an evidence also suggests that some environmental quality indicators improve as income increases.

Alternatively, Daly (1993b) proposes that trade can induce environmental degradation and that degradation can lead to income losses and these income losses can result in further environmental degradation. Copeland and Taylor (1997, 1999) have employed a theoretic framework for this hypothesis as the "trade-induced degradation hypothesis".

As far as the effect of trade on natural resources are concerned, most theoretical and empirical studies are based on modifications of the Heckscher-Ohlin (H-O) model. These studies include McGuire (1982), Merrifield (1988), Siebert (1992), and Diao and Roe (1997). One modification is to treat environmental damage avoidance as the third goods in the model, the output of which competes with the production of other two conventional goods. Another modification introduces environmental indicators as factors of production. Recent research in this area includes McGuire (1982), Merrifield (1988), and Siebert (1992). In most trade-environment research, the cross-sectional (H-O-V) has been widely used.

Another empirical model successfully applied to international trade is the gravity model as can be seen in the studies of Hamilton and Winters (1992), van Beers and van den Bergh (1997), and Wall (1999). Extending the basic gravity model to include of domestic environmental policy variables, van Beers and van den Bergh (1997) empirically explore the impact of environmental measures on particular trade flows. Two types of environmental indicators: one relating to economic costs of the environmental policy imposed on producers in a narrow sense, and another indicating environmental indicators in a broad sense. It found that the impact of broad policy indicators that do not directly reveal environmental costs is not significant, while more narrow policy indictors

that are more directly in line with the "polluter pays principle" do have a significant negative impact on exports.

The literature survey suggests that most commonly used methodologies in the trade and environment issues vary in accordance with the area of research concerned. Among them, an econometric application of the Heckscher-Ohlin-Vanex (H-O-V) model to trade and environmental issues made by Tobey (1990) extends the conventional H-O-V model by introducing a qualitative variable into the net-export and endowment equation to represent the environmental endowment measured by the stringency of environment policy. It is worth noting that the previous empirical research in trade and environment using H-O-V and the gravity model indicates the cross-sectional analyses in nature and thus it demands time-series approach to this problem to explain the long-run effects. The proposed research will develop a variant of H-O-V model of Thailand.

Tobey (1990) extends the conventional H-O-V model by introducing a qualitative variable into the net-export and endowment equation to represent the environmental endowment measured by the stringency of environment policy. Other resource endowments include capital, different types of labor and land uses, coal, minerals, and oil. Five aggregate pollution-intensive commodity groups are examined: paper, mining, iron and steel, nonferrous metals, and chemicals. Econometric estimation of the model is based on observations from 13 developed and 10 developing countries. In brief, the above mentioned H-O-V and the gravity model indicate the cross-sectional analyses in nature and there are lack of specific time series applications in this area.

In assessing environmental assessment The Pressure-State-Response (PSR) Framework which has been widely used. In particular, a widely used that can be found in

the studies of the Organization for Economic Cooperation and Development's “Pressure - State - Response” (PSR) framework (OECD, 1991, 1993). This framework has formed the basis for recent developments of the Driving Force- State- Response (DSR) and the Driving Force, Pressure- State- Impact- Response (DPSIR) Frameworks. The OECD PSR framework does not attempt to specify the nature or form of the interactions between human activities and the state of the environment.

1.4 Expected Outcomes

This research using both the environmental assessment indicators in relation to driving force, state, and response under DSR model and trade-environment modeling technique investigates the magnitude and sign of effects of trade liberalization on environment and growth of Thailand. The results rest primarily on the degree of openness, provision of environmental safeguards and level of economic development. The research findings aim to contribute to the following areas:

(a) effects of trade liberalization upon agricultural, forestry and other sectoral effects, and the use of trade policies for environmental purposes;

(b) use of environmental policy measures as strategic trade instruments to protect industries and stimulate growth;

(c) effects of environmental regulations on comparative advantage, specialization, industrial redeployment, trade patterns and terms of trade; and

(d) reconciliation of the conflicting objectives of trade policy and environmental policy.

This research attempts to provide insightful information on trade and investment with environmental focus to the following organizations: (a) Office of the National

Resources and Environment Policy and Planning, Thailand, (b) Department of Industry and Mineral Resources, (c) Department of Trade Promotion, (d) Environmental Impact Evaluation Bureau and (e) Others such as NGO (Non-government Organizations) in Thailand.

With respect to technology transfer and or contributions, since there exists a relatively few empirical research in this area and thus it contributes the existing related literature and research with the robust methodology. It would enable to contribute the environmental management in the related ministries in Thailand and suggests effective environmental management practices to other transition economies in Greater Mekong Sub-region (GMS) countries.

Chapter 2

Land-Use Structure and Regulatory Development and Trade in Forestry Products

2.1 Natural Resource Management in Thailand: Institutional Perspectives

The Nation Forest Policy has set a more realistic target of forest area of 128 million rai (or 40 % total land area) as forest area in 1985, in which about 15% was conservation forest and the remaining 25% was commercial forest.

The Fifth National Economic Development Plan of Thailand clarified nation policy regarding land reform project, a landholding ceiling, the establishment of land kind, and land settlements. The Sixth Plan also emphasized land reform, particularly for private land–through the establishment of a land bank again, improving the land tax system, and carrying the land settlement projects on the land already allotted. The legal statue for both forestry and land use are closely related.

Mechanisms for Thailand land reform Act started in 1975. The Agricultural Land Reform Act specifies the meaning of land reform as "the improvement of agricultural land tenure and land rights and the distribution of land for farming and residence." Under this act, land was to be made available by the government or expropriated from private owners who held land in excess of the legally prescribed amount or who were not themselves making proper use of the land. As of September 1985, Agriculture Land

Reform Office has designated areas in 109 districts and district subdivisions in 34 provinces in the Central, North, and Northeast as agricultural land reform areas.

Thailand is situated in the tropical zone, covering two main types of tropical forest—deciduous and evergreen. Total forest areas comprise 107 241 thousand rai in 2009 and thus 35.1 percent of the country is covered by forests. Rice and crop land showed 660, 776 thousand rai (7.81%) and 27400 thousand (7.3%) respectively. In terms of forest by region, the forest area constitutes 49.59 percent in the North; 25.56 percent in the Central Plain; 21.90 percent in the South; 21.89 percent in the East ; and 14.35 percent in the Northeast. About 31.7% of land indicated unclassified land.

Table 2.1 Land Use Area: 1993-2009 (Thousand Rai)

Land use type	1993	1998	2003	2008	2009
1. Total land (1+2+3+4)	320696	320696	320696	320696	320696
2.Area of agricultural holding	89786	83471	106319	106319	131595
3. Forest land	118762	111674	112685	112634	107241
Rice	65786	62680	58915	56951	66077
Field crop/vegetable/herb, flowers	26440	22570	22928	23556	27400
Permanent crop/rubber	20984	22246	22852	25506	28517
Pasture and pen	1469	467	1199	1744	1004
fresh water culture	-	-	1225	1044	-
Others	4171	3710	5564	3831	8596
4. Unclassified land	112057	125551	101692	101743	81860

Source: *Thailand Environment Statistics 2012,* National Statistical Office, Bangkok.

Table 2.2 Land Use Area: 1993-2009 (Percent)

	1993	1998	2003	2008	2009
1. Total land (1+2+3+4)	100	100	100	100	100
2.Area of agricultural holding	28	26	33.2	33.2	33.2
3. Forest land	37	34.8	35.1	35.1	35.1
Rice	20.5	19.5	18.4	17.8	17.8
Field crop/vegetable/herb, flowers	8.2	7	7.1	7.3	7.3
Permanent crop/rubber	6.5	6.9	7.1	8	8.0
Pasture and pen	0.5	0.2	0.4	0.5	0.5
fresh water culture	-	-	0.4	0.3	-
Others	1.3	1.2	1.8	1.2	0.3
4. Unclassified land	35	39.2	31.7	31.7	31.7

Source: *Ibid.*

In Thailand, the Protected Areas Strategy policy has made a commitment to increase Northern Thailand's protected areas from the existing 6% to 12% of the total land base. Such restrictions on the use of land may have implications for resource dependent regional economies. In the long run, these restrictions on land use may improve environmental quality and thus promote growth in tourism and service sectors.

The economy of the province of Thailand is dependent mainly on its resource base industries, in particular, agriculture, forestry and fishery. Primary resource industries account for approximately 23% of the provincial economy and 13% of the total employed labour force. This suggests that any change or shock in resource based sectors may have an environmental impact.

2.2 Trade in Forest Products

Trade in Forest Products constitutes a particular challenges in trade and environmental policy making in Thailand. The extraction and use of natural resources need to make adjustment to balance the competing needs of current and future generations. The manner in which they are traded and managed have important environmental and sustainability implications. There also exists volatility in domestic prices and exchange rates that affect traded forest products. Thus a number of characteristics peculiar to natural resources influence the manner in which they are traded and the nature of the rules applied to this trade. Differing international and inter-generational interests inherent in natural resources trade make transparent, predictable, well-designed and equitable trade rules particularly valuable. The evidence also suggests that scarce natural resource endowments must be nurtured, managed strategically and attached to trade policies to gain country welfare.

The volume of exports and imports of sawn timber and logs in the absence of effect of exchange rate on forest product are reported in Table 2.2 for the period 1993-2008. The import share of log in total import of log fell from 43% in 1993 to 14.1% in 2008, while the import share of sawn timber in total import of sawn timber increased from 56.9% in 1993 to 86.5% in 2008. The volume of import of log fell from 1366 thousand cu.m in 1993 to 234.1 thousand cu.m in 2008 indicating the growth rate of -82.9%. In contrast, the volume of import of timber fell from 1801 thousand cu.m in 1993 to 1430 thousand cu.m in 2008 indicating the growth rate of -20.6%.

The export share of log in total import of log remained unchanged as 4% during the period:1993-2008, while the export share of sawn timber in total import of sawn

timber increased from 5.7% in 1993 to 61.2% in 2008. The volume of export of log increased from 13.6 thousand cu.m in 1993 to 6.3 thousand cu.m in 2008 indicating the growth rate of -53.9%. In contrast, the volume of export of timber fell from 180 thousand cu.m in 1993 to 1013 thousand cu.m in 2008 indicating the growth rate of 462.6%.

Table 2.3 Import and Export of Logs and Sawn-Timber

Unit : 1,000 cum.

Year	Imports			Exports		
	Total	Logs	Sawn timber	Total	Logs	Sawn timber
1993	3,168.2	1,366.0	1,801.5	316.8	13.60	180.1
1994	4,065.7	1,548.0	2,516.8	406.6	15.40	251.6
1995	3,463.5	1,378.0	2,085.6	346.4	13.70	208.5
1996	3,151.8	936.0	2,215.5	316.2	9.30	221.5
1997	2,358.6	89.5	1,463.0	235.9	8.90	146.3
1998	1,239.6	278.0	961.2	108.2	11.90	96.2
1999	1,723.5	468.5	1,255.0	231.6	0.04	231.6
2000	1,514.4	487.3	1,027.0	378.7	0.15	378.5
2001	1,802.3	516.8	1,285.4	402.9	0.35	402.5
2002	2,565.9	641.3	1,924.5	1,562.2	3.06	1,559.1
2003	2,030.4	380.1	1,650.2	1,105.8	0.08	1,105.8
2004	2,216.6	381.3	1,835.2	1,790.9	1.48	1,789.5
2005	2,335.3	395.5	1,939.7	1,369.9	7.99	1,361.9
2006	1,227.2	293.2	934.0	1,316.1	2.50	1,313.6
2007	1,933.3	231.0	1,702.2	1,739.9	5.37	1,734.5
2008	1654.7	234.1	1430.5	1019.47	6.27	1013.2

Source: *Thailand Environment Statistics 2010,* National Statistical Office, Bangkok.

Table 2.4 Import and Export of Logs and Sawn-Timber (In percent)

Year	Imports			Exports		
	Total	Logs	Sawn timber	Total	Logs	Sawn timber
1993	100.0	43.1	56.9	10.0	0.4	5.7
1994	100.0	38.1	61.9	10.0	0.4	6.2
1995	100.0	39.8	60.2	10.0	0.4	6.0
1996	100.0	29.7	70.3	10.0	0.3	7.0
1997	100.0	3.8	62.0	10.0	0.4	6.2
1998	100.0	22.4	77.5	8.7	1.0	7.8
1999	100.0	27.2	72.8	13.4	0.0	13.4
2000	100.0	32.2	67.8	25.0	0.0	25.0
2001	100.0	28.7	71.3	22.4	0.0	22.3
2002	100.0	25.0	75.0	60.9	0.1	60.8
2003	100.0	18.7	81.3	54.5	0.0	54.5
2004	100.0	17.2	82.8	80.8	0.1	80.7
2005	100.0	16.9	83.1	58.7	0.3	58.3
2006	100.0	23.9	76.1	107.2	0.2	107.0
2007	100.0	11.9	88.0	90.0	0.3	89.7
2008	100.0	14.1	86.5	61.6	0.4	61.2

Source: calculation based on Table 3.

Figure 1

Import of Log and Timber

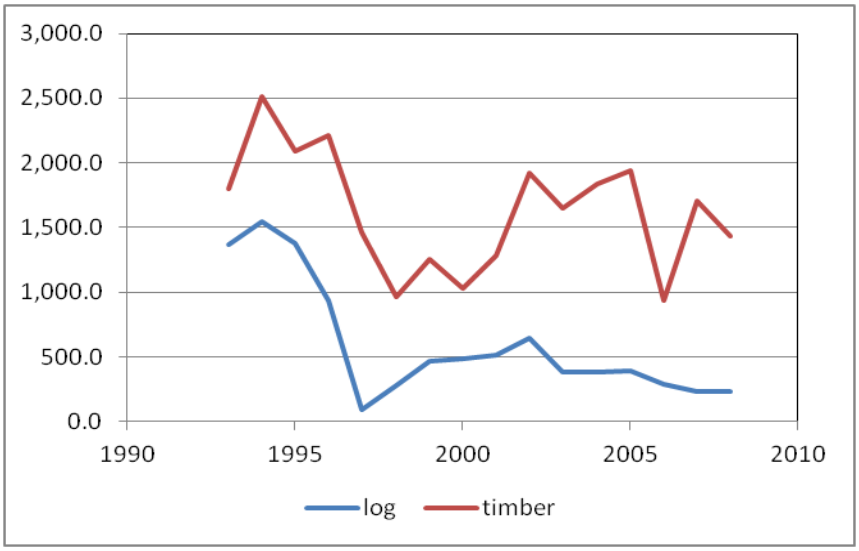
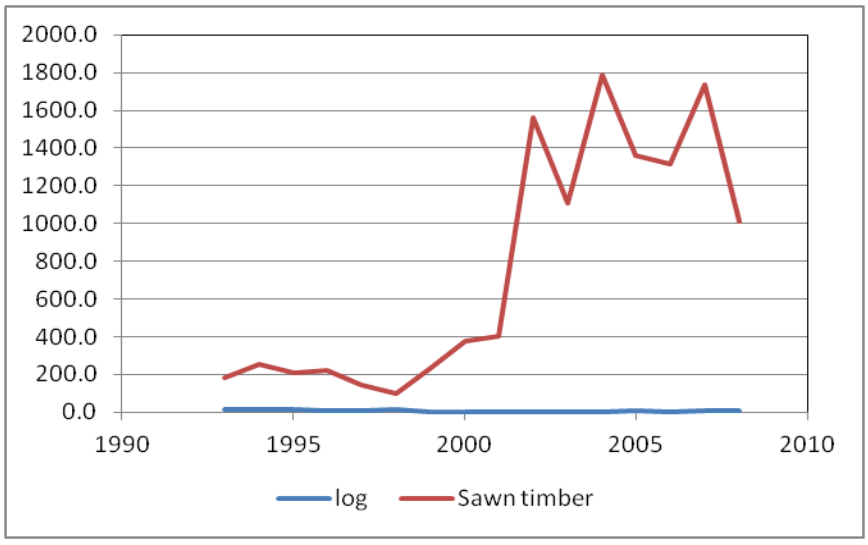


Figure 2

Export of Log and Timber



2.3 The Effect of Trade Liberalization in Resources

It has been widely accepted that Thailand's economic growth over the last three decades has been driven by rapid industrialization, urbanization, and extensive use of natural resources: agricultural, forestry, fishing and mining. This growth, result in a certain level of degradation in land, forest and water quality, loss of natural habitats, and generated increasing levels of air and water pollution. The Government and public sector of Thailand has launched new initiatives to improve air and water quality, reforest degraded land, adopt energy efficient technologies and invest in pollution abatement technologies.

Conversion of land from forest land to agriculture or residual land, slash-and-burn agriculture, and extensive exploitation of water have added to rapid deterioration of natural resources. The deforestation has led other environmental problems, such as climate change, conversion to dry lands, sedimentation of rivers, and loss of natural habitats. In the fisheries sector, over-harvesting of marine fisheries has reduced and coastal areas have been seriously degraded by expansion of capture fishing, shrimp aquaculture, industry and tourism. Thus the integrated approach to sustainable resource management is being pursued to eliminate harmful subsidies (e.g. for pesticides and over-fishing), and to assist in the capacity building of local institutions and communities.

Thailand shows quite successful in improving air quality in urban areas, specifically Bangkok. Emissions from traffic are being reduced due to the introduction of unleaded gasoline and compulsory catalytic converters as early as 1995. The establishment of various emission standards in Thailand also could reduce air pollution.

In order to reduce Ozone Depleting Substances (ODS), the World Bank is assisting Thailand in implementing a National CFC Phase-out Plan.

Rapid industrial expansion, population growth and urban migration also added pollution (e.g. solid and hazardous waste, air, noise, and water). The World Bank points out that fine particles in Bangkok's air exceed WHO standards by 2.5 times, and other air pollutants are also causing major health impacts. Overall, it is estimated that air and water pollution costs the country 1.6 - 2.6 percent of GDP per year. It is also found that volumes of untreated domestic sewage, industrial wastewater and solid hazardous wastes have affected water resources. The result suggests that about one third of Thailand's surface water bodies are considered to be of poor quality and thus it calls for more effective enforcement of environmental laws; stronger institutional capacity, both national and local; and increased investments in pollution prevention and control, with private sector participation.

Carbon emission in transportation sector contributed 28.1 percent of all Thailand CO_2 emissions in 2008 and it declined to 27.2% in 2011. CO_2 emission of the power sector account for more than 39.6 percent of the total CO_2 emissions in 2006 and increased to 41.5% in 2011. (Table 5). It is interesting to note that transport sector forms the bulk of CO2 emissions from oil product combustion. Only small amounts are emitted in commercial and residual area, where it was 5345 ton in 2006 compared to 7811 ton in 2011. There is considerable amount of CO_2 emission under manufacturing is reported.

Table 2.5

Estimated Carbon Dioxide Emission by Sector: 2006-2011

(Thousand ton)

	2006	2007	2008	2009	2010	2011
Transportation	53818	54554	52380	55342	54015	53675
%	28.1	27.9	26.4	28.0	27.3	27.2
Power	75839	82087	83370	81797	82517	82033
%	39.6	42.0	42.1	41.4	41.7	41.5
manufacturing	45567	42318	45023	42786	44108	43965
%	23.8	21.6	22.7	21.6	22.3	22.3
Commercial and residential area	5345	5849	6389	6916	7324	7811
%	2.8	3.0	3.2	3.5	3.7	4.0
Others	10712	11039	10984	10816	10816	10024
%	5.6	5.6	5.5	5.5	5.5	5.1
Total	191281	195647	198146	197657	198059	197508

Note 1. Excluding emission from renewable energy and international bunker oil, diesel and jet fuel.

2. Electricity generation from power sector excluding hydro ectric.

3. Others include agriculture, construction and mining.

Source: Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand.

2.4 Sustaining Natural Resources: Institutional Framework

The development of environmental regulations in Thailand is examined from institutional perspective in this section. These regulations of Thailand are summarized sources as follows:

1. Constitution of Kingdom of Thailand, 1997

(i) Recognition of traditional local communities participation

(ii) Legal protection quality, healthy and consistent survival

(iii) Right to be informed, explained and reasoned

(iv) State obligation to encourage, promote peoples participation on preserving, maintaining and utilization natural resources and biological diversity

(v) Conservation natural resources in in accordance with law

(vi) Powers and duties of local government

2.Thailand National Forest Policy, 1985

3. national reserved forest Act 1964

4. national park Act 1961

5. wild life preservation and protection act 1992

6. land code 1954 and land code promulgation act, 1954

(i) application for land certificate

(ii) land and state ownership of land

(iii) insurance of land title documents

7. The Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (NEQA 1992)

8. (NEQA 1992) Pollution Prevention and Mitigation Policy in accordance with the Policy and Perspective Plan for Enhancement and Conservation of the National Environmental Quality 1997-2016

9. Water Quality Standards (August 2009)

10. Air Quality and Noise Standards (October2007)

11. Soil Quality Standard (November 2004)

12. Notification of Pollution Control Department (in Thai)

13. Other Laws Related to Pollution Control

14. Pollution Control Officials and Other Competent Officials

15. Example of Environmental Enforcement (in Thai)

16. Environmental Regulation of Prime Minister's Office (in Thai)

In brief, the evidence suggests that Thailand has established relatively the regulatory and institutional development in this area.

Chapter 3

The Livelihood Patterns, Natural Resource-Use and Environmental Effects: Case Study of Households Living Near Forests in Chiang Rai

3.1 Framework of Analysis: Driving Force- State- Response

In assessing the environmental effects of human activity, the Pressure- State- Response (PSR) Framework which has been widely used, that can be found in the studies of the Organization for Economic Cooperation and Development (OECD, 1991, 11993). This framework has formed the basis for recent developments of the Driving Force- State- Response (DSR) and the Driving Force, Pressure- State- Impact- Response (DPSIR) Frameworks. The OECD's PSR framework does not attempt to specify the nature or form of the interactions between human activities and the state of the environment.

The PSR framework merely states that human activities impose pressures (such as pollution emissions or land use changes) on the environment, which can induce changes in the state of the environment (for example, changes in ambient pollutant levels, habitat diversity, water flows, etc.). Society then responds to changes in pressures or state with environmental and economic policies and programs intended to prevent, reduce or mitigate pressures and/or environmental damage. Indicators for this model can be

powerful tools to identify and support PSR relationships, both at the reporting stage and subsequently during policy analysis.

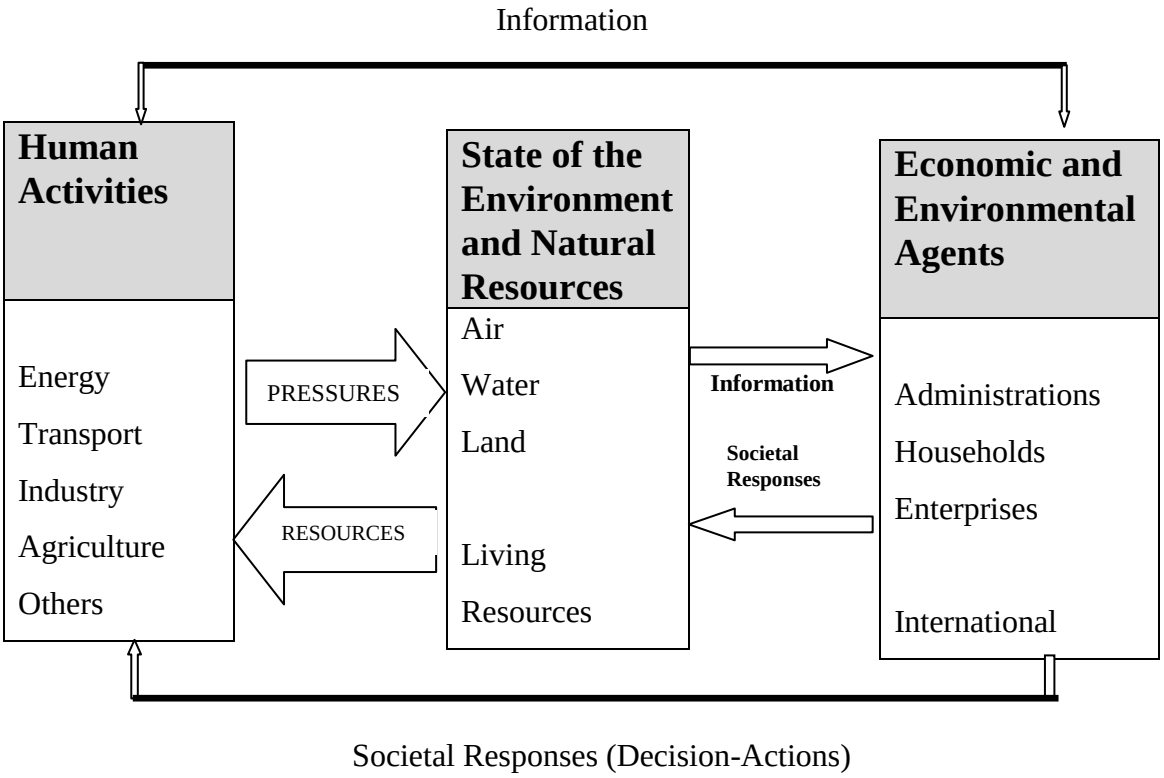
For example, the pressure on the environment is caused by the application of pesticides and it results in impact on the levels of pesticides in groundwater. The response to increasing levels of chemical residues in groundwater is to use the financial instrument of taxation to modify the levels of pesticide use that are responsible for the pressure. It suggests the need for continued monitoring of the situation.

One of the main problems has been trying to differentiate between pressure and state indicators, and the need to expand the framework to work more specifically with the needs for describing sustainable development. A development of PSR has been the Driving Force–State–Response (DSR) framework selected by the United Nations Commission on Sustainable Development.

PSR Model

The PSR Framework for Sustainable Development (DSR), the components are provided below.

PRESSURE	STATE	RESPONSE

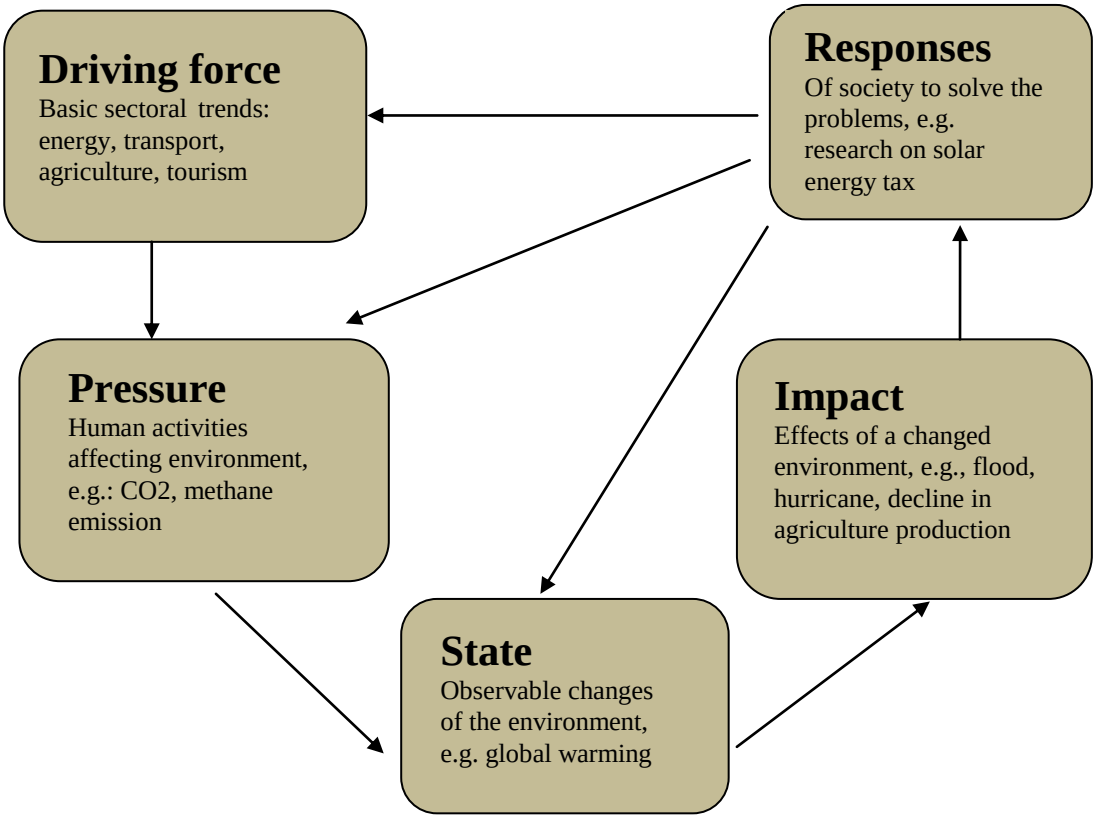


Driving Force - State - Response Model

In the Driving Force - State - Response Framework for Sustainable Development (DSR), the components are depicted below.

The DPSIR Framework

for Reporting on Environmental Issues



•Driving Force: human activities, processes and patterns that impact on sustainable development

•State: the state of sustainable development

•Response: policy options and other responses to changes in sustainable development

In the DSR framework, the term “Pressure” has been replaced by that of “Driving force” in order to accommodate more accurately the addition of social, economic, and institutional indicators. In addition, the use of the term "driving force" allows that the impact on sustainable development may be both positive and negative as is often the case

for social, economic, and institutional indicators. The DSR framework is actually a matrix that incorporates three types of indicators horizontally and the different dimensions of sustainable development vertically, namely social, economic, environmental, and institutional. State of the environment indicators in the DSR framework can be established to bring scientific findings to the policy-makers. The indicators should principally have an explicit target group in the country or region under study. A set of indicators under this model reflects a means devised to reduce a large amount of data to a simpler form, while retaining essential meaning of the data. However, even this model is changing, and the EU is now looking at the "Driving Force - Pressure - State - Impact-Response" (DPSIR) Framework, where

D: Driving forces constitute factors influencing a variety of relevant variables. Examples: the number of cars per inhabitant; total industrial production; GDP.

P: Pressure indicators describe the variables which directly cause environmental problems; examples: toxic emissions, CO_2 emissions, noise etc. caused by road traffic; the parking space required by cars; the amount of waste produced by scrap cars.

S: State indicators show the current condition of the environment; examples: the concentration of lead in urban areas; the noise levels near main roads; and the global mean temperature.

I: Impact indicators measure the ultimate effects of changes of state. Example: the percentage of children suffering from lead-induced health problems; the mortality due to noise-induced heart attacks; the number of people starving due to climate-change induced crop losses.

R Response indicators demonstrate the efforts of society (i.e. politicians, decision-makers) to solve the problems; examples: the percentage of cars with catalytic converters; maximum allowed noise levels for cars; the price level of gasoline; the revenue coming from pollution levies; the budget spent for solar energy research.

The DPSIR model is an extension of the PSR (Pressure-State-Response) model, developed by Anthony Friend in the 1970s, and subsequently adopted by the OECD's State of the Environment group.

3.2 Driving Forces, Pressure, State, Response Model Survey Results

This section investigates linkages between livelihoods and natural resource-use by analyzing the current utilization rates, associated values and the dynamics of household resource-use. The surveys were conducted in four villages namely: Ban Sobyod, Ban Pong Kong, Ban Maengern and Ban Saew, in Chiang Rai Province where 35% of forest are located geographically. The sample size includes 231 household and stratified random sampling is used.

Objective of this study are as follows:

(i) to examine livelihood patterns in villages situated near forests, that can impose pressure on forest resource use ,

(ii) to investigate resource-use pattern and the associated risk structure and

(iii) to mitigate impact of livelihood patterns on resource-use and to provide recommendations on the improvement activities and management practices.

The Survey instruments in this survey reflects:

1. Driving forces

(i) Basic demographic profile (family size, gender, age distribution, internal growth, migration),

(ii) Property assets (private land, production assets),

(iii) Resource utilization (land tenure and land-use systems (land allocation, security, harvesting rates),

(iv) Livelihood patterns (main occupations, sources of income, income shares from natural resource use/ecosystem services, expenditure, access to health),

(v) Wealth and income expenditure distribution,

(vi) Infrastructure development (transport, water, energy, irrigation, communication, markets)

2. State: state of environment

3. Response activities

(i) resource management practices

(ii) conservation measures

4. Impact

(i) Change in resource-use and

(ii) Risks / natural resource related problems.

Table 3.1 Survey Design and Sample Unit

District	Village no (Moo)	Name of Village	Number of household interviewed
Chiang Rai Province			
Chiang San	5	Ban Sobyod, Moo 2	62
Chiang San	7	Ban Pong Kong, Moo 10	56
Chiang San	12	Ban Maengern, Moo 12	25
Chiang San	5	Ban Saew, Moo 4	70
Total		4 Villages	213

Population characteristics of households in selected villages in Chiang Rai Province are provided in Table 3.1. The male household head constitutes about 72% to 82% of households in Ban Sobyod, Ban Pong Kong and Ban Maengern, while in Ban Saew, female household head shows 82% of total population under survey. The population structure composes of male (80%) and female (20%) under study. The

livelihood patterns and employment status of household for observing potential pressures on natural resource-use, in particular, in the forest and fishery. On employment number of person with employment in Ban Saew indicates about lowest (54.6%),while Ban Sobyod indicates the highest ratio of 73% as reported in Table 3.2. The employment ratios in Ban Pong Kong and Ban Maengern reflect about 60% each. On health access of household, about 94% to 100% of household in these villages are able to access health services.

Table 3.2 Household Characteristics and Livelihood Pattern

Population Characteristics						
	Gender of Household Head			Gender of Member		
Village	Male	Female	Total	Male	Female	Total
Ban Sobyod, Moo 2	72	28	100	57	43	100
Ban Pong Kong, Moo 10	72	28	100	51	49	100
Ban Maengern, Moo 12	85	15	100	52	48	100
Ban Saew, Moo 4	18	82	100	53	47	100
Occupation and Health Access						
Village		Employment Status		Health Access		
	Yes	No	Total	Yes	No	Total
Ban Sobyod, Moo 2	73.1	26.9	100.0	98.5	1.5	100
Ban Pong Kong, Moo 10	60.1	39.9	100.0	97.5	2.5	100
Ban Maengern, Moo 12	61.6	38.4	100.0	94.8	5.2	100
Ban Saew, Moo 4	54.6	45.4	100.0	100.0	0.0	100
Land-Use of Household (Rai)						
Village	Agriculture	Forestry	Property	Housing	Total Area	
Ban Sobyod, Moo 2	58.4	0.0	41.6	0.0	100.0	
Ban Pong Kong, Moo 10	60.9	0.0	39.1	0.0	100.0	
Ban Maengern, Moo 12	53.1	4.5	42.3	0.0	100.0	
Ban Saew, Moo 4	50.1	10.2	39.7	0.0	100.0	
Livestock Breeding (Number of Animals)						
Village	Cow	Buffalo	Chicken	Duck	Goats	Bird
Ban Sobyod, Moo 2	15.8	10.2	91.7	0.0	0.0	0.0
Ban Pong Kong, Moo 10	29.9	0.6	1.8	44.2	71.4	100.0
Ban Maengern, Moo 12	36.2	89.3	5.7	46.4	28.6	0.0
Ban Saew, Moo 4	18.1	0.0	0.8	9.3	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Compilation based on survey data.

Table 3.3 Type of Occupation and Income

Type of Occupation (Percent)				
Village	Government	Private	Farmer	Total
Ban Sobyod, Moo 2	-	36.8	63.2	100.0
Ban Pong Kong, Moo 10	47.7	31.8	20.5	100.0
Ban Maengern, Moo 12	40.5	25.1	35.4	100.0
Ban Saew, Moo 4	-	-	-	-
Monthly Income and expenditure				
Village	Monthly Expenditure*	Monthly Income**		
Ban Sobyod, Moo 2	2126	3617		
Ban Pong Kong, Moo 10	na	3074		
Ban Maengern, Moo 12	218	4490		
Ban Saew, Moo 4	na	3552		
Water Resource Use				
Village	Cannel	River	Irrigation	Other
Ban Sobyod, Moo 2	46	47	42	4
Ban Pong Kong, Moo 10	55	53	48	9
Ban Maengern, Moo 12	44	44	22	12
Ban Saew, Moo 4	47	48	24	13

Source: *Ibid*.

Table 3.4 Environmental Risk/ Resource Problems (%)

Degradation in Resources								
Village	Water quality		Soil quantity of land		Soil erosion		Total	
Ban Sobyod, Moo 2	52.3		25.0		22.7		100	
Ban Pong Kong, Moo 10	31.0		41.4		27.6		100	
Ban Maengern, Moo 12	31.4		54.3		14.3		100	
Ban Saew, Moo 4	33.3		60.0		6.7		100	
Environmental Risks								
	Drought		Floods/ rain		Forest fires		Landslides	
Village	Yes	No	Yes	No	Yes	No	Yes	No
Pa Ka , Moo 2	91.1	8.9	37.5	62.5	55.4	42.9	30.4	67.9
San Ton Pao , Moo 5	84.1	15.9	65.2	34.8	50.7	49.3	30.4	69.6
Mae Khom, Moo 7	93.2	6.8	66.1	33.9	8.5	91.5	15.3	83.1
Pa Teang, Moo 4	92.1	7.9	66.7	33.3	12.7	87.3	17.5	81.0

Source: *Ibid*.

Land-use pattern of the households under survey is summarized in Table 3.2 in terms of agricultural land, forestry, property and housing land. Agricultural land shows 54% of total land in the village followed by property land 42% as shown in Ban Rong Hai. However, households do not own forest and property lands. Similarly households in Bang Pong Kong do not hold forest Property land and agriculture land constitute 60.9%. In Maengerm and Ban Saew household own agricultural land about 50% followed by property land (40%), but they do not own housing land. Forest lands of household in Maengerm and Ban Saew show 4.5% and 10.2% respectively.

On livestock breeding, Ban Rong indicates a relatively higher amount of cow breeding compared to other two villages. Chicken also constitute part of household

income. The reliable data on resource-use and monthly income and expenditure is not available. Majority of household (63%) in Ban Sobyol were farmers, while in Ban Maengern were about 35.4%. On water resource use, in Ban Saew and Ban Sobyal and river is the major water resource, while Ban Ponkong and Bansaew cannel was major water resource.

The livelihood patters and employment status i.e., number of person with employment in these villages in the context of pressures on resource-use, in particular, in in Ban Saew indicate the lowest ratio of 54.6%, while the ratio for Ban Sobyod indicates the highest ratio of 73% as shown in Table 3.2. The ratio reflects about 60% each in Ban Pong Rong and Ban Maengern. On household access to health, about 94% to 100% of households in these villages are able to access health services.

The structure of environmental risks associated with natural disaster under survey is reported in Table 3.4. Drought and flood are major risks faced in Ban Sobyod and Ban Mae Khom. In contrast, about 47% of respondents state that there exist drought while about 42% indicates forest fire in Pa Ka. Soil collapse situation presents the largest risk in Ban Pa Ka and San Ton Pao compared to other two villages under study as shown in Table 3.4.

Chapter 4

The Effect of Trade Liberalization on Natural Resource of Thailand: CGE Modeling Approach

The modeling of effect of trade liberalization on natural resources and environment of Thailand is performed in this chapter applying Computational General Equilibrium **(**CGE) model. The specification of CGE model is presented in Section 4.1 and the trade policy scenarios, i.e. simulation design and results are discussed in Section 4.2.

4.1 Description of CGE Model

In explaining the effect of economic trade policy change on natural resource sectors an applied general equilibrium models are often used, which initially built on the Social Accounting Matrices (SAM). In linking households under survey with standard SAM survey, first the household hold category in the standard CGE model was aggregated into three categories: agricultural households, non-agricultural households and government-employed households in the standard CGE model.

The standard CGE model explains all of the payments recorded in the SAM using a set of systems of equations. The model therefore follows the SAM disaggregation of factors such as land, labour, capital; activities: economic activities by sectors; commodities based on sectors, and institutions: household, enterprises, government and other institutions. The equations define the behavior of the different actors such as:

producer and consumers. The production and consumption behaviors are model applying nonlinear, first-order optimality conditions. Therefore production and consumption models are estimated using the maximization of profits and utility, respectively. The equations also include a set of constraints that have to be satisfied by the system. Transfers from the rest of the world to households are fixed in foreign currency. In fact, all transfers between the rest of the world and domestic institutions and factors are fixed in foreign currency. The households use their income to pay direct taxes, save, consume, and make transfers to other institutions. Exports and domestic sales on the assumption that suppliers maximize sales revenue for any given aggregate output level, subject to imperfect transformability between exports and domestic sales, expressed by a constant elasticity of transformation (CET) function. The CGE model includes three macroeconomic balances: the (current) government balance, the external balance (the current account of the balance of payments, which includes the trade balance), and the Savings.

To model labor allocation of households among various activities, three sectors are considered: formal, informal, and agricultural. Individuals can be wage workers or self-employed. Thus, three types of activities include: i) agricultural activity, ii) informal activity, iii) wage-earning in the formal sector. The model is explicitly explores agricultural households as producers. Traditionally, CGE models represent the behavior of sectors that hire workers and contribute value-added through the production factors. However this specification does not take into account the heterogeneity of producers, nor does it represent interactions between production and consumption decisions.

In modeling the consumption function, the demand for leisure, and consequently labor supply, is determined by the maximization of utility. The separability of demand and labor supply behavior depends on the existence and operation of the labor market: if it and functions perfectly, then the household independently maximizes profits and utility. Non-agricultural households supply informal and/or formal wage work. The demand for leisure and consequently their total labor supply depends on their wage rate and income apart from labor income. Since the supply of formal wage work is completely rationed on the demand side, the potential impact of an exogenous shock on formal labor demand or on the formal wage rate is the same as for agricultural households.

The standard CGE model of Lofgren, Harris and Robinson (2002) can be summarized comprising four equation blocks viz. (i) price block, (ii) absorption block, (iii) production and trade block, and (iv) institution block and system constraint block in the following section. The notations of variables of these equations are provided in Appendix 1.

The variables and parameters used as linkages between periods are aggregate capital stock, population, domestic labor force, working capital supply, factor productivity, export and import prices, export demand, tariff rates, and transfers to and from the rest of the world.

Producers are assumed to maximize profits in the presence of constant returns to scale and perfect competition. There are two primary factors of production: labor (skilled and unskilled), location (rural and urban), and sector type (formal and informal); and capital. In addition, working capital is assumed to be complementary with physical capital. Production is related to factor inputs through a constant elasticity of substitution

(CES) production function, which allows producers to substitute among primary inputs so that the marginal revenue product of each factor equals its wage or rental rate (for capital). Producers demand intermediate inputs assuming fixed input–output coefficients (Leontief technology). In addition to input costs, producers also consider relevant taxes and subsidies.

The model explains the flow of single commodity from producers to final demand. First, producers use factor inputs according to a CES production function to produce output. This output is sold in domestic or international markets. Producers allocate supply between domestic sales and exports using a constant elasticity of transformation (CET) function, which assumes imperfect transformability between exports and domestic sales. The share of production for domestic and export markets depends on relative prices. The domestic price of an export is the international price times the exchange rate plus any export taxes or subsidies. The goods sold on the domestic market is, in turn, assumed to be an imperfect substitute for an imported goods of the same commodity classification, assuming a CES aggregation function—the Armington specification.

There are four institutions in the model—households, enterprises, government, and the rest of the world and their activities are to (1) produce, (2) consume, and (3) accumulate capital. Households save a constant share of their disposable income and buy consumption goods. They own the enterprises and work in those enterprises. Household income is the sum of salaries, profits, net government transfers, and rest-of-the-world transfers. Household consumption of goods and services is determined by a linear expenditure system. Enterprises buy intermediate goods, hire factors of production,

produce commodities and services, and sell them in the market. The government receives taxes, consumes goods and services, and makes transfers to households. The capital account acts as a loanable funds market, collecting savings from households, firms, government, and the rest of the world and making investment.

Each sector uses a nested CES function to produce three composite factors consisting of working capital combined with skilled and unskilled labor and physical capital in the urban formal sector. The database for the CGE model is based on the 1998 social accounting matrix (SAM) of Thailand employed by Li (2002).

The standard CGE model can be summarized comprising four equation blocks as follows:

1. Price Block,
2. Production and Commodity Block,
3. Institutions Block, and
4. System Constraint Block.

The standard CGE model explains all of the payments recorded in the SAM in terms of factors, activities, commodities, and institutions in a form of nonlinear simultaneous equations. Production and consumption decisions are undertaken based on maximization of profits of producers and utility of consumers, respectively. In the following section each equation is described briefly. The notations of variables of these equations are provided in Appendix 1.

The price block defines the import price, export price, output (activity) price, consumer price index (CPI) and producer price index.

I. Price Block

Import Price

1. $PM_c = (1+t_c).\ pwn_c.EXR$

Export - price

2. $PEc = (1+t_c) \times EXR$

Demand Price of Domestic Nontraded Goods

3. $PDD_c = PDS_c$

The import price in local-currency units is the price paid by importers. The import price shown in Equation (1) states the world price of these imports, reflecting the exchange rate and import tariffs plus transaction costs per unit of the import. The market price paid by domestic commodity demanders is the composite price, PQ that applies only to payments for these imports.

Aggregade Intermediate Input Price

7. $PINTA_a = \sum_{c \varepsilon C} PQ_c.i\ ca_{ca}$

Activity Revenue and Costs

8. $PA_{7\alpha}. = (1-t\alpha_\alpha)Q\ A_{ac} = PV\ A_{ac}.QV\ A_{ac} + PINT\ A_{ac}.QINT\ A_{ac}$

Consumer Price Index

9.. $\overline{CPI} = \sum_{c \varepsilon C} PQ_c.cwts_c$

Producer Price Index for Nontraded Market Output

10. $DPI = \sum_{c \varepsilon C} PDS_c dcwts_c$

II. Production and Trdae Block

CES Technology Activity Production Function

$$11 QA_{\alpha} = \alpha_{\varepsilon}^{\alpha}.(\delta_{\varepsilon}^{\alpha} QV\ A_{\alpha}^{-\rho} + (1-\delta_{\varepsilon}^{\alpha}).QINT\ A_{\alpha}^{-\rho})$$

CES Technoligy Value – Added – Intermediate Ratio

$$12. \frac{QV\ A_{\alpha}}{QVT\ A_{\alpha}} = \begin{bmatrix} PINT\ A_{\alpha} & \delta_{\alpha}^{\alpha} \\ INT\ A_{\alpha} & 1-\delta_{\alpha}^{\alpha} \end{bmatrix}^{1+\rho}$$

The aggregated domestic output from the output is output of different activities of a given commodity, a CES function is used. The demand for the output of each activity is derived from cost minimization given quantity of aggregated output subject to this CES function. Activity-specific commodity prices clear the market for each disaggregated commodity. Demand for value-added is a function of activity level.

Leontief Technology : DemandF or Aggregate Value Added

$$13. QVA_{a} = iva_{a}.QA_{a}$$

Leontief Technology : Demand for Aggregate Intermediate input

$$14. QINTA._{a} = \text{int}\, a_{a}.QA_{a}$$

Value – Added and Factor Demand

$$15. QVA_{a} = \alpha_{\alpha}^{vI}\left(\sum_{j\varepsilon F} \delta^{v\alpha}_{f\alpha}.QF^{\rho}_{f\alpha}\right)$$

Equation (13) illustrates the quantity of value-added is a CES function of disaggregated factor quantities. According to equation (16), factors demand is determined

Factor Demand

$$16.WF_f = WFDIS_{f\alpha} = PVA_a(1-tv_a).QV\left(\sum_{f\varepsilon F}\delta_{f\alpha}^{vI}QF_{f\alpha}^{-\rho}\right)^{-1}$$

Disaggrega ted Intermediate Inp ut Demand

$$17.QIN_{T\alpha} = ica_{c,\alpha}.QINTA_a$$

Equation (13) illustrates the quantity of value-added is a CES function of disaggregated factor quantities. According to equation (16), factors demand is determined at the point where the marginal cost of each factor is equal to the marginal revenue product of the factor.

$$18.QXA_{ac} + \sum_{h\varepsilon H} QHA_{ach}\ .\theta_{ac}.QA_a$$

Outp ut Aggregatio n Function

$$19.QX_c = \alpha\left[\sum_{a\varepsilon a}\delta_{\alpha}^{vac}.QXAC_{ac}^{-pc^{ac}}\right]_c^{1/\rho_c^{\alpha c-1}}$$

First – Order Conditionfor Outp utAggregatio n Function

The factor demand is determined based on profit maximization subject to a production technology that can be a constant elasticity of substitution (CES) function or, a Leontief function of the quantities of value-added and aggregate intermediate input. The optimal set of factors is determined at the point where the marginal revenue product of each factor is equal to its wage.

III Institution Block

$$20.PXAC_{\alpha} = PX_{c}QX_{c}\left[\sum_{a\varepsilon a}\delta_{\alpha}^{vac}.QXAC_{ac}^{-pc^{ac}}\right]^{-1/}_{c}\ \delta_{\alpha}^{vac}.QXAC_{\alpha C}^{-pc^{ac}}$$

Output Transformation (CET) Function

$$21.QX_{ac} = \alpha_{c}^{f}\left(\ \delta_{\alpha}^{vac}.QE_{\alpha C}^{-pc^{ac}} + (1-\delta_{c}^{f})QD_{\alpha C}^{-pc^{ac}}\right.$$

Export – Domenstic Supply Ratio

$$22.\frac{QE_{c}}{QD_{c}} = \left(\frac{PEC}{P_{DS_C}}.\frac{1-\delta_{C}^{t}}{\delta_{C}^{t}}\right)^{1/\rho_{c}^{t}}$$

Output Transformation for Domenstically Sold Outputs Without Exports and for Exports without Domenstic Sales

$$23.QE_{c} = QD_{c} + QE_{c}$$

Composite Supply (Armington) Function

$$24..QQ_{c} = \alpha_{c}^{t}\left(\delta_{C}^{t}QM\bar{C}^{\rho} + QE_{C}\right)^{-\rho}$$

The households and transfers from other institutions. Transfers from the rest of the world to households are fixed in foreign currency. The households use their income to pay direct taxes, save, consume, and make transfers to other institutions.

Infra – Institutional Transfers

$$25.TRII_{ii} = shii_{ii.}\ (1-MPS_{i}).\ \ (1-TINS_{i}).YI_{i}$$

Household Consumption Expenditures

$$26.EH_{h} = \left[1-\sum_{i\varepsilon INSDNG} shii_{iih}\right].(1-MPS_{h}).(1-TINS_{h}).YI_{h}$$

Factor Income

$$27.YF_{i\,f} = \sum_{a\varepsilon A} WF_{f.}.WFDIST_{fa}.QF_{fa}$$

Intitutional Factor Incomes

$$28.YIF_{i_f} = shif_{if}\left[(1-tf_f).YF_f - trnsfr_{rowf}.EXR\right]_i$$

Household Consumption Spending on Marketed Commodities

$$29.PQ_{c.}.QH_{c_h} = PQ_c.Y_{ch}^m + \beta_{ch}^m.\left[EH_h - \sum_{c\varepsilon C} PQ_c.Y_{ch}^m - \sum_{a\varepsilon A}\sum_{c\varepsilon C} PXAC_{ac}.y_{ach}^h\right].$$

Investment Demand

$$30.QINV_c = IADJ.qinv_c$$

The final institution is the rest of the world (RoW). Transfer payments between the rest of the world and domestic institutions and factors are all fixed in foreign currency. Household consumption covers marketed commodities, purchased at market prices that include commodity taxes and transaction costs, and home commodities, which are valued at activity-specific producer prices. Household consumption is allocated across different commodities (both market and home commodities) according to linear expenditure system (LES) demand functions, derived from maximization of a Stone. Investment balances.

The income that remains after taxes, savings, and transfers to other institutions is spent on consumption.

Government Consumption Demand

$$31. QG_c = GADJ.qg_c$$

Government Revenue

$$32.. YG = . \sum_{i \varepsilon INSDNG} TINS_i.YI_i + \sum_{f \varepsilon F} tf_f.YF_f + \sum_{a \varepsilon A} tva_a.PVA_a.QVA_a$$
$$+ \sum_{a \varepsilon A} ta_a.PA_a.QA_a + \sum_{c \varepsilon CM} tm_c.pwm_c.QM_c.EXR + \sum_{c \varepsilon CE} te_c.pwe_c.QE_c.EXR$$
$$+ \sum_{c \varepsilon C} tq_c.PQ_c.QQ_c + \sum_{f \varepsilon F} YIF_{govf} + trnsfr_{govrow}.EXR$$

Government Expenditure

$$33. EG = \sum_{c \varepsilon C} PQ_c.QG_c + \sum_{i \varepsilon INSDNG} trnsfr_{igov}.\overline{CPI}$$

The equations also include a set of constraints that have to be satisfied by the system. The CGE model includes three macroeconomic balances: the (current) government balance, the external balance (the current account of the balance of payments, which includes the trade balance), and the savings.

Factor Markets

$$34. \sum_{a \varepsilon A} QF_{fa} = QFS_f$$

Composite Commodity Markets

$$35. QQ_c = + \sum_{a \varepsilon A} QINT_{ca}. + \sum_{h \varepsilon H} QH_{ch} + QG_c + QINV_c + qdst_c + QT_c$$

Current – Account Balance for the Rest of the World, in Foreign Currency

$$36. \sum_{c \varepsilon VCM} pwm_c.QM_c + \sum_{f \varepsilon F} trnsfr_{rowf} = \sum_{c \varepsilon CE} pwe_c.QE_c + \sum_{i \varepsilon INSD} transfr_{irow} + \overline{FSAV}$$

Government Balance

$$37. YG = EG + GSAV$$

4.2 Simulation Design and Results

The model is based on information at the household level, an aggregate SAM. In this aggregated SAM, the labor factor is disaggregated into three types of work: agricultural family work, informal wage work and formal wage work. Household incomes come from various sources: agriculture, informal activities, formal wages, dividends of formal capital, income from sharecropping, and transfers from other households and from the government. Apart from income from the formal sector and transfers, all income is endogenous in the model. Part of total income is saved, and savings rates are endogenous. The implicit assumptions are that government savings and total investment are flexible, that the exchange rate is fixed, and foreign savings are flexible.

The model is static and thus no change in investment with three sectors: agricultural, manufacturing, and transport, communication. The agricultural sector produces two types of good and services: tradable good that is exported and a non-tradable good. The two other sectors each produce one type of good. The agricultural (informal sector) good is a non-tradable good, while the formal good is tradable. The production factors are labor, land and formal capital. Total labor supply is endogenous and determined at the household level. The levels of agricultural and informal production are also determined at the household level, as is the agricultural labor demand. Informal labor demand is determined at the aggregate level by the demand for informal goods and for agricultural wage labor. The supply of informal labor is determined at the individual level through the labor allocation model described earlier. Formal labor demand is exogenous. Capital stocks are specific and fixed for agricultural and formal activities, while the capital used in the informal sector is integrated into work. Capital and labor are

substitutable in agricultural technology when represented through a Cobb-Douglas function. The formal labor market operates with exogenous demand at fixed prices.

First, we initialize the model and estimate a base-run forecasts as ‘Base’ scenario using sectoral data from the Thailand SAM 1998. The change between Base scenario or a base scenario and the different policy simulations reflect the impact of those policies or exogenous shocks on the economic sectors.

Simulation 1 (SIM1): 5% tariff cut in agriculture imports (trade Liberalization)

Simulation 2 (SIM2): 20% increase in agriculture and forestry exports

Simulation 3 (SIM3): 250% increase in capital

Simulation 4 (SIM4): 300% increase in production tax of industry j

Simulation 5 (SIM5): 200% increase in commodity tax of industry j

In each policy simulation, nine types of effects are examined and reported in Table 4.1 as follows:

- Public final consumption of commodity,
- Domestic demand for commodity produced locally,
- Supply of commodity by sector to the domestic market,
- Quantity of product exported by each sector ,
- GDP at market prices,
- Final demand of commodity for investment purposes (GFCF),
- Demand for type of capital by industry,
- Demand for type of labor by industry, and
- Consumer price index.

Simulation 1 (SIM1): Effect of 5% tariff cut in agriculture import

(Trade liberalization)

The Effect of 5% tariff cut in agriculture imports are performed using CGE model. The impacts of SIM1 are compared with ones under 'Base' scenario focusing on agriculture and forestry sectors. The results suggest that public final consumption of services increases by 868%, while that of consumption in agriculture, administration and food sector declines. Domestic demand for commodity produced locally increases in a large proportion, while demand for agriculture and forestry sectors, services also increases moderately. Supply of commodity by sector to the domestic market increases and quantity of product exported by each sector declines by 98% to 100%. However, GDP at market price increases by 3% under SIM1. Demand for investment in agriculture largely increases, in contrast, demand for investment increases except services under this simulation. Demand for labor increases 114% in agriculture and forestry and 41% in service respectively. The effect on CPI is insignificant.

Figure 4.1 shows the impact of 5% tariff cut on imports on resource allocation in the economy. The figure depicts how the economy reacts to the trade liberalization.

Simulation 2 (SIM2): 20% increase in agriculture and forestry export tax

Simulation 2 (SIM2) examines the effects of 20% increase in agricultural and forestry export tax. The results under SIM2 are compared with ones under Base scenario focusing on agriculture and forestry sectors. The results reveal that public final consumption increases by 139%, 1872% and 39% in agriculture, services and food sector, while that of consumption of other industry decreases.

Domestic demand for locally produced commodity from services and food sectors increases in 18% and 1868%, while demand for agriculture, and other industry also decreases. Supply of commodity by sector to the domestic market increases in agriculture, industry and services increases except food and administration. However, GDP at market price fall by -3%. Demand for investment in all sectors largely increases, while demand for investment increases in all sectors fall. Demand for labor in agriculture, industry and services. The effect on CPI is insignificant. If export taxes are increases by 20%, the growth rate declines by -3% under SIM2. The effect of imposing environmental tax on production simulation is different from a reduction in import tariff because it directly affects consumption in the first step.

Table 4.1 Public final Consumption of a Commodity

Sector	BASE	SIM 1 TARCUT	SIM 2 PWMICR	SIM 3 INVSTAGR	SIM 4 TTIP	SIM 5 TTIC
agr	824	148	1970	118	704	270
ser	430898	4169331	8498588	176293374	472856	-2231142
adm	7363	-9009	-243	-1339	-16915	83
food	182	-11	253	-7679	19	-1792
othind	21766	10015	1637	22816	4410	7066
		Percent Change				
Sector		SIM 1 Δ%	SIM 2 Δ%	SIM 3 Δ%	SIM 4Δ%	SIM 5Δ%
agr		-82	139	-86	-15	-67
ser		868	1872	40813	10	-618
adm		-222	-103	-118	-330	-99
food		-106	39	-4310	-90	-1083
othind		-54	-92	5	-80	-68

Figure 4.1 Public final Consumption of a Commodity

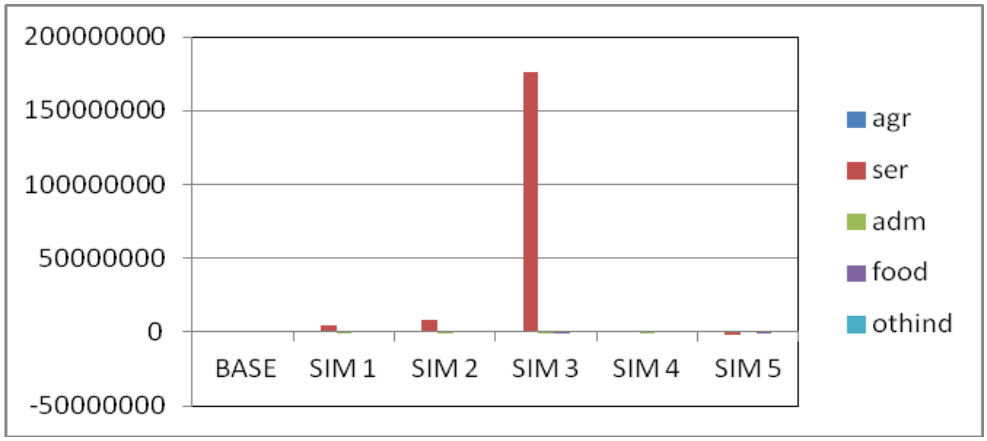


Table 4.2 Domestic Demand for Commodity Locally Produced

valDD	BASE	SIM 1 TARCUT	SIM 2 PWMICR	SIM 3 INVSTAGR	SIM 4 TTIP	SIM 5 TTIC
agr	1149030	1485242	682471	1243740	1283820	1268281
ser	2132107	2695768	2514946	2574670	2054182	2513209
adm	719513	-501607	-679915	-622471	-1175034	-490961
food	55	2781	1082	971	273	-3078
othind	4326345	50292	1392359	486550	1099901	938072
		Percent Change				
		SIM 1Δ%	SIM 2 Δ%	SIM 3 Δ%	SIM 4Δ%	SIM 5Δ%
agr		29	-41	8	12	10
ser		26	18	21	-4	18
adm		-170	-194	-187	-263	-168
food		4956	1868	1666	397	-5697
othind		-99	-68	-89	-75	-78

Figure 4.2 Domestic Demand for Commodity Locally Produced

Simulation 3 (SIM3): 250% increase in capital

Simulation 3 (SIM3) accounts for the effects of 250% increase in capital in agriculture and forestry. The results show that public final consumption of services increased by substantially, while that of consumption of services and other industry reduces. Domestic demand for commodity (food) produced locally increases by 1666%. Supply of commodity by food sector to the domestic market increases substantially. However, GDP at market price increases by 6% in this case. Demand for investment in services largely increases, in contrast, demand for labor except services. Demand for labor increases by 114% in agriculture and 41% in service respectively. The CPI increases substantially by 5%. Figure 4.4 depicts the effects of 250% increase in capital in agriculture and forestry.

Simulation 4 (SIM4): 300% increase in production tax of an industry

Simulation 4 (SIM4) demonstrates the effect of 300% increase in production of resource base industries: agriculture and forestry imports on economy. The results indicate that public final consumption of services increases by 10%, while other industry declines. Domestic demand for commodity locally produced, i.e., food substantially, while demand for agriculture, service also increases. Supply of commodity by sector to the domestic market and quantity of product exported by each sector declines by 100%. However, GDP at market price decreases by -18% under SIM4. Demand for investment declines in all sectors, in contrast. The CPI increases by 5%.

Table 4.3 Supply of Commodity i by Sector j to the Domestic Market

valDS	BASE	SIM 1 TARCUT	SIM 2 PWMICR	SIM 3 INVSTAGR	SIM 4 TTIP	SIM 5 TTIC
agr	1148980	1484648	684960	1245128	1283306	1268498
agr	50	7	2273	-2028	-557	75
agr	50	-1561	-398	-3241	-2557	156
ind	50	813	4566	-4128	-1368	-161
ind	4326345	49527	1393562	485460	1099521	937772
ser	2132057	2694561	2512499	2575368	2054192	2513345
ser	5	2559	3733	4346	2388	-2611
adm	719513	-504919	-683071	-625073	-1176131	-491285
Percent Change						
	BASE	SIM 1 Δ%	SIM 2 Δ%	SIM 3 Δ%	SIM 4 Δ%	SIM 5 Δ%
agr		29	-40	8	12	10
agr		-86	4446	-4156	-1215	50
agr		-3222	-897	-6582	-5213	212
ind		1525	9032	-8357	-2837	-422
ind		-99	-68	-89	-75	-78
ser		26	18	21	-4	18
ser		51079	74567	86819	47664	-52320
adm		-170	-195	-187	-263	-168

Figure 4.3 Supply of Commodity i by Sector j to the Domestic Market

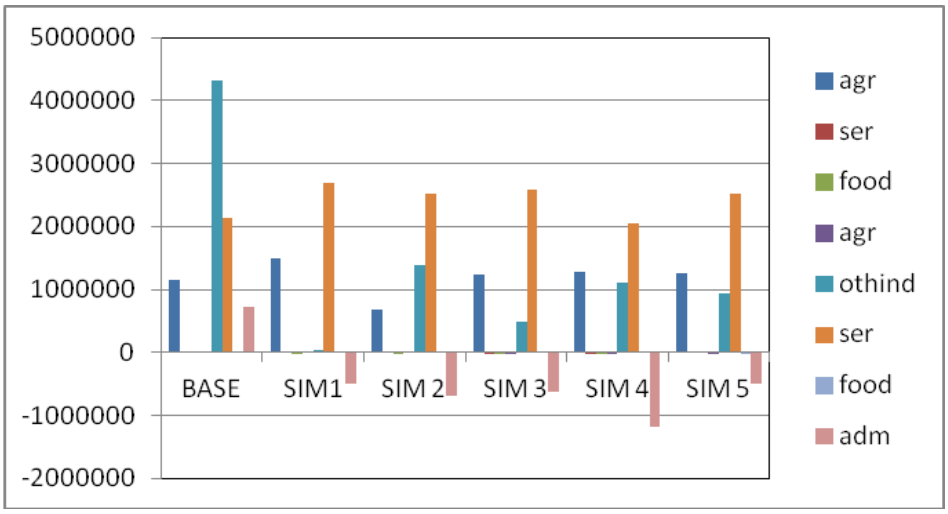


Table 4.4 Quantity of Product x Exported by Sector j

	BASE	SIM 1 TARCUT	SIM 2 PWMICR	SIM 3 INVSTAGR	SIM 4 TTIP	SIM 5 TTIC
agr	154862	2265	-5075	1667	346	-1590
food	17207	-7	459	-1385	-44	21
othind	1281735	-164712	-172775	17728	-159234	-187685
ser	185858	3223	2511	4824	-1040	62
		Percent change				
		TARCUT Δ%	PWMICR Δ%	INVSTAGR Δ%	TTIP Δ%	TTIC Δ%
agr		-99	-103	-99	-100	-101
food		-100	-97	-108	-100	-100
othind		-113	-113	-99	-112	-115
ser		-98	-99	-97	-101	-100

Figure 4.4 Quantity of Product Exported by sector j

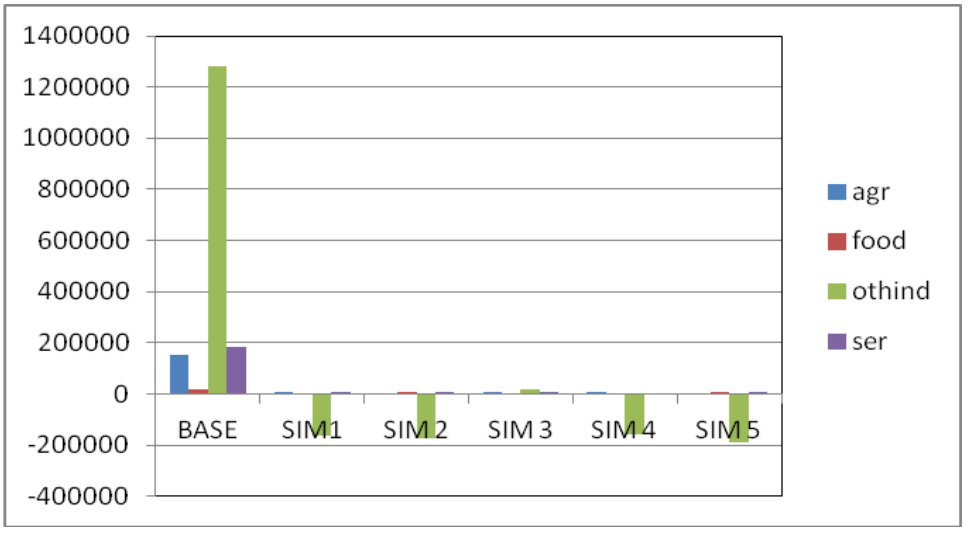
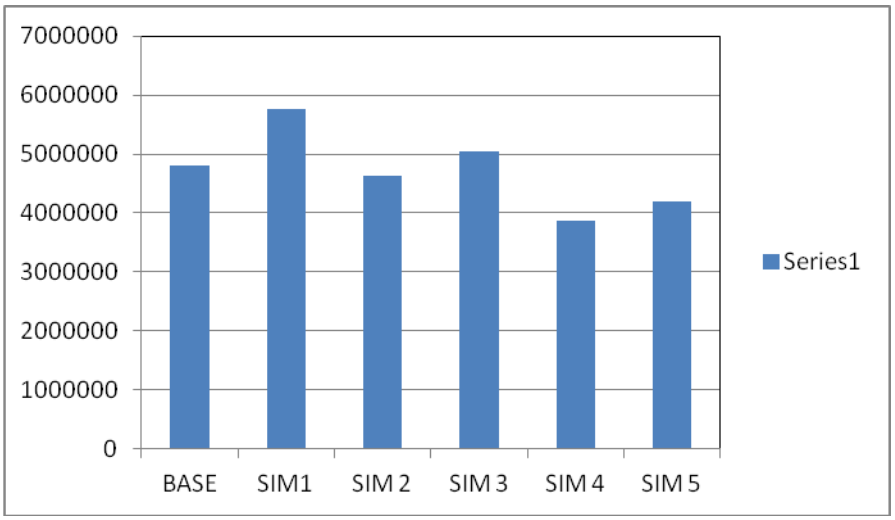


Table 4.5 GDP at Market Prices

BASE		SIM 1 TARCUT	SIM 2 PWMICR	SIM 3 INVSTAGR	SIM 4 TTIP	SIM 5 TTIC
	4798760	5762732	4620375	5041691	3869623	4197149
			Percent change			
BASE		TARCUT Δ%	PWMICR Δ%	INVSTAGR Δ%	TTIP Δ%	TTIC Δ%
		11	63	10	10	10

Figure 4.5 GDP at Market Prices



Simulation 5 (SIM5): 200% increase in commodity tax of an industry

In Simulation 5 (SIM5), the effects of 200% increases in commodity tax in agricultural and forestry. The results demonstrate that public final consumption in all sectors. Domestic demand for commodity locally produce increases in a large proportion, while demand for agriculture, forestry and service also increases. Supply of commodity by sector to the domestic market, i.e., agriculture and food decline substantially of product exported by each sector declines by 100% respectively. However, GDP at market price decreases by -12% in this simulation. Demand for investment in agriculture largely increases, in contrast, demand for investment increases in all sectors except services. Demand for labor declines in industry all sectors except declines. The effect on CPI remains unchanged as minimal. The results indicate how the economy reacts to the changes in the commodity l tax on forestry production, exports respond positively and imports negatively to a reduction in capital inflows, but the changes are relatively small.

Table 4.6 Investment Demand by Sector

valINV	BASE	SIM 1 TARCUT	SIM 2 PWMICR	SIM 3 INVSTAGR	SIM 4 TTIP	SIM 5 TTIC
agr	13958	5697213	28880	3825	-2173	-8951
ser	3464	8625	261339	5276339	-17350	244170
adm	295507	-10394	-134645	-86053	-740057	-14514
food	687	915	409	-3715	409	-1602
othind	485324	1067812	203080	-224498	-98943	-343681
Percent change						
	BASE	TARCUT Δ%	PWMICR Δ%	INVSTAGR Δ%	TTIP Δ%	TTIC Δ%
agr		40717	107	-73	-116	-164
ser		149	7445	152240	-601	6950
adm		-104	-146	-129	-350	-105
food		33	-40	-641	-40	-333
othind		120	-58	-146	-120	-171

Figure 4.6 Investment Demand by Sector

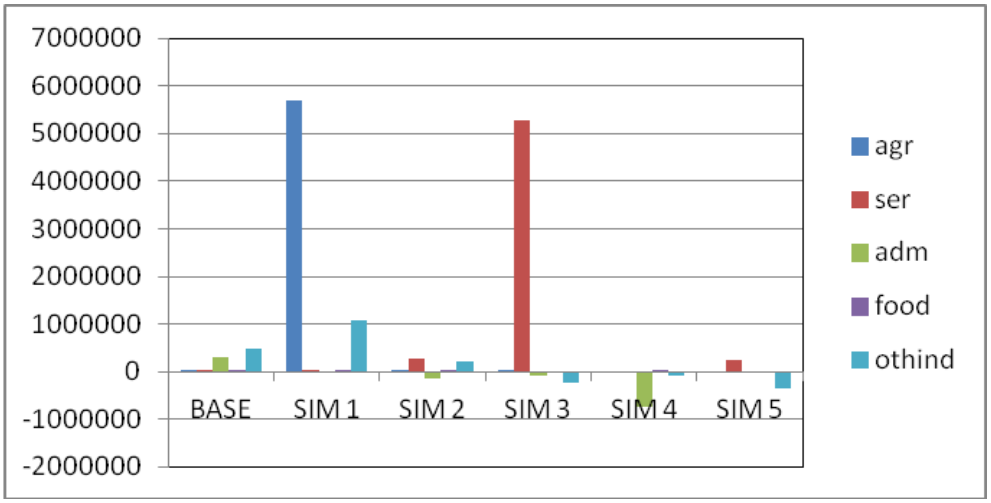


Table 4.7 Demand for Type k Capital by Industry j

valKD		SIM 1 TARCUT	SIM 2 PWMICR	SIM 3 INVSTAGR	SIM 4 TTIP	SIM 5 TTIC	SIM 1 TARCUT
cap	agr	421771	421771	421771	421771	421771	421771
	ind	132049	132049	132049	132049	132049	132049
	ser	500270	500270	500270	500270	500270	500270
land	agr	5	5	5	5	5	5
	ind	5	5	5	5	5	5

Figure 4.7 Demand for Type k Capital by Industry j

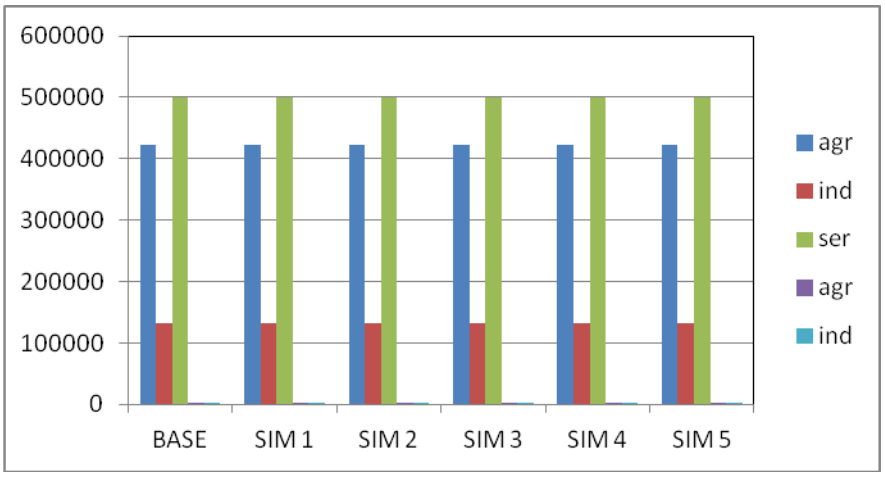


Table 4.8 Demand for type l labor by industry j

Demand for type 1 labor by industry j

valLD		BASE	SIM 1 TARCUT	SIM 2 PWMICR	SIM 3 INVSTAGR	SIM 4 TTIP	SIM 5 TTIC
	agr	190729	407825	-76493	175929	189557	145060
	ind	120962	-97277	388581	135908	121472	166462
	ind	45252	5122	8104	5577	3080	4075
	ser	536704	756130	683892	715211	444991	680196
	adm	136124	-42804	26329	-3186	270343	34113
			Percent change				
			TARCUT Δ%	PWMICR Δ%	INVSTAGR Δ%	TTIP Δ%	TTIC Δ%
	agr		114	-140	-8	-1	-24
	Ind		-3	32	-180	221	12
	ind		-89	-82	-88	-93	-91
	ser		41	27	33	-17	27
	adm						

Figure 4.8 Demand for type l labor by industry j

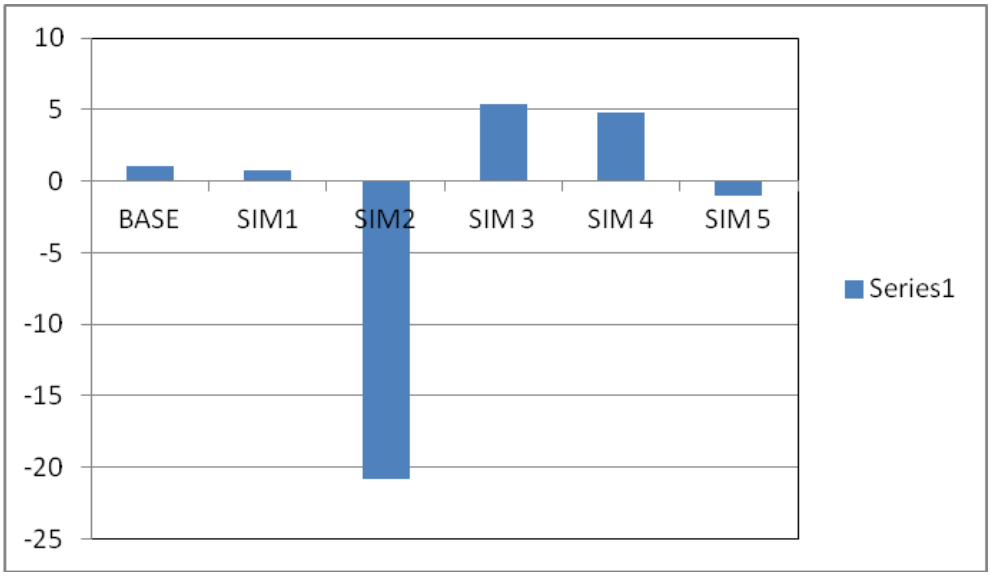
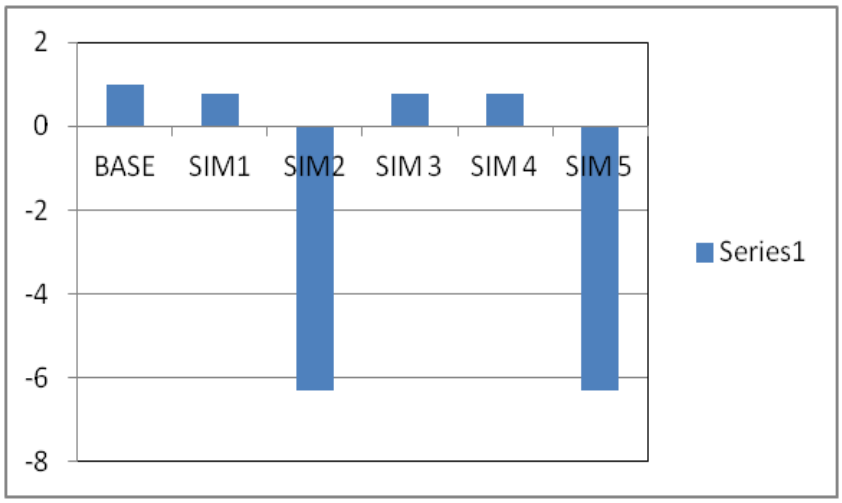


Table 4.9 Consumer Price Index

valPIXCON		Consumer price index				
BASE	SIM1	SIM2	SIM 3	SIM 4	SIM 5	
1	1	-21	5	5	-1	

Figure 4.9 Consumer Price Index



In sum, all simulation exercises except case 2 (SIM2), lead to a decline in public consumption of agriculture and forest products. A negative effect (-41% decrease) in domestic demand for agriculture and forest products is found under SIM2. On the supply effect, SIM2 provides a negative effect (-40% decline) in agriculture and forest production. The negatives effects (about 95% to 100% decline) in exports are found in all policy simulations. On investment effect by sector, SIM1 and SIMS2 render positive effects. SIM1 also provide a positive employment effect, i.e. 140% increase in agriculture and forest sector under SIM1. Overall welfare in the context of GDP also increase by 21% and 6% under SIM1 and SIM6 respectively indicating that the tariff liberalization of forestry import generates better scenario compared to the production tax and export tax. The use of production tax and commodity tax enable to reduce or control over public consumption in agriculture and forest products at the expense of national welfare.

In addition, in selecting policy alternative to meet simultaneously couples of objectives such as welfare and price stability objectives, suitable policy alternatives can be monitored using this framework. Similar reasoning can be applied in selecting policy alternatives to meet couples of objectives such as export objective and environment objectives in most integration framework.

Chapter 5

Conclusion

5.1 Findings of the Study

This study performs an analytical assessment of trade and environment linkages and their impacts on natural resources and environment of Thailand. It also seeks to search complementary policy in favor of environment and enhance competitiveness and assesses sustainable development of Thailand.

The study investigates linkages between livelihoods and natural resource-use by analyzing the current utilization rates, associated values and the dynamics of household resource-use in four villages in Chiang Province. It explores the effect of trade liberalization on resource allocation and macroeconomic impacts and the welfare of Thailand. The research also examines the factors determining trade, growth and environment of Thailand based on the integrated assessment, which would enhance national capacity of the related ministries in Thailand, in particular, to respond effectively the challenging opportunity emerged from the trade, environment, employment and industry.

The research study contains two main parts. First, the present research investigates the effect of trade related policy on natural resource-use in relation to agriculture, forestry, fishery and water resources. Second, it seeks to investigate the effects of various trade and environmental policy scenarios on the economic sectors applying computational general equilibrium (CGE) model. The complementary policy in favor of environment, enhanced competitiveness and sustainable development of Thailand are also discussed.

In the first part of micro-level households' resource-use, the study finds broad changes in resource-use based on 213 households in four villages in Chiang Rai Province. In observing the environmental effects of human activity, the study applies the "Driving Force–State–Response" (DSR) framework employed by the United Nations Commission on Sustainable Development.

The indicators for impact assessment are constructed based on livelihoods, characterizing the rural economy and natural resource-use in relation to agriculture, forestry, fishery and water resources in four villages locating near forests in Chiang Rai Province. This analysis attempts to ascertain the significance of natural resource utilization in the region for rural livelihoods, forest-use in the regional and national economies. It is anticipated that a robust analytical framework for this indicator dataset will enable effective policy implementation. The major economic activities in these villages are agriculture, livestock keeping and fishing. Crop farming constitutes mainly subsistence agriculture. Most of the available arable lands are currently cultivated land and irrigated land.

On land-use pattern of the households under surveys, agricultural land shows 54% of total land in the village, followed by property land 42% as shown in Ban Rong Hai. However, households do not own forest and property lands. Similarly households in Bang Pong Kong do not hold forest land, property land, but agriculture land constitutes 60.9% of total land in the village. The livelihood patters and employment status in these villages for the purpose of observing pressures on resource-use. Number of person with employment in Ban Saew indicates about lowest ratio of 54.6%, while such ratio for Ban Sobyod indicates the highest ratio of 73%. The ratio reflects about 60% each in Ban Pong

Rong and Ban Maengern. On household access to health, about 94% to 100% of households in these villages are able to access health services.

The structure of environmental risks associated with natural disaster under survey is reported in Table 3.4. Drought and flood are major risks faced in Ban Sobyod and Ban Mae Khom. In contrast, about 47% of respondents state that there exist drought while about 42% indicates forest fire in Pa Ka. Soil collapse situation presents the largest risk in Ban Pa Ka and San Ton Pao compared to other two villages under study as shown in Table 3.4.

The effect of trade related policy on natural resource use, in particular, in agriculture and forestry sector, five policy simulation are performed using CGE model in this research as follows:

Simulation 1 (SIM1): 5% tariff cut in agriculture and forestry imports (trade liberalization),

Simulation 2 (SIM1): 20% increase in agriculture and forestry exports,

Simulation 3 (SIM3): 250% increase in capital,

Simulation 4 (SIM4): 300% increase in production tax on industry and

Simulation 5 (SIM5): 200% increase in commodity tax on industry.

In each policy simulation, nine types of effect such as effects on public final consumption of commodity, domestic demand for commodity locally produced, supply of commodity by sector to the domestic market, quantity of product exported by each sector, GDP at market prices, final demand of commodity for investment purposes, demand for type of capital by industry, demand for type of labor by industry, and consumer price stability.

The impacts of each simulation are compared with ones under ‘Base’ scenario focusing on agriculture including forestry sector. In brief, all simulation exercises except SIM2 (export tax in agriculture including forestry), lead to a decline in public consumption of agriculture and forestry products. A negative effect (-41% decrease) in domestic demand for agriculture and forest products is found under SIM2. On the supply effect, SIM2 provides a negative effect (-40% decline) in agriculture and forest production. The negative effects (about 95% to 100% decline) in exports are found in all policy simulations. On investment effect by sector, SIM1 (trade liberalization) and SIM2 offer positive effects. SIM1 also provides a positive employment effect, i.e. 140% increase in employment in agriculture and forestry sector. The GDP in the context of welfare also increases by 21% and 6% under SIM1 and SIM6 (commodity tax) respectively indicating that the tariff liberalization of forestry import generates better scenario compared to the production tax (SIM5) and commodity tax (SIM6). The use of production tax and commodity tax enable to reduce or control over public consumption in agriculture and forest products at the expense of national welfare.

In conclusion, in selecting policy alternatives to meet simultaneously couples of objectives such as welfare and price stability, the desirable policy alternatives can be exercised using this framework. Similar reasoning can be applied in selecting policy alternatives to meet couples of objectives such as export objective and environmental objectives in the integrated framework.

5.2 Recommendations

On the basis of the findings under study, the following recommendations can be made.

1. The livelihood of households living near forests in Chiang Rai highlights the importance of managing environmental risk through improving income of households whose incomes are lower the national average of poverty line. It demands livelihood diversification, demographic responses such as migration and employment opportunities in the context of sustainable development.

2. The livelihood approach comprises the focus on natural capital, social capital, human capital, physical and financial capital. Thus to enhance opportunities in these activities in this region are critical and can consider these linkages in the framework of livelihood strategy.

3. The trade related environmental policy needs to incorporate in environmental related trade policies in the form of integrated approach to maintaining sustainable development as discussed above.

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APPENDIX 1: CGE MODEL NOTATIONS[1]

PMc = import price in LCU (local-currency units) including transaction costs,
pwmc = c.i.f. import price in FCU (foreign-currency units),
tmc = import tariff rate,
EXR = exchange rate (LCU per FCU),
PWc = composite commodity price (including sales tax and transaction costs), and
icmc.c = quantity of commodity c. as trade input per imported unit of c.
The import price in LCU (local-currency units) is the price paid by domestic
PEc = export price (LCU),
pwec = f.o.b. export price (FCU),
tec = export tax rate,
icec. c = quantity of commodity *c.* as trade input per exported unit of *c*.
PDDc = demand price for commodity produced and sold domestically,
PDSc = supply price for commodity produced and sold domestically, and
icdc. c = quantity of commodity *c.* as trade input per unit of *c* produced and sold domestically.
QQc = quantity of goods supplied to domestic market (composite supply),
QDc = quantity sold domestically of domestic output,
QMc = quantity of imports of commodity, and
tqc = rate of sales tax (as share of composite price inclusive of sales tax)
PXc = aggregate producer price for commodity,
QXc = aggregate marketed quantity of domestic output of commodity,
QEc = quantity of exports.
PAa = activity price (gross revenue per activity unit),
PXACa c = producer price of commodity *c* for activity *a*, and
θ_{ac} = yield of output c per unit of activity *a*.
PINTAa = aggregate intermediate input price for activity *a*, and
icac a = quantity of *c* per unit of aggregate intermediate input *a*.
The activity-specific aggregate intermediate input price shows the cost of disaggregated intermediate inputs per unit of aggregate intermediate input.
taa = tax rate for activity,
QAa = quantity (level) of activity,
QVAa = quantity of (aggregate) value-added,
QINTAa = quantity of aggregate intermediate input, and

This section is prepared on the basis of Lofgren, Hans, R. Harris, S. Robinson, 2002. *A Standard Computable General Equilibrium (CGE) Model in GAMS*, Microcomputer in Policy Research 5, International Food Policy Research Institute, Washington.

PVAa = price of (aggregate) value-added.
cwtsc = weight of commodity c in the consumer price index, and
CPI = consumer price index (exogenous variable).
dwtsc = weight of commodity *c* in the producer price index, and
DPI = producer price index for domestically marketed output.
a_a^a = efficiency parameter in the CES activity function,
δ_a^a = CES activity function share parameter, and
ρ_a^a = CES activity function exponent
ivaa = quantity of value-added per activity unit, and
intaa = quantity of aggregate intermediate input per activity unit.
tvaa = rate of value-added tax for activity a,
a_a^{va} = efficiency parameter in the CES value-added function,
δ_a^a = CES value-added function share parameter for factor f in activity a,
QF_{fa}= quantity demanded of factor f from activity a,
ρ_a^a = = CES value-added function exponent,
WFf = average price of factor, and
$WFDIST_{fa}$ = wage distortion factor for factor f in activity a (exogenous variable).
$QINT_{ca}$ = quantity of commodity *c* as intermediate input to activity *a*.
QXACa c = marketed output quantity of commodity *c* from activity *a*, and
QHAa c h = quantity of household home consumption of commodity c from activity a for household h.
a_a^{ac} = shift parameter for domestic commodity aggregation function,
δ_a^a = share parameter for domestic commodity aggregation function
ρ_a^a = domestic commodity aggregation function exponent.
a_c^t = a CET function shift parameter,
δ_c^t = a CET function share parameter, and
ρa_c^t = *a CET function exponent.*
a_c^q = an Armington function shift parameter,
δ_c^q = an Armington function share parameter, and
ρ_c^q = an Armington function exponent.
QTc = quantity of commodity demanded as transactions service input.
YFf = income of factor *f*.
$YIFi_f$ = income to domestic institution *i* from factor *f*,
$shifi_f$ = share of domestic institution *i* in income of factor f,
tf_f = direct tax rate for factor *f*, and

$trnsfr_{i\,f}$ = transfer from factor *f* to institution *i*.
i ∈ INSDNG(=INSDGN′⊂ INSD) = a set of domestic nongovernment institutions,
YI_i = income of institution i (in the set INSDNG), and
$TRII_{ii.}$ = transfers from institution *i.* to *i* (both in the set INSDNG)
$shii_{ii}$ = share of net income of *i.* to *i*
MPS_i = marginal propensity to save for domestic nongovernment institution (exogenous variable), and
$TINS_i$ = direct tax rate for institution *i*
= a set of households, and
EH_h = household consumption expenditures.
$QH_{c\,h}$ = quantity of consumption of marketed commodity *c* for household *h*,
γ_{ch}^{m} = subsistence consumption of marketed commodity *c* for household *h*,
γ_{ach}^{h} = subsistence consumption of home commodity *c* from activity a for household *h*, and
β_{ch}^{m} = marginal share of consumption spending on marketed commodity c for household h.
β_{ach}^{h} = marginal share of consumption spending on home commodity c from activity *a* for
household *h*.
QINVc = quantity of fixed investment demand for commodity,
IADJ = investment adjustment factor (exogenous variable), and
$qinv_c$ = base-year quantity of fixed investment demand
QGc = government consumption demand for commodity,
GADJ = government consumption adjustment factor (exogenous variable), and
qg_c = base-year quantity of government demand.
YG = government revenue.
EG = government expenditures.
QFS_f =quantity supplied of factor (exogenous variable).
qdstc = quantity of stock change.
FSAV = foreign savings (FCU) (exogenous variable).
GSAV = government savings.
mps_i = base savings rate for domestic institution i,
MPSADJ = savings rate scaling factor (= 0 for base),
*MPS*01*i* = 0-1 parameter with 1 for institutions with potentially flexed direct tax rates, and
DMPS = change in domestic institution savings rates (= 0 for base; exogenous variable).

APPENDIX 2: Thai SAM

Table 3.6 SOCIAL Accounting Matrix of Thailand: 1988

SECTORS	PRIMAA	AINDUSA	MANUA	UTICONA	TRADEA	SER-A	PRIMAC	AINDUSC	MANUC	UTICON(	TRADEC	SER-C	LAB	CAP
PRIMA-A							1148980							
AINDUS-A								1362878						
MANU-A									4326345					
UTICON-A										719513				
TRADE-A											1677846			
SER-A												2132057		
PRIMA-C	92547	362524	235059	49682	345	129329								
AINDUS-C	46025	376244	23525	0	769	107806								
MANU-C	190389	111879	2182141	207441	237283	169137								
UTICON-C	21025	30164	130647	36930	33616	123720								
TRADE-C	105951	110589	508591	88207	162183	126278								
SER-C	66878	52249	275907	42413	241219	203525								
LAB	95787	95787	362888	136124	135758	536704								
CAP	421771	132049	500270	142260	835148	670803								
A-HHD													202476	297923
G-HHD													425463	64894
N-HHD													830051	1237662
ENT-G														124496
ENT-P														897921
GOV														79405
YTAX														
ITAX	13665	91393	107317	16456	31525	64755	9235	6355	68802	93		4003		
TAR							1963	6117	50099	6		3852		
S-I														
ROW							161597	83843	1432424	3784	71078	249579		
TOTAL	1148980	1362878	4326345	719513	1677846	2132057	1321775	1459193	5877670	723396	1748924	2389491	1457990	2702301

Source: Calculations based on Li, Jennifer Chung-I, "A 1998 Social Accounting Matrix (SAM) for Thailand", TMD Discussion Paper No.95, Washington DC: International Food Policy Research Institute.

Table 3,6 SOCIAL Accounting Matrix of Thailand: 1988 Cont

SECTORS	A-HHD	G-HHD	N-HHD	ENT-G	ENT-P	GOV	YTAX	ITAX	TAR	S-I	ROW	TOTAL
PRIMA-A												1148980
AINDUS-A												1362878
MANU-A												4326345
UTICON-A												719513
TRADE-A												1677846
SER-A												2132057
PRIMA-C	70608	27668	113860			831				15633	223689	1321775
AINDUS-C	189171	92511	356467			55				-24282	290902	1459193
MANU-C	177269	86691	334041			22112				493031	1666256	5877670
UTICON-C	9787	4787	18445			7364				295545	11366	723396
TRADE-C	34720	42795	165657			13136				100926	289891	1748924
SER-C	114914	141634	548255			457207				3675	241615	2389491
LAB												1457990
CAP												2702301
A-HHD						11443					19820	531662
G-HHD						2945					3826	497128
N-HHD						36068					35199	2138980
ENT-G												124496
ENT-P	1011	13903	28848			18976					78981	1039640
GOV							276736	413599	62037		20677	852454
YTAX	2576	41166	94444	3419	34199	104351						276736
ITAX												413599
TAR												62037
S-I	-68394	45973	478963	90297	632621	281451					390300	1851211
ROW					302668	866				966683		2882222
TOTAL	531662	497128	2138980	124496	1039640	852454	276736	413599	62037	1851211	2882222	

Source: Calculations based on Li, Jennifer Chung-I, "A 1998 Social Accounting Matrix (SAM) for Thailand", TMD Discussion Paper No.95, Washington DC: International Food Policy Research Institute.

Bibliography

Dr. Khin Maung Nyunt is an Assistant Professor, School of Management, Mae Fah Lung University, Chiang Rai, Thailand.