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Thongphet Lamphayphan

04 January 2013, Hiroshima, Japan

Abbreviation

ABAC	Assumption Business Administration College
AFTA	Association of South East Asian Nations Free Trade Area
ASEAN	Association of Southeast Asian Nations
ATM	Automated Teller Machine
BOT	Bank of Thailand
CBM	Central Bank of Myanmar
CEPT	Common Effective Preferential Tariffs
CER	Closer Economic Relation
CNPC	China National Petroleum Corporation
DEDE	Department of Alternative Energy Development and Efficiency
EGAT	Electricity Generating Authority of Thailand
EGCO	Electricity Generating Public Company of Thailand
EPPO	Energy Policy and Planning Office
EU	European Union
EWIS	Early Warning Information System
FDI	Foreign Direct Investment
FEC	Foreign Exchange Certificates
FTA	Free Trade Agreements
GDP	Dross Domestic Product
GMS	Greater Mekong Subregion
GSP	Generalized System of Preferences
GTZ	Germany Technical Cooperation
Gwh	Gigawatt hour
IEA	International Energy Agency
IMF	International Monetary Fund
IPP	Independent Power Plant
IRM	Integriertes Ressourcen Management
IV	Instrumental Variables
Km	Kilometer
KWh	Kilowatt hour
LIP	Law on Investment Promotion

MEA	Metropolitan Electricity Authority
MESSAGE	Model of Energy Supply Systems Alternatives and their General Environmental
MFN	Most Favorite Nation
MIC	Ministry of Industry and Commerce
MOF	Ministry of Finance
MOFA	Ministry of Foreign Affairs
MOU	Memorandum of Understanding
MSE	Mean Squared Error
MW	Megawatt
NBC	National Bank of Cambodia
NEM	New Economic Mechanism
NEM	New Economic Mechanism
NGPES	National Growth and Poverty Eradication Strategy
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PBOC	People's Bank of China
PEA	Provincial Electricity Authority
PPA	Power Purchase Agreement
PRC	People’s Republic of China
RMB	Renminbi
RMSD	Root Mean Square Deviation
RMSE	Root Mean Square Error
RMSPE	Root Mean Squared Percent Error
SBV	State Bank of Vietnam
SDR	Special Drawing Right
SEF	Strategic Environment Framework
SENT	Sustainable Energy Network Thailand
SME	Small and Medium Enterprise
SPP	Small Power Producer
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development

US	United States
USD	US Dollar
USD	United States Dollar
VSPP	Very Small Power Producers
WB	World Bank
WTO	World Trade Organization

Introduction

In many countries particularly the underdeveloped countries, natural resources base has traditionally been seen by national government and aid agencies alike as one of the prime assets for development and poverty reduction. There are a number of literatures showing both positive and negative impacts of natural resources in different countries as well as regions. The positive impact of natural resources on the economy leads the country to success in the aim of high economic growth. On the other hands, natural resources may harm the economy if it is not well analyzed. The inverse impact from natural resources trade leads to the initiation of the term *Resource Curse*. This paradox motivates a number of literatures concerning the effects of natural resources trade, and the solutions for the countries suffering from the negative impacts.

In the Greater Mekong Subregion (GMS), natural resources sector is one of the driving forces of economic growth in the subregion. The subregion has significant potential for rapid and sustainable growth, given its abundance of natural resources and its strategic location that acts as a "land bridge" between South and East Asia. The GMS consists of six diverse economies along the Mekong River—Cambodia, China (Yunna Province and Guangxi Zhuang Autonomous Region), Laos, Myanmar, Thailand, and Vietnam—with per capita GDP range from 379 USD (Myanmar) to 3,841 USD (Thailand) in 2008. The purpose of the integration of these countries is to promote regional development.

Since the beginning of the GMS program, poverty which is the major impediment of many countries in Asia has declined significantly. Despite the Asian economic crisis in 1997, the subregional economic growth rate from 1994 to 2004 was at an average of 6 %. Moreover, the economy grew more than 8 % between 2005 and 2006. This is a proof of a significant improvement in self-development capability of each country, a closer and more harmonious relationship among member countries, and a significant increase in trade and foreign investment in the subregion.

The economic growth and economic restructuring of the subregion is largely driven by increasing regional trade integration. Strong rates of economic growth in the GMS economies have been fueled in part by increased trade orientation. In terms of trade, most of trading partners of the GMS countries are among the subregion and other Asian countries whereas the United States as none-Asian country is a big trading partner of some of the GMS economies. Among the member countries, China and Thailand have played important role as ones of the major trading partners of each GMS countries.

The success of this regional cooperation has been the achievement of substantial progress in nine priority sectors of cooperation, namely, transport, energy, telecommunications, environment, agriculture, tourism, trade facilitation, investment, and human resource development. In order to sustain and boost the economic performance of the subregion, the following 5 strategic thrusts are set:

- Strengthen infrastructure linkages through a multi-sectoral approach
- Facilitate cross-border trade and investment
- Enhance private sector participation in development and improve its competitiveness
- Develop human resources and skill competencies
- Protect the environment and promote sustainable use of the subregion's shared natural resources.

The abundant resources in the GMS provide income as well as sustenance to the great majority of people in the subregion who are leading subsistence or near subsistence agricultural lifestyles. The water from many rivers in the GMS supports agriculture and fisheries, and also provides energy in the form of hydropower while land yields coal, petroleum, minerals, and timber. Coal reserves of the subregion are abundant, and oil and gas reserves are considerable. Due to the rich endowment of the subregional natural resources, foreign investor interest is considerably focused on this sector. Both international and intra-regional investment in infrastructure, hydropower, mining, and industrial tree plantations are becoming attractive sectors in the subregion.

The GMS has a high potential of hydroelectric power particularly in Laos, Myanmar, and Yunnan province whereas the large demand for power is mostly concentrated in Thailand and Vietnam. Among the member countries, Thailand seems to be the largest importer of electricity followed by Vietnam. With the implementation and further development of the Regional Power Trade Operating Agreement in the GMS, cooperation will continue to increase with projects for cross-border electricity trade. The current level of cooperation in energy sector appears to be increasing. In September 2007, for example, Laos and Thailand agreed to increase the commitment to hydropower trade in the first Lao-Thai high-level forum on sustainable hydropower development. Apart from large-scale power trade from Laos to Thailand, all six GMS member countries currently engage in small cross-border exchanges for supply to border towns of neighbors. Over the medium and longer term, revenues from exports of electricity and minerals in Laos, and prospective oil receipts in Cambodia are likely to reduce their dependence on revenues from tariffs which are the vital sources of their incomes. In addition, energy cooperation in the GMS could reduce the total cost of energy by 200 billion USD for the period 2005 to 2025. Such significant benefits are possible because: (1) the GMS is facing significant increases in energy demand over the coming years, (2) there is a disparity between a member country's energy demand and its endowment of energy resources, and (3) as the region develops, the least-cost way to meet one country's demand for energy will often be to import from its neighbors.

High economic growth of the Association of Southeast Asian Nations (ASEAN) as well as GMS countries shows the result of strong economic cooperation in the region. As a result, demand of electricity in the region as well as the subregion has increased gradually. The electricity demand in most GMS economies which has grown at over 8 % per annum during 1993 - 2005 has been surged by rapid economic growth in the subregion. Although the GMS members are endowed with substantial energy reserves, they are unevenly distributed between member countries due to the geographic difficulty. Among the GMS members, Laos, Myanmar, Yunnan province of China, and Vietnam have energy sources to be self-sufficient while Thailand is energy deficient and is likely to increasingly rely on imports. The electricity demand of Thailand which has average growth of 5.56 %, dominates the largest proportion among other GMS economies, followed by Vietnam. Being one important source of electricity, Lao hydropower has been recognized as the most abundant, and cost-effective source in the Greater Mekong River Basin with a theoretical hydroelectric potential of about 26,500 MW. The sharp increase in energy demand in the subregion will offer greater benefits for Laos in

terms of the increasing revenue from electricity export. Among the GMS economies, both Thailand and Vietnam, for example, are currently increasing the imports of electricity from Laos.

Among the GMS countries, Laos and Thailand have the most similarity in terms of culture, language, and etc. This similarity is one of the important factors strengthening the relationship between two countries. Up to now, both countries have increased bilateral cooperation in order to boost and strengthen trade and investment between two countries. The increasingly growth in trade relationship between Laos and Thailand is partly indicated by an increasing number of friendship bridges with the purpose to promote trade and investment, in both countries. Up to now, there are 4 friendship bridges (the latest bridge is under construction) built to connect between Laos and Thailand. The first Thai-Lao Friendship Bridge opened in 1994. Due to the increasing trade cooperation, two countries are further preparing to facilitate and expand more trade and investment relation with the goal to double trade value from 4 billion USD, to 8 billion USD by 2015.

Laos has trade relations with more than 50 countries around the world. As a land-locked country, cross-border trade with neighboring countries such as Thailand, Vietnam, and China is vital for the Lao economy. Since 1990s, Laos has signed bilateral trade arrangement with mostly ASEAN members, except Brunei and Singapore. Among them, Thailand is the most important trading partner followed by Vietnam, due to geographical proximities and similar culture. Over three quarters of Laos' imports are sourced from its ASEAN neighbors, with 69 % from Thailand. Due to the relatively deep trade relation, Thailand has remained a dominant market, accounting for over 96 % of Laos' exports to the original ASEAN members. Laos considerably relies on products from Thailand indicated by the increasing imports from Thailand. Concurrently, Laos also exports a number of products to Thailand. The principal export products to Thailand are electricity, wood and wood products, mining, agricultural products, and garment.

Similar to most developing countries, export products from Laos are mainly agricultural and primary products. The principal export items are mining products, electricity, wood products, garments, and agricultural products while the main imports items are machinery and equipment, vehicles, fuel, and consumer goods. In order to reach high economic growth, the Lao government intensely aimed to export electricity particularly hydropower generation, thus significantly increasing of the electricity export. Around 80 % of

Laos' official exports remain concentrated on two items exporting to two destinations: electricity for Thailand, and garment for the European Union. Laos possesses abundant energy resources with less environmental impact, principally hydropower covering 97 % of energy sources. Hydropower is the most abundant and cost-effective natural resources for electricity generation in the country. This sector directly creates more income earning opportunities through the sale of electricity. In addition to the direct increasing employment for Lao people along the projects, purchase of locally sourced goods can boost local economies and create more jobs. This implies that the governmental goal of sustainable economic growth and poverty reduction is achievable. The export of electricity to neighboring countries has also significantly played a crucial role on the economy in terms of contribution to GDP, government's budget, and revenues from export. The high economic growth of about 8 %, for example, has reduced official poverty rates from 46% in 1992 to 26% in 2010. This growth mainly came from high foreign investment in hydropower, followed by mining, and construction sectors.

Being at the hub of the GMS region and its substantial hydropower potential, Laos is strategically recognized to play a significant role in realizing the following economic, environmental, and sector benefits of electricity trading in the subregion. Electricity export is a key sector serving two vital national priorities: (1) it promotes economic and socio advancement by providing reliable and affordable domestic power supply to society and industry, and (2) it earns foreign exchange from electricity exports. The export of electricity to neighboring countries, particularly Thailand, is a country's foreign earner covering 10 % of GDP. Laos has exported surplus electricity to Thailand since the commissioning of the first hydropower plant in 1972, and has continued to supply the large amount of electricity to Thailand since then. Thailand is the biggest electricity importer from Laos accounted with about 90 % of total electricity export. Thailand is likely to gradually raise the import of electricity from Laos, since the expansion of power plants in Laos mostly come from hydropower based plants which have less environmental issues. This is a significant benefit for Thailand in terms of reduction of Carbon Dioxide (CO_2) emission. The import of electricity from Laos also provides political, and fuel diversity to balance Thailand's reliance on gas import from its neighboring country. As a demand from Thailand increases, about three-fourth of total electricity generation in Laos would be exported to Thailand while the remaining will be served to domestic demand, and exported to Vietnam, and Cambodia by 2035. After the concession agreements, and power purchase agreements between the Lao and Thai governments, there are five projects, after several studies in respect of feasibility, capacity as

well as social and environmental impact, the Lao government agrees to export electricity to Thailand.

Thailand is a net electricity import country with the energy import dependency of 50 % in 2000, and is estimated to import about 60 % to 70 % of its energy needs by 2030, and about 80 % to 89 % by 2050. This increase is mainly due to the growing demand, and the limited domestic energy resources availability in the country. Most of energy supply in Thailand is from natural gas, followed by coal-lignite energy. As in 2011, natural gas dominated approximately 67 % followed by coal - lignite energy (20 %). Over the past decade, the increasing demand in Thailand is strongly influenced by the rapid growth in industrial consumption in the country. Due to the increasing demand, Thailand has imported energy from its neighboring countries such as Laos, and Myanmar. In order to fulfill the significant increase in energy demand, in 2007 the Thai Cabinet had approved the Nuclear Power Infrastructure Establishment Plan. There will be 5 units of a 1,000 MW nuclear power plant beginning to be in commercial operation in 2020. This implies the possibility that Thailand will reduce demand from its neighboring countries as well as the demand from Laos. If it is the case, this will have large impact on Laos' electricity export industry due to the expected reduction in the import demand from Thailand which is the largest electricity market covering about 90 % of Laos' total electricity export. However, regarding the nuclear power project, there have been critics whether to build the nuclear power plants in such a country unprepared in terms of potential and social responsibility as Thailand. Environmentalists and local villagers living in the provinces listed as potential sites for nuclear power plant construction have formed an alliance called the *Network of People against Nuclear Power Plants* to protest against the planned construction of nuclear power plants in the country. The feasibility of building nuclear power plant in Thailand became further unclear since the incidence of damages of Japanese nuclear power plants in Fukushima caused by the earthquakes and tsunamis that struck the northeastern coastline of Japan on 11 March 2011. Since the accident in Japan's Fukushima nuclear power plant in March, the Thai government decided to postpone its plans to build a nuclear power plant for three more years becoming 2023. Moreover, there are increasing conflicts to the case of building nuclear power plant. Therefore, there is also a possibility that Thailand may abolish the nuclear power plants project in the country, and import more electricity from its neighboring countries as well as from Laos. The case of the decrease or increase in electricity demand from Thailand and other cases which are expected to have impact on the Laos's electricity leading to the impact on the whole economy are simulated in

this study. A number of simulations cases are conducted in order to see the effect of the changes in one economy on both economies in quantitative form.

This study aims at several specific targets:

- To describe the natural resources sector in general and the natural resources trade among the Greater Mekong Subregion (GMS) countries.
- To describe the trade and investment interrelationship between two interdependent GMS members—Laos and Thailand with specific focus on Laos' electricity trade with Thailand.
- To develop the two-stage least squares (2SLS) method in order to analyze bilateral trade on electricity between Laos and Thailand.
- To build small macroeconometric models of Laos and its trading partners.
- To develop a simulation model of Laos' electricity trade with Thailand.

In the present study, there may be various limitations causing difficulties for archiving more favorable result from the research. However, the primary limitations of this study are as follows:

- Due to the limited time and data shortage, macroeconometric model of each country in this study is presented in the form of demand-side. For example, due to the limited data on labor, wage, and etc which are variables on the supply-side, the estimation of potential gross domestic product is not estimated. In this study, the gross domestic product equation in each macroeconometric model is therefore based on expenditure approach which is the demand-side compilation approach, assuming that it is equal to the potential gross domestic product which is the supply-side compilation approach. The estimation results are expected to be improved with the inclusion of supply-side model with more detail and number of equations.
- In time series analysis, although there is no formal restriction on the minimum number of sample size, the larger number of sample the more potentially precise result. However, due to the lack of time series data

particularly on Lao economy, the data applied for the analysis in this study is limited to 25 samples ranging from the period of 1986 to 2010.

- Although the Greater Mekong Subregion (GMS) consists of Cambodia, Laos, Myanmar, Thailand, Vietnam, and Yunnan province and Guangxi Zhou Autonomous of China, sometimes, the statistical data of China as a whole economy (i.e. GDP, exports, imports, and etc) are presented instead of data of Yunnan province and Guangxi Zhou Autonomous due to the lack of data on specific areas.

- The GMS is a natural economic area consisting of six countries endowed with variety of natural resources in each country such as hydropower, petroleum, minerals, forest and etc. These subregionally rich natural resources are fundamentally an important component of the GMS economic growth. Thus, doing a research on the trade of such resources among all of six member countries absolutely give more contribution. However, doing this kind of research is relatively time consumed in terms of collecting data of each type of natural resource in each member country, and estimating relatively large-scaled macroeconometric models. Therefore, there are only two GMS member countries doing trade on one specific product employed in the analysis of this study. In other words, only electricity trade between Laos and Thailand is mainly analyzed in the current study.

- Applying the Three-Stage Least Squares (3SLS) method instead of Two-Stage Least Squares (2SLS) may give better result in this study. However, 3SLS method is a combination of 2SLS and seemingly unrelated regressions (SUR) which may be time-consumed while the period of this study is quite limited. Although the main advantage of 3SLS over 2SLS is a gain in asymptotic efficiency, the main disadvantage is that the estimators for a single equation are potentially less robust, since they will be inconsistent if the instrumental variable assumptions that the dependent variable is predetermined fail in any equation. In addition, model specifications are more important than estimation methods, therefore the application of 2SLS method is still common in recent researches on macroeconometric model such as Fair (2009), Chow (2011), and etc.

Based on the limitation in this study, there are several avenues for future research on the trade among the GMS countries as follows:

- Since some data of some resources-rich countries are not available, the number of researches on natural resources based on macroeconometric method is relatively limited. Therefore, obtaining data of resources-rich countries that have more plentiful and easy-accessed data, building macroeconometric models based not only on the demand-side, but also the supply-side will give more contribution to this field. In addition, the more data are available the more samples can be employed in the estimation in order to obtain more favorable results.

- Applying macroeconometric model method, it is not necessary for doing a research only on electricity trade between such two interdependent GMS countries as Laos and Thailand, but investigating various natural resources trade among GMS countries that have plentifully available data related to the study objectives is also interesting.

- Given precise data obtained from the GMS countries, in addition to 2SLS method such estimation method as 3SLS applying for each behavioral equation in each GMS country's macroeconometric model is recommended. Applying this estimation method may yield more efficient estimates for simultaneous equation systems. However, applying this method has to be cautious particularly on the data employed in the estimation, since it is sensitive to model specification errors. In addition, applying 3SLS method requires large sample size.

Chapter 1

Natural Resources and Economic Growth

Introduction

Natural resources are fundamentally an important component of natural conditions. They include mainly forest, land, mineral, biological, climatic, and water resources. For the time being, natural resources undoubtedly play a major role in the world's development. They are what we use to create our industrialized civilization. The abundance of natural resources is important for country's development and prosperity. In some countries, natural resources such as timber, natural gas, oil, and coal reserves have been a major engine of economic growth and job creation providing the country with a stable economy for development

While the abundance of natural resources has enormously contributed to Australia, Botswana and Norway over long periods, it has brought serious problems in terms of low growth, increased inequality, and corruption in many resources rich countries. Instead of stimulating the economy, having natural resources may take away incentives to develop other economic areas which are potentially more important for long run growth. Furthermore, in some countries such as Angola and Sierra Leone, natural resources have been at the heart of violent conflicts with devastating effects for society. Such paradox of natural resources is well-known as Resource Curse.

Over the past couple of decades, the real impact of natural resources on economic growth has been a subject of intense debate. The purpose of this chapter is therefore to show the exact nature of natural resources on the economy, and provide some essential recommendations to avoid potentially adverse effect of natural resources that may harm the

growth. This chapter reviews the impacts of natural resources on economic growth as well as the main issues of detriment caused by the paradox of natural resources. The evidences from natural resources rich countries in terms of positive or negative impact of natural resources are presented in this chapter. Based on the experience from natural rich countries, the points to key policy implication for turning the paradox of natural resources into a driver rather than a harm of development are also presented.

1.1. Classification of Natural Resources

Natural resources are an important component of natural conditions. They include mainly water, lands, minerals etc. According to Wikipedia (2011b), the classification of natural resources is as follows:

On the basis of renewability, natural resources may also be classified as renewable resources, and non-renewable resources:

- Renewable resources are those that can be reproduced or replenished easily. Some renewable resources such as wind, air, sunlight, etc remains available and their quantity is not affected by human use. Many renewable resources can be depleted by human consumption, but may also be replenished, thus maintaining a flow. Some of these resources take a short time for renewal (i.e. agricultural crops) while others take a comparatively longer time (i.e. water, and forest).

- Non-renewable resources are formed over very long geological periods (i.e. minerals and fossil fuels). Since their rate of formation is extremely slow, they cannot be replenished once they get depleted. Some of these can be re-used by recycling them (i.e. metallic minerals) while some cannot be recycled (i.e. coal, and petroleum).

Considering their stage of development, natural resources can be referred as Potential Resources, Actual Resources, Reserve Resources, and Reserve Resources:

- Potential resources are those that exist in a region and may be used in the future. For instance, petroleum may exist in many parts of India, having sedimentary rocks but until the time it is actually extracted and put into use, it remains a potential resource.

- Actual resources are those that have been surveyed, and are being used in present times. The development of an actual resource wood processing depends upon the technology available and the cost involved.

- Reserve resources are the part of an actual resource which can be developed profitably in the future.

- Stock resources are those that have been surveyed but cannot be used by organisms due to lack of technology. For example, hydrogen.

With respect to the availability natural resources may be divided into Inexhaustible, and Exhaustible natural resources:

- Inexhaustible natural resources are those present in unlimited quantity in nature and are not likely to be exhausted easily by human activity. For example air, sunlight etc.

- Exhaustible natural resources are those that can be exhausted by human activity in the long run. However, the amounts of these resources are limited. For example, natural gas, petroleum, coal etc).

On the basis of origin, natural resources may be categorized as biotic, and abiotic resources:

- Biotic resources are obtained from the biosphere such as fish and other marine organisms, birds and their products, animals, forests and their products. Mineral fuels such as petroleum and coal are also included in this category because they are formed from decayed organic matter.

- Abiotic resources consist of non-living things for example air, water, land, and minerals including gold, iron, copper, silver etc.

Considering the distribution, natural resources can be categorized as ubiquitous, and localized resources:

- Ubiquitous resources are those that are found everywhere. For example, air, land etc.

- Localized resources are those that are found only at certain places. For example, fossil, fuels minerals etc.

1.2. Growth Based on Natural Resources

The natural resources base has traditionally been seen by national government and aid agencies alike as one of the prime assets for development and poverty reduction. “Resource-based growth” is the common term for such strategies (Martinussen, 1997). Despite a number of arguments that Dutch disease effects largely explain the growth collapse in resources-abundant economies, Auty (2008) argues that they neglect the importance of

policy in mediating outcomes. His subtle explanation is that export base theory shows how natural resources booms can also sustain economic diversification. This theory is developed by Innes (1920), North (1955) and Watkins (1963) in order to explain the growth of diversified, prosperous, regional economies based upon the export of primary products, rather than upon industrialization.

The main concept of the resources-driven development is that the smaller the natural resources rent to GDP and the more diffusely it is spread across economic agents, the higher probability of engendering a developmental political state that sustains rapid growth in per capita GDP which in turn strengthen sanctions against anti-social governance (Auty, 2008).

Stijns (2005, 2009) assumed that resources abundance is likely to affect economy in many different ways, which they called "Channels of Operation". One of them is the effect of natural resources on human capital accumulation. Stijns (2009) shows positive nexus between education and subsoil wealth per capita indicated by the decrease in both male and female illiteracy when the subsoil wealth per capita distribution is moved up quartile by quartile. Following up on the empirical strategy by Brunnschwelie and Bulte (2008) in exploring the determinants of resources dependence, Brunnschwelie and Bulte (2009) analyzed the impacts of resources dependence as well as abundance on prosperity of the onset of conflict by running three different regression equations including a resources dependence equation, an income equation, and a conflict regression equation. They found that resources dependence may be influenced by both biophysical context (resources abundance and geography), and by institutional framework and policy choices it generates (government system and trade openness). Their specific empirical results demonstrated a (weakly) concave relationship between resources dependence and the onset of conflict in the sense that resources dependence initially leads to higher probability of conflict, but then decreases the probability. In other words, their conclusive results are consistent with the view of Homer-Dixon (1999) that resources scarcity—rather than resources abundance—may drive conflict.

Lederman and Malony (2007) found that, regard less of the estimation technique, trade structure variables are important determinants of economic growth rate. They found no evidence of resource curse which is the term used for the negative impact of natural resources on the growth using any of various measures of resources abundance. They found, in the panel context, that natural resources exports enter positively and significantly at 1 % level. Both of them strongly argue the Sachs and Warner (1995b)'s assertion that resources abundance negatively affects growth. Likewise, Mehlum et al (2006), Gylfason (2008) and Hillbom (2008) found that Botswana, which is the world largest producer of gem diamonds (Mahajan, 2009), does not suffer from Dutch disease which is also a term used for the

negative impact of natural resources on the growth. Instead, its per capita GDP based on purchasing power parity had climbed to 13, 992 USD in 2009 (IMF, 2010). The well-management of its diamonds by using the rents to support the economic growth, have made Botswana the richest country in mainland Africa (World Bank, 2007b).

Natural resources are one of the top 20 most important determinants of economic growth (Sala-i-Martin, 1997). Through history, it has played an essential role for prosperity in a number of countries characterized as developed (Kolstad and Wiig, 2009b). In many export concentrated countries, natural resources also cover large proportion of their total exports. As shown in Table 1.1, it is clear that, with very few exceptions, countries with the highest export concentration scores also have substantial high shares of natural resources in their total exports[1]. The export concentration indices obtained from United Nations (2009) shows the value from 0 to 1 with values closer to 1 indicating greater concentration of export. The table shows that in Guinea-Bissau and Angola–the respective highest and the second highest export concentration–natural resources play significant roles in their economies indicated by the 99.62 % and 99.75 % share of natural resources in total export, respectively.

[1] According to Sachs and Warner (1995b, 1997a), the share of natural resources in total exports is represented by the share of primary commodities.

Table 1.1: Export Concentration and Share of Natural Resources in Merchandise Exports in 2008

	Export Concentration Index (0-1)	**Share of Natural Resources in Total Export (%)[2]**
Guinea-Bissau	0.98	99.62
Angola	0.97	99.75
Venezuela	0.93	96.02
Azerbaijan	0.92	98.64
Nigeria	0.91	94.29
Sudan	0.91	99.28
Libyan Arab Jamahiriya	0.85	97.62
Gabon	0.84	96.54
Suriname	0.82	15.08
Maldives	0.82	99.99
Turkmenistan	0.81	95.87
Saudi Arabia	0.80	92.82
Samoa	0.79	14.77
Equatorial Guinea	0.77	96.92
Yemen	0.77	94.14
Congo	0.76	86.69
Iran (Islamic Republic of)	0.76	89.42
Mali	0.74	94.29

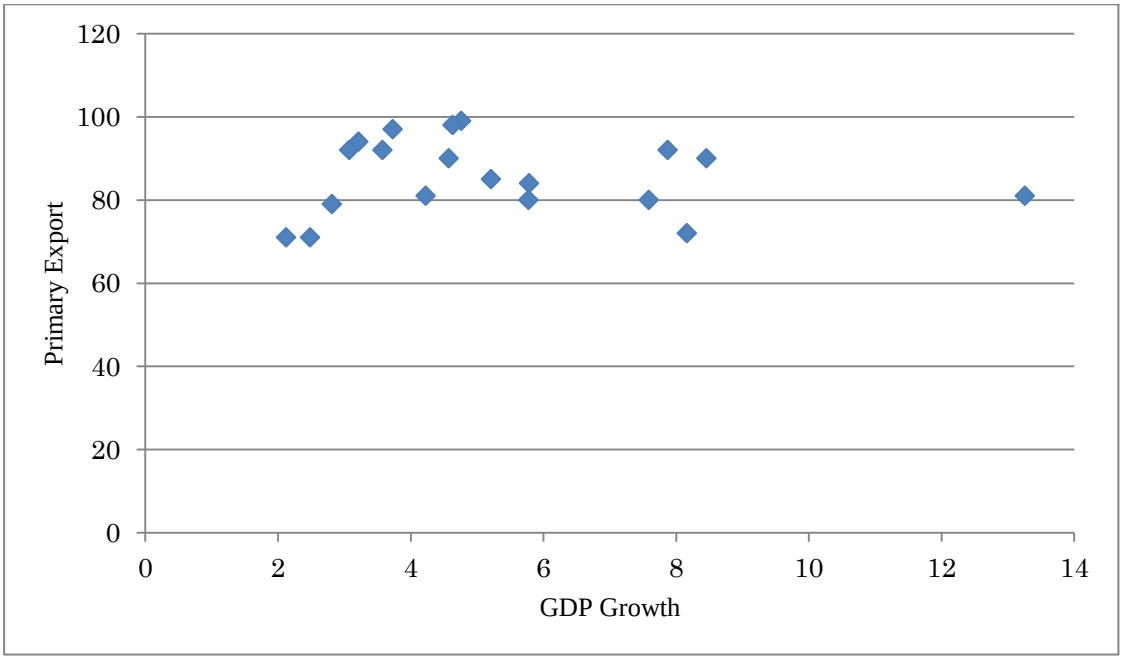
Source: United Nations (2009) and author.

There is increasing number of empirical evidences showing the contribution of natural resources on economic growth. A number of literatures show that countries with a greater endowment of natural resources have a better opportunity to attain prosperity and higher rates of growth than countries with relatively poor endowment of natural resources. In many countries, natural resources are an important determinant of their wealth. Figure shows that countries with primary products export as a proxy of natural resources dependence covering over 70 % share of total merchandise export have enjoyed high growth. The data obtained from UNCTAD (2012a) shows that natural resources export countries including Ghana, Kazakhstan, Panama, Paraguay, Peru, Qatar, Turkmenistan, and Zimbabwe[3] have enjoyed high growth. Among them, Paraguay of which 81 % of its export is primary products has impressive growth of 13.25 % in 2011.

[2] Calculated by the author using data from United Nations (2009).

[3] Over 80 % of their exports are primary products.

Figure 1.1: Primary Export as % of Total Export versus GDP Growth in 2010 of Natural Resources Dependent Countries with High Growth



Source: World Bank (2002), and UNCTAD (2012a).

Although some resources-rich countries suffer from negative economic growth (i.e. Azerbaijan, Kazakhstan, the Russian Federation, Turkmenistan, Uzbekistan and Venezuela), Botswana, Ghana and China are the example of resources-rich countries with positive genuine saving rates enjoying substantial growth[4] (van der Ploeg, 2010). Conducting a simple frequency count of the pro poorness of 240 growth spells in extractive and non-extractive economies, Davis (2009) found that extractive economies have positive growth spells that are more frequently pro-poor. Finding from Chambers (2009) shows that an increase of natural-resources utilization will raise the balanced growth path's output growth rate. More specifically, when more natural resources are utilized in production within a country, its subsequent 5-year growth rate in output will rise.

It is interesting that sometimes resources dependence and resources abundance have different effect on the economic growth. Some literatures show positive impact of natural

[4] Other examples from Auty (2001a) are Australia, Canada, Malaysia and Norway who are the exceptions to the resource curse hypothesis, whereas Nigeria and Mexico appear to suffer from the resource curse.

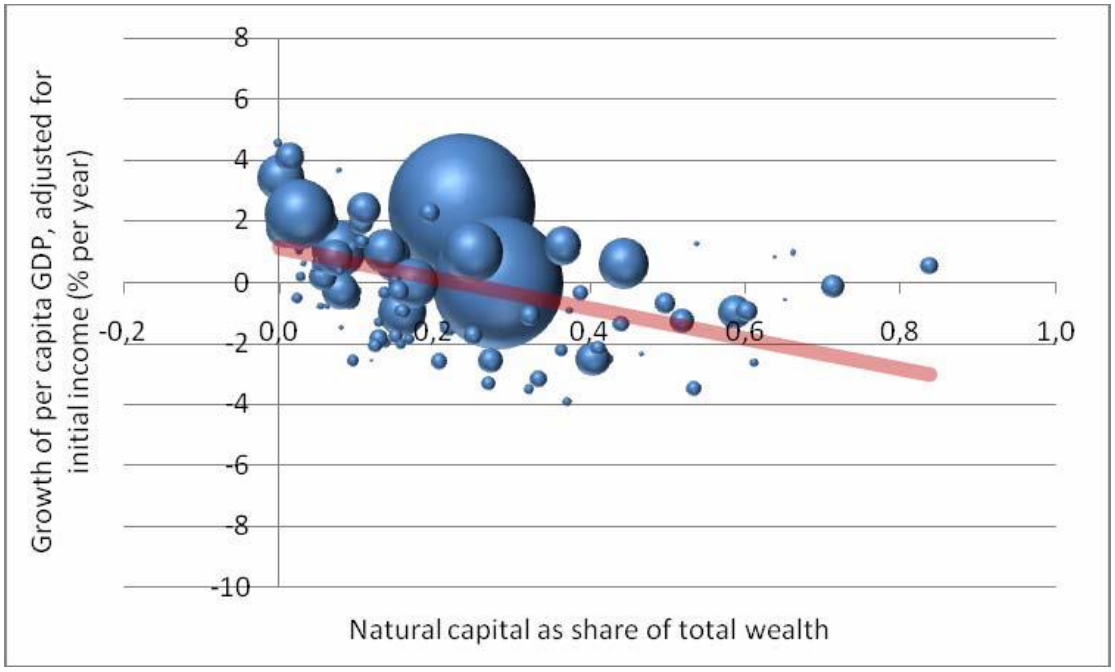
resources dependence on the growth while natural resources abundance has negative impact (i.e. Arezki and van der Ploeg, 2007; Torvik, 2009). On the other hands, natural resources dependence has negative impact on the growth (i.e. Gylfason and Zoega, 2006; Gylfason, 2008) while natural resources abundance has positive impact (i.e. Gylfason and Zoega, 2006; Brunnschweiler, 2008; Gylfason, 2008). Gylfason (2008) found that natural capital share representing natural resources abundance statistically contributes to economic growth. Furthermore, using subsoil assets instead of natural capital in the regression analysis thus excluding timber resources, non-timber forest resources, pastureland, cropland and protected areas from consideration to focus on mineral assets, his finding showed that the total effect of an increase in the subsoil asset share on growth remains negative as long as total per capita wealth is below 25, 000 USD which is true of 82 among 164 countries.

A number of paradoxical finding of a negative relationship between a sizable resources sector and economic growth has attracted attention from academics, policy-makers as well as international organizations (Brunnschweiler and Bulte, 2008). A sizable body of literature show the negative impact of natural resources on the economic growth (i.e. Barro, 1991; DeLong and Summers, 1991; Mankiw et al, 1992; King and Levine, 1993; Sala-i-Martin, 1997; Rodriguez and Sachs, 1999; Sachs and Warner, 1995a, 1995b, 1997a, 1997b, 1997c, 1999, 2001, Boschini et al, 2003; Gylfason and Zoega, 2006; van der Ploeg, 2006; Arezki and van der Ploeg, 2007; Elliott et al, 2008; Gylfason, 2008; Mehlum et al, 2008; Torvik, 2009). Assuming that the share of primary product exports in gross domestic product (GDP) is a suitable proxy for resources wealth, it has been shown that many countries that are well-endowed with natural resources are likely to grow slower than their resources-poor counterparts (i.e. Sachs and Warner, 1997a, 2001; Auty, 2001a; Gylfason and Zoega, 2006). Gylfason and Zoega (2006) detected two distinct groups of countries among 85 samples. The first group consists of eight African countries (Central African Republic, Chad, Guinea-Bissau, Madagascar, Mali, Niger, Sierra Leone and Zambia) all of which the economies are dependent on natural resources with natural capital constituting more than a quarter of their natural wealth, but have experienced negative per capita growth since 1965. The other group consists of eight mostly Asian countries (China, Indonesia, Japan, Korea, Malaysia, Mauritius and Thailand) that are relatively independent of their natural resources, but whose economies have grown rapidly since 1965.

According to Gylfason (2008), natural resources are a fixed factor of production that impedes potential economic growth, causing a growing population and a growing stock of capital to run into diminishing returns. Figure 1.2 shows the relationship between the shares of natural capital in total wealth used as a proxy for natural resources dependence and average

annual per capita GDP growth of 164 resources-rich countries in 1960-2000. Gylfason found the expected relationship that a decrease in the natural capital share by 20 % of total wealth statistically corresponds to an increase in per capita GDP growth by 1 percentage point per year.

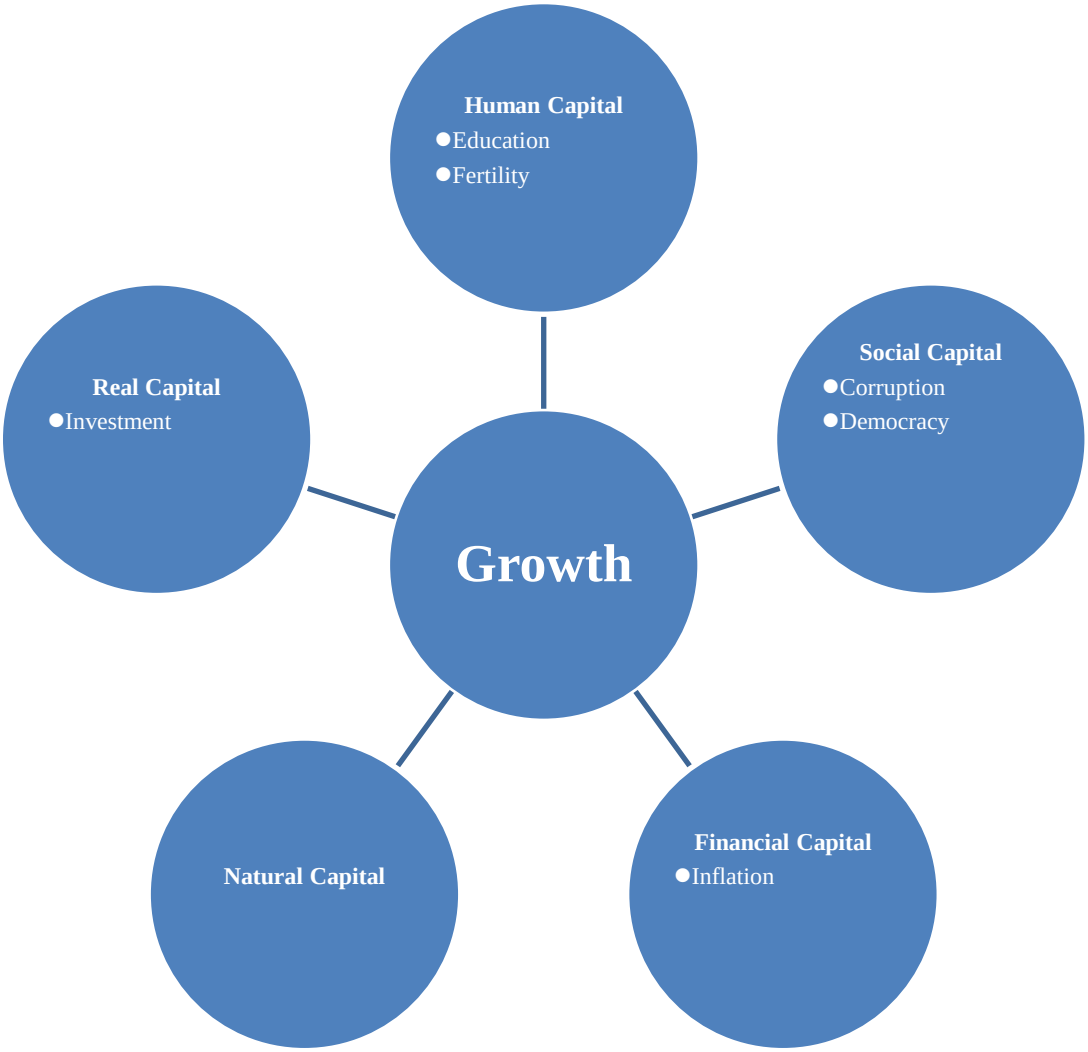
Figure 1.2: Economic Growth and Natural Capital (1960 - 2000)



Source: Calculated by Gylfason (2008) based on data from World Bank (2006, 2007b).

Gylfason (2008) distinguished total capital or total national wealth into five categories: real capital, human capital, social capital, financial capital and natural capital. Among these kinds of capital, natural capital seems different in that it tends to unleash forces that may have an adverse impact on the accumulation of other kinds of capital. He also mentioned that no country was ever held back by the burden of too much real capital or human capital or social capital or financial capital.

Figure 1.3: Different Kinds of Capital and Growth



Source: Author.

Sala-i-Martin and Subramanian (2003) showed the evidence that between 1965 and 2000, Nigeria—Africa's largest oil exporter—received substantial percentage of its GDP from oil revenues totaled about 350 billion USD. In the 30 years after 1970, however, the percentage of Nigerians living in extreme poverty (1 USD/day) increased from 36 % to almost 70 %. According to van der Ploeg (2010), negative genuine saving rates of many resources-rich countries are often judged to be detrimental to their economic performance.

There may also be political economy reasons for negative genuine saving (which leads to negative growth) to do with institutions, corruption, and badly functional market.

Despite a large number of positive or negative impacts of natural resources on economic growth, some literatures found neither negative nor positive impact of natural resources on the economic growth. (i.e. Ding and Field, 2005). Recurrent booms and busts tend to increase real exchange rate volatility (Gylfason et al, 1999), thus reducing investment in the tradable sector as well as exports and imports of goods and services. According to Gylfason and Zoega (2006), natural capital may crowd out real capital by reducing national saving and investment, thus impeding economic growth. They found that accumulation of physical through investment, human capital through education and social capital through civil liberties are inversely correlated with the natural resources dependence. However, they also found that natural resources abundance measured by resources per head of population is positively correlated with investment, education, civil liberties and economic growth.

1.3. Natural Resources Curse

Less natural resources-rich countries are not necessarily poor. Among the world's richest countries, Hong Kong, Japan, Luxembourg, Singapore and Switzerland, for example, are clearly not resources-rich countries (Gylfason and Zoega, 2006). Instead, natural resources may lead to the negative impact on the economy. Various theoretical reasoning and statistical evidence suggest that possession of natural resources endowment can confer negative effects on economy (i.e. Sachs and Warner, 1995b, 1997a, 1997c, 2001). Evidently, many resources-rich African countries such as Angola, Nigeria, Sudan and the Congo continue to experience low per capita income and low quality of life while the East Asian economies such as Hong Kong, Japan, Korea, Singapore and Taiwan have achieved western-level standards of living despite having less exportable natural resources (Frankel, 2010). Frankel (2010) considered six channels whereby natural resources might possibly lead to poor economic performance as follows:

1. High commodity price volatility imposes risk and transactions costs
2. Specialization in natural resources can be detrimental to growth if it crowds out the manufacturing sector that is the locus of positive externalities
3. Specifically, mineral riches can lead to civil war which is certainly an obstacle to development

4. Endowment of point source commodities5 such as oil and minerals, and some crops can lead to poor institutions including chronic power struggles, inequality, corruption, class structure, and absence of rule of law and property rights.

5. The Dutch Disease resulted from a commodity boom entails real appreciation of the currency and increased government spending both of which expand non-traded goods and service sectors such as housing and render uncompetitive non-commodity export sectors such as manufacturing.

6. The Prebisch (1950) hypothesis of long-term trends in world commodity prices (however, this channel is counteracted by theoretical arguments for a positive trend, and empirical findings that there is no consistence either way).

According to Aldave and García-Peñalosa (2009), the empirical literature has identified three factors that seem to be most systemically correlated with poor economic performance: low educational attainment in the population, widespread corruption and abundant natural resources. The best known formal empirical tests for the resource curse, among others, are found in the works of Sachs and Warner (1995a, 1995b, 1997a, 1997b, 1999 and 2001) employing natural resource exporters as a share of GDP as their proxy, they persistently found a negative correlation between natural resources and economic growth. Although there has been strong historical evidence indicating the positive impact of natural resources on the economic growth, the reality is sometimes different. Beginning with Sachs and Warner (1995b), a number of recent works have shown a broadly similar conclusion about the inverse impact of natural resources on economic performance. Economists have noticed that many countries have a wealth of natural resources are also full of very poor people (Wenar, 2008). During the last 50 years, instead of the prosperous growth, it appears that there are a number of countries rich in resources such as diamond or oil do worse in terms of economic development or growth leading to the term *resource curse* by Sachs and Warner (1995b).

The term *resource curse thesis* was used to describe how the natural resources-abundant countries were unable to use that wealth to boost their economies, and how these countries had lower economic growth in comparison with the countries poor in

[5] Point source resources are those where ownership is concentrated and exploitation is capital intensive. They are typically oil and minerals, but also plantation-grown agricultural crops (Stevens, 2008).

natural resources (Auty, 1993). Natural resources, according to Gylfason and Zoega (2006), are a fixed factor and hence, almost by definition, impose a restriction on economic potential. Depending on production technology, this restriction may cause a growing labor and a growing stock of capital to run into diminishing returns.

A large body of empirical evidence demonstrates an inverse relationship between natural resources endowments and economic growth, even when controlling for a variety of variables (Bulte and Damania, 2008). It has been widely held that countries specializing in natural resources extraction have suffered from the so-called: "Resource Curse" (see Davis and Tilton, 2005; Stevens, 2005; Davis and Cordano, 2009). The resource curse seems to be particularly more related to point resources such as minerals and petroleum, rather than diffuse resources such as land (Leite and Weidmann, 1999; Auty, 2001b; Sala-i-Martin and Subramanian, 2003; Isham et al, 2004, 2005; Kolstad et al, 2009; van der Ploeg and Poelhekke, 2009).

The resources curse is also well-known as the paradox of plenty referring to the paradox that countries or regions rich in natural resources, specifically point-sources nonrenewable resources like minerals and fuels, tend to have less economic growth and worse development outcomes than countries with fewer natural resources endowments. This paradox is due to several reasons including a decline in the competitiveness of other economic sector caused by appreciation of the real exchange rate, volatility of revenues from the natural resources sector due to exposure to global commodity market swings, government mismanagement of resources or ineffectual institutions (Wikipedia, 2010).

According to Pegg (2010), despite a number of sources, at least five different dimensions are highlighted in the resource curse literature. First, resources-abundant countries are alleged to not invest adequately in education (Gylfason, 2001challenged by Stijins, 2006). Second, resources-abundant countries are subject to increase risks for civil war (Collier and Heoffler, 1998, 2000, 2004, 2005; Ross, 2004). Third, resources-abundant countries have difficulties in establishing or consolidating democratic forms of governance (Ross, 2001a; Jensen and Wantchekon, 2004). Fourth, it is believed that resources abundance leads to the risk of increased corruption and have corrosive effects on the quality of institutions (Ades and Di, 1999; Leite and Weidmann, 1999 partially challenged by Petermann et al, 2007; Mehlum et al, 2008; Bulte and Damania, 2008; Kolstad and Wiig, 2009b). And fifth, oil and mineral-abundant states are seen acceptable to the Dutch disease and other ailments which finally lead to slow or negative growth (Sachs and Warner, 1995b; 2001 challenged by Davis, 1995 and Stijins, 2005).

Due to the attractiveness of high profitability in natural resources extraction, economic diversification may be neglected or delayed by the authorities. Even the authorities try to diversify the economy, this is made difficult since the resources extractive operation is vastly more lucrative and out-competes other industry. A sizable body of literatures have found the Dutch disease in resources-rich countries (i.e. Gylfason et al, 1999; Kronenberg, 2004; Boyce, 2008; Elliott et al, 2008; Arezki and Ismail, 2010; Ismail, 2010). The theoretical literature on Dutch disease has mainly focused on the implication of resources booms on the real effective exchange rate (Arezki and Ismail, 2010).

Depending on country case studies, the empirical evidence for the Dutch disease is rather mixed (i.e. Gelb et al, 1988; Spatafora and Warner, 1999). In economics, Dutch disease is a concept that purportedly explains the apparent relationship between the increase in exploitation of natural resources and a decline in the manufacturing sector. It refers to a situation where an increase in commodity price (such as oil price) increases real wages and appreciates the real exchange rate which in turn lowers competitiveness and production of non-resources exports (manufacturing) sector (van Wijnbergen, 1984; Matsuyama, 1992; Sachs and Warner, 1995b, 1999, 2001; Torvik, 2001). Natural capital tends to crowd out foreign capital by reducing the demand for foreign exchange, contribute to an overvaluation of the currency of the home country (Gylfason, 2008).

The example of the phenomenon from Arezki and Ismail (2010) is the appreciation of the real exchange rates of Nigeria and Venezuela over the period 1992 to 2009 when the oil export unit value increases. According to Corden and Neary (1982, pp. 827), the Dutch disease operates through two distinct channels: the resources movement effect and the spending effect. The resources movement effect refers to the shift in production towards the natural resources sector. For example (in WTO, 2010) in an economy with three sectors: natural resources, manufacturing and a sector producing non-traded goods, the booming natural resources sector will take factor inputs (including labor) away from the rest of the economy. This leads to an exceed demand for non-traded goods, thus the increase in price of non-traded goods. The spending effect refers to the fact that additional spending caused by the increase in natural resources results in a further appreciation of the real exchange rate. In other words, the extra revenues originating from the resources exports boom raise domestic incomes as well as internal demand for all goods. Since the price of tradable goods is set on world market, the additional spending boosts the relative price of non-tradable goods resulting in a further appreciation of the real exchange rate (WTO, 2010).

Elliott et al (2008) tested whether there is a Dutch disease in the Southern United States as a result of forest resources concentration using cross sectional data from 815

counties. Their empirical result suggested that the county economies in the South suffer from Dutch disease. Using standard channels of economic growth—forest concentration, pupil expenditures, business payrolls, federal expenditures per capita and education—1 % increase in forest concentration reduces income growth by 0.021 %. Although the education investment represented by the pupil expenditures supports the growth, its effect is very small.

Testing the implications in highly-disaggregated manufacturing sector data across countries covering data from 1977 to 2004, Ismail (2010) found that the empirical results on oil-exporting countries are fourfold. First, the Dutch disease exists due to the negative impact of permanent increases in oil price on the manufacturing sectors. Put differently, oil booms have resulted in reducing manufacturing output even after a number of robustness tests. Second, oil windfall shocks seem to have a stronger impact on manufacturing sectors in oil-exporting countries with more open capital markets to foreign investment, due to outflow of investment in manufacturing following a declining marginal return on capital, which is due to the expansion of labor-intensive non-tradable sectors. Third, as windfall increases the relative factor price of labor to capital and capital intensity in manufacturing sectors appreciate. Fourth, Ismail found that manufacturing sectors with higher capital intensity are less affected by windfall shocks than their peers possibly due to a larger share of the effect being absorbed by more labor-intensive tradable sectors.

1.4. Solutions to the Natural Resources Curse

A substantial body of studies suggests that, depending on the level of institutions of countries, countries with bad institutions of democratic accountability and rule of law suffer a negative impact of natural resources whereas counties with good institutions do not (i.e. Mehlum et al, 2008; Bulte and Damania, 2008; Collier and Goderis, 2008). Mehlum et al (2008) argued that poor institutions cannot prevent rent-seeking activity that can offset the gain from natural resources abundance. Rent-seeking reduces the net increase in income for the society. Institution is a key to avoiding rent-seeking by increasing the relative profitability of entrepreneurs' productive options (Mehlum et al, 2008). Stevens (2008) commented that in countries where institutions are good, politicians are less able to use patronage to influence election outcomes. On the other hands, in countries where institutions are bad perverse political incentives will dominate, and these will have negative impacts on the economy. The recommendation to solve the negative outcome is therefore the policy improvement. He suggested that countries should improve the quality of their institutions to undermine the negative political-economic impact that natural resources exploitation will otherwise have.

According to Kolstad and Wiig (2009b), for years, the observation that institutions need to be improved to address the resource curse has been interpreted as a need to improve formal institutions (see also, Nilsson, 2008) through technical means such as rewriting the petroleum law or recognizing bureaucracies. Likewise, the advice from Norman (2009) is that taking care to support the development of rule of law in resources-rich developing countries may be of particular importance. Karabegović (2009) commented that nations with sound economic institutions are more capable of managing the revenue from natural resources and forming it into positive impact on the economic growth. In addition, sound economic institutions also increase efficiency by eliminating barriers to entrepreneurial activity and establishing a rule of law, which is crucial for economic activity. Such institutions, she added, mitigate the curse by reducing incentives for rent-seeking and corruption. This is consistent with the recommendation that addressing corruption is essential in helping resources-rich developing countries escape the detriment of the resource curse (Kolstad and Søreide, 2008).

A commonality of centralized and decentralized political economy models of the resource curse is that resources rents create dysfunctional behavior (rent-seeking of patronage) when institutions are poor which decreases allocative efficiency in the country (Kolstad and Wiig, 2009b). Using two types of model namely the rent-seeking model of Mehlum et al (2008) emphasizing the importance of institutions of private sector efficiency (i.e. the rule of law, bureaucratic efficiency, risk of expropriation and reputation of contracts) and the patronage model of Robinson et al (2006) stressing the institutions of public sector accountability, Kolstad (2009) found that countries with better private sector institutions (rule of law) suffer less from the resource curse. Dropping the rule of law index and its interaction with natural resources abundance and includes the democracy index and its interaction, it supports the patronage model of Robinson et al (2006) that better public sector institutions (more accountable government) appears to ameliorate the resource curse. However, the adjusted R^2 value which is used to indicate how good one term is at predicting another decrease into 0.69 suggesting reduced fit. Adding both institutional indices and their interaction terms, and testing the hypothesis simultaneously, Kolstad (2009) found that only the rule of law interaction term is statistically significant. In other words, when controlling for the impact of private sector institutions, public sector institutions have no additional explanatory power. Therefore, his final result concludes that only private sector institutions are important in avoiding the resource curse. His suggestion is that policy makers and donors in poor resources-rich institutions should prioritize the development of institutions governing the private sector.

Like stamping out of corruption, increased democracy can be viewed as an investment in social capital (Gylfason, 2008). Empirical findings of Bhattacharyya and Hodler (2010) support their theoretical prediction that natural resources foster corruption in resources-rich countries with poor democratic institutions. They also suggest that natural resources may tend to reduce the corruption in strong democracies. In terms of political regimes, Lujala (2009) showed that democratic countries are likely to experience less devastating conflicts in the resources-rich economies.

Since corruption is detrimental on growth, it is essential to reduce the possibility of corruption in order to escape from the curse in the resources-rich countries. According to Kolstad and Wiig (2009a), lack of transparency can exacerbate corruption-related problems; transparency, therefore, has been viewed as central to curbing corruption (see also Stiglitz, 2003) and other dysfunctions in natural resources-rich countries. They pointed out that transparence has indirect impact on moral costs through its effect on social norms. In sum, they concluded that transparency is likely to reduce the corrupt behavior in the resources-rich economies. They also showed that transparency play the role in reducing the possibility of rent-seeing activities and increasing the accountability of the government. In addition, information is also a key factor in facilitating and sustaining cooperative behavior which reduce the possibility of corruption.

Gylfason (2008) suggested that since restriction against foreign trade and direct investment exacerbates the Dutch disease, trade liberalization would help reduce the extent of the overvaluation and relieve the symptom of Dutch disease. Gylfason (2008) also pointed out that both economic and political diversifications are good for growth because economic diversification directs economic activity away from excessive reliance on primary production in agriculture or a few natural-resources-based industries, thus facilitating the transfer of labor from low-paying occupations in low-skill-intensive farming or mining to more lucrative occupations in more high-skill-intensive jobs in manufacturing and services where political diversification stimulates growth by redistributing political power from ruling elites to the people, thus, in many cases, replacing an extended monopoly of often ill-gotten power by democracy and pluralism. Gylfason also suggested that resources-rich economies especially need diversification, because these countries often face jeopardy—that is, natural resources wealth that is concentrated in the hands of relatively small groups that seek to preserve their own privileges by standing in the way of both economic and political diversification that would disperse their power and wealth.

A suggestion to avoid the Dutch disease from Elliott et al (2008) is to redesign policies to promote education, improve efficiency of business and government investments in

forest-dependent communities. As suggested by Ismail (2010), there are fiscal and structural policies that may mitigate the Dutch disease. On the fiscal side, mitigating the Dutch disease effects comes down to decreasing the degree of spending out of windfall on non-tradable services. He thus suggested two fiscal policy measures to counter the Dutch disease. First, decrease spending out of windfall income through investment in foreign assets. Second, direct that spending towards import-heavy expenditures. On the structural side, policies related to the openness of the factors market to inflows of labor and capital may help offset some of the impact of resources price shocks. Easier immigration policies can offset the pressures on the exchange rate by drawing labor from outside to supply the increased demand for non-tradable sectors. More open capital accounts can also mitigate the shortage of capital during windfall booms by allowing for capital inflow.

1.5. Natural Resources Externalities

Natural resources not only have direct impact on the economy, but they also have indirect impact via their effect on civil war (Collier, 2000; Collier and Hoeffler, 1998, 2000, 2004, 2005), corruption (i.e. Leite and Weidmann, 1999; Kronenberg, 2004; Bulte and Damania, 2008; Kolstad et al, 2009; Kolstad and Wiig, 2009a; Bhattcharyya and Hodler, 2010), rent seeking (i.e. Torvik, 2002; Gylfason, 2008; Kolstad et al, 2009; van der Ploeg, 2010), democracy (i.e. Ross, 2001a; Andersen and Aslaksen, 2008; Bulte and Damania, 2008; Gylfason, 2008; Collier and Hoeffler, 2009), human resource (i.e. Bils and Klenow, 2000; Kronenberg, 2004; Bulte and Damania, 2008; Gylfason, 2001, 2008), institutional quality (i.e. Ross, 2001b ; Isham et al, 2005; Gylfason and Zoega, 2006; Stevens and Dietsche, 2008; Karabegović, 2009; Norman, 2009; Van der Ploeg , 2010), and etc.

Another aspect of the resource curse is that natural resources seem to relate to the onset as well as the duration and intensity of civil war. According to Auty (2008) and Collier (2000), for example, the growth collapse that resulted from the cumulative distortion of the economy in resources-rich countries may not be the 'trigger' of civil strife, but they provide the conditions in which such triggers can easily emerge. Collier (2000) also suggests that civil strife has strongly positive link not only with primary exports, but also with economic decline (that is growth collapse).

In many resources-rich countries, the competition for resources rents has fuelled war (le Billon, 2001). In extreme cases, struggles over natural resources revenue can spark civil wars that destroy physical and institutional infrastructure (Gylfason and Zoega, 2006;

Mehlum et al, 2006). According to Brunnchweiler and Bulte (2009) the pioneering empirical contribution based on cross-section analysis by Collier and Hoeffler (1998) found that resources dependence had a significant curvilinear effect on the onset and duration of war. The effect on duration is consistent with the findings of Lujala (2009, 2010) that conflicts in which natural resources located are longer and more violent than other types of conflict. Specifically, Lujala (2010) found that if natural resources are located inside the actual conflict zone, the duration of conflict is doubled. The longer duration of conflicts as a result of the exploitation of gems in a conflict zone is positively associated with the large number of combat-related deaths (Lujala, 2009).

A number of literatures points out that natural resources are the cause of conflicts within the countries (i.e. Smillie et al, 2000; United Nations, 2001; Auty, 2004; Collier and Hoeffler, 2006; Humphreys, 2005; Ross, 2006; Schollaert and Van der gear, 2009). The example of an African resources-rich country is that the conflict in the Democratic Republic of the Congo has become mainly about access, control and trade of five key mineral resources: coltan, diamonds, copper, cobalt and gold (United Nations, 2001). Schollaert and Van der gear (2009) pointed out that ethnic heterogeneity might indeed appear as a curse, since many of the war-torn countries highly depend on the exploitation of natural resources, and since this type of activity is characterized by low opportunity cost of fighting. According to Collier (2007), many conflicts within societies are often provoked by natural resources (i.e. Schollaert and Van der gear, 2009) as different factions and groups fight for their share. Sometimes, these emerge openly as separatist conflicts in regions where the resources are extracted (i.e. in Cabinda province which is an oil-rich area of Angola), but the conflicts are often in the hidden form, i.e. fights for access to budgetary allocations between different ministries. Lujala (2009) empirically found that in resources-rich countries, gemstone mining and hydrocarbon production in the conflict zone have largely positive relationship with the number of battle deaths (both more than double the number of battle deaths) whereas hydrocarbon outside the conflict zone are significantly associated with a decline in the number of combat deaths. A more detailed analysis of Lujala (2009) revealed that conflicts over territory with hydrocarbon production are the most severe, with example being the secessionist conflicts in the oil-rich Southern Sudan and Niger Delta[6].

[6] According to Lujala (2009), the second Sudanese Civil War from 1983 - 2004 accumulated more than 55,000 battle deaths, whereas the Nigerian Civil War (the Biafran War) in 1960s killed more than 70, 000 in combat deaths in just four years.

Concentrating mainly on the causal link between natural resources and the onset of civil war, Brunnschweiler and Bulte (2009) found the evidence of a link between natural resources wealth and the onset of civil war[7], but on the opposite perspective to the resources curse literature. They argued that civil war creates dependence on primary sector exports, but the reverse is not true. Their estimated results statistically showed that countries with more abundant natural capital appear to have lower probability of becoming engaged civil war. Their empirical result is also consistent with Brunnschweiler and Bulte (2008) in the sense that natural resources abundance has positive effect on income, and that the resources abundance indirectly reduces the risk of the onset of civil war via an income effect. They found that higher incomes attenuate the risk of conflict especially a major conflict (see also Miguel et al, 2004; Colier et al, 2009) since the increasing resources abundance by one standard deviation decreases risk of civil war from 7.1 % to 6.7 %. In addition, the evidence that resources dependence causes civil war was not found in their study.

Possessing natural resources has indirect impact on economic growth (Leite and Weidmann, 1999; Sala-i-Martin and Subramanian, 2003) through increases in rent-seeking (Lane and Tornell, 1996; 1999; Baland and Francois, 2000; Torvik, 2002; Hodler, 2006; Gylfason, 2008), measured by the level of corruption (Leite and Weidmann, 1999), and that corruption negatively affects the growth (Mauro, 1995; Leite and Weidmann, 1999; Kronenberg, 2004; Bulte and Damania, 2008). Corruption is another key part of the resource curse (Kolstad et al, 2009). Many extractive operations of natural resources are illegal and encouraged by multi-national corporations in collusion with national governments (Ayres, 2004). In many oil-rich countries, corruption issues are the same as those of other developing countries, but their incidence and impact maybe heightened by the presence of large resources rents (Kolstad et al, 2009). In resources-abundant countries, it is often easier to maintain authority through allocating resources to favored constituents than through growth-oriented economic policies. This political corruption is fueled by enormous flows of money from natural resources sector. It is often expected that resources-rich economies may be more susceptible to corruption than others. This is particularly to occur in the case of point-source natural resources (Auty, 2001b). In many developing countries that are rich in natural resources, corruption is a massive problem explaining why resources-rich countries perform badly in terms of socio-economic development (Kolstad and Wiig, 2009a). Countries with a lot of fighting activities caused by natural resources are likely to suffer from corruption and erosion of the quality of the legal system, which discourages saving and investment in

[7] They based their definition of civil war on the Correlates of War database by Gleditsch (2004) which was first developed by Russet et al (1968).

productive capital (Hodler, 2006). The extent of corruption in resources-rich countries distorts the set of policies chosen by the government, with detrimental effects on the economic performance (Bulte and Damania, 2008).

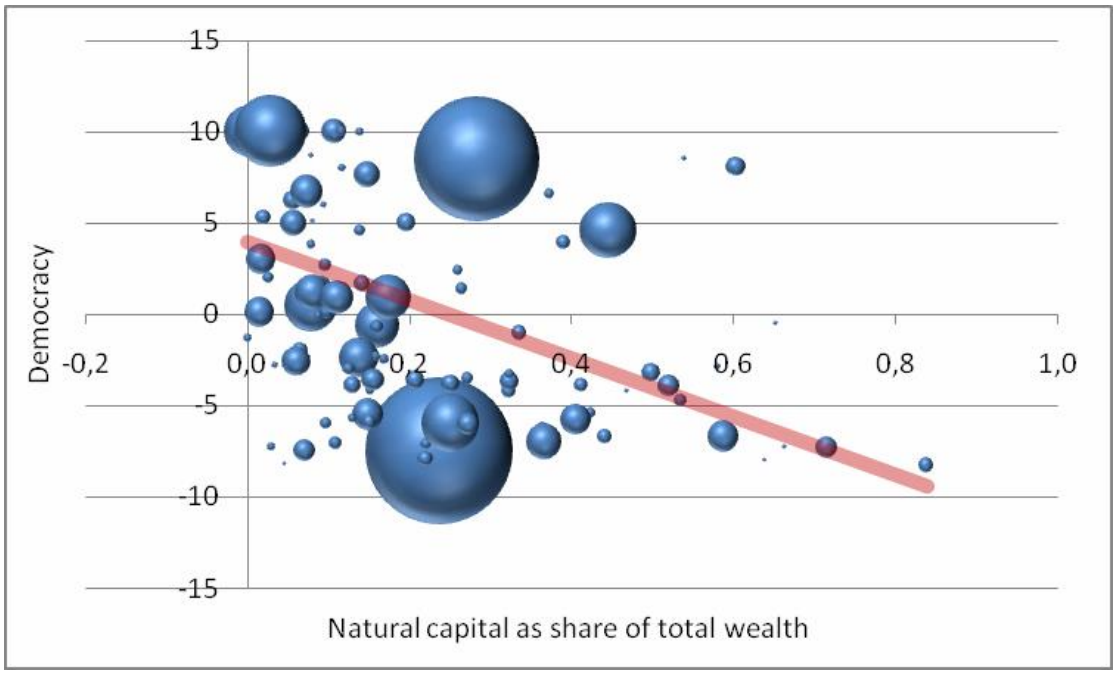
Using a game-theoretic model, Bhattcharyya and Hodler (2010) showed that resources rents increase corruption if and only if the quality of the democratic institutions is below a certain threshold level. To test the prediction, they use a reduced form model and panel data from 1980-2004 of 124 countries. Their findings imply that resources-rich countries indeed have a tendency to be corrupt (unless the democratic institutions are sufficiently sound) since resources windfalls encourage their government to engage in rent-seeking. But in the case of Australia and Norway, this tendency can be checked by sound democratic institutions that keep governments accountable to the people.

Over the last decade, the literature on economic growth has identified the critical importance of institutional quality (Karabegović, 2009). Since the economic institutions determine how economic inputs—human, physical, and natural resources capital—are transformed into economic outputs such as economic growth, they are important for the nation's growth (Sobel, 2008). Natural resources seem to affect economic growth directly through macroeconomic variables as well as indirectly through institutions (Gylfason and Zoega, 2006). There is a variety of literatures on the way which institutions matter for growth. Theory suggests that conflict over natural resources can affect human, social, and institutional capital (Norman, 2009). In addition to the direct impact, the natural resources indirectly affect the economic growth by affecting the quality of institutions (Ross, 2001b; Acemoglu et al, 2005; Isham et al, 2005; Norman, 2009), and that institutions in turn have an impact on economic growth (Acemoglu et al, 2005; Isham et al, 2005; Norman, 2009). Recent research into the natural resources has specified institutions as a key variable in determining whether a country suffers from the resource curse (Stevens and Dietsche, 2008). Resources-rich countries with badly defined property rights and rapacious rent-seeking really are worse off (van der Ploeg, 2010). According to Isham et al (2005), natural resources those extracted from a narrow geographic or economic base such as oil, minerals (i.e. copper, diamonds) and plantation crops (i.e. bananas) are strongly associated with weak public institutions which are, in turn, strongly associated with slower growth. Van der Ploeg (2010) found that as natural resources revenues and resources rents dwindle away at a faster rate in comparison to homogeneous society, the country ends up with lower foreign assets in the long run and a lower level of sustainable consumption. This often occurs especially large in countries with a large degree of fractionalization, poorly developed property rights and not much monopoly power on the market for its natural resources.

Rapacious rent-seeking rather than anticipation of better times may be one important reason why many natural resources-rich countries face disastrous economic and social outcomes (Van der Ploeg, 2010). The more agents are involved in rent-seeking, the more income is reduced (Kolstad et al, 2009). Extensive rent-seeking can breed corruption in business and government, thus distorting the allocation of natural resources and reducing both social equality and economic efficiency (Gylfason, 2008). In resources-rich countries, rent-seeking domestic producers often demand protection against foreign competition, for instance, in the form of restrictions against foreign direct investment and trade, exacerbating the Dutch disease that manifests itself through reduced incentives to produce non-primary goods and services for export which the overvalued currency renders uncompetitive at world market prices, reducing trade (Gylfason, 2008).

Resources rents can either enhance or undermine the contribution of democracy to growth (Collier and Hoeffler, 2009). Some of the most resources-rich economies in the world are also among the least democratic and least egalitarian (Gylfason, 2008). Some studies found that natural resources impede democracy as found, for example, by Ross (2001a); Gylfason (2008) for the negative effect of oil on democracy; that is, countries that have high revenues from oil are less democracy.

Figure 1.4: Democracy and Natural Capital



Source: Calculated by Gylfason (2008) based on data from Polity IV database and World Bank (2006).

The result estimated by Gylfason (2008) as illustrated in Figure 1.3 shows that democracy as a representative of social capital varies inversely with the natural capital share across countries. The slope of the regression line through the scatter suggests that a decrease in natural capital share by 20 percentage point (i.e. from 40 % of total wealth to 20 %) goes along with more than three-point increase in the democracy index. The figure shows that liberalization from excessive reliance on natural resources goes along with increased freedom from dependence on narrow political elites and vice versa. In other words, natural capital tends to crowd out social capital and vice versa. This is consistent with the finding of Ross (2001a) that oil wealth is inversely related to democracy. When democracy is endogenous variable, Gylfason (2008) found that resources dependence weakens democracy while resources abundance strengthens.

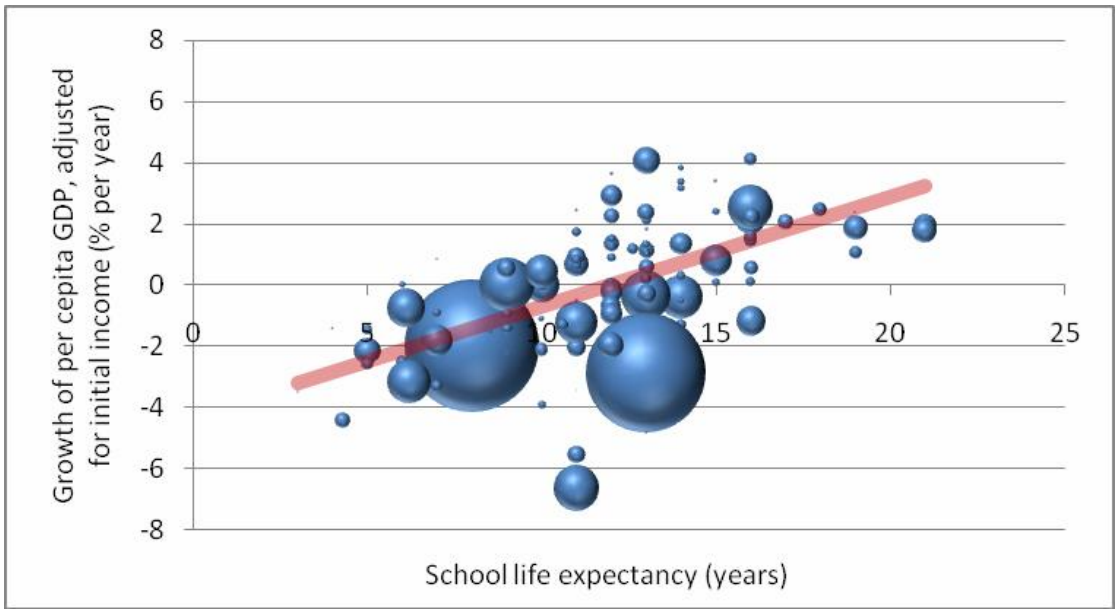
Bulte and Damania (2008) suggested that the main effect of resources abundance on economic growth occurs through interaction with political variables. Depending on the type of political regime, they demonstrated that resources endowments allow government to extract greater surplus (bribes) by pursuing policies that are detrimental to GDP in autocratic regimes. Their study, however, found that the effect is mitigated or even reversed into positive in democratic systems. Using a cross-country sample of up to 90 countries from all continents to empirically investigate whether constitutional features determine how natural resources abundance affects economic growth, Andersen and Aslaksen (2008) found that presidential democratic regimes suffer from the resource curse whereas parliamentary democratic regimes do not.

Natural resources, not only reduce growth through Dutch disease, rent-seeking, corruption and overconfidence, but also have negative impact on human resources. In many countries, natural resources industries tend to pay far higher salaries than what would be available elsewhere in the economy attracting the best talent from both private and government sectors (Wikipedia, 2010). Therefore, their best skilled personnel are depreciated. In addition, natural resources also lead to the neglect of public and private incentives to accumulate human capital (that is education) (Gylfason, 2001; 2008). There is also evidence from Gylfason (2001) that, cross countries, public expenditures on education relative to national income, expected years of schooling and school enrolment are all inversely related to natural resources dependence. Recent work by Bulte and Damania (2008) suggested that resources booms might be logically linked to low education through rent-seeking and corruption.

The regression result by Gylfason (2008) showed that an increase in school life expectancy by three years from one place to another goes along with an increase in per capita growth by more than one percentage point indicating the important of education on growth

and vice versa (Bils and Klenow, 2000). When education is treated as endogenous, Gylfason (2008) found that resources dependence hurts education while resources abundance helps[8].

Figure 1.5: Economic Growth and Education (1960 - 2000)

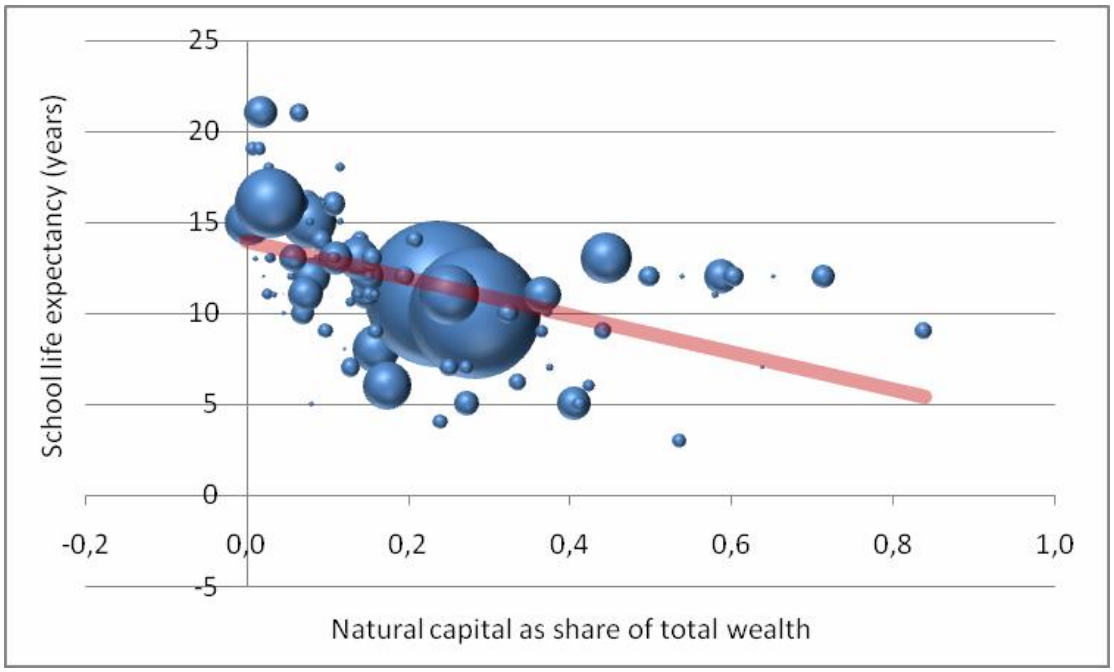


Source: Calculated by Gylfason (2008) based on data from World Bank (2007b) and UNESCO.

According to Gylfason (2008), natural capital tends to crowd out human capital by weakening public and private incentives to promote education. Except for Botswana where government expenditure on education relative to income is among the highest in the world, Gylfason showed the inverse relationship between school life expectancy and natural resources dependence as proxied by the share of natural capital in total wealth of 164 resources-rich countries.

[8] Gylfason (2008) defined resources abundance as the amount of natural capital that a country has at its disposal: forests, land, oil fields, mineral deposits, and the like whereas resources dependence is the extent to which the nation in question depends on these natural resources for its livelihood.

Figure 1.6: Education and Natural Capital (2000 - 2005)



Source: Calculated by Gylfason (2008) based on data from UNESCO and World Bank (2006)

Focusing on the relationship between resources abundance and the institutions that establish or fail to establish the rule of law, Norman (2009) found the inverse effect of the mineral abundance (as distinct from a resource extraction intensive economy) on the rule of law which is an important requirement for growth. However, the robust evidence for direct effect of the mineral abundance on the economic growth was not found.

Much of the emphasis is also on the observation that resources abundance tends to worsen income inequality (Fields, 1989; Auty, 1994; Sarraf and Jiwanji, 2001; Lam and Wantchekon, 2003). Lam and Wantchekon (2003) found that resources abundance exacerbates income inequality between the populace and political elite. However, Benedikt and Samuel (2009) found that inequality falls, in the short run, in response to a resources boom. They argue that low growth and high inequality in the resources-abundant countries is due to their bad economic policies (see also Auty, 2001a, 2001b).

In order to prove the above mentioned literatures concerning the effects of natural resources, in this study, data of 25 natural resources abundant countries are provided in Table. The natural resources abundance is measured by the share of natural capital in total wealth. In

this study, the natural resource abundant country is measured by the share of natural capital in total wealth. In other words, country which has over 50 % share of natural capital in total wealth is said to be a natural resources abundant country. Table, illustrates level of democracy measured by democracy index, education measured by school life expectancy from primary to tertiary education, and per capita economic growth of 25 random natural abundant countries in 2005.Regarding data collection, share of natural capital in total wealth, democracy index, school life expectancy, and per capita growth rate are obtained from World Bank (2010a), Norris (2012), UNESCO (2012), and World Bank (2005), respectively.

Table 1.2: Natural Capital and Democracy, Education, and Growth in Natural Resources Abundant Countries in 2005

Income Group	Countries	Share of natural capital in total wealth (%)	Democracy index	School life expectancy (year)	Per capita growth (%)
Lower middle income	Angola	96.39	3.32	8.8	18.26
	Bhutan	85.27	4.57	9.4	8.77
	Bolivia	55.11	5.84	9.9	4.42
	Central African Rep	87.40	1.18	6.3	2.40
	Chad	92.85	1.62	6.1	17.33
	Congo	69.70	2.15	4.3	7.78
	Guinea-Bissau	55.55	1.99	8.9	3.46
	Laos	55.08	2.10	8.5	7.10
	Liberia	95.04	5.07	9.5	9.48
	Madagascar	54.97	3.93	9.1	4.60
	Nigeria	55.01	3.83	8.5	3.07
	Papua New Guinea	95.32	6.32	6.1	3.59
	Rwanda	55.33	3.25	9.0	9.30
	Sudan	56.89	2.38	4.9	6.32
	Tonga	58.90	1.02	13.1	-0.94
	Uganda	56.60	5.13	10.2	6.33
	Average	*70.34*	*3.35*	*8.28*	*6.95*
Upper middle income	Algeria	52.28	3.44	11.5	5.09
	Azerbaijan	76.37	3.15	9.6	26.4
	Brunei Darussalam	78.79	1.25	14.0	0.38
	Ecuador	51.45	5.72	10.9	5.74
	Gabon	71.9	3.47	11.4	3.02
	Iran, Islamic Rep	53.63	1.98	10.3	4.62
	Kuwait	65.3	3.74	13.4	10.6
	Oman	52.27	3.26	8.8	3.99
	Saudi Arabia	66.39	1.77	11.4	5.55
	Average	*63.15*	*3.08*	*11.25*	*7.26*
	Average	**67.75**	**3.25**	**9.35**	**7.06**

Source: Norris (2012), UNESCO (2012), and World Bank (2010a).

Table 1.2 shows that, with score ranging from 0 to 10, most of natural resources abundant countries have relatively low level of democracy with average score of only 3.25. The upper middle income natural resources abundant countries are particularly less democratic indicated by the average score of 3.08 where the average score of lower middle income countries[9] is 3.35. Among the lower middle income resources abundant countries, Central African Republic and Chad, whose shares of natural capital in total wealth are relatively high, have significantly low level of democracy. In the case of upper middle income countries, Brunei Darussalam with the highest share of natural capital in total wealth has the lowest level of democracy with score of only 1.25. This supports the findings from Ross (2001 a); Gylfason (2008), and Bhattacharyya and Hodler (2010).

According to the data obtained from UNESCO (2012), countries with high human development such as Norway, Australia, and Netherlands have 16.9, 16.6, and 15.9 years of school life expectancy[10], respectively while the average school life expectancy in the natural resources abundant countries, as shown in Table 1.2, is only 9.35 years. Despite the high natural resources abundance, among the lower middle income countries, school life expectancy in Central African Republic is relatively low whereas Azerbaijan with large share of natural capital has the lowest number of years of school life expectancy compared with other upper middle income countries. The data in the table supports the findings from Gylfason (2001, 2008) that natural resources abundance and education have inverse relationship.

[9] According to the definition of the World Bank, economies are divided into 4 groups according to their gross national income (GNI): Low income (1,025 USD or less), Lower middle income (1,026USD to 4,035 USD), Upper middle income (4,036 USD to 12,475 USD), and High income (12,476 USD or more). However, in this study, the economies are divided into Lower middle income (4,035 USD or less) and Upper middle income (4,036 USD or more).

[10] School life expectancy is the total number of years of schooling which a child of a certain age can expect to receive in the future, assuming that the probability of his or her being enrolled in school at any particular age is equal to the current enrolment ratio for that age. The purpose school life expectancy is to show the overall level of development of an educational system in terms of the average number of years of schooling that the education system offers to the eligible population.

Although the average years of school life expectancy in natural resources abundance countries is relatively low, the average per capita growth rate in these countries are relatively high. Among them, Angola with the highest share of natural capital in total wealth even has the highest growth of 18.26 % followed by Chad (17.33 %) with relatively large share of natural capital of 92.85 %. The data in Table 1.2 implies the positive relationship between natural resources and growth. This supports the findings from Sala-i-Martin (1997), Brunnschweiler (2008), Chambers (2009), and Davis (2009).

Chapter 2

Presentation of Growth and Development in the Greater Mekong Subregion

Introduction

Over the past two centuries, world economy has become increasingly more integrated. The large and comprehensive regional group includes the World Trade Organization (WTO), the European Union (EU), the North American Free Trade Agreement (NAFTA), the Association of Southeast Asian Nations (ASEAN), the Mercosur or Southern Common Market, the Asia Pacific Economic Cooperation (APEC), the Southern Africa Development Community (SADC), the Common Market for Eastern and Southern Africa (COMESA), the Economic and Monetary Community of Central Africa, and so on.

The Greater Mekong Subregion (GMS)–made up of Cambodia, Yunnan Province and Guangxi Autonomous of China, Laos, Myanmar, Thailand, and Viet Nam–is designed to enhance economic relations among the member countries. It is one of the world's fastest growing economic cooperation group registering an average growth of around 8 % annually with real per capita income more than tripled between 1993 and 2010. Fuelled by the expansion of subregional trade and investment, the GMS represents a successful example of economic transition and integration. The GMS focuses on 5 strategic thrusts including strengthening infrastructure linkages through a multisectoral approach, facilitating cross-border trade and investment, enhancing private sector participation and improve competitiveness, developing human resources and skill competencies, and protecting the environment and promote sustainable use of natural resources.

The appropriate policy has stimulated strong rate of economic growth in the subregion. The aim of the GMS is to link member countries through improvements in infrastructure, and

thereby promote subregional trade and investment in order to stimulate the growth. Over two decades after the constitution of the GMS, trade and investment liberalizations have been vital components of reform in almost all GMS countries. These sectors significantly encourage foreign direct investment (FDI) as a means of promoting subregional socio - economic development, technology transfer, and employment. As a result, flows of FDI into the GMS have sharply increased.

The primary objective of this chapter is to present the economic growth and development of the GMS as a whole as well as individual economy. This chapter contains the description of subregional growth and development, structure of trade, subregional growth in subsector, and important economic indices of the GMS. Furthermore, this chapter specifically describes major economic structure as well as economic institutions which are the important components of development in the individual GMS countries.

2.1. Economic Growth in the Greater Mekong Subregion

The Greater Mekong Subregion (GMS) consists of six diverse economies along the Mekong River—Cambodia, China (Yunna Province and Guangxi Zhuang Autonomous Region), Laos, Myanmar, Thailand, and Vietnam—with per capita GDP range from 824 USD (Myanmar) to 5,395 USD (Thailand) in 2011 (IMF, 2012b).

Figure 2.1: Map of the Greater Mekong Subregion

Source: http://mekongtourism.org

The GMS Program was established for the aim of promoting regional development. Since its inception in 1992, the program has been achieving substantial progress in nine

priority sectors of cooperation, namely, transport, energy, telecommunications, environment, agriculture, tourism, trade facilitation, investment, and human resources development. At the first summit in November 2002, the GMS leaders endorsed a ten-year strategic framework that set five strategic thrusts for the program as follows (ADB, 2011b):

- Strengthen infrastructure linkages through a multi-sectoral approach
- Facilitate cross-border trade and investment
- Enhance private sector participation in development and improve its competitiveness
- Develop human resources and skill competencies
- Protect the environment and promote sustainable use of the subregion's shared natural resources.

The GMS has been described as one of the fastest growing subregions in the world. The basic driving force of subregional economic growth have been the significant increases in investment, export growth and strong agricultural sector performance facilitated by more integration, openness to trade, and reform (AusAID, 2007).

Table 2.1: Human Development Index and Its Components of the Greater Mekong Subregion in 2011

	Cambodia	China	Laos	Myanmar	Thailand	Vietnam
Human Development Index (Value)	0.52	0.68	0.52	0.48	0.68	0.59
Life Expectancy at Birth (Years)	63.1	73.5	67.5	65.2	74.1	75.2
Mean Years of Schooling (Years)	5.8	7.5	4.6	4	6.6	5.5
Expected Years of Schooling (Years)	9.8	11.6	9.2	9.2	12.3	10.4
Gross National Income Per Capita (PPP 2005 USD)	1848	7476	2242	1535	7694	2805
GNI Per Capita Rank Minus HDI Rank	11	-7	4	7	-14	8
Non-income HDI (Value)	0.58	0.72	0.56	0.53	0.71	0.66

Source: United Nations Development Program (UNDP, 2011).

Although the rich natural resources endowments of the GMS have made it one of the fastest growing areas in the world with GDP growth of almost 8 % in 2005, in absolute term large numbers of people still live in poverty, particularly in rural areas of each country. For instance, about three quarters of 310 million people in the GMS still live in rural area and rely on subsistence or semi-subsistence agriculture (AusAID, 2007).

As shown in Table 2.1, the human development index in most countries is relatively low. Despite the significant growth in the subregion, income inequality remains high. The poverty is still widespread especially in Cambodia, Myanmar, and Laos indicated by, for example, low gross national income per capita compared to those of China, Thailand, and Vietnam. The development indicators of these countries, particularly Myanmar, still continue to lag behind others in the subregion. Furthermore, lack of basic health and education, and gender inequalities are still the major challenges of the subregion (AusAID, 2007). The perceived lesson from the Asian crisis was an implication that countries in the region need to enhance and strengthen economic cooperation in order to sustain the dynamic growth and stability in the region. The GMS is also an example of the successful regional integration. It focuses on the cooperation in transportation, tourism, energy, telecommunication,

environment, human resources development, agriculture, trade facilitation and investment (Abonyi, 2008).

As a result of greater openness of the GMS economies, foreign direct investment (FDI) flows into the subregion have been on the rise, with significant increases in 2005 and 2006 particularly for Cambodia, Laos, and Thailand. Total merchandise exports from 1992 to 2005, for example, grew by more than 300 %, spurred by ASEAN Free Trade Area (AFTA) (UNEP, 2009). According to CASTALIA (2008)'s investor perception survey, investor either in the region or internationally are very positive about Thailand and Vietnam as investment destinations while the views on China and Laos are mixed. The sentiment toward Myanmar is the most negative among GMS member countries. The investor perceptions survey conducted by CASTALIA (2008) shows the highest score for Thailand, among other GMS member countries, as an investment destination due to its relatively clear rules, and strong and stable macro-economy. In terms of capital market, regional financiers feel that in many cases foreign capital is not needed, since Thai banks have mobilized enough baht savings to be able to finance power projects within Thailand, and even export-oriented hydropower-projects in Laos.

CASTALIA's survey shows that Vietnam is particularly well regarded by Singaporean investors. Vietnam's market reforms as well as the stable macro-economy and rapid growth are the important factors attracting investors in the region. Instead of part of GMS, provinces of Guangxi and Yunnan were thought as part of China. Investment decisions in these provinces were, therefore, determined as part of an overall China's strategy. Singaporean investors were unlikely to be interested, regarding China as not particularly welcoming of Singaporean investment. In energy sector, Hong Kong was more interested in opportunities in Chinese energy sector.

Rather than going toward to invest directly, foreign investors go to Cambodia to visit and learn more the opportunities for their investments. Some companies were worried that the returns available in Cambodia would not be enough to offset the risks of investing in Cambodia. Regarding investment in Laos, almost all investors were aware of hydropower businesses in Laos, and considered these to be attractive and bankable opportunities while non-hydropower businesses are less attractive. Thai investors seem to have an advantage over other international investors that were not able to negotiate the existing systems. The strength of Thai capital markets and their ability to finance such projects was also considered an advantage of Thai investors in Laos. Investors who were interested in non-hydropower sectors found the risks in domestic project high rendering them un-financeable. The main constraints discouraging investors were political risks, and low returns in particular. The survey showed

that most of investors were generally discouraged by the level of risk in Myanmar. Hence investment environment is rather negative.

Corruption remains one of the significant impediments to broad-based economic growth and poverty reduction in the GMS. Since it distorts, and diverts the allocation of resources and increases the cost of doing business in the subregion (AusAID, 2007). Conducting desktop research and the private stakeholder survey, CASTALIA (2008) found that in many GMS countries, a lack of transparency and competitive process project is a barrier to efficient foreign direct investment (FDI), and also private sector participation particularly in electricity sector. It is found that corruption seems to be the constraints in most of GMS member countries discouraging foreign investment. The Corruption Perceptions Index (CPI) obtained from the corruption watchdog organization, Transparency International (2010), encompasses corrupt practices in both the public and private sectors. The CPI ranks countries according to the perception of corruption in public sector. The score is ranked from 0 (high corrupt) to 10 (very clean). Country with score close to 0 is considered high corrupt where country with score close to 10 is considered low corrupt.

Table 2.2: Corruption Perception Index (2000 - 2011)

	Cambodia	**China**	**Laos**	**Myanmar**	**Thailand**	**Vietnam**
2000	-	3.1	-	-	3.2	2.5
2001	-	3.5	-	-	3.2	2.6
2002	-	3.5	-	-	3.2	2.4
2003	-	3.4	-	1.6	3.3	2.4
2004	-	3.4	-	1.7	3.6	2.6
2005	2.3	3.2	3.3	1.8	3.8	2.6
2006	2.1	3.3	2.6	1.9	3.6	2.6
2007	2	3.5	1.9	1.4	3.5	2.6
2008	1.8	3.6	2	1.3	3.5	2.7
2009	2	3.6	2	1.4	3.4	2.7
2010	2.1	3.5	2.1	1.4	3.5	2.7
2011	2.1	3.6	2.2	1.5	3.4	2.9

Source: Transparency International (2012).

As illustrated in Table 2.2, Cambodia, Laos, and Myanmar are ranked close to the bottom on, with Vietnam ranked notably better, but remaining in the bottom half of all countries ranked. Transparency International (2012), in its corruption perceptions index, ranked Myanmar as the most corrupt country in the world, tied with Somalia. Among GMS countries, China and Thailand are quite standout performers ranked relatively high.

According to CASTALIA (2008), on average, private sector stakeholders showed positive response on investment climate in the GMS. However, in summary, perceptions of investment climate varied from country to country as shown in the following key findings:

- Among other member countries, investment climate in Thailand and Vietnam were viewed most positively, with investors being most excited about the prospects in these countries.

- Cambodia, Laos, Yunnan, and Guangxi generated less interest but potential investors were nevertheless positive, while the responses to investing in Myanmar were almost universally cool.

- Many investors supported the idea of freer energy trade within the subregion.

Since 1992, when the six member countries first entered into the program of economic cooperation, there have been several accomplishments. Economic linkages among the six member countries have been strengthened through a series of improved infrastructure, and other highly pragmatic projects. In turn, the emergence of a new trade area significantly attracted investor interest, promoting social development and economic growth in the subregion. Building of trust and confidence among member countries is one of the GMS Program's most fundamental accomplishments. From its inception in 1992, the emphasis has been on practical results in a wide range of specific projects. Facilitation of cross-border trade and investment is especially important for the GMS. The initial emphasis of the GMS Program was on developing physical infrastructure linkages as the means to increase trade and investment among countries in the subregion. The focus on provision of infrastructure has brought significant benefits to the subregion. The key investment projects are in energy, road transport, environment, and human resource development. These sectors have played key roles in promoting subregional economic development and poverty reduction. To date, ten infrastructure projects with overall investments of approximately 2 billion USD have been completed or are under implementation. Without these hard as well as soft infrastructure projects, local communities would have difficulty in accessing to markets and services. Towards the end of the first decade, the GMS Program began to emphasize reducing non-physical barriers between member countries. One illustration of this is the framework agreement signed by the governments of Cambodia, Laos, Thailand, and Vietnam to facilitate the cross-border movement of goods and people.

The share of FDI by developing countries is now less than 20 % of the global total, compared with 40 % in the mid-1990s. In order to attract FDI, the GMS member countries

will have to adjust to new investment determinants, which emphasize the progress in transport, communications and information technologies, domestic policy framework, the management and organizational techniques of firms, and the presence of industrial clusters. In spite of the key roles of natural resources and low-wage labor in the subregion, they are no longer adequate. The ability of the GMS countries to attract FDI will depend significantly on the extent to which they can provide adequate infrastructure, complementary resources, competent suppliers, and institutions that harness technology effectively. A favorable environment for private firms, especially for small and medium-sized enterprises is another important task for the GMS in promoting investment. The establishment of economic corridors and other cooperation initiatives in the subregion will bring economies of scale in production and distribution, and improve the capacity to export. The comparative advantage for enterprises located along the major economic corridors of the GMS has been agriculture-based and labor-intensive products. With the support of credit, marketing, technical, and management, this advantage will pave the way for the GMS to attract more investment. Furthermore, the GMS Business Forum, in collaboration with the governments and local business, will help promote more investment in the subregion.

The lack of project financing is an impediment for the development of the GMS Program. Therefore, private sector must be given a greater role in financing subregional projects. The essential role of financial sector in facilitating cross-border trade and investment has been focused by private sector in GMS. One of the major constraints to cross-border business transactions is the lack of a reliable payment system among commercial banks in the GMS. For example, commercial banks involved in cross-border transactions apply different banking regulations. Harmonizing banking regulations among member countries has been identified as another important area to be addressed.

The vision and the goal of the GMS are as follows (ADB, 2002):

- All of the GMS member countries envision a Mekong subregion that is more integrated, equitable and prosperous.

- The large contribution will be to realizing the potential of the subregion through (i) an enabling policy environment and effective infrastructure linkages that will accommodate cross-border trade, tourism, investment and other forms of economic cooperation in the subregion, and (ii) the development of human resources and skills competencies.

- Environment and social interests will be fully respected in the implementation and formulation of the GMS Program. This is to ensure that the subregional development process is equitable and sustainable.

Objectives of facilitating trade and investment in the GMS are:

- To promote the competitiveness of the GMS by facilitating cross-border trade and investment in the subregion.

- To address inadequate information for trade and investment in order to stimulate business expansion in the border areas.

- To develop a system of support to small and medium enterprises (SMEs) as the primary beneficiary of cross-border trade and investment facilitation measures.

- To implement trade facilitation measures initially focusing on single-stop customs inspection procedures.

In order to promote trade and investment, Southern, North-South, East-West economic corridors are established with the following objectives:

- To serve as an "initializing project" for subregional economic cooperation which could serve as a "locomotive" for economic development in the GMS.

- To further facilitate and strengthen trade and development between and among the member countries.

- To support development and reduce poverty of rural and border areas, provide employment opportunities for women, increase the earnings of low-income groups, and promote tourism in the project influence area.

- To reduce costs of transportation in the project influence area, and increase the efficiency of the movement of goods and passengers.

After the Asian financial crisis, and the current world economic downturn, stimulating investor confidence in the subregion is of paramount importance of the GMS. To do so, commercialization of state-owned enterprises, strengthening of financial markets, and liberalization of trade and investment regimes are essential. Inadequate infrastructure, lack of transparent regulations and procedure, and inefficient customs clearance procedures which are

among the major impediments to cross-border trade and investment will be reduced or even eliminated.

The pace of regional integration will not only depend on how fast the GMS countries can adapt to the Association of Southeast Asian Nations Free Trade Area (AFTA), Asia-Pacific Economic Cooperation (APEC), World Trade Organization (WTO), and other trade-investment liberalization initiatives, but it also depends on how efficiently they can establish cross-border infrastructure and streamline the flow of goods and people in the subregion. To maximize the benefits of cross-border infrastructure linkages between the GMS member countries as well as to take advantage of the move towards free trade arrangements involving ASEAN and China, the Agreement for the Facilitation of the Cross-border Movement of Goods and People will be implemented immediately. This will continue to be a major agenda of the GMS Program. Cross-border trade facilitation in the subregion will first focus on simplifying customs procedures at selected border crossings. Notable among these is the single-stop customs inspection for border crossings at Poipet and Bavet (Cambodia), Savannakhet and Dansavanh (Laos), Mukdahan and Aranyapratet (Thailand), and Lao Bao and Moc Bai (Vietnam). Based on experience gained, singlestop customs inspection systems in the subregion will be refined and replicated in other areas. In addition, coordination of common hours of operation will be enhanced. Subsequent phases of cooperation will cover transparency of customs procedures and adherence to the Kyoto Protocol[11].

The components of facilitating cross-border trade and investment in the GMS are:

- Development and maintenance of a cross-border trade and investment information system in the subregion which is responsive to the needs of private business sector including the establishment of public-private partnership mechanisms at the local level to maintain this information system. Specific activities will include:
    - Collection of detailed information on cross-border and transit trade for specific product categories (including volume and value traded, tariff and non-tariff measures, and factor costs of production), industrial

[11] The Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change (UNFCCC), aimed at fighting global warming. The UNFCCC is an international environmental treaty with the goal of achieving the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".

facilities (i.e. export processing zones), investment incentives, business-related services (i.e. insurance, banking, and shipping), and existing and potential business opportunities.

- Construction of data base management, data bases for market access and trade conditions, design and implementation of an internet-based searchable data base application.

- Training components for systems development.

- Development of products and services to support small and medium-sized enterprises (SMEs) in the GMS including:

  - Organization of trade and investment missions, investment guides, guides for business planning and development, and a directory of SME.

  - Market encounters to promote matching of business opportunities among SMEs.

  - Assistance in the formulation of business development plans.

- Implementation of single-stop customs inspection at selected border crossings in Poipet and Bavet (Cambodia), Savannakhet and Dansavanh (Laos), Aranyapathet and Mukdahan (Thailand), Lao Bao and Moc Bai (Vietnam), with possible replication of the pilot scheme to other cross-border sites based on lessons learned and experience gained.

- Expansion of customs facilitation measures to other areas such as transparency of customs procedures, single-window inspection, automation of customs procedures, and coordination of hours of business operations.

- Reduction of trade barriers in agricultural commodities.

- Coordination of policies and regulations on trade-related financial services in the subregion.

2.2. Geographical Structure of the Greater Mekong Subregion's Trade

Since the establishment in 1992, the Greater Mekong Subregion (GMS) become gradually integrated into the regional as well as global trading environments. The increasingly growing openness of the GMS is increasing the opportunities for market diversification for member countries. Most of trading partners of the GMS countries are Asian countries whereas the United States as non-Asian country is a big trading partner of some of the GMS economies.

Table 2.3: Trading Partners of Each GMS Countries

	Ranking	Export	Import
Cambodia	1	United States	Thailand
	2	Hong Kong	China
	3	Canada	Singapore
China	1	United States	Japan
	2	Hong Kong	Korea
	3	Japan	United States
Laos	1	Thailand	Thailand
	2	China	China
	3	Vietnam	Vietnam
Myanmar	1	Thailand	China
	2	India	Thailand
	3	China	Singapore
Thailand	1	United States	Japan
	2	Japan	China
	3	China	United States
Vietnam	1	United States	China
	2	Japan	Singapore
	3	China	Japan

Source: Asian Development Bank (ADB, 2011c).

Table 2.3 shows three major exporting and importing partners of each GMS economy. Among the member countries, China and Thailand have played important role as ones of major trading partners of each GMS countries. According to the data obtained from ADB (2011c), the major export products of Cambodia are garment, shoes, natural rubber, rice, cigarettes, pepper, fish, and wood. The main export destinations of these products are the United States, Hong Kong, and Canada. Cambodia imports mainly fuels, vehicles, consumer goods, machinery mostly from Asian countries. Its main import partners are Thailand, China, and Singapore.

With regard to the diversification of export destinations, exports of China are quite diversified. Basically, the destinations of country's exports are the United States, Hong Kong, and Japan. Its major export goods are electrical and other machinery including data processing equipment, textiles, apparel, steel and iron, optical and medical equipment. China mainly imports from Japan, followed by Korea, and the United States. The main products imported to China are electrical and other machinery, mineral and oil fuels, optical and medical equipment, plastics, metal ores, and organic chemicals.

Thailand followed by China, and Vietnam are the major exporting-importing partners of Laos. The largely contributed exports are wood products, garments, electricity, coffees, tin, copper, and gold. Since Laos is unspecialized in producing machinery and equipment, vehicles, and fuel, it has to import from its trading partners.

Most of goods produced in Myanmar are concentrated to Asian countries including Thailand, India, and China. Its exports are distributed across primary products groups including natural gas, wood products, pulses, beans, fish, rice, clothing, jade and gems. The major sources of country's imports are also Asian countries namely China, Thailand, and Singapore.

Thailand—the most advanced economy in the subregion—is a heavily export-dependent economy with exports accounting for more than two thirds of its GDP. The country's trade pattern differs from other GMS countries. Its major sources of export income are from the exports of machines and equipment. Export of agricultural products, especially rice is also one of the most important sectors in Thailand. It has been among the top of rice exporters in the world until today (Baldwin and Childs, 2011). Considering the structure of export destinations for Thailand, its major partners are the United States, Japan, and China. Machinery and parts, electronic integrated circuits, vehicles, chemicals, crude oil and fuels, and iron and steel are among the country's principal imports. Thailand's primary sources of imports are Japan, followed by China, and the United States.

With regard to the market diversification, the structure of export destinations for Vietnam is somewhat similar to those of China and Thailand. The United States, Japan, and China have been significantly crucial for Vietnam as the large export markets. The principal exports from Vietnam are clothes, shoes, crude oil, marine products, wooden products, rice, electronics, and machinery. Regarding the import, Vietnam mainly imports from Asian countries including China as the largest source of import, followed by Singapore as the second large source of its import, and Japan as the third. The country's primary import

commodities are machinery and equipment, petroleum products, steel products, electronics, raw materials for clothing and shoe industries, plastics, and automobiles.

2.3. GDP Growth in Subsector in the Greater Mekong Subregion

The Greater Mekong Subregion (GMS), with the land area of 2.3 million Km^2, consists of 250 million people. On average, per capita GDP is 2,700 USD. The economies are primarily based on subsistence agriculture with approximately 63 % of total population dependent on agriculture contributing to about 22.6 % of total GDP in the subregion (Prabhakar, 2012). However, they are gradually diversifying into various modern economic sectors, more market-oriented system. The subregion is well-known as an abundant and diverse area of natural resources. The Mekong River itself has sustained rural livelihood and supported the significant economic development in the subregion. Along with agricultural base, the subregion is endowed with fisheries, timber, a wide variety of minerals, coal, petroleum, natural gas, and some of Asia's best potential for hydropower projects. These rich natural resources provide income and sustenance to people living along the areas. Energy resources such as coal, oil and gas reserves, and hydropower potential in the GMS are abundant particularly in Laos, Myanmar, Thailand and Vietnam. These rich natural resources are still relatively underused.

Table 2.4: Selected Economic Indicators in 2011

	GDP Growth (%)	GDP (million USD)	Population (million)	GDP per capita (USD)
Cambodia	6.7	12,861	15.103	851.529
Laos	8.4	7,891	6.565	1,203.555
Myanmar	10.41	5,925	62.417	831.91
PRC	10.3	7,298,147	1348.121	5,413.571
Thailand	7.8	345,649	64.076	5,394.362
Vietnam	6.8	122,722	89.316	1,374.008

Source: Asian Development Bank (ADB, 2011a)

Human resources base is also a potential subregional asset due to its large size and affordable labor. With the young population and above average population growth rates, the subregion offers a significantly large number of future workers as well as substantial consumer market. The abundance of natural and human resources have made the GMS a new frontier of Asian economic growth with high potential to be one of the world's fastest growing areas. In

addition, tourism has become one of the GMS's key sectors contributing to the subregion. The beauty of subregional nature and diversified landscapes, and various cultural groups are the attractions of the GMS. The physical attractions combined with fascinating diversified cultures have played an important role in stimulating tourism in the subregion. Tourism in the subregion has long been one of the key components of the overall GMS economic cooperation program. Despite the recent global economic issues, tourism sector in the subregion has remained resilient and continued to be an important contributor to the economic growth in the subregion. It has continued to serve as one of the main driving forces for subregional poverty reduction in terms of increasing the employment, enhancing the economic value of natural and cultural assets, and earning foreign exchange.

There are large differences in economic structure among the GMS countries, reflecting both levels of development and relative resources endowments. Cambodia, Laos, and Myanmar are still heavily agrarian economies with more than one-third of GDP derived from agriculture while the richer economies have largely shift out of this sector. The economies of the GMS countries have collectively grown at one of the fastest rates in the world since the early 1990s with the more development of market-based economy (Thailand), and the transitions from central planning to a market-based system (Cambodia, China, Laos, Myanmar, and Vietnam) and becoming more integrated with the region as well as the world. The Mekong region has relied on the export of its large endowments of natural resources in order to obtain income to import capital and goods (Nilson and Segnestam, 2001). Agriculture covering logging, forestry, fishing, hunting and etc is assumed to be a proxy for natural resources. As shown in Table 2.5, there is high resources dependence in Cambodia, Laos, and Myanmar.

Table 2.5: Origins of GDP in 2010 as % of GDP

	Agriculture	Industry	Manufacturing	Service
Cambodia	36	23	15	40
China	10	46	29	43
Laos	32	31	7	35
Myanmar[12]	40	23	17	37
Thailand	12	44	35	42
Vietnam	20	41	19	38
World Avg	3	26	17	71
Low Income	25	25	13	50
Mid Income	9	36	20	55
High Income	1	24	16	74

Source: World Bank (2012).

According to ADB (2007), in Cambodia, Laos, and Vietnam (CLV), the total agriculture sector accounts for 50 % - 70 % of employment. Growth in production and exports from this sector will be necessary in terms of the improvement in incomes, and the reduction of poverty. Among them, Laos has a comparative advantage in substantial agricultural and natural-resources products such as vegetables, cereals, coffee, silk, crude rubber, zinc, copper, jute, and electric energy. Laos is the most dependent on the GMS for its trade. Based on recorded trade flow, cross border trade between Laos and other GMS countries are more than 60 %. In Laos, access to finance, deficient infrastructure, and regulatory uncertainty are listed as the main obstacles discouraging the economy. Vietnam possess a substantial number of agro-based products including rice, fresh and processed fish, tea, fresh fruit and nuts, coffee, and spices, among others. Cross border trade between Vietnam and People's Republic of China (PRC), Cambodia, Laos, and Thailand is believed to account for about 20 % of its total import and 10 % of its total exports. The main obstacles in Vietnam are the inadequate access to land, deficient infrastructure, and insufficient access to finance.

[12] Data of Myanmar are obtained from ADB (2010).

2.4. Major Economic Indices of the Greater Mekong Subregion

The Greater Mekong Subregion (GMS) economies are growing fast, with average GDP growth of 8 % a year since the establishment of the economic cooperation in 1992, despite some adverse shocks. This is a proof of a significant improvement in the self-development capability of each country, a closer and more harmonious relationship among member countries, and a significant increase in trade and foreign direct investment in the subregion. The economic growth and economic restructuring of the subregion is largely driven by increasing subregional trade integration. Strong rates of economic growth in the GMS economies have been fueled in part by increased trade orientation. The export, based on recorded trade flow, rose to 154 billion USD in 2005 from 37 billion USD in 1992, or at a compound average annual rate of 11.6 % higher than the rise in world export of 8.4 %. The export growth in the GMS was particularly strong in Cambodia and Vietnam. Intra-GMS exports, excluding China, rose at an annual average rate of 19 % during 1994 - 2006. The increase in export was even higher at an average annual rate of 22 %.

Articulated through the 3Cs—enhancing 'connectivity', increasing 'competitiveness', and achieving a greater sense of 'community', the GMS has experienced a period of rapid economic growth over the last decade with the average rate of 6.5 % (Groff, 2012). The significant growth is based on strong foundations whether expressed in terms of consumption, income or in terms of human development index. With various contribution of such abundant natural resources as water, land, and energy, the average GDP of the GMS economies grew at a rate of 7.3 % in 2010 (IMF, 2011). The recent economic and social progress of the GMS is characterized by robust economic growth. Over the past decades, subregional economic development has outpaced many other parts of the world indicated by the average annual GDP growth rate of between 5 % and 10 %. The average annual GDP growth rate of the GMS was even over 9.5 % between 2000 and 2009. The significant growth was primarily fueled by intra-regional demand for energy, food, and commodities. Foreign direct investment (FDI) has significantly contributed to the subregional development with increasing amounts originating mainly within the GMS. Moreover, the export between 1992 and 2004, for example, grew at the significant rate of 300 % (GMS, 2011).

As Asia perspective, it is well known that trade regulation in the GMS countries is said to be not so strict. According to Rutherford et al (2008), informal trade in natural resources is widespread in especially Cambodia, Laos, and Vietnam. For example, some parts of Cambodia is generally suspected, though not formally confirmed, that a number of companies from China are involved in informal ventures in gold, timber, and other minerals exported to China. Some state officials in Vietnam estimate that the majority of rubber and coal destined to China is

informal, with no records of the exported tonnage and value, and no duties paid to the state. In Laos, it is widely known that several Chinese companies are setting up informal operations for commodities such as timber, cassava, sugar, and corn, which are then transported across the border.

As have been acknowledged that GMS is endowed with abundant mineral resources. The capacity to fully tap its potential, however, varies across the GMS member countries. As international perspective, the suggestion from UNEP (2009) is therefore to leverage regional cooperation to facilitate cooperation, and strengthen capacities in mineral resources development programs in the subregion. In addition, the GMS needs to develop an integrated and encompassing mineral resources management plan. This would identify opportunities, and outline availabilities of mineral reserves for bi or multilateral regional cooperation for capacity building and/or developing of the mineral reserves to fully exploit the potential of mineral resources in the subregion. According to the result of the investor perceptions survey by CASTALIA (2008), investment climate in the GMS, on average, is viewed positively. Although each of GMS countries is at different stage of development, there was thought to be great growth potential in the subregion. One respondent noted that greater regulation, openness, and stability can improve the opportunities of the countries, while another felt that the legal infrastructure still makes foreign investment difficult for smaller project. Generally Thailand and Vietnam were viewed as attractive investment destinations, with many investors being most excited about the prospects there. Some companies reported that they were even expanding operations in Thailand, and Vietnam while there was less interest in other countries because of perceived political, and market risk.

Trade and investment liberalization has been an important component of reform in the GMS encouraging foreign direct investment as an important component in boosting technology transfer, employment, and economic development in the subregion. At the Annual General Meeting of the Asian Development Bank in May 2008, the President of the Bank, Haruhido Kuroda, cites the GMS program as "A partnership that invests in people and programs to create a more inclusive, environmentally sustainable subregion—well integrated within itself, with its neighboring countries, and with the global economy" (Lee, 2008). The GMS economic cooperation program is the driving force in bringing together the six countries that share the Mekong River. The subregion has significant potential for rapid and sustainable growth, given its abundance of natural resources and its strategic location that acts as a "land bridge" between South and East Asia (ADB, 2009b). As a "land bridge" between South and East Asia, GMS is ideally positioned for trade with its neighboring countries along the region. Although the rich human and natural resources in the subregion make it a new frontier of economic growth,

approximately 55 million people are still living in poverty on less than the equivalent of one dollar a day. Moreover, due to the increasing combined effects of demographic and economic changes, the impact of infrastructure projects, illegal exploitation, and relative weakness of the regulatory regime, natural resources base in the subregion has become under stress. In recognition of these subregional issues, the six GMS countries—Cambodia, China, Laos, Myanmar, Thailand, and Vietnam—entered into a program of economic cooperation with the assistance of the Asian Development Bank (ADB) in 1992 (UNEP, 2009).

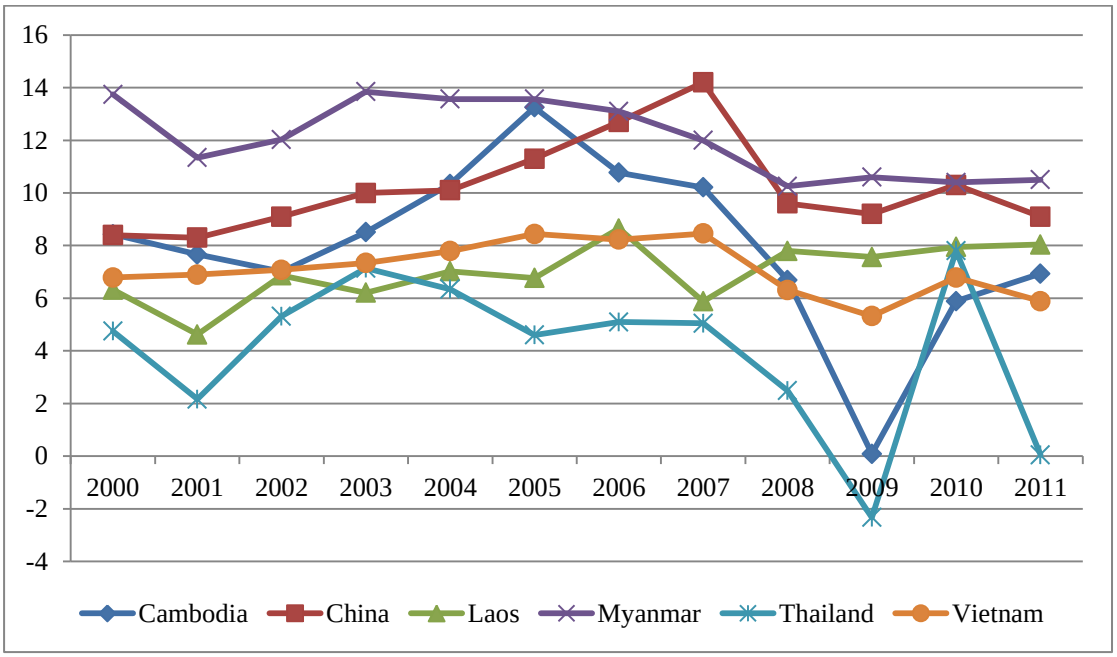
Since the beginning of the GMS program in 1992, poverty, which is the major impediment of many countries in Asia, has declined significantly. Between 1990 and 2003, for instance, the proportion of people living on less than 1 USD a day fell from 46 % to 33.8 % in Cambodia, 33 % to 13.4 % in China, 52.7 % to 28.8 % in Laos, 10.1 % to less than 1 % in Thailand, and 50.7 % to 9.7 % in Vietnam. The GMS program has played a vital role in dynamic economic performance among the subregional countries. Despite the Asian economic crisis in 1997, the subregional economic growth rate from 1994 to 2004 was at an average of 6 % indicating the favorable result of the integration. Moreover, the subregional economy further grew, on average, with the rate of more than 8 % between 2005 and 2006. The high growth has been as a result of the easier traveling, communicating, and doing business across the GMS. Both international and intra-regional investment in infrastructure, mining, hydropower, and industrial tree plantations are becoming attractive sectors (Lee, 2008).

2.5. Institutional Structure Development of the Greater Mekong Subregion Countries

2.5.1. Economic Structure in Individual Countries

The competitiveness in Asia has been mainly driven by the creation of regional supply chains with various countries in the region adding value to specific parts of the supply chain. Furthermore, the improved logistics through regional integration, as proved by the success of Association of South East Asian Nations, the Greater Mekong Subregion, and other regional groups, has been the strength of Asian economy.

Figure 2.2: GDP Growth of the Greater Mekong Subregion Countries (2006 - 2010) (in %)



Source: Asian Development Bank (ADB, 2011a).

Over the past two decades, the Greater Mekong Subregion (GMS) cooperation program has shown successful outcomes, and contributed to poverty alleviation and subregional economic growth as to broader realization of the subregional vision of an integrated, harmonious, and prosperous group. In recent years, GMS member economies have not made any change in terms of economic strategy. In other words, they have still concentrated on improving infrastructure as a driving force of regional growth, and on the subregional vision. Fulfilling regional vast potential, erasing poverty, and boosting sustainable development have still been the primary goals of GMS cooperation. The high priority of the subregion has still been on promoting nine areas consisting of transport, energy, telecommunications, environment, agriculture, human resources development, tourism, trade and investment. As reported in Asian Development Outlook 2011 (ADB, 2011a), the recent economic performance of each GMS country indicated by GDP growth is illustrated in Figure 2.2. The detailed explanation of each country's economic performance is as follows:

In 2010, a bounce-back in tourism and clothing exports, coupled with increased production of paddy rice, drove a 6.3 % recovery in GDP from a sharp slowdown in 2009 caused by the global economic crisis. In the same year, the primary sector producing about a third of GDP grew by an estimated 4.2 %. Paddy rice output rose by about 5 % to 7.9 million

tons, mainly a result of favorable weather, higher quality seeds, and better access to fertilizers. Livestock production increased by about 5.5 %, whereas forestry and logging and fisheries output registered only slight growth. As a result of the recovery in global travel, tourist arrivals rose by 16 % to 2.5 million and tourism receipts by 14.5 % to 1.78 billion USD. The favorable growth was contributed by the arrivals from Asia including Vietnam (up 48 % to 466,700), Korea (up 47 % to 289,700), and China (up 39 % to 177,700). This rebound in tourism contributed to estimated growth of 4.3 % for services. Industry was the main contributor to GDP growth in 2010, expanding by an estimated 11.6 % (it had contracted in 2009). External demand for Cambodian garments, principally from the United States (US) and the European Union (EU), rebounded. The US garment imports from Cambodia rose by 19 % in USD terms. Construction activity in 2010 remained sluggish, reflecting a fall in foreign investment in property during the global crisis and slow pickup in residential building. Bank lending to private sector picked up from 6.5 % year-on-year at end-2009 to 27 % 12 months later, reflecting the economic recovery. The riel appreciated by 2.4 % against the USD over 2010.

Economic growth in the second half of 2010 increased the full-year rate of expansion in China to 10.3 % in a return to the pre−global recession double-digit pace. All sectors contributed to the solid growth, led by industry with a 12.2 % increase that contributed about two-thirds of total GDP growth. Services and agriculture expanded by 9.5 % and 4.3 %, respectively. From the demand side, investment and consumption explained 92 % of total growth with the large contribution from investment. Unlike 2009 when net exports fell as global trade slumped, net export in 2010 contributed positively to GDP growth by 0.8 %. Monetary policy supported growth, even as the authorities reined in the highly expansionary stance taken during the global recession. Rising food prices, abundant liquidity, and higher costs of imported oil and commodities pushed up consumer prices during 2010, when inflation averaged 3.3 %. In early 2011, the Chinese government changed some of the weights in the consumer price index basket, lowering that for food and raising the one for housing. Global recovery in trade saw the country's trade flows soar by nearly 35 % to about 3 trillion USD in 2010. Merchandise exports in nominal USD terms rebounded by 31 %. The rapid increase in imports reflected strong demand, and higher prices for oil, other commodities, and capital goods. China became Brazil's top trade partner in 2009 with bilateral trade showing a more than 12-fold increase in value since 2001. Some 85 % of its exports to Brazil are manufactured products, while soybeans and minerals account for two-thirds of its imports. Foreign direct investment (FDI) in 2010 reached 105.7 billion USD, up by 12.4 % from the previous year. By sector, manufacturing, real estate, and services attracted the most FDI. Chinese direct investment abroad increased by 23.4 % to 59 billion USD in 2010. The major

targets of its FDI were energy, mining, and agriculture mostly in Asia. Large investments in energy-related projects in some Central Asian countries have turned the China into the second-largest investor there, after the Russian Federation.

After decelerating a little during the global recession, Laos's economic growth picked up to 7.5 % in 2010, returning to the average expansion rate of 2004 - 2008. This prolonged period of growth mainly reflects substantial investment in mining and hydropower. Most of the contribution to the economic growth was from industrial sector. Industry, representing about one-quarter of GDP, grew by 18.0 % in 2010. Output of electricity more than doubled as the Nam Theun 2 hydropower plant—the biggest electricity power plant in the country—at 1,070 MW, reached full capacity in April. Some smaller new plants, including Xeset 2 and Nam Leuk 1 and 2, also started generating power to export mainly to Thailand. Mining production rose by 19.0 % in 2010, spurred by higher global metal prices. Output of copper from the two main mines−Phu Bia and Sepon—rose by 21.0 % to 147,500 tons. Gold production rose by 7.0 % to 173,000 Ounces and silver by 13.5 % to about 500,000 Ounces. Construction activity benefited from expansionary fiscal and monetary policies. The global recovery in travel lifted the number of tourists by about 25 % to 2.5 million in 2010, with a strong rebound in tourism from Europe and the United States. About 6.0 % of growth was supported by hotel and restaurant industry. Other services to grow by at least 6 % were retail and wholesale trading, financial services, and transport and communications (boosted by the introduction of third-generation mobile telephone and Internet services). Services as a whole grew by 5.0 %. In contrast, agriculture which accounts for a third of GDP, suffered from bad weather (droughts followed by floods) as well as from diseases in pigs and cattle. Production of the main crop (rice) increased by about 4 % to 3.26 million tons, and fisheries recorded solid growth of 7.0 %. Agricultural sector as a whole, though, grew by just 2.0 %. Consumer prices were on an upward trajectory last year, putting average inflation at 6.0 %. Higher global oil prices pushed up the cost of fuel and transport, and bad weather and animal diseases disrupted food supplies, raising food prices.

Myanmar's growth recovered to an estimated of about 5.1 % in the fiscal year ended 31 March 2010 (FY 2009)[13], after slowing in the previous year owing to the impact of Cyclone Nargis and weakness in demand for imports from neighboring economies. The recovery was a result of the improvement in mining, agriculture, manufacturing, and the transport and communications subsectors. The major driving force of economic growth was agriculture, including livestock, forestry, and fisheries, accounting for over half of

[13] FY: Fiscal Year.

employment and about 40 % of GDP. More recently, economic growth edged up to an estimated 5.3 % in FY 2010 (ending 31 March 2011), with a large contribution from construction, particularly in Naypyidaw, the new capital, and Mandalay (a highway connecting these cities was under construction). The lift in economic growth in FY 2010 was largely supported by the recovery in its neighboring countries that import goods such as food and natural gas from Myanmar. Average inflation rate was estimated at 8.2 % in FY 2009, and 7.3 % in FY 2010. The export of natural gas continued to support the external accounts. Earning from this source recovered to 2.7 billion USD in FY 2010 as a result of the increased demand from Thailand. Inflows of FDI into the hydrocarbon sector raised the international reserves to about 5.3 billion USD at end-FY 2010. In order to meet the favorable economic performance, the government privatized several state assets in 2010, including 243 gasoline stations, an airline, public buildings, and rice distribution operations. Further asset sales are expected to be possible.

A strong recovery from a contraction in 2009 lifted Thailand's GDP growth to 7.8 % in 2010. Rebounding demand for exports boosted manufacturing sector and bolstered both business and consumer confidence. Several weeks of violent demonstrations in central Bangkok during April and May 2010 had a temporary and limited impact on economic recovery. Investment had slumped in 2009 and been slack for several years before that. However, it became the biggest contributor in 2010 which added 5.2 % points of GDP growth. Private fixed investment grew by 13.8 %, mainly in export-oriented manufacturing. As export orders picked up, higher capacity utilization in industries such as electrical machinery and automobiles prompted investment in new equipment, which rose by 14.7 % for the year. On the supply side, industry was the largest contributor of the GDP growth. Manufacturing production surged by about 20 % in the first half then moderated to 8 % growth in the second due to a base effect and softer global demand. Automobile production jumped by about 60 % owing to a rebound in both domestic and export demand. Manufacturing sector contributed 5.4 % points of GDP growth, and industry as a whole added 6.0 % points. The contribution for services was just about 2 % points to total growth. Hotel and restaurant services expanded by 8.4 %, resulted by a pickup in tourism in the second half (arrivals had fallen during the protests in the capital). Tourist arrivals for the full year rose by 11.7 % from 2009 to 2010. Agriculture, though, had another bad year because of drought, followed by floods. The sector contracted by 2.2 %. Production fell for fruit, cassava, sugarcane, corn, rice, and palm oil. Interruptions to food supplies due to the bad weather added to inflation pressures induced by rising global prices for commodities and oil, and stronger domestic demand. Merchandise exports in 2010 rose by 28.5 % to 193.7 billion USD, reflecting strong external demand for both manufactured and agricultural goods. Shipments of manufactured items, including autos and components,

electrical appliances, machinery and computers rose by about 31 %, agricultural products by 36 %. Exports to China, India, and Southeast Asia all jumped by about 35 %, while those to major industrial economies (the European Union, Japan, and the United States) together rose by nearly 24 %. Recovery in domestic and external demand caused a near 37 % surge in imports to 179.6 billion USD in 2010. Imports of raw materials and intermediate goods needed for export-oriented industries shot up by 42 %, and the recovery in investment drove a 27.7 % rise in imports of capital goods. Higher prices for imported oil added to the import bill. Surging imports brought down the merchandise trade surplus to 14.0 billion USD.

Vietnam's GDP growth picked up to 6.8 % in 2010, supported by recovery in the global economy, an accommodative monetary policy, and the residual impact of domestic fiscal stimulus in 2009. Private sector investment was stimulated by strong consumption growth of about 9.7 %. Industry expanded by 7.7 % contributing 3.2 % points of total GDP growth in 2010. Stronger external demand spurred 8.4 % growth in manufacturing, and public infrastructure investment pushed up growth of construction by 10.1 %. Services in 2010 grew by 7.5 %, contributing 3.1 % points of GDP growth. Hotels and restaurants picked up by 8.7 %, assisted by a steep 34.8 % increase in visitor arrivals. Retail and wholesale trading raised by 8.1 %, reflecting the expansion in private consumption. Due to the flood in central regions followed by drought in the north, agricultural output was subdued edging up by 2.8 % in 2010. Based on the official poverty measure, the reduction in urban unemployment and poverty incidence fell to 10.6 % from 12.3 % in 2009, supported by the faster economic growth. In December 2010, inflation in Vietnam became the highest in Southeast Asia with the rate of 11.8 %, averaging 9.2 % for the year. Furthermore, by March 2011, it was running at 13.9 % year on year, mainly caused by rising food prices and school fees. Exports rose by 26.4 % in USD with significant increases in exports of electronics and computers (29 %), footwear (25 %), and textiles (up by 23 %). In contrast, exports of crude oil fell by 20 %, as volumes plunged by 40 % owing to depletion of oil fields. Imports rose by 21.2 %, reflecting demand for inputs for manufacturing and the country's reliance on imported capital equipment. More favorable trade with its largest trading partner (China) was accelerated by a free-trade agreement between the Association of Southeast Asian Nations and China, from January 2010. The imports from China rose by 23 % to about 18.0 billion USD and exports there shot up by 49 % to 6.3 billion USD in 2010. Net inflows of foreign direct investment (FDI) in 2010 rose by about 3 % to 7.1 billion USD. However, FDI approvals at 18.6 billion USD missed the country's target likely reflecting investor uncertainties over policy direction. FDI approvals for real estate projects fell whereas approvals for manufacturing more than doubled.

Aside from such factors as inflation and interest rates, exchange rate is one of the most crucial determinants of a country's relative level of economic health. It plays a vital role in particularly a country's level of trade. In an open economy, exchange rate policy of the country can exert considerable influence on external competitiveness, inflation, trade balance, and the functioning of foreign exchange market. The current de facto exchange rate policies of East Asia according to the International Monetary Fund (IMF) as of April 30, 2008, are divided into four general categories: (1) Pegged; (2) Crawling Peg; (3) Managed Float; and (4) Free Float. Many East Asian countries including the GMS countries have adopted "managed float" exchange rate policies.

Table 2.6: De Facto Exchange Rate Policies of the Greater Mekong Subregion Countries as of 30 April 2011

Country	Exchange Rate Policy
Cambodia	Managed Float
China*	Crawling Peg
Myanmar	Managed Float
Laos	Managed Float
Thailand	Managed Float
Vietnam*	Crawling Peg

*Status of exchange rate policies of China and Vietnam subject to debate; some analysts think both nations have recently adopted a managed float (see, Martin, 2010).

Source: International Monetary Fund (IMF, 2011b).

In 1992, Cambodia adopted a managed floating exchange rate regime based on the USD. The current exchange rate regime in Cambodia may be characterized as *an official* and *a parallel exchange rate*. The official exchange rate is determined by the National Bank of Cambodia (NBC) for transactions between the National Bank of Cambodia (NBC), government and public sector. On the other hands, the parallel market rate is a freely floating exchange rate and is determined by market. It is used for all private sector transactions. Cambodia has adopted a market-oriented exchange rate policy with the official exchange rate adjusting to movements in the parallel market rate. The main purpose of its exchange rate policy is to maintain price stability. In order to maintain the confidence in the Cambodia Riel and to reduce currency substitution, management of floating rate has been targeted to a stabilization vis-à-vis the USD. The Dollar-Riel market exchange rates are taken every working day from three markets in Phnom Penh, and the official rate is set the same day on

this basis. Since 1995, the official exchange rate has not differed by more than ±1 % from the market rate. The spread between the official and market rates is lower than 1 %. The NBC intervenes in the market when psychological factors and market sentiments cause disorder in the foreign exchange markets and the foreign exchange fluctuate sharply. The purpose of the intervention is to smooth foreign exchange movements through foreign exchange auctions, and to defend against speculative attack (Bonnang, 2009).

The increasing trade surplus of China against the United States, the rapid economic growth, and the low level of relative price in China imply that the Renminbi (RMB) is undervalued by about 34 %[14]. China allows more flexible setting of the exchange rate with a narrow band of 0.3 % of a central parity within which the exchange rate to move. China maintained its fixed exchange rate regime from 1994 to July 2005 that maintained the exchange rate at 8.28 Chinese Yuan per USD. China finally abandoned its exchange rate policy of dollar peg beginning from 21 July 2005, and replaced it with a managed floating exchange rate regime. The RMB exchange rate was valued from 8.28 to 8.11 RMB per USD. Under new policy, the RMB exchange rate would not be pegged to the USD, instead, a basket of currencies be used as reference to set the exchange rate depending on trade, investment and debt relationship of its major trading partners. The announcement of the exchange rate reform addressed a number of important issues. First, it removed the fixed dollar peg of the RMB in favor of a managed floating exchange rate regime based on market demand and supply with reference to a basket of currencies. Second, the People's Bank of China (PBOC) adjusted the exchange rate from 8.26 to 8.11 RMB per USD revaluing the RMB by 2.1 %. Third, it established a regime by which PBOC announced the central parity rate, based on inter-bank foreign exchange market outcome, which serves as reference for trading the following trading day. Fourth, the exchange rate of RMB per USD in the inter-bank foreign exchange market would be limited to float within around 0.03 % around the central parity rate. The exchange rate of RMB against non-USD currencies would be allowed to float based on the band to be announced by the PBOC. The provisions also allowed the PBOC to exercise discretionary measures depending on economic and financial conditions to manage the exchange rate movement (Bo, 2008).

Since the economic reform, known as New Economic Mechanism (NEM), in 1986, more comprehensive measures have been implemented in Laos including the new tax policy, trade liberalization, removals of price controls, and the creation of a two-tier banking system. Furthermore, in mid-1988, a law on foreign investment was adopted and promulgated, together

[14] Frankel (2005), Williamson (2000).

with decrees on, exchange rate policy, credit and interest rate policies. Trade balance has always been in deficit and foreign exchange has always been scarce. In the 1980s, an exchange control system was operated; export proceeds had to be given up to the monetary authorities and residents were not allowed to hold foreign exchange accounts with banks. However, during 1985 to 1987, Laos adopted a multiple exchange rate system. The first official exchange rate was 10 Kip per USD. This exchange rate was used to convert loans from international organizations such as Asian Development Bank (ADB), International Monetary Fund (IMF) and the World Bank or foreign loans and grants into Kip, as well as Kip into USD when settling debts through the national monetary authority. The second official exchange rate was at 35 Kip per USD. This rate was valid for diplomats and the expenditures of the embassies. The third rate was the official commercial exchange rate of 95 Kip per USD. One reason for fixing the official commercial rate at a much lower level than the market rate was to protect State-owned companies. Meanwhile, the source of foreign exchange for the government was mainly exports of electricity and logs by State-owned companies. The fourth exchange rate was for inward remittances to the residents of the Country at 270 per USD. A fifth exchange rate was applied for export-import mixed companies during 1986 and 1987 when the government had just adopted the New Economic Mechanism policy. A sixth exchange rate was that which existed in the parallel or free market; during the period 1985 to 1987, it was around 390 - 420 Kip per USD. Although that rate was illegal, there was never a case of anyone being arrested for exchanging foreign currency in the market. Foreign exchange transactions outside the banking system were quite essential, particularly large commercial transactions among private traders, which were prevalent all over the country. The amount of foreign exchange that circulated in the parallel market has never been officially verified (the banks did not accept deposits in foreign currencies during that period). In March 1988, the Lao government unified the different official rates and adopted a single exchange rate system accompanied by a steep devaluation from 95 to 350 Kip per USD and later to 450 Kip to USD. The government also adopted a more flexible exchange system under which the official exchange rate could fluctuate by between 5 % and 10 % of the official rate. In October 1989, the government took a bold step when it allowed all commercial banks to accept foreign currency deposits from the public. With that new service, those people who wanted to save their money in US dollars or in Thai baht could do so at any bank. This policy has helped the Lao banking system gain confidence from the public. Moreover, the government has been quite successful in mobilizing a substantial amount of foreign exchange into banking system instead of leaving it unmonitored in the parallel market[15].

[15] www.unescap.org/drpad/publication/ldc1_1788/chap7.pdf

The exchange rate in Myanmar is administered by the Central Bank of Myanmar in accordance with instructions from the Ministry of Finance and Revenue. Myanmar limits foreign currency operation to three state owned banks—the Myanmar Economic Bank, the Myanmar Foreign Trade Bank and the Myanmar Investment and Commercial Bank. The Myanmar Kyat is officially pegged to the Special Drawing Right (SDR) at 8.508,47 per SDR[16]. Based on the fixed Kyat-SDR rate, Myanmar applies margins of 2 % to spot exchange transactions. The exchange rates of the Kyats for the Euro, Indian Rupee, Japanese Yen, Pakistan Rupee, Pound Sterling, Singapore Dollar, Sri Lanka Rupee, Swiss Franc and United States Dollar are determined by daily calculations on the basis of the value of these currencies against the SDR issued by the International Monetary Fund (IMF). Other currencies, however, are determined on the basis of the daily foreign exchange rates of Singapore Market. Foreign exchange certificates (FEC) are issued since 1993 by the Central Bank of Myanmar in denominations of 1, 5, 10, and 20 units and are exchangeable with hard currencies or with acceptable traveler's cheques. In Myanmar, FECs are widely used and served the needs of visitors and investors. An FEC is equivalent to 1 US dollar. FECs are available for Kyats at the exchange centers operating in Yangon and in other major cities. Holders of FECs may deposit them into their foreign exchange accounts. Annually, an import program for the public sector is prepared as part of the foreign exchange budget drawn up jointly by the Ministry of Finance and Revenue and the Ministry of National Planning and Economic Development. An import program for the public sector is prepared annually as part of the foreign exchange budget drawn up jointly by the Ministry of National Planning and Economic Development and the Ministry of Finance and Revenue. Imports are permitted commensurate to the level of service or export earnings. All payments for invisibles outside the public sector are subject to approval which is granted on a case-by-case basis. Prior approval from the Controller of Foreign Exchange is required for all outward remittances (CBM, 2011).

Thailand has operated the managed-float exchange rate regime since 2 July 1997, replacing the basket-peg regime which had been in operation since 1984. The value of the Thai Baht has since then been largely determined by market force. The Bank of Thailand (BOT) manages the exchange rate by intervening in the foreign exchange market from time to

[16] SDR (Special Drawing Rights) are supplementary foreign exchange reserve assets defined and maintained by the International Monetary Fund (IMF). SDRs represent a claim to currency held by IMF member countries for which they may be exchanged. As they can only be exchanged for Euros, Japanese yen, Pounds sterling, or USD, SDRs may actually represent a potential claim on IMF member countries' non-gold foreign exchange reserve assets, which are usually held in those currencies.

time in order to prevent excessive volatilities in the markets while fundamental trends are accommodated. Put differently, movements in the exchange rates which are in line with the changes in financial development and economic fundamental would only be smoothened and not resisted. Since the adoption of the managed-float exchange rate regime, the Thai Baht has generally moved in line with the economic fundamental. Thailand's managed-float exchange rate regime together with the inflation targeting framework formally introduced in May 2000, with short-term interest rates as the operating target has worked well for its economy. The flexibility in exchange rates helps absorb shocks to the Thai economy while the inflation target performs the role of a new nominal anchor for monetary policy. To help safeguard against potential instability and speculative activities in the currency market, the BOT, for example, imposed a few measures on certain types of foreign exchange transactions as follows: On 29 January 1998, non-residents who do not have any underlying trade or investment activities in Thailand are allowed to obtain Thai Baht credit facilities from their on-shore couterparties up to a combined outstanding amount of 50 million Baht per entity. On 23 July 2003, to promote capital outflows, some exchange regulations were relaxed such as allowing institutional investors to invest more abroad and allowing Thai residents to issue structured products which link returns to foreign variables such as foreign exchange rates and foreign assets. As a result, demand for investment in foreign debt securities rose markedly. On 20 August 2003, the BOT approved the total investment of 2,449.26 million USD. On 11 September 2003, the amount of Thai Baht that on-shore financial institutions can borrow short-term (less than 3 months) from non-resident without underlying trade or investment is limited to no more than 50 million Baht per entity. However, transactions that have underlying trade or investment are allowed without restrictions (Bank of Thailand, 2004).

Since the mid-1980s, when Vietnam moved to a transitional path to a market-oriented economic system, the exchange rate regime has undergone major changes. The country's exchange rate policy is implemented and administered by its central bank–the State Bank of Vietnam (SBV). In line with the broader economic reform process, Vietnam's exchange rate regime has evolved changes from a system of multiple exchange rates to a single announced fixed rate, then to the current system incorporating a narrow adjustable band around the official rate, which is itself set on a daily basis and is meant to reflect the interaction of market forces. The current exchange rate regime in Vietnam has been described by the authorities as a managed float. In principle, under a managed float, the exchange rate is determined by market forces, and the government's influence on this rate is affected only through its own purchases and sales in the foreign exchange market[17]. In the case of Vietnam,

[17] Moosa (2004).

the justification for the term ‘float’ being in the above description is that the SBV no longer sets the official exchange rate, but simply ‘notifies’ the average interbank rate determined on the preceding business day through the interaction between supply and demand in the market. The regime is ‘managed’ in that the exchange rate can move only within a stipulated band, the SBV remains a major participant in the market, and various forms of administrative exchange controls and rationing are maintained. The SBV has become the dominant player in the Vietnam’s interbank market. Given the fact that the targeted official exchange rate has been kept stable for long time and the trading band has been quite narrow, the SBV has been required to stand ready to respond to any instances of non-clearance of the market in the country (Nguyen, 2009).

2.5.2. Major Economic Institutions in the Greater Mekong Subregion

In the economy, banking and financial system plays essential role in the form of catering to the need of credit for all the sections of society. Their performance directly affects the efficiency, stability, and growth of the economy. In international trade, a country not only needs sound functioning capital and insurance markets, but also transparent fiscal and financial regimes, and sound monetary and banking policies in order to promote efficient trade. A sound system helps the country in efficiently providing loans, mitigating risks, and managing cash flows, and etc. An efficient banking and financial system has become more essential, since most of the economies in the globalization have been heavily involved in international trade.

The regional as well as subregional integration brings an opportunity for more cooperation and exchange by facilitating banks to enjoy accessing global funding sources and technical assistance. This provides the country to meet the capital needs, and serve as a stimulus for modernization of the banking sector. Furthermore, a sound financial system contributes to the growth of the country by allocating them to the most efficient uses as well as mobilising financial resources. Most of the Greater Mekong Subregion (GMS) countries are working to improve their banking and financial system indicated by the successful establishing the so-called two-tier banking systems—where the central bank is the bank of the commercial banks, and the commercial banks are indirect contact with companies—from former mono-banking systems in most of the member countries. The two-tier banking system is the separation of central banking from commercial banking functions in the country.

As a result of the significantly liberalization in financial sector, Cambodia has experienced solid growth over the last decade with significant macroeconomic and political

stability. Capital market development in the country is managed by a financial sector blueprint (2001-2010) approved by the Royal Government of Cambodia in August 2001. Foreign exchange market in Cambodia is active as roughly 90 % of the transactions are taken place in USD. Foreign investment regime in the country is generally liberal, despite the restriction in some sectors such as legal, accountancy, and certain areas of construction, transportation, and foreign trade, as well as broadcasting, printing, gemstone exploitation, rice mills, wood and stone carving manufacture. There are no controls on either residents or non-residents for holding of foreign exchange accounts. With the cooperation between Asian Development Bank expert and the National Bank of Cambodia (NBC), financial system in the country was put in place with the ten-year blueprint from 2001 to 2010. The new Law on Banking and Financial Institutions formally adopted in 1999 was to stipulate relicensing for existing viable commercial banks with sufficient capital and asset quality. Banking system in Cambodia consists of the NBC as the central bank with 20 provincial branches, 1 representative office of a foreign bank, and 13 commercial banks including 1 state-owned, 3 foreign bank branches, and 9 locally incorporated banks. The NBC plays a role as a supervisor for the specialized banks which have mainly rural and microcredit functions. The supervision by the NBC has been gradually strengthened by the introduction of new inspection and auditing methods for modern banking system.

Over the past decades, the Chinese authorities have taken a number of steps in order to ensure that financial sector will be able to support its rapid growth. Financial system in China has been rather slowly and methodologically transformed considering the fact that the reform of banking system based on market mechanisms began less than two decades ago. Prior to the reform, traditionally banks met the government policy goals by financing the state-own enterprises regardless of their profitability or risk. Following 2002, the structural reform of major commercial banks in the country showed favor progress in the four years. The reform of banking system has been mainly supported by introduction of foreign funds, tax exemptions, infusion of capital, and other changes of government policy. Since December 2006, banking sector in the country has been more opened to foreign banks in accordance with its accession commitments to the World Trade Organization (WTO). Currently, China has eliminated the then prevalent strict restrictions on foreign banks' local currency business. These changes, however, is not meant to ensure that the business foundation of Chinese banks has become completely stable. Most of major Chinese commercial banks are still fragile in terms of diversification of their services, business profitability, and asset quality of the banks compared to leading banks in other countries. Due to such weaknesses and issues as the loose credit culture and widespread disregard for the rule of law, the function of Chinese banking system is not yet efficient. In order to improve its banking system, Chinese government, with the

cooperation from commercial banks, is strengthening the institutional mechanisms for exposing and eliminating financial crime and corruption. In July 2006, 68 members of the China Banking Association agreed to sign an anti-bribery commitment and 3 conventions pledging to promote fair competition, strengthen self-discipline, establish a system to combat commercial bribery, and resist illegal transactions implying the favorable improvement of banking system in China.

Banking sector is the most important part of the financial system in Laos. Financial system in the country is relatively small, and heavily dependent on government guidance. All capital transactions require the Bank of Laos as a central bank to approve. Supervision and regulation of financial services are not sufficiently strong. Banking sector was dominated by 3 state-owned banks accounting for about 70 % of the whole assets. Currently, there are 10 private and foreign banks with limited activities. The credit is mostly directed by the government. As a result of the Asian financial crisis in 1997 and the directed finance inherited, banking sector in Laos was impeded by non-performing loans caused by the steep depreciation of the local currency (Kip) in USD denominated loans. A reform of banking system is necessary for the country in order to solve the non-performing loans problem and achieve the necessary capital adequacy. Since the launch of financial sector reforms, banking sector in Laos has gone through drastic changes. Banking sector has completely transformed from a mono-banking system into a two-tier banking system. At the present, banking business environment in Laos is improved with the promotion for many banks to enter in the marketplace to provide a variety of financial services. Originally, banks were concentrated only in Vientiane Capital with the reluctance to expand their banking service to other provinces. However, not only the branches expanded to other provinces, but the service units, Automated Teller Machine or ATM network are also launched to facilitate banking operations. After the banking system reform, level of NPLs has been controlled with the ratio of less than 5 % of total net lending.

Heavy restriction in financial sector is a serious economic problem in Myanmar. As an autocratic state, severe restrictions are imposed on many areas. Foreign investment has to be approved by the Cabinet on a case-by-case basis before doing business. Investor is also required to get a business license to trade after the permission from the Cabinet. Financial structure of the country comprises of state-owned banks and state insurance institution, and private banks. State-owned banks are Central Bank of Myanmar (CBM) and other four specialized banks. The Myanmar Insurance is the sole insurance institution underwrites a variety of insurances. Financial sector in Myanmar is heavily intervened by the government. Under the Central Bank of Myanmar Law in 1990, the CBM was established to exercise

supervision and regulatory authority over financial institutions of both state and privately owned to set reserve requirements, prescribing interest rates on deposits and loan, minimum cash margin, and ratios of asset and liabilities. The CBN is responsible to conserve the available foreign exchange reserve of the country under the instructions from Ministry of Finance Exchange. Private banks were once nationalized in 1963 during the previous government. However after the adoption of market-oriented economic system in late 1988, private banks were allowed to operate again since 1992. As a result of the reform, number of foreign banks permitted to enter into joint ventures with domestic private banks has increased.

In Thailand, the consistent annual growth rates of 4 % - 6 % and the highest per capita gross domestic product (9, 700 USD in 2011) among the GMS countries are primarily the result of sound free-market economic policies, manufacturing and agricultural exports, and services including tourism, banking and finance. According to the Thai laws, foreign investor is permitted to have 100 % business ownership except in 32 restricted service occupations. In most case, business transactions involving money market instruments, short-term money securities, capital market securities, bonds, real estate, foreign exchange transactions, and some outward direct investments are required the approval from the Thai government. Financial sector in Thailand is regulated by the Ministry of Finance (MOF) and the Bank of Thailand (BOT). Economic and financial system policy, government property, taxation, treasury, oversees public finances, and overseas operations of state enterprises and government monopolies are under the supervision of the MOF. The BOT as the central bank is responsible for supervision and examination of financial institutions, setting monetary policies, provision of banking facilities to the government and financial institutions, management of the foreign exchange rate, printing and issuing banknotes as well as other security documents. Some large commercial banks are shared with the state. The government, for example, holds 56 % of Krung Thai Bank, 48 % of Siam City Bank, and 49 % of Bank Thai, all of which are among the top 10 domestic banks. In some cases, foreign ownership of Thai financial institutions is restricted. The reform of Thailand’s banking and financial system was pursued after the severe Asian financial crisis in 1997. Financial regulation and supervision are even more transparent and have been further improved.

During 1988 - 1989, banking system of Vietnam was transformed from the then mono-banking system into a two-tier banking system. According to the new system, the State Bank of Vietnam (SBN) restricted itself to acting as the central bank. In addition to its national financial responsibilities, the SBV is assumed some of the duties of a commercial bank. Its commercial banking activities were taken over by four sector-specialised state-owned commercial banks. In order to promote its financial activity, during the 1990s the Vietnamese

government encouraged the entry of new players into financial sector. As a result of the new policy, number of representative offices and branches of foreign banks as well as the so-called joint-stock commercial banks significantly increased. Furthermore, joint venture between state-owned commercial banks and foreign banks were initiated, although the services offered by them were strictly circumscribed. Despite the less importance in terms of financing firms, number of non-bank financial institutions such as finance and insurance companies has increased. At the present, the largest insurance company in Vietnam is still state-owned. Stock market in Vietnam established in July 2001 is still in its infancy compared to the international standard. Despite the reform in its financial system, the government still involves in the supervision, regulations of financial institutions. Currently, 5 of 63 commercial banks in Vietnam are state-run, and 4 of them provide about 70 % of all lending. According to the decree issued in 2006, the Vietnamese government permits fully foreign-owned banks to open in the country with some restrictions. In order to promote a more efficient operation in banking sector, Vietnam has continued to further reform its banking system from 2010 to 2020. From April 2007, for example, the Vietnamese government has permitted foreign banks to open fully foreign-owned subsidiaries in the country.

Chapter 3

The Greater Mekong Subregion Development and Natural Resources Policy

Introduction

It is commonly known that natural resources are what we use to create our industrialized civilization. By their mere existence, they have recreational as well as commercial values contributing to overall social welfare levels. One of the aims of the GMS is to improve the infrastructure to promote freer flow of goods and people, and enable the development and sharing of resources base in the subregion. The rich natural resource endowments in the subregion have made it a new frontier of economic growth in Asia. It is, indeed, recognized as one of the world's most growing areas. The GMS is an area of enormous wealth combined with variety of natural resources such as land, forest, fisheries, minerals, and energy in the form of coal and petroleum reserves and hydropower.

Natural resources sector is one of the key contributors to the subregional strong rate of economic growth encouraging foreign direct investment since the establishment of the GMS in 1992. It has supported the subregional development in term of income, and sustenance to the great majority of people who are leading subsistence agricultural lifestyles. Land yields minerals, coal, and petroleum, while water from the Mekong River provides fisheries, agriculture, energy in the form of hydropower, as well as transport corridors

Modernization and industrialization are increasingly emerging from a process of transition in the subregion. In other words, most of the GMS countries are shifting from subsistence farming to more market-based systems, and more diversified economies. In parallel with this, more trade in natural resources has considerably increased among member countries. In the GMS, there is a significant trade in agricultural commodities and wood, minerals, coal,

oil, natural gas, hydropower, and other products derived from natural resources endowed in the subregion. Among others, hydropower is abundant in Laos and Yunnan province while coal, oil, and gas reserves are abundant in Myanmar, Thailand and Viet Nam.

The consequences of the increase in natural resources-based trade have impact on environmental degradation in the subregion. In parallel with the subregional high growth rate, the increasing trade in natural resources has raised environmental concerns over resource depletion. The impacts are of particular concern in member countries heavily rely on natural resource-based exports, and weak environmental regulation. Therefore, protecting the subregional wealth of natural resources has become an important task for the GMS to achieve sustainable development. One of the subregional vision is to promote sustainable management of subregional shred natural resources in order to reverse earlier degradation and mitigate adverse environmental issues as a consequences of the natural resources trade. Following the GMS's vision, governments in most member countries have been gradually adopting new laws aimed to create a transparent rules based private sector environment, protection of the environment and sustainable use of natural resources in order to address environmental challenges common in the subregion.

In this chapter, growth and development of natural resources in the GMS as well as trade in natural resources among member countries are presented. Moreover, this chapter shows future development of natural resources and policies for reducing negative impacts as a result of natural resources trade in order to achieve sustainable development in the subregion.

3.1. Growth of Natural Resources in the Greater Mekong Subregion

Foreign investor interest is focused on the rich endowment of the subregional natural resources. Despite the abundant natural resources in the GMS, most of them are underdeveloped. Although it has been described as high potential, due to the lack of finance, hydropower in the GMS has still largely undeveloped. Mineral exploration has also been low intensive in labor (Rutherford, 2008).

Table 3.1: Projected Average Annual Energy Investment between 2005 and 2025 Compared to GDP

GMS Economy	Projected Average Annual Energy Investment (Million USD)			Total as % of GDP
	Electricity	Non-electricity	Total	
Cambodia	159	541	700	9.7%
Laos	724	151	875	20.3%
Myanmar	1,290	227	1,517	17.5%
Thailand	2,980	549	3,528	1.7%
Vietnam	1,947	848	2,796	4.6%
Guangxi	2,163	690	2,853	7.1%
Yunnan	1,708	894	2,602	7.2%

Source: CASTALIA (2008).

The current investment environment or the attractiveness for investors, especially as demonstrated through the current levels of foreign direct investment (FDI), private sector participation and the state of capital markets in the countries in Thailand, Vietnam and China are already in favorable condition. On the other hands, Cambodia, Laos, and above all, Myanmar are still struggling to attract FDI and lack adequate capital markets (CASTALIA, 2008).

According to CASTALIA (2008), investments in energy sector across the subregion between 2005 and 2025 will need to be about 300 billion USD. Except for Thailand, Guangxi and Yunnan, all other GMS member countries will need to finance investments in the order of 5 % to 20 % of their GDPs. To meet the needs, only the reliance on public spending will make it difficult for these countries. The ability to attract private sector investment either from domestic investor or from foreign investor will become increasingly important.

In three members of the GMS—Cambodia, Laos, and Vietnam—Chinese state-owned enterprises are becoming major investors fuelling natural resources extraction. For example,

The Sinohydro Corporation—the largest hydropower dam building company in China—is developing number of hydropower projects in both Cambodia and Laos. The Chalco (Aluminium Corporation of China) has cooperated with Lao and Thai companies to put forward an assessment of environmental impact for bauxite mining in Laos and is also engaged in Vietnam. The China Nonferrous Metals International Mining Co. Ltd is active in copper mining in Vietnam and bauxite mining in Laos. And the China Southern Power Grid Co. Ltd. is active as well as exploring opportunities in all Cambodia, Laos, and Vietnam (Rutherford et al, 2008).

Cambodia has a very liberal policy of welcoming private investment in most sectors of its electricity industry. For example, 12 of 24 regional electricity distributors are private, and a number of village-level electricity suppliers throughout the country are private companies (CASTALIA, 2008). Most of FDI inflow to Laos is directed to natural resources sectors particularly mining and hydropower. In 2006, for example, approximately 70 % (and 50 % in 2007) of total FDI inflow to Laos went to three hydropower projects under construction, and the rest went to mining projects, agricultural plantation and processing industries (Rutherford et al, 2008). Yunnan province of China is well endowed with natural resources such as hydropower, coal, minerals attracting significant investment. Agricultural sector is reasonable diversified with an increasing role of tobacco plant and flower. Yunnan's investment into hydropower will also be conductive to its industrialization.

Investment environment either in natural resources or other sectors in Thailand is scored well, because it is considered to have relatively clear rules, and a strong and stable macro-economy. A particular sector impressed by foreign investors is power sector, due to the fact that in the Asian crisis in 1997, Thailand not only respected its power purchase agreements (unlike Indonesia and the Philippines which forced renegotiations in some cases), but even voluntarily adjusted arrangements in the investors' favor in some cases. In addition, stable policy as well as regulations to encourage biofuels has been effective in ensuring significant number of foreign investor interest (CASTALIA, 2008).

Investment in power production sector is becoming more predictable and is beginning to become market-driven in Vietnam. The relative clarity of direction and fixity of purpose exhibited by the government have made Vietnam an attractive investment destination. Most of foreign investors were attracted to Vietnam's market reforms, as well as its stable macro-economy and rapid growth. In spite of some constraint, fiscal space was also cited as an opportunity for private firms to provide the investment that the government might not be able to (CASTALIA, 2008).

Recently, not only focusing on facilitating free flow of goods, people and capital by putting the necessary hardwiring—power plants, roads, and transmission lines; there has been also a range of policy interventions and technical assistance projects with the main purpose of promoting the role of private sector, liberalizing regional trade and investment, and promoting export-oriented natural resources exploitation (Lee, 2008). According to the suggestion from CASTALIA (2008), given that coal and oil are easily transportable within as well as outside the region, the important task for the Greater Mekong Subregion (GMS) countries in ensuring the most efficient use of these resources is to remove the constraints of trade. In other words, coal and oil should be simply traded without significant restrictions (quotas) or price distortions due to government policy. This will ensure that both consumers and investors receive clear price signals, leading to an efficient level of consumption, and investment to meet that consumption.

While the economically viable natural resources such as coal, hydroelectric and natural gas-based power generation plants are important, GMS countries should also explore the potential of clean and renewable energy sources such as solar, wind or biomass-based energy with relatively low cost and reasonable price to ensure the energy sufficiency in the subregion (UNEP, 2009). Energy efficiency is the goal of efforts to reduce the amount of energy required to provide products and services. Not only the GMS members, but also in many countries, it is also seen to have national security benefit, because it can be used to reduce the reliance of energy imports from foreign countries and may slow down the rate at which domestic energy resources are depleted (Wikipedia, 2011a). Energy efficiency is also important in the GMS in order to meet the increasing demand in the subregion. The benefits from of improving energy efficiency in Asia-Pacific are: improved energy security, lower growth rate of Carbon Dioxide (CO_2) emissions, and increased energy services.

Although most member countries have begun to set up the programs and targets, GMS countries are still in early stages of promoting energy efficiency, and need learn from experiences in other countries. The most concrete actions of promoting energy efficiency in the region have so far taken place in Thailand while a more concrete approach including labeling, concrete programs, and energy efficiency standards is still needed in most countries. In addition, there are three main categories of the barriers to the energy efficiency as follows (CASTALIA, 2008):

1. Barriers to be addressed at the energy policy level:

    - Poor collection rates, non-economic pricing of energy, and inappropriate tariff structures

- Market incentives for energy suppliers to supply more energy rather than less (such as biases towards new investments)
- Lack of energy efficiency standards, information campaigns, codes, norms or labeling systems
- Inadequate regulatory or legal frameworks to support energy service companies

2. Barriers to be addressed at the end-users level:
    - Lack of awareness of financial or qualitative benefits arising from energy saving measures
    - Lack of knowledge and skills to implement such energy savings measures
    - Capital constraints and corporate culture leading to more investment in new production capacities rather than energy efficiency
    - Greater weight given to addressing upfront costs as compared to recurring energy costs, especially if these costs are a small proportion of production costs
3. Barriers to be addressed for the provision of finance and expertise:
    - Limited experience and awareness among financiers as well as investors of potential financial returns
    - Due to high transaction costs associated with smaller projects, inexperience and lack of competition in the area, and risks associated with assessing and securitizing revenues generated through energy savings, local banking sectors tend not to show interest in energy efficiency finance
    - Limited access to robust systems, and skills for measurement, monitoring and verification of energy savings

Promoting energy efficiency in GMS makes sense due to the success of energy efficiency in other countries, for example, Organization for Economic Co-operation and Development (OECD) countries. Since energy efficiency is important for the GMS countries,

it should be more promoted. To do so, the suggestions from CASTALIA (2008) are that the GMS countries should:

- Move energy prices to cost-reflective levels to strengthen financial incentives for energy efficiency. One way to make cost-reflective pricing politically and socially viable would be through a rising block tariff. Basic needs would be priced as at present while consumption in excess of basic needs would be priced at full cost, providing correct signal for energy efficiency as demand grows

- Develop a regional approach to energy efficiency standards and labeling regulations for appliances

- Undertake fuel efficiency programs to improve fuel conversion rates in existing plants through refurbishment and improved operating procedures

- Promote the development of private enterprises that take over energy services in large industrial and commercial premises and are incentivized to reduce energy consumption

- Support projects to promote energy efficient light bulbs

- Promote the development of efficient buildings

- Promote knowledge networking and information sharing to ensure that lessons learnt in energy efficiency initiatives in each country are shared with other countries in the region

In the GMS, a more holistic and multisectoral approach to regional cooperation will be pursued in the next decade. Accordingly, the following five strategic thrusts are identified (ADB, 2002):

1. Strengthen infrastructure linkages through a multisectoral approach

2. Facilitate cross-border trade and investment

3. Enhance private sector participation and improve its competitiveness

4. Develop human resources and skills competencies

5. Protect the environment and promote sustainable use of shared natural resources

An abundance of natural resources in the GMS is one of the key factors promoting the development of the GMS. The fifth strategic thrust implies that the abundance of natural resources in the subregion tends to be worse unless appropriate policy is applied. According to the fifth strategic thrust, the serious extent of environmental degradation must be stopped and reversed. Cooperation for proper management of shared natural resources and collective action to resolve cross-border environmental problems are among the steps needed to achieve this goal. Environmental considerations must be at the forefront of all decision-making regarding development projects. While the primary responsibility for environmental protection rests with national and local governments, cooperation with neighboring countries is critical to resolving unintended negative outcomes of development activities that go beyond national borders. Cooperation of each GMS country is also vital in order to ensure sustainable use of subregional natural resources. Thus, the following initiatives are included in the strategic framework for the GMS Program:

- Subregional monitoring of the accumulative environmental impact of development: Investments in large-scale infrastructure in the next ten years will put additional strain on the environment in the GMS. To minimize the negative social and environmental impacts of these projects, a subregional approach will be adopted. The Strategic Environment Framework (SEF) for the GMS provides an appropriate policy, technical and procedural basis for subregional planning and monitoring. The Early Warning Information System (EWIS) included in the SEF will enable GMS governments to monitor the cumulative environmental impact of development projects, and respond to it in a proactive manner. The ultimate goal of the SEF is to engender sustainable rural development, restore fish stocks, improve forestry coverage (and thus reduce siltation, soil erosion, and flooding), protect endangered species, and reduce pollution in international waterways.

- Sound practices for sustainable use of shared natural resources: Protection and management of watershed areas and wetlands, considering their severe degradation will be considered priority. To reverse the negative impacts of deforestation and environmental degradation of watersheds, GMS governments will adopt a framework of mutually consistent policies, strategies and guidelines for environmental protection and sustainable use of the subregional shared natural resources. The framework will include

measures to reduce poverty in watershed areas such as creating employment alternatives to slash-and-burn agriculture and other undesirable activities along the subregion.

- Participation in International Environmental Initiatives: Regional cooperation on the environment should link with global initiatives such as the World Summit on Sustainable Development. All member countries will be supported in sharing experiences with other nations in international environmental initiatives. In order to strengthen the subregion's capacity for environmental assessment and management, the GMS Working Group on the Environment will be responsible for promoting cooperation with other international programs.

3.2. Development of Natural Resources in the Greater Mekong Subregion

The improvement of poverty reduction in 2005 was mainly related to Asia and Oceana, where the share of people living on less than 1.25 USD a day (the poverty rate) fell from 39 % in 1996 to 26 % in 2005. China was especially remarkable as its poverty rate fell from 26 % to 16 % during the same period (UNCTAD, 2010). In Latin American countries, the main beneficiaries of a reduction in transport costs were agriculture, natural resources-intensive, and labor-intensive sectors (de Ferranti et al, 2002, pp. 18). In the Mekong area, local resources dependence is almost entirely based on natural resources. Combined, the lands of the Greater Mekong Subregion (GMS) cover about 2.3 million Km^2. It is a large area of variety of human and natural resources and enormous wealth including a rich agricultural base-timber and fisheries-minerals, and energy in the form of coal, hydropower and petroleum reserves. These rich resources boost the subregional economic development and support rural livelihoods in an interrelated fashion. Not only supports fishery and agriculture which are a source of income and protein, the Mekong River also plays an important role as a transport corridor, and a source of hydropower in the subregion.

Each GMS country has various social, economic, and environmental constraints as well as opportunities. Most of them, however, have formulated a range of strategies and plans to deal with primarily poverty incidence, and overall socio-economic development in their own countries. In general, the development in the subregion is supported by the abundance of natural resources. The shared natural resources in the GMS are of prime importance in the economic and social development of the subregion. Majority of population in the GMS are

engaged in agriculture or other traditional occupations largely dependent on natural resources base (UNEP, 2009). Roughly one-third of the GMS are covered with forests, and another 40 % is rich agricultural cropland. The subregion also shares significant mineral deposits particularly petroleum, and coal reserves. In addition, there is a high potential for hydropower development in the subregion. All of these have historically supported economic development, and sustained rural livelihoods in the subregion (UNEP, 2009).

Minerals in Cambodia are largely unexplored and undeveloped. The contribution of this sector to Cambodia's GDP is relative low. However, over the past few years, foreign investors from Australia, China, South Korea, Thailand and the US have shown interest in Cambodia's mineral potential such as land-based metallic minerals (bauxite, copper, gold and iron ore), industrial minerals (gemstones and limestone), and onshore and offshore oil and gas reserves. All of these abundant natural resources could play an increasingly essential role in the Cambodian economy (Rutherford, 2008). The three main investment sectors boosting the Lao economy are electricity, agricultural, and mining. For example, mining industry—although is still in its infancy compared to other countries—is singled out as a priority investment sector in the National Growth and Poverty Eradication Strategy (NGPES). This is due to its potential to promote country's economic and social development, and enable Laos to graduate from the status of least developed country by 2020 (Rutherford, 2008). This indicates that natural resources have played an essential role for the Lao economy. In 2006, for example, as a result of the rapid growth in exports, trade deficit declined by more than 30 % driven by mining sector (World Bank, 2007a).

The estimation from CASTALIA (2008) showed that by 2025, electricity subsector will account for 17.9 % of total energy consumption (by energy value) in the GMS, up from 12.2 % in 2005. Ensuring efficient trade flows and production in electricity is particularly important as—under the GMS Integrated scenario—23 % of total GMS electricity consumption is met from trade within the subregion. This compares to only 9.6 % on average for all other traded energy subsectors. Clearly, significant benefits will be gained by facilitating electricity trade between GMS economies. With the implementation and further development of the Regional Power Trade Operating Agreement in the GMS, cooperation will continue to increase with projects for cross-border electricity trade.

With the exception for Thailand and to some extent Vietnam, investment and business environment in most GMS countries is not conductive to private investment particularly in electricity sector (CASTALIA, 2008). According to Integriertes Ressourcen Management (IRM) (2008), using an energy strategy mode—the Model of Energy Supply Systems Alternatives and their General Environmental Impact (MESSAGE)—to particularly

quantify the advantages of energy sector cooperation in the GMS, promoting energy sector cooperation in the GMS could result in a reduction of total energy costs for the GMS by 200 billion USD (or 19 %) for the period 2005 - 2025. These benefits are possibly because:

- The GMS is facing large increases in energy demand over the coming years
- There is a disparity between a country's demand and that energy endowment of energy sources in each GMS country
- As the region develops, the least-cost way to meet country's demand for energy will often be to import energy from neighbors

Trade in natural gas in the GMS is likely to increase over the coming year. As predicted by IRM (2008), natural gas will continue to be a major source of electricity generation accounting for about 15 % of electricity production by 2025, with almost all of the new additions will be in the form of combined-cycle gas power plants. Due to the benefits from natural gas-power generation—natural gas burns cleaner than other fossil fuels and produces less pollutants and carbon dioxide emissions—the investment in this sector was predicted to increase. IRM's modeling showed that investment in natural gas generation would be 25 % higher under the GMS integrated scenario. Given the important environmental benefits of natural gas-powered generation, gas-powered electricity production has been identified as a priority. The large investments in natural gas-powered generation in the GMS will be in Thailand and Vietnam.

IRM (2008) identified power plants using agricultural residues for fuel as one of its top priority project since it can substitute for liquid fuels based on hydrocarbon resources and contribute to energy supply security. Another important aspect is that it helps achieve the important goal of poverty reduction in rural area, since this technology can be used off-grid. Cambodia, Thailand and Vietnam together comprise 89 % of predicted capacity expansion in this sector over 20 years where the large-scale biomass generations are Thailand and Vietnam (CASTALIA, 2008). The prediction of IRM (2008) indicated that by 2015, about 7,600 MW of biomass-fired generation will be need. The least-cost expansion of electricity generation in the region will involve installing approximately 19,400 MW of biomass-fired generation in the GMS between 2005 and 2015. The model also predicted that by 2015, biomass-fired generation will supply approximately 250 TWh of electricity per annum.

Other than natural gas and biomass, coal was the largest energy contributor to the GMS energy supply in 2005. The majority coal resources are in Vietnam and Yunnan province of China which have considerable quantities of coal having the prospect of

increasing energy and lowering costs through coal liquefaction technology. Together, these two regions hold 98 % of the 81 billion ton of coal equivalent (tce) available in the GMS (CASTALIA, 2008). IRM (2008)'s modeling showed that demand for coal and oil in GMS will grow quickly. In order to meet this growing demand, large scale investment and increasing trade in coal and oil between GMS countries will be needed. The modeling also indicated that development of 29 billion USD in coal to liquids plants is likely to be economically justified between 2005 and 2015.

The IRM (2008)'s modeling showed that rather than importing refined product and exporting crude oil, it would make economic sense for the GMS to invest in facilities to refine oil in the region. Among the GMS countries, Vietnam is already constructing its first oil refinery. Cambodia is also a possible location for a second refinery in the subregion with the possibility to economically invest 5 billion USD in refining capacity by 2015. In addition, electricity trade between GMS countries is projected to significantly increase by 2025 resulting in lower electricity cost for the whole subregion (CASTALIA, 2008).

3.3. Trade in Natural Resources in the Greater Mekong Subregion

One concern in moving toward (low) uniform tariff rates across products and countries in the Greater Mekong Subregion (GMS) is the potential adverse impact of low tariffs on government revenues, especially such countries heavily rely on the revenues from tariff as Cambodia and Laos. However, a variety of factors are likely to mitigate such impact. First, the loss of revenues from lower tariffs will be offset to some extent by the likely increase in volume of imports. Second, lower and more uniform tariff rates should help reduce the incentives for smuggling and result in higher receipts to the government. Third, improvement in customs administration, partly aided by more uniform tariffs, has the potential to increase customs receipts significantly. Over the medium and longer term, revenues from exports of minerals and electricity in Laos and prospective oil receipts in Cambodia are likely to reduce their dependence on revenues from tariffs which are their major sources of income. In addition, increased integration between the GMS countries will raise competitiveness pressures for domestic industries, underscoring the importance of relieving constraints on trade and investment to improve their overall economic efficiency.

The GMS boasts abundant natural resources and huge development potential. With a long history of cultural and economic exchanges among the nations, the area has formed peculiar cultural and economic characteristics based on different folk customs and natural

landscapes of the six nations sharing the river. These abundant resources provide income as well as sustenance to the great majority of people in the subregion who are leading subsistence or near subsistence agricultural lifestyles. Water from many rivers in the GMS supports agriculture and fisheries, and also provides energy in the form of hydropower while land yields coal, petroleum, minerals, and timber. Coal reserves of the subregion are abundant, and oil and gas reserves considerable. Most of these abundant energy resources are in Myanmar, Thailand and Vietnam. These resources are still relatively underused.

Modernization and industrialization are increasingly emerging from a process of transition and transformation in the GMS. The Mekong countries are gradually shifting from subsistence farming to more diversified economies, and to more open, market-based systems. In parallel with this change are the growing commercial relations among the six Mekong countries, notably in terms of cross-border trade, investment and labor mobility. Moreover, natural resources, particularly hydropower, are beginning to be developed and utilized on a subregional basis (Xinhua, 2011).

The GMS program has been a key element achieving the goal which remains at the core of development efforts—poverty reduction. As a result of the economic integration in the GMS, there are substantial benefits for various sectors in the region. According to CASTALIA (2008), using IRM modeling to evaluate the costs and benefits in establishing the energy cooperation in the GMS, energy cooperation in the GMS could reduce total cost of energy by 200 billion USD for the period 2005 to 2025. Such significant benefits are possible because:

- The GMS is facing significant increases in energy demand over the coming years.
- There is a disparity between a member country's energy demand and its endowment of energy resources.
- As the subregion develops, the least-cost way to meet one country's demand for energy will often be to import from its neighbors.

According to CASTALIA (2008), energy trade in GMS is as follows:

Since the establishment of Asian Development Bank's regional cooperation in 1992, GMS cooperation in the energy sector has been focused on power sector, cross border electricity trading and the interconnection of transmission networks. The current level of cooperation in energy sector appears to be moderate and is likely to be increasing. In September 2007, for example, Laos and Thailand agreed to increase the commitment to hydropower trade in the first Lao-Thai high-level forum on sustainable hydropower development. Apart from large-scale power trade from Laos to Thailand, all six GMS member countries currently engage in small cross-border exchanges for supply to border towns of neighbors.

The GMS has a high potential of hydroelectric power particularly in Laos, Myanmar, and Yunnan province whereas the large demand for power is mostly concentrated in Thailand and Vietnam (UNEP, 2009). Among the member countries, Thailand seems to be the largest importer of electricity followed by Vietnam. Nam Theun 2—the fourth hydropower project in Laos with about 5,000 MW combined capacity—has sold substantially all of its electricity availability to the Electricity Generating Authority of Thailand (EGAT) on the basis of long-term Power Purchase Agreement (PPA). China and Thailand signed a memorandum in 1998 allowing Thailand to buy electricity from Yunnan province of China. The Jingjong hydropower project which is the first hydropower project built in China with capacity of 1,500 MW is planned to export power to Thailand from 2013. Furthermore, Thailand also has plans to import hydropower from Cambodia and Myanmar. In Myanmar, five hydropower dams on the Salween river system with the estimated capacity of 12,500 MW are planned with 85% to be exported mainly to Thailand. In order to meet the increasing demand of energy, a number of studies are being conducted to prepare future projects in the GMS such as the GMS Transmission Project (PRC-Laos-Thailand) and the GMS Power Interconnection Project Phase 1 (Laos-Vietnam).

A large portion of future electricity generation investment will be in coal-powered generation. Most of the future additions to coal-powered capacity will be using abated coal technology. However, between 2005 and 2010, coal-based generation investment was predicted to be 11.3 billion USD lower due to cross-border trade of hydropower substituting for local-based generation. Given that coal-based generation investment is predicted to decrease in the medium term, and that avenues for investment in this generation sector are well established, no-production priorities for coal-powered generation have been identified in the study of CASTALIA (2008). Initially, Myanmar and Vietnam are net exporters of coal in GMS. In 2005, Thailand, Guangxi and Yunnan provinces of China were the large importers

of coal where Vietnam was the largest exporter of coal in the region exporting 15 million tons. This would have been sufficient to cover the import demands of Thailand of 8.6 million tons valued at about 383 million USD. Currently, there are plans to increase a large amount of coal exports from Vietnam to Guangxi. The Tianchang Investment Co. Ltd of Guangxi, Marubeni Corporation of Japan and National Coal and Mineral Group of Vietnam signed an agreement for China to import five million tons of coal from Vietnam between 2007 and 2011[18]. Due to the increasing demand in the country, Vietnam, however, consumes all of its coal internally leading to the reduction in its coal export. Despite the trade in coal energy between some member countries, the current level of GMS cooperation in coal sector appears to be low, and the expansion of coal production may not necessarily lead to increased subregional trade. This is due to the fact that the process of converting coal to liquid fuel releases carbon dioxide in quantities that can exceed those released in the extraction of petroleum and its refinement by up to 50 % (Cleaner Coal Technology, 1999). While carbon sequestration is currently being explored to mitigate emissions from coal liquefaction, high cost of sequestration further reduces the financial viability of liquefaction.

Crude oil and refined oil products are widely consumed across the GMS. Total oil reserves in GMS is about 1.2 billion—42 % in Cambodia (most of which are recent discoveries), 28 % in Vietnam, 16 % in Thailand, and 11 % in Yunnan province of China—with the highest availability of grade 1 (lowest extraction cost) crude oils in Vietnam and Yunnan province. In 2025, the largest change in trade flows is Cambodia's shift to become a major exporter of light oil products. This is made possible by investment in refining capacity to capitalize on recently identified oil reserves. Alongside increased exports of light oil from Cambodia are increasing exports from Myanmar and Yunnan. Despite having significant crude oil reserves in the country, Vietnam was the largest importer of light oil products in 2005 due to a lack of refining capacity within the country. In 2025, all imports of crude oil are predicted to come from the rest of the world. Between 2005 and 2025, imports of light oil into Thailand and Guangxi will more than double. Such large crude oil importers as Thailand, Guangxi and Vietnam will import less crude oil for internal refining. For this reason, no priority trade flows of crude oil were identified. GMS cooperation in oil and oil products sector is low because most trade occurs with the rest of the world. In 2005, for example, the Middle East was Thailand's major oil supplier supplying 79.3 % of Thailand's total imported oil (CASTALIA, 2008).

[18] ADB (2005).

Within GMS countries, natural gas and oil extraction are of interest to both public and private investors. Government authorities have been responsible for the facilitation of large cross-country transmission of gas from Myanmar to Thailand and China. However, current level of cooperation in natural gas sector is low to moderate. There is minimal trade within the region since most local resources are rather used for internal consumption than for export. In 2005, Myanmar was the only exporter of natural gas within the region exporting to Thailand which was the only major importer. About 30 % of natural gas consumption for electricity generation in Thailand was met by imports from Myanmar. Due to the increasing demand in Thailand, since September 2007, energy authorities of both countries have been negotiating the construction of a marine, joint-venture natural gas pipeline for more export of gas to Thailand from the recently confirmed M-9 block in the offshore Mottama area. In 2025, Myanmar is predicted to be the only natural gas exporter whose exports increase by 31 % in 2025. Most of its increase is from the import from Thailand (most likely to fuel its gas power plants), and a small amount from Laos. The key natural gas flow in the subregion is the export of natural gas from Myanmar to Thailand and from Myanmar to Yunnan (CASTALIA, 2008).

Since 2007, Myanmar and Thailand have been negotiating a new pipeline to allow additional natural gas exports to Thailand. There is potential for the flow from Myanmar to Thailand to be higher than 30 % with recent recovery of Myanmar's natural gas reserves in the M-9 block of the Mottama offshore area. The M-9 field is estimated to be able to produce for domestic consumption and export to Thailand with the estimated gas reserve of more than 1.4 trillion cubic-metres and daily production rate will be about 300 million cubic feet. Of that, about 240 million cubic feet will be exported to Thailand daily and the remaining 60 million cubic feet will be to serve domestic consumption (Wild, 2011). In January 2007, China National Petroleum Corporation (CNPC) signed production contacts with Myanmar's Ministry of Energy covering crude oil and natural gas exploration projects in three deep-water blocks of the western Myanmar coast. A feasibility study for the construction of a gas pipeline from Myanmar to Yunnan province has been launched by CNPC and Myanmar Oil and Gas Enterprise. The pipeline will transport 170 billion cubic-meters of natural gas per year sometime in the next 30 years although the completion of construction has not been disclosed. Although there is a trade in natural gas among the GMS member countries, current cooperation in natural gas sector is low to moderate since most local resources are used for internal consumption.

3.4. Future Development of Natural Resources in the Greater Mekong Subregion

As the subregion experienced rapid economic growth, heavy pressure is being exerted on the natural resources resulting in serious consequences such as degradation and indiscriminate conversion of agricultural lands, polluted water bodies, poor urban air quality, declining fish and wildlife population, deforestation, and even migration of populations. The common challenge for the Greater Mekong Subregion (GMS) is therefore, to balance the following three dimensions—economic, social, and environmental—of sustainable development (UNEP, 2009).

In terms of economic issues, industrial development in the GMS, except for Thailand and Vietnam, has been relatively weak. The benefits of industrial development have also not reached the masses, as evident from persistently high levels of poverty in most member countries. Not only economic issues, environmental degradation also has serious implications for people in the GMS, since more than half of the population in the subregion relies on natural resources, and primary sector activities—fisheries, forestry, agriculture—for their livelihood as well as economic growth. In addition, social issues are serious challenges for the GMS countries that need to be overcome. Despite the abundance of natural resources and strong economic growth in the subregion, in 2000 about 55 million people still lived in poverty (UNEP, 2009). Energy access issue is one of the national security challenges for many Asian countries including the GMS member countries. The demand for oil, which is needed for growth in transport and various economic activities, is likely to exceed capacity for production in the GMS. This issue raises the questions about the energy sustainability in the subregion (AusAID, 2007).

It is now widely acknowledged that the current consumption-oriented lifestyles, and energy intensive in Western economies is putting sever stress on natural resources and the environment, and amounts to living beyond the earth's means. Therefore, the suggestion from UNEP (2009) is that adopting such lifestyles for Asian countries is not a viable path for long term. Environment in the GMS tends to be at risk. Water, land, and other natural resources that are the source of livelihood for the great majority of people in the subregion are threatened. Population in the Mekong region is 240 million with 65.7 million of them living within the hydrological basin of the Mekong River, and mostly relying in natural resources for their livelihood (Nilson and Segnestam, 2001). Natural resources depletion and environmental damage as a result of unconstrained and poorly managed exploitation of resources being creating are the cause of economic, social and environmental outcomes which are a broad challenge facing the GMS countries. Strategies to reduce such negatives impacts are therefore needed in order to enable the sustainability. Recently, it is feared that the current

over-extraction of forest and other natural resources will lead to permanent environmental damage. The progressive removal of the forest cover in upper watersheds, for example, will cause deterioration of the protective functions of soil and water conservation, which impact negatively on bio-diversity and downstream water dependent on agricultural production. Therefore, it has become increasingly apparent that economic development in GMS has been, and continues to be at the expense of natural resources depletion[19]. The sustainable use and management of the Mekong River's water resources is also a challenge which is needed to be resolved. Civil society groups have warned that hydropower development projects in Cambodia could displace thousands of people and seriously destroy the environment unless adequate effort are stepped up to effectively assess the social and environmental impacts of power plants in consultation with the public (International Rivers, 2008).

According to Lee (2008), the following issues are the challenges for the GMS countries:

- The single greatest determinant of vulnerability in the face of economic change is ethnicity. Ethnic minorities are the most acutely affected by changes in natural resources base due to an inability to compete in new agriculture and new commerce as well as rapid cultural change.

- The second greatest determinant of vulnerability in the face of economic change is the level of dependence on natural resources (especially forests and rivers). The group under the most pressure from rapid external incursion on natural resources (in the form of land concessions, hydropower, mining, and logging) are those who are most dependent on natural resources.

- The ability of natural resources to continue to support poor people's livelihoods in the Mekong is at a crisis point. River and forest resources are currently in the states of rapid ecological decline caused by human overexploitation with various reasons. Some of this has been an inevitable corollary of rapid population growth in the subregion. However, the main cause has been a consequence of the establishment of private tenure rights over common property resources through plantations, commercial logging, commercial fishing lots, and hydropower plants. Moreover, such a shift in resources tenure serves to deny poor people in rural area access to resources that is vital for their livelihoods.

[19] http://www.adb.org/gms/pp_env7.asp

- The transition to modernized and commercialized forms of agriculture can serve to disempower women's roles in agriculture. Several traditional cultures have sophisticated divisions of labor between male and female which ensure female play an important role in livelihood decision making. By contrast, modern land certificates tend to entrench the male with greater power as the head of household. Furthermore, Agricultural wage labor tends to have significant differentiation of remuneration between male and female.

Chapter 4

Laos' Electricity Trade with Thailand

Introduction

Since the transition from centrally planned into market economy in 1986, the Lao government has encouraged all economic sectors to participate in business process except for such important business sectors as electricity, water supply, communications, and national bank are still owned by the state. Furthermore, under its socio-economic development agenda, trade has been increasingly becoming an important driver of Laos' economic growth, and poverty reduction. The aim of country's for foreign trade policy is to thrust towards reducing progressively the trade deficit to establish a balanced or over-balanced status. In order to promote foreign trade, the government has signed commercial cooperation agreements, payments and other agreements with foreign countries to lay the foundation for trade relations. Currently, Laos has bilateral agreements with Cambodia, China, Mongolia, Myanmar, Thailand, Vietnam, the Russian Federation, and other Eastern European countries with the aim of further developing and strengthening trade relations with other countries on the principle of equality and mutual benefits.

Laos' trade has been mainly influenced by growing complementarities between Lao economy and its neighboring countries, foreign direct investment (FDI), membership of Association of Southeast Asian Nations (ASEAN) and ASEAN Free Trade Area (AFTA), and trade concessions from the European Union (EU). At the present, Laos has trade relations with more than 30 nations including mainly Asian countries such as China, Japan, Singapore, Thailand, and Vietnam, and the EU. The focus of governmental trade policy is to strengthen bilateral trade relations with mainly neighboring countries including China, Thailand, and

Vietnam using border trade as a mechanism for trade expansion. Regarding exports to these countries, Laos is mainly an exporter of agricultural and other primary products including wood and wood products, forest products, tea, garments, handicrafts, minerals, and electricity.

Regarding trading partnership, the Lao economy has largely remained dominated neighboring countries whereas Thailand is the major trading partner of Laos with more than half of Laos' imports are from Thailand, followed by China, and Vietnam. Laos and Thailand have a clear path visible toward significant investment, and mutually beneficial trade relation. With the aim to further promote bilateral trade, both countries agreed to facilitate trade and investment by establishing an academic cooperation, local product exhibitions, one-stop customs clearance service. Moreover, the two governments have projected to double trade value from currently 4 billion USD to 8 billion USD by 2015 implying the strong trade relation between two countries.

Among the country's chief exports, electricity is one of the major export goods and foreign capital earners playing an essential role in fueling economic growth. It is considered financially sustainable, and fiscal revenue from the exports will support the governmental agenda of poverty reduction. Electricity trading with neighboring countries is important for Laos since it is a substantial contributor to foreign exchange earnings, and interconnections with Thailand, Vietnam, and China provide least-cost supplies to border towns. Among electricity trading partners, Thailand is the prime market covering about 90 % of Laos' total electricity exports. Electricity export to Thailand is likely to increase due to the increasing demand for electricity together with higher cost of natural gas based production in Thailand.

It has been a long term collaboration of efforts in promoting electricity trade between Laos and Thailand. The governments of two countries signed the first Memorandum of Understanding (MOU) on electricity development cooperation in June 1993 with the purpose to generate 1,500 MW of electricity in Laos to export to Thailand by 2000. Due to the significant demand from Thailand, two countries have extended the MOU several times. Eventually, the latest MOU was signed in December 2007 for extending the amount of electricity export to Thailand 7,000 MW by 2015. In order to meet domestic demand as well as demand from Thailand, the Lao government has promoted more investment on electricity sector. As a result, there are more than 70 hydropower projects with 15 are either operational or under construction.

This chapter provides an overview of Laos' trade including trade policy, commodities and geographical structures of trade. Furthermore, the structure and dynamics of Laos' trade with Thailand is presented in this chapter with more concentration on the trade in electricity

between Laos and Thailand. This chapter also describes major development in electricity industries of Laos and Thailand as well as the growth and development of electricity trade between two countries in more detail.

4.1. Trade Policy of Laos

Over two decades since its transition from a centrally planned to a market-oriented economy in 1986, Laos has gradually increased trade with Thailand, China, Vietnam, and other countries mainly in the same region. Opening up to international and regional markets has ushered Laos in a new era for more communities, local organizations, and businesses nationwide. The 6th and soon the 7th National Social Economic Development Plan provides Laos the better framework for progress with foreign trade and exports playing a central role in the economy (IEF, 2011). The agenda of the Lao government is to graduate from the least developed country status by 2020. To achieve this agenda, the government set the goal of achieving robust economic growth rates, at the average of 7% - 8 % per annum.

As a least developed country, a number of its export items receive preferential market access to many industrial countries' markets under such agreements as the Generalized System of Preferences (GSP) schemes[20], and the European Union's "Everything but Arms" initiative. In order to promote its trade relation with foreign countries, Laos has also been involved in several negotiations concerning free trade agreements (FTA). Among the latest, Laos signed a free trade agreement between ASEAN members, Australia, and New Zealand in 2009 (Word Bank, 2009). I addition, in July 2009, the National Assembly of Laos approved a new investment law in order to promote investment in the country. The aim of new law is to merge separate foreign and domestic investment laws, provides for national treatment of domestic and foreign investors, and streamlines the investment approval process (ADB, 2009a).

According to the Department of Transport of the Lao PDR (2005), main policy for trade sector in Laos is to:

- Promote both internal and external trade liberalization and trade facilitation.
- Facilitate and promote export sector, maintaining existing markets, expand market access.

[20] The Generalized System of Preferences (GSP) is a formal system of exemption from the more general rules of the World Trade Organization (WTO). Specifically, it's a system of exemption from the Most Favored Nation (MFN) principle that obliges WTO member countries to treat the imports of all other WTO member countries no worse than they treat the imports of their "most favored" trading partner.

- Encourage both domestic and foreign investment as a mean to promote import substitution and export promotion.

- Promote border trade and small scale import-export with a view to encourage production for re-import.

- Facilitate transit services and promote a site export, strengthen bilateral and multilateral trade with every country in the international economic cooperation and integration such as World Trade Organization (WTO), and ASEAN Free Trade Area (AFTA).

Export promotion, as stated in the "Import/Export Information" provided by the Embassy of People's Democratic Republic of Laos (2007) to the United States of America, is recognized as the main task of trade policy. The government therefore adopts the export policy to encourage production for export in the following ways:

- Increasingly exploiting hidden domestic potential: strongly promoting production and exports, and rendering them programmable, radically and systemically changing the procedures, and mechanism that obstruct production and export.

- Encouraging foreign investment in the sector of production for export in all forms.

- Widening export markets in foreign countries. Prohibited export goods are fire arms and bullets, bombs, cultural antiques, materials that contain drugs, toxic chemicals, and rare wild animals.

Export goods controlled by the government through the use of quotas are rare timber, logs, sawn timber, tree trunks, and through the issuance of an authorization complying with international law and practice.

Trade facilitation is essential for Laos in order to attract more number of foreign investors. According to the Ministry of Commerce (MIC) (2011b), trade facilitation could make a significant contribution to National Socio – Economic Development and poverty reduction by:

- Reducing the cost of production through shorter documentation and inspection procedures and leading to shorter times for customs clearance.

- Helping the government to effectively collect revenue and reduce illegal transactions.

- Increasing export competitiveness due to lower costs of production as a result of simple and easy export procedures and low trade compliance cost.

- Ensuring market access for Small and Medium Enterprises (SMEs).

- Attracting foreign direct investment (FDI) into Laos, which will boost National economic growth.

Some of the primary stakeholders who play essential roles in facilitating trade in the country are government agencies as well as private sector. The government agencies include Ministry of Industry and Commerce (Import-Export Department), Ministry of Finance (Customs Department), Ministry of Public Works and Transportation (Transport Department), Ministry of Agriculture and Forestry (Livestock and Fishery Department and Plantation Department), and Ministry of Health (Food and Drugs Department). The private sector includes private sector and business representatives: Lao National Chamber of Commerce and Industry, Import – Export Association, buying agents, distributors and trading houses, Transport Service Providers: transport companies (shipping lines, airlines, railway companies), freight forwards, customs brokers, and Insurance and Financing Service Providers: Banks, Insurance Companies.

4.2. Commodities Structure of Laos' Trade

Similar to most developing countries, export products from Laos are mainly agricultural and primary products. Principal export items are mining products (copper and gold), electricity, wood products, garments, and agricultural products (coffee, rice, maize and other crops) while the main imports items are machinery and equipment, vehicles, fuel, and consumer goods (Sisouphanthong, 2009). According to GTZ (2010), at the present, hydropower and minerals dominate the overall export items, and could reach as much as 70 % to 80 % of the country's total export. The proportion of agriculture, forestry, and fishery products for exports, on average, showed a decreasing trend while the share of light industry and small industry products increased significantly with the garment export ranked as the top of all export products. Garment sector has just become a new export product of Laos included in the list of principal commodities after the late 1990. In addition, Laos imports capital goods, spare part, raw materials and various consumer goods from its trading partners mainly in Asia

(IMF, 2008). The growth of electricity export has been significant while the growth of export values of wood product, coffee and garment has declined due to the influence of the Asian financial crisis in 1997. In order to resolve the economic problems suffered from the crisis, the Lao government intensely aimed to export electricity particularly hydropower generation, thus significantly increasing of electricity export.

At the present, trade balance of Laos has gradually improved as a result of the decline in imports and fairly stable exports mainly driven by minerals, electricity, and food processing. Trade condition is likely to improve with the significant support from exports of electricity and minerals projected to grow by 33 %. Due to the trend to increase by about 12 % in imports driven by consumer goods, raw materials, and capital investment items, the current account deficit is forecasted to show further decline from 6.6 % (World Bank, 2010b).

4.3. Geographical Structure of Laos' Trade

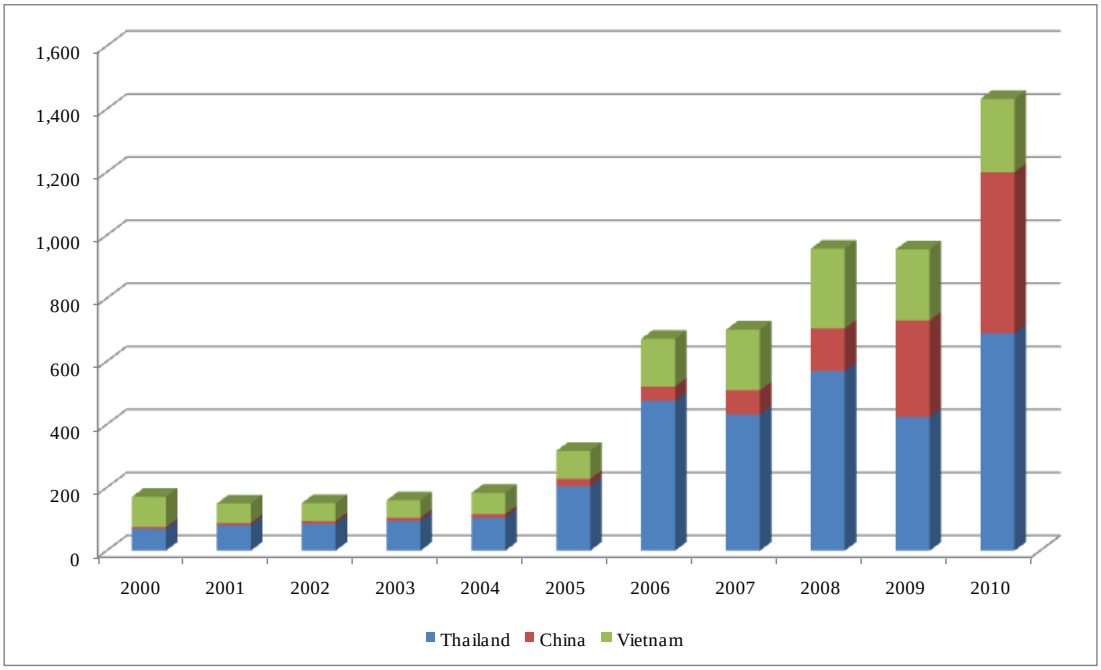
Over two decades after the introduction of the New Economic Mechanism (NEM) in 1986, the Lao government encouraged all of economic sectors to participate in the business process. Only some significant business sectors are still owned by the state such as electricity, communication, water supply, and national bank while most of business sectors are owned by private sector. Currently the proportion of private enterprises comprises more than 80 % of total business community; and most of the products produced from these enterprises are intended to export. Principal export items from Laos are garment, electricity, wood and wood products, coffee, and etc. According to the data from ADB (2011), main export markets are Thailand which is the largest export market of Laos covering the largest proportion of 33.03 % of total export partners of Laos in 2010, along with China 24.47 %, Vietnam 11.11 %, United Kingdom 3.34 %, and United States 2.69 %.

Currently, export market of Laos is relatively large indicated by several trade agreements either Asian countries or non-Asian countries. The agreements are mainly, on the principle of mutual benefits and equality, of further developing and strengthening trade relations between the countries. Laos has bilateral agreements on trade with Cambodia, China, Mongolia, Myanmar, Thailand, the Russian federation, and Vietnam, for Asian countries, and other eastern-European countries as well. Laos has trade relations with more than 50 countries around the world (bilateral trade agreements by Laos is shown in the Appendix 5). Trade volume has increased each year by an average of 18.7 %. However, foreign trade deficit has

still increased by an average of 15.4 % per year, but the percentage of the increment of trade deficit has dramatically reduced because of the extension of export market.

Essential trading partners of Laos are mainly in Asia and Pacific such as Thailand, Vietnam, China, Japan, and some European nations such as France, Germany, Belgium, Italy, Netherland, United Kingdom, and others. Main export goods exported to these countries are wood products, electricity, garment, gypsum, rattan products, coffee, sesame, and handicraft products. In the part of 1990s, Laos experienced high growth rate of around 21 % per year. Since the Asian crisis in 1997, Lao exports, however, had been decreasing, or at the best, stagnating. Although the government is finding out the way to diversify the Lao economy, around 80 % of official exports still concentrated on two items exporting to two destinations: electricity for Thailand, and garment for the European Union. In addition to electricity, nearly 80 % of exports to Thailand consist of wood products (Haddad, 2006).

Figure 4.1: Export Volumes to Main Trading Parners of Laos (in Million USD)



Source: Asian Development Bank (ADB, 2011).

Over the last decade, generic growth in Laos has been driven by rapid growth in exports. Thailand, Vietnam, and China are the potential trading partners driving Laos to meet or even exceed the growth rates over the next decade. These neighboring countries have shown the highly success in a number of export industries as well as service sector in the region. The

increasing demand in parallel with their economic developments will give Laos benefits from exporting to these countries. As shown in Figure 4.1, exports from Laos dramatically increased more than fivefold from around 400 million USD in 2000 to a peak of approximately 2,000 million USD in 2010. However, since the Lao economy is highly susceptible to regional and global turbulences, the overall export volumes in 2009 declined to 1,521 million USD due to the effects of the global economic crisis. In 2010, exports recovered with a steady increase at around 2,000 million USD driven by the increase in exports to Thailand and China. About mid-way through the decade, Thailand took over from the European Union as the most important export destination with rapid growth of export from Laos to Thailand.

4.4. Structure and Dynamics of Trade between Laos and Thailand

Laos is participating in the Association of South East Asian Nations Free Trade Area (AFTA), and also undertaking commitments under the Common Effective Preferential Tariffs (CEPT) scheme[21]. In addition, it is joining the free trade area (FTA) negotiations with ASEAN-dialogues partners: China, Republic of Korea, Japan, India, and Australia and New Zealand together as Closer Economic Relation (CER)[22].

As a land-locked country, cross-border trade with neighboring countries such as Thailand, Vietnam, China, and etc is vital for the Lao economy. Over three quarters of country's imports are sourced from its ASEAN neighbors, with 69 % from Thailand (Word Bank, 2009). Laos and Thailand are two members of the Greater Mekong Subregion (GMS) that have long trade relation. Both countries share a common border lying along the Mekong River. Because of the similarity in culture, language and so on, trade cooperation between two countries has been significantly growing in high rate. Up to now, both countries have increased bilateral cooperation in order to boost and strengthen trade and investment between two countries. According to Pratruangkrai (2012), in 2011, two-way trade between Laos and

[21] The Common Effective Preferential Tariff (CEPT) scheme is a co-operation among ASEAN countries to reduce intra-regional tariffs and eliminate non-tariff barriers for a period of ten years effective January 1st 1993. It requires that tariff rates levied on a broad range of products traded within the region be cut to no more than 5%, and that quantitative restrictions and other nontariff barriers be eliminated.

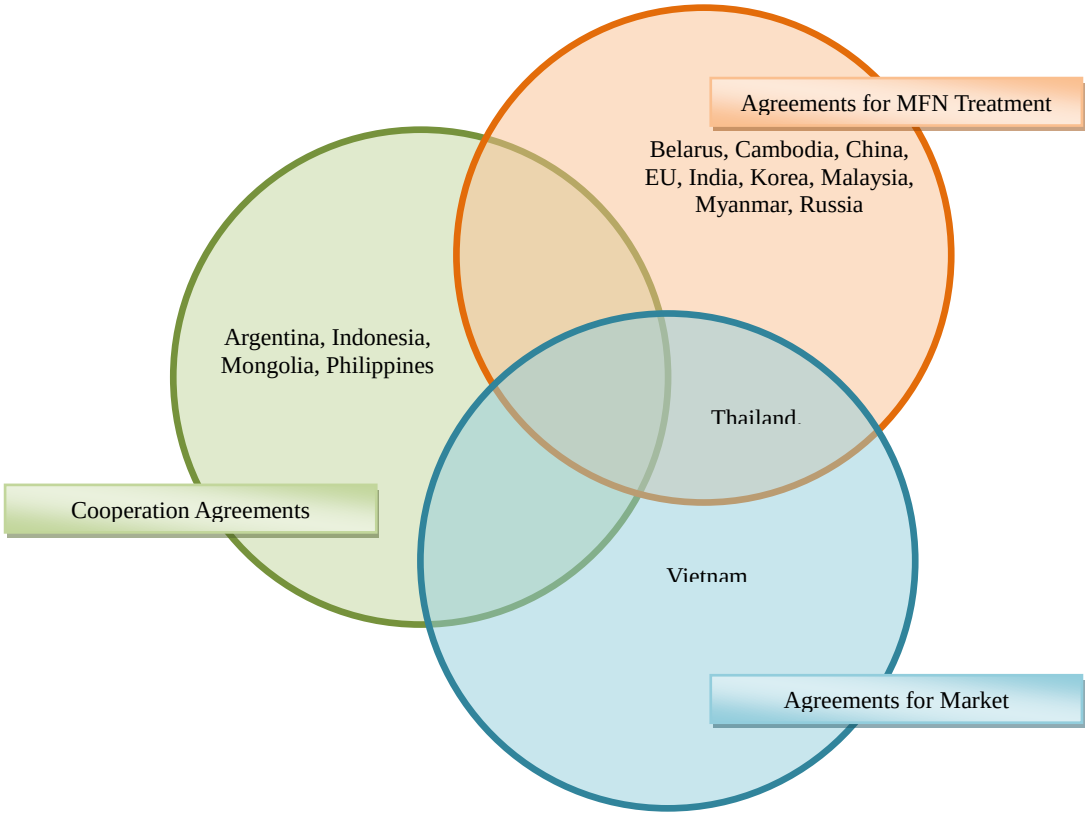
[22] Closer Economic Relations (CER) is a free trade agreement between the governments of New Zealand and Australia.

Thailand reached significant volume of 3.91 billion USD growing up to 35.8 % from 2010 indicating the significantly strong trade relation between them. The volumes of Thai export to Laos were 2.78 billion USD, while its imports from Laos were 1.12 billion USD in the same year. Due to the increasing trade cooperation, two countries are further preparing to facilitate and expand more trade and investment relation with the goal to double trade value from 4 billion USD to 8 billion USD by 2015 (Ngamsaithong, 2012).

Bilateral trade with neighboring countries is considered the core for the country's economic development. Since 1990s, Laos has signed bilateral trade arrangement with 16 countries, most of which are among ASEAN members, except Brunei and Singapore. Among them, Thailand is most important trading partner followed by Vietnam, due to geographical proximities and similar culture. Other bilateral trades are with former socialist countries in East Asia including China, North Korea and Mongolia, and in Eastern and Central Europe including Belarus, and Russia. As illustrated in Figure 4.2, based on the nature of bilateral agreements, trading partners of Laos are grouped in three categories composing of agreement for market access concession, agreement for Most Favored Nation (MFN) treatment[23], and cooperation agreement.

[23] In international politics and international economic relations, Most Favored Nation (MFN) is a status or level of treatment accorded by one state to another in international trade. Nominally, the country which is the recipient of this treatment must receive equal trade advantages as the MFN by the country granting such treatment.

Figure 4.2: Typology of Laos' Bilateral Trade Arrangements



Source: Pholsena (2007).

As shown in Figure 4.2, bilateral trade agreements concerning market access concessions were signed with Thailand, Vietnam and the USA. Thailand was granted preferential market access to 23 agricultural products from Laos. Due to the relatively deep trade relation, Thailand has remained a dominant market, accounting for over 96 % of Laos' exports to the original ASEAN members (Brunei, Indonesia, the Philippines, Malaysia, and Thailand). Among the countries trading with Laos, most of the exports from Laos are concentrated to Thailand, China, and Vietnam. According to the data from ADB (2011), export from Laos to Thailand in 2011 was 689.67 million USD or about 33 % of total exports while exports to China, and Vietnam 510.92 million USD, and 232.13 million USD, respectively.

Table 4.1: Trade with Thailand (in Million USD)

	Exports	Imports	Trade Balance
2000	68.8841	419.046	-350.162
2001	81.0224	451.703	-370.681
2002	85.0123	444.003	-358.991
2003	94.3497	501.542	-407.192
2004	104.281	639.548	-535.267
2005	204.392	846.244	-641.852
2006	475.453	1125.43	-649.977
2007	431.494	1442.82	-1011.33
2008	568.735	1932.64	-1363.91
2009	423.735	1800.52	-1376.79
2010	689.676	2348.38	-1658.7

Source: Asian Development Bank (ADB, 2011).

Table 4.1 shows that Laos considerably relies on products from Thailand indicated by the increasing imports from Thailand. Currently, Laos also exports a number of products to Thailand. Principal export products to Thailand are electricity, wood and wood products, mining, agricultural products (wheat, Job's tears, ground nuts, sesame, broom), and garment. Tourism industry in Laos also significantly contributes to the Laos economy. Over 55 % of tourists coming to Laos are from Thailand, followed by Vietnam (4 %), where 4 % and 3 % are from the United States and France, respectively (Pholsena, 2007).

The increasingly growth in trade relationship between Laos and Thailand is indicated by an increasing number of friendship bridges with the purpose to promote trade and investment, in both countries. Up to now, there are 3 friendship bridges built to connect between Laos and Thailand. The first Thai-Lao Friendship Bridge over the Mekong River opened on 8 April 1994 links Vientiane capital of Laos and Nong Khai province of Thailand. The total cost was approximately 30 million USD, funded by the Australian government as development aid for Laos (Nongkhai Information, 2012). The second Thai-Lao Friendship Bridge opened on 9 January 2007 links Savannakhet province of Laos and Thailand's Mukdahan province. This bridge costs about 2.5 billion Baht or about 70 million USD, mainly funded by a Japanese loan (International Herald Tribune, 2006). The Third Thai - Lao Friendship Bridge over the Mekong opened for traffic on 11 November 2011 is a bridge that connects Khammouane province of Laos with Nakhon Phanom province of Thailand. This bridge is entirely funded by the Thai government at a cost of more than 1.7 billion Baht (Mekong Institute, 2012).

In order to tighten trade relationship between two countries, the Fourth Thai–Lao Friendship Bridge over the Mekong River was approved to be built across the Mekong River. This bridge will link Luangnamtha province of Laos and Chiang Rai province of Thailand. This will further increase trade and travel not only between the two countries, but also among the six countries in the GMS. This bridge is estimated to cost about 1.4 billion Baht which will be equally funded by the Chinese and Thai governments (Bangkok Post, 2011). The main benefiters are not only Laos and Thailand, but also China in terms of increasing trade, investment, transportation and tourism.

4.5. Major Development in Electricity Industries in Laos and Thailand

Laos possesses abundant energy resources with less environmental impact, principally hydropower covering 97 % of energy sources (ADB, 2006). Hydropower is the most abundant and cost-effective natural resource for electricity generation in the country. The exploitation of hydropower through electricity export is at the heart of Lao government's strategy for earning foreign currencies needed to support the country's development. Being at the hub of the Greater Mekong Subregion (GMS) and its substantial hydropower potential, Laos is strategically recognized to play a significant role in realizing the following economic, environmental, and sector benefits of electricity trading in the subregion. Export of electricity of Laos to neighboring countries, particularly Thailand, is a foreign earner covering 10 % of GDP. This sector plays a crucial role in such a country still heavily reliant on foreign support. In order to reduce the reliance on external aids, energy is identified as one of the strategic growth sectors in the country supporting both rural electrification, and earning foreign exchange through the export. Currently, there are a large number of electricity power plants for export, and some accounted for about 10 % is for domestic consumption. In addition to the 10 % of total capacity that was to be made available for domestic supply through independent power plants (IPPS), several medium sized IPP projects have been nominated in order to meet the increasing demand in the country as well as demand from neighboring countries especially Thailand and Vietnam (EPD, 2009).

Table 4.2 shows the data on forecasted demand for electricity in Laos until 2020. However, the Asian Development Bank (ADB) has projected electricity demand in Laos to grow at an average of 7.7 % until 2030, while electricity generation will grow faster at 12.1 %.

Table 4.2: Forecast of Domestic Electricity Demand for the Whole Country (2012 - 2020) (in MW)

	Year	Demand	Supply	Balance
Need to Import	2011	786	579	-207
	2012	1,021	786	-235
	2013	1,165	859	-306
	2014	1,419	1,161	-258
Excess Electricity to Be Exported	2015	2,083	2,349	266
	2016	3,180	6,851	3,670
	2017	3,290	7,342	4,052
	2018	3,401	8,298	4,897
	2019	3,403	8,473	5,070
	2020	3,488	8,737	5,249

Source: Electricité du Laos (EDL, 2012).

Under the Seventh National Socio-Economic Development Plan for 2011 - 2015, the Lao government intends to build 10 more hydropower plants which have capacity to generate approximately 5,015 MW of electricity (Lao Voice, 2011). As illustrated in Table 4.2, not only exporting electricity to neighboring countries such as Thailand, Laos also imports some amount of electricity from its neighboring countries including Thailand, Vietnam and China to accommodate the increasing consumption of electricity in the country especially the rural area where electricity have not reached. This is due to the fact that it is a cheaper alternative than to extend national grid to each corner of the country (The 22 KV transmission lines cost between 10,000 USD and 15,000 USD per Km, depending on the accessibility of the road). However, from 2015, Laos will have adequate electricity to meet domestic demand, and even have surplus electricity prepared for export.

Electricity export plays a vital role for Lao people as well as the country. In addition to the benefits to Lao people through the expansion of health, education, infrastructure, and other social services improvement; the expansion of the transmission system to support, the electricity export will strengthen the availability of competitive price and reliable electricity, stimulating industrialization in remote area, and improving people's quality of life. According to Watcharejyothin (2009), the urbanization rate in the country is estimated to gradually rise from 22 % in 2005 to 36 % by 2035 together with the forecasted increase of electrification rate in rural area from 33 % in 2005 to 95 %. These are consistent with the government's national target that 90 % of households would be electrified by 2020. Thus the implication that poverty reduction plan is achievable through electrification.

The government's target growth rate of 7.5 % appears achievable due to the impetus contribution of several hydropower projects, and expansion of gold and copper mines in the country (ADB, 2006). Solid economic growth of 7.2 % in 2008 implies a pace of development. This growth was based on expansion of industrial sector especially hydropower, and mining (ADB, 2009a). Electricity export is a significantly important sector in Laos in terms of earning foreign currency of 4,500,820,000 USD between December 1999 and February 2001. By 2010, the Lao government expected the capability of power plants in the country to generate more electricity up to 2,000 MW, helping to increase per capita income from the present 330 USD to over 1,000 USD by 2020, thus withdrawing the country from its current status of being least developed country (Vientiane Times, 2005).

In developing countries, improvement in power sector is not the main target as it is in developed countries. Instead, there are three main pillars for the development of electricity sector: (1) inviting private investments, (2) adjustment of power prices to reflect the true cost of generation and distribution, and (3) poverty eradication (Nakayama, 2009). At the 6th Party Congress in 1996, the Lao government set a poverty reduction goal which aimed to withdraw the country from being a least developed country by 2020. One important sector supporting this goal is electricity export. It is a key sector serving two vital national priorities:

- It promotes economic and socio advancement by providing reliable and affordable domestic power supply to society and industry.
- It earns foreign exchange from electricity exports.

Although the GMS countries are endowed with substantial energy reserves, they are unevenly distributed between member countries due to the geographic difficulty. Being one important source of electricity, Lao hydropower, for instance, has been recognized as the most abundant, and cost-effective source in the Greater Mekong River Basin with a theoretical hydroelectric potential of about 26,500 MW in the whole country excluding the mainstream Mekong. About 18,000 MW of this is technically exploitable, with 12,500 MW found in the major Mekong sub-basins, and the rest were found in minor Mekong or non-Mekong basins. Although the amount estimated is substantially high, only less than 2 % of them have been developed over 30 years. However, under current government policy, development rate trend to increase to accelerate electricity supply to the rapidly growing economies in the region. Power sector, especially hydropower, has become an important contributor to economic development, and national poverty reduction effort of Laos. Electricity export in 2008, for example, amounted to about 30 % of all country's export (EPD, 2009).

Domestic demand for electricity in Laos has been growing very fast in accordance with the government's poverty reduction plan in terms of rural electrification. In addition, the demand largely comes from mining industry, manufacture, and business (EDL, 2008). Watcharejyothin and Shrestha (2009) forecasted that by 2035, service sector would dominate total domestic consumption of electricity in Laos with the share of about 32 % along with the industrial sector (29 %), while the residential which is the current largest electricity consumer in Laos, would have the share of 23 %, followed by transportation sector with the share of 16 %. Despite the relatively high rate demand forecast, electricity consumption in Laos is still very low compared to consumption in other Association of South East Asian Nations (ASEAN) countries.

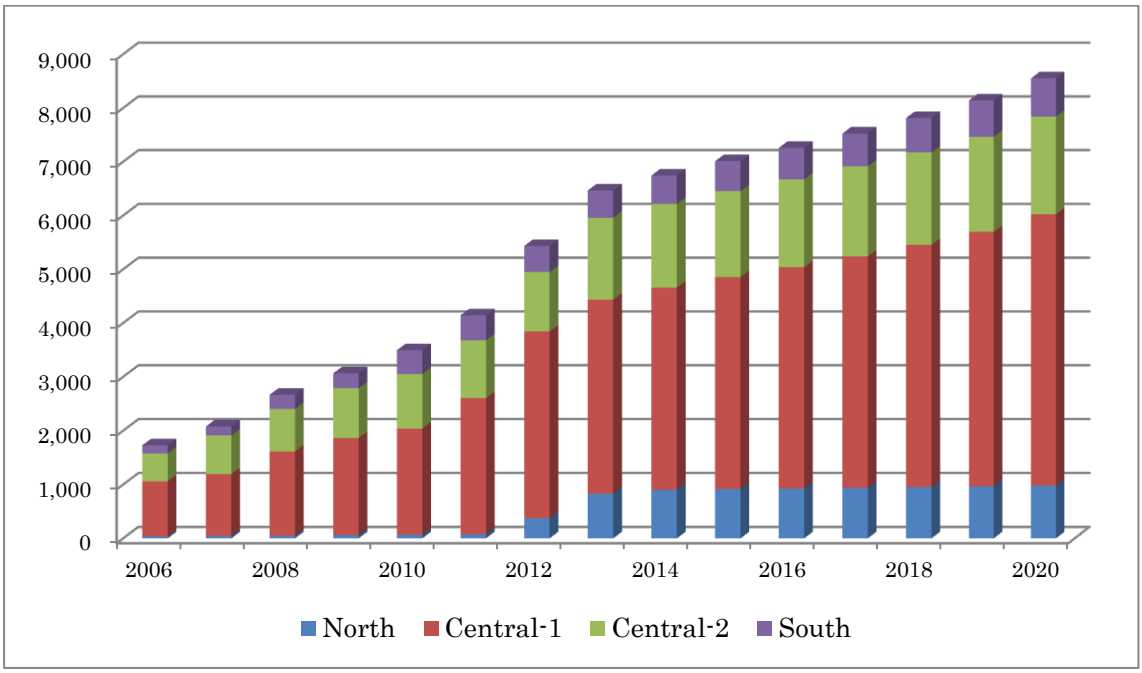
The government prepares to fulfill the demand of electricity consumption in order to attain the goal of increasing the electrification ratio from the current level of 45 % of households electrified in 2005 to 90 % by 2020 (Vientiane Times, 2008). The goal to increase the electrification ratio for the whole country will be achieved through:

- On-grid household electrification—involving main transmission / distribution grid extensions to meet the 90 % target, after deduction of off-grid installations.

- Off-grid household electrification—an embryonic but successful program of electrification of off-grid households employing state, donor and private resources is underway in the country and targets electrification of 150,000 households by 2020. If this target is to be achieved by 2020, this program will need to be substantially scaled-up

The average growth of electricity consumption was expected to be in high level due to two main reasons: one is the increase of the Electricité du Laos (EDL)'s customers in accordance with expanding transition and distribution network system, and growing up electrification ratio. The other reason is the increase of par capita energy consumption in accordance with their frequently changed lifestyles. As illustrated in Figure 4.3, the whole country is divided into four main areas (central-1, central-2, northern, and southern areas) based on characteristics of the country, and the existing power grids in order to conduct electricity demand forecast. The forecast of EDL (2008) shows that the average growth rate of energy demand for the whole country from 2006 to 2020 is estimated to be about 13 % and peak load is at 11 %.

Figure 4.3: Domestic Demand Forecast (in Kwh)



Source: Electricité du Laos (EDL, 2009c).

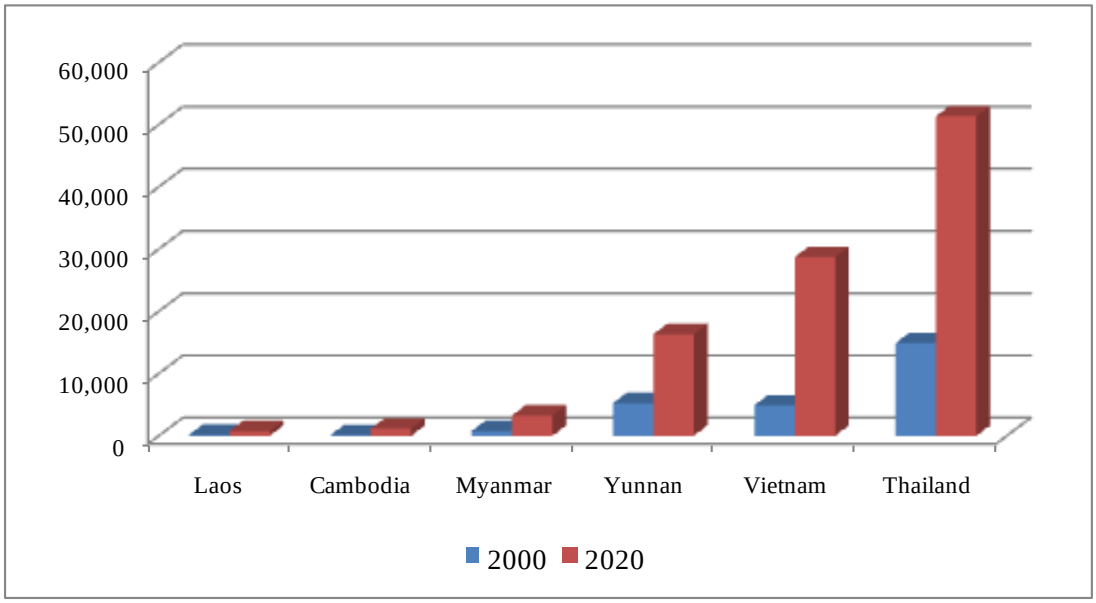
Energy consumption in the Northern area covers only 2 % of total energy consumption in the year 2006. However, due to the increase of particularly mining projects that will be established soon, demand for electricity is forecast to increase particularly from 2012 onwards. The average growth of energy demand in this area is estimated to be the highest compared to other areas, with the average of 29 %, and 20 % for peak load, from 2006 to 2020. Due to the fact that the Central-1 area consists of large number of consumers covering, for example, 57 % of total energy consumption in 2006, demand for this area is relatively high with average growth of 13 %, and peak load of 10 %. Central-2 area is the second largest system after Central-1 with the expected average growth of 10 % for both electricity demand, and peak load in the period 2006 to 2020. Main power supply in Southern area comes from domestic hydropower plants. This area is also connected with Electricity Generating Authority of Thailand (EGAT) through 115 kV grids for power exchange program. The average growth of demand in this area is predicted to be 13 %, and 9 % for peak load from 2006 to 2020.

In addition to the increasing domestic demand in Laos, there are high demands for electricity from neighboring countries particularly the GMS member countries. In recent years, energy demand in the GMS has been outpacing production to a greater extent, and is likely to further increase. This sharp increase in parallel with rapid regional economic growth will offer

greater benefits for Laos in terms of the increasing revenue from electricity export to its neighboring member countries. Among the GMS economies, both Thailand and Vietnam, for example, are currently increasing the imports of electricity from Laos.

Over the last decade, power industry globally has undergone rapid changes. High economic growth of the ASEAN as well as GMS countries shows the result of strong economic cooperation in the region. As a result, demand of electricity in the regions has increased gradually. Several international grid interconnections are therefore planned with the main purpose to accommodate the increasing demand. Greacen and Palettu (2007) forecasted the electricity demand in the Mekong region to grow rapidly by 2020. In order to meet the demand, Laos and Myanmar as poorer countries in the GMS are lining up to supply the richer country in the region particularly Thailand, and Vietnam.

Figure 4.4: Peak Demand in 2000 and Projected Peak Demand in 2020 (in MW)



Source: Nordconsult (2002).

As clearly illustrated in Figure 4.4, electricity demand of Thailand dominates the largest proportion among other GMS economies, followed by Vietnam, Yunnan Province of China, and Myanmar, respectively where Laos and Cambodia have less proportions compared to other member countries. Thailand's average demand growth for electricity is about 5.56 %

(Kessels, 2012). On average, demand in Thailand is around 77 folds of demand in Laos due to the tremendous rise in consumption particularly in industries in Thailand.

Electricity demand in most GMS economies has been surged by the rapid economic growth in the subregion. Although all of individual member countries can generate electricity for domestic consumption, some members have abundant power resources whereas others rely largely on power imports leading to high cost of power consumption. In order to optimize the use of power resources and to fulfill significantly high demand in the region, ASEAN Power Grid Project was established in 2003 (ASEAN Secretariat, 2008). This collaborative project of all ASEAN member countries gives the priority to five optimal interconnection projects as follows (EGAT, 2004):

- Thailand - Laos interconnection project
- Thailand - Cambodia interconnection project
- Vietnam - Cambodia interconnection project
- Malaysia (Peninsula) - Indonesia (Sumatra) interconnection project
- Malaysia (Sarawak) - Indonesia (West Kalimantan) interconnection project

Thailand is the world's 50th largest country in terms of total area (slightly smaller than Yemen and slightly larger than Spain), with a surface area of 513,000 Km^2, and the 21st most-populous country, with approximately 64 million people. It is a net electricity importing country with energy import dependency of 50 % in 2000, and is estimated to import about 60 % to 70 % of its energy needs by 2030, and about 80 % to 89 % by 2050 (Shrestha et al, 2007). This increase is mainly due to the growing demand, and the limited domestic energy resources availability in the country. Laos has exported surplus power from Nam Ngum Hydropower Plant to Thailand since its commissioning of Laos' hydropower plant in 1972. A memorandum of understanding (MOU) between the two countries, dated 4th June 1993, on developing 1,500 MW of electric power in Laos by year 2000 for export to Thailand, and the Lao new foreign investment policies paved the way for private sector participation in development of Lao electricity resources as a major export commodity. The Theun-Hinboun hydropower project was the first to be implemented under the MOU, and the first major investment under the new foreign investment policies of Laos. Except for a minor local supply to the nearby area, electricity being produced is to export to Thailand (ADB, 2008a).

The Thai economy has remarkably been characterized by rapid expansion, particularly during the period 1987 - 1991, when significant structural changes occurred. In consequence of a rapid industrialization of the country leading to high GDP growth, demand of electricity in the industrial sector, in particular, has been growing rapidly with the average of 16 % up to 1991. By 1995, manufactured goods accounted for about 81 % of total exports (Lahmeyer, 2004). Electricity has become important factor supporting Thai economic activities.

Watcharejyothin and Shrestha (2009) found that power generation system in Thailand that relies mostly in natural gas accounting for approximately 70 % of total generation capacity of the country is expected to dramatically decrease within 29 years due to the limited domestic gas resource ability. In order to increase power generation to fulfill the demand in the country, EGAT (2007) , under power development plan 2007, was assigned the construction of four 700 MW combined cycle power projects which are planned to supply additional capacities by the end of the 10th National Economic and Social Development Plan period including :

- Songkhla combined cycle block 1 sited in Songkhla province
- South Bangkok combined cycle block 3 sited in the existing South Bangkok power plant in Samut Prakan province
- North Bangkok combined cycle block 1 sited in Chachoengsao province
- Bang Pakong combined cycle block 5 in Nonthaburi

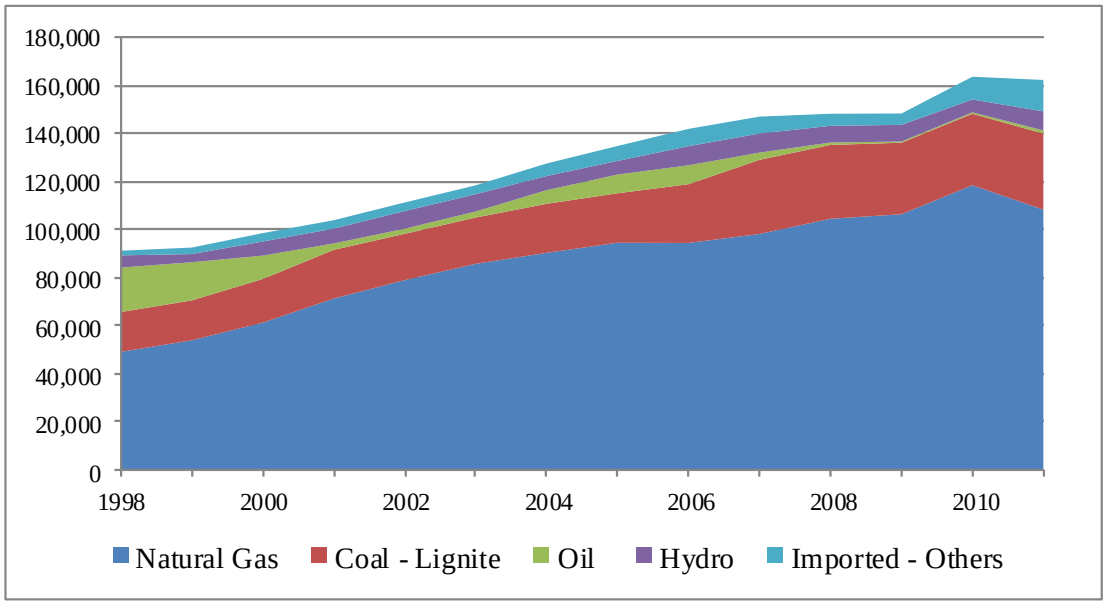
As a result of the increasing power generation, more than 99 % of the population in Thailand has access to electricity utility. Electricity in the country is produced by the state-owned enterprise called Electricity Generating Authority of Thailand (EGAT), electricity generating company, independent power producers (IPPs), and small power producers (SPPs). All electricity generated is purchased by the EGAT, then transmitting to the Provincial Electricity Authority (PEA), and the Metropolitan Electricity Authority (MEA).

In Thailand, initially the Electricity Generating Authority of Thailand (EGAT) was the sole electricity producer in the country. Due to the Thai government's policy promoting the role of private sector in electricity generation in order to encourage competition in generation business, electricity sector was later not monopolized by the government. Consequently, in 1994, there were a number of independent power producers and small power producers taken part in electricity supply, resulting in improvement in electricity generation and service quality in the country. Furthermore, Thailand is currently promoting the use of renewable energy in

electricity generation resulting to the increase in a number of very small power producers (VSPPs), using renewable energy as main fuel (EPPO, 2010).

According to the data from Energy Policy and Planning Office (EPPO, 2012b), in 2010, total electricity generation in Thailand accounted for 163,668.3 Gwh. In terms of the sources of energy generated in the country, natural gas covers the largest proportion of Thailand's power generation. One-third of the natural gas consumed in Thailand is imported, mainly from Myanmar. In 2010, for example, electricity generated from natural gas dominated about 72 % of total national grid generation, followed by coal-lignite, and hydropower covering 18.2 % and 3.3 % of total national grid generation, respectively. However, power generation system in Thailand that relies mostly in natural gas is found to dramatically decrease within 29 years due to the limited domestic gas resource ability (Watcharejyothin and Shrestha , 2009).

Figure 4.5: National Grid Classified by Type of Energy Sources (in Gwh)



Source: Energy Policy and Planning Office (EPPO, 2012b).

In Thailand, the installed capacity in the whole country is shared by government or state electric utility on the average of 56.1 %, and private power producers 43.9 %. As shown in Figure 4.5, most of energy supply in Thailand is from natural gas, followed by coal-lignite energy. As in 2011, natural gas dominated approximately 67 % followed by coal - lignite energy (20 %). Other sources of energy covered only small proportion, for example, the energy imported—others covered about 8 % whereas hydropower shared only around 5 %.

As reported by the data from EPPO (2012b), the peak generation of national grid in 2011 was officially recorded at 162,343 Gwh with a slight decrease of 0.80 % compared to 2010. The growth of electricity generation in Thailand is relatively high with the average of about 47.7 %. Total energy in 2011 slightly decreased from 163,668 Gwh in 2010, to 162,343 Gwh or decreased by 0.80 %. Energy generated from natural gas in the country totaled 108,261 Gwh, down 8.6 % from the previous year, and accounted for 67 % of total national grid generation. Energy generated from coal and lignite was 31,681 Gwh, up 6.4 % from the previous year, and accounted for 20 % of national grid generation. About 1,331 Gwh of total energy generation was from fuel oil increasing 121.8 % over the previous year, and accounted for 0.81 % of national grid generation. Total energy generated from hydropower was 7,935 Gwh, up 48.4 % from the previous year, and accounted for 5 % of national grid generation. Energy generated from other sources and imported was about 13,084 Gwh, increasing 37.7 % from previous year, and accounted for 8 % of national grid generation.

According to ADB (2009a), demand for energy in GMS is rising rapidly. The rapid economic growth has fueled a significant expansion in energy demand, which has grown at over 8 % per annum during 1993 - 2005. Most energy demand growth in each member country is foreseen to annually increase in the range of 7 % to 16 %. At present, the GMS energy sector continues to be dominated by large utilities directly or indirectly owned by governments. The overall demand for energy is expected to grow to over 238 Gwh by 2025. Among other GMS countries, Thailand is the largest importer of energy, and has to import nearly 40 % of its energy in the form of electricity, natural gas, and oil products.

Linh et al (2010) forecasted that energy requirement and peak demand of member economies as well as the whole GMS will increase by more than 3 times in period 2006 - 2020. Thailand will still be the major energy-consumption center with 41 % and 36 % total shares in terms of energy consumption and peak demand respectively in 2020. Annual electricity demand in Thailand is forecasted to grow by more than 4.19 % per annum while the economy is expected to expand at the average of 4.1 % per annum (EGAT, 2010c). According to Power Development Plan 2007 - 2021, as the demand is expected to considerably increase, the total installed electricity capacity in Thailand will increase from 28,530.3 MW in 2007 to 44,281 MW by the end of 2021 (Namwong, 2010).

According to EPPO (2010), prior to 1997, for example, before the economic crisis (Tom Yam Kung Crisis), Thailand had experienced a high growth rate of electricity consumption, with an average growth rate of 11.9 % since 1986 - 1996, and during the year of economic crisis, demand decreased by 2.6 %. After the crisis, there was a slowdown in

electricity demand, with an average growth rate of 4.9 % during 2000 - 2009. However, in 2011, the demand stood at 146,818.85 Gwh.

Table 4.3: Domestic Consumption of Energy in Thailand (in Gwh)

Year	Category						
	Residential	Business	Industry	Agriculture	Other	EGAT Direct Customer	Total
2000	19,392.58	21,115.29	39,546.26	154.15	5,786.99	1,751.82	87,747.09
2001	21,177.91	22,192.23	41,658.51	178.78	6,096.49	1,716.76	93,020.68
2002	22,145.15	23,763.15	44,805.66	192.03	6,557.86	1,943.26	99,407.11
2003	23,329.53	25,336.85	48,293.79	227.88	7,070.52	1,949.26	106,207.83
2004	24,538.33	28,687.23	50,810.54	245.40	7,916.17	2,127.99	114,325.66
2005	25,514.09	30,163.82	53,894.12	249.52	8,406.63	2,409.19	120,637.37
2006	26,914.91	31,702.35	56,994.75	240.24	8,897.76	2,487.23	127,237.24
2007	27,959.57	32,838.93	59,436.12	267.76	9,287.60	2,702.14	132,492.12
2008	28,689.98	33,206.05	60,266.29	281.74	9,420.51	3,072.06	134,936.63
2009	30,256.50	32,633.78	60,873.53	317.86	9,289.03	2,894.15	134,792.89
2010	33,216.49	35,980.36	67,952.49	335.29	10,309.03	2,913.95	148,708.89
2011	32,801.09	N/A	67,795.60	300.31	N/A	N/A	148,988.68

Source: Energy Policy and Planning Office (EPPO, 2012c).

Table 4.3 shows final consumption of electricity by type of economic sector in Thailand comprising the consumption in residential, business, industry, agriculture, Electricity Generating Authority of Thailand (EGAT) direct customer, and other sectors in the country. Over the past decade, the increasing demand in Thailand is strongly influenced by the rapid growth in industrial consumption in the country. Data from the table shows that, excluding other sectors, electricity consumption in industrial sector covered the largest share total electricity consumption in the whole country with the share of 44.35 % in 2010. Since industrial sector in Thailand is the main driving force for the Thai economy, large proportion of electricity is consumed by this sector. The second consumer is business sector covering 24.20 % of total electricity consumption, followed by residential sector sharing 22.33 % slightly less proportion than business sector while the agriculture consumed in small proportion of only 0.23 %. Comparing to 2009, electricity consumption in all sectors increased due to the improvement in the economy. In 2010, industrial sector maintained to have the high increase in electricity consumption with the 6,554.71 Gwh increase or 11.03 % increase compared to previous year. The business sector which is the second largest consumer in Thailand showed the increase in electricity consumption by 3,346.58 Gwh or 10.25 % compared to 2009. Following the business sector, consumption in the residential sector increased by 2,955.52 Gwh or 9.77 %

while consumption in the agricultural sector increased by 19.39 Gwh or 6.14 % in comparison to the previous year. This table clearly shows the increasing demand in Thailand implying that importing more electricity from other countries is necessary for Thailand in order to sustain its economy.

The expected increasing price of fossil fuel by 1.5 times per year by 2050 (IEA, 2004) implies the trend that Thailand would consume from alternative sources of electricity either in Thailand itself or by importing hydropower with less environmental impact from its neighboring countries. Watcharejyothin and Shrestha (2009) found that power development in Thailand is becoming an important issue for 3 main reasons. First, an opposition to fossil fuels for power generation has stemmed from environmental concern. The second reason is that the requirement to diversify fuel used in power generation, and the last reason is that the use of nuclear power is further away, but comprehensive plans could soon be announced. In order to avoid these potential complexities, importing power from neighboring countries which is accounted for about 13,084 Gwh or about 8 % of total power generation in 2011 (EPPO, 2012b), for instance, is now considered as the new alternative power supply source for Thailand in the future. Nonetheless, they forecasted that final energy consumption would grow at about 4 % by 2035. Electricity import from Laos would rise to about 85 % of Thailand's total power imports. The industrial sector would remain the largest consumer of total energy in the country with the share of 46 %, followed by the transportation (30 %), business (11 %), residential (10 %), and agriculture (3 %), respectively.

According to NIDA (2006), the country's GDP would grow by 7.5 % per year during 2000 - 2020, and decrease to 5.5 % per year during 2021 - 2050. The main driving force of the growth would be energy-intensive manufacturing such as steel, cement, and chemicals in industrial sector. The increasing growth in commercial sector is also the second main driving force. The urbanization rate would double in 2050 compared to 2000 (from 18,893,000 to 40,396,000) due to the migration of people from rural to urban areas, and the transformation of big villages into cities (United Nations, 2008). Per capita GDP would be 20 folds due to both high economic growth, and low population growth (United Nations, 2004). This significant change would lead to the expansion of infrastructure, and facilities demand. In other words, it implies the high demand for electricity in order to sustain the economic growth.

When electricity demand increased considerably for the first time in around 1967, as a result of the economic and industrial growth in the country, the Electricity Generating Authority of Thailand (EGAT) as the main power producer in the country showed interest in introducing nuclear power plant in the country in order to meet such high demand. However, the project was suspended many times due to the public opposition by environmentalists and

activists groups, the issue of economic repercussion, and variety of reasons. The suspension of the nuclear power project in 1980s was mainly caused by the Chernobyl disaster which was a nuclear accident that occurred on 26 April 1986 at the Chernobyl Nuclear Power Plant in Ukraine (Namwong, 2010). However, construction of nuclear power project was reconsidered due to the significant growth in economic as well as industries in Thailand. In 2007, the Thai Cabinet had approved the Nuclear Power Infrastructure Establishment Plan—a roadmap for nuclear power program development to meet a target commercial date in 2020. As specified in the Thailand Power Development Plan 2010 - 2030, there will be 5 projects of a 1,000 MW nuclear power plant beginning to be in commercial operation in 2020 (Parchitmpattapong, 2010). Nuclear power is expected to reduce Thailand's natural gas consumption in power generation from 70 % to 40 % (Thongrung, 2011).

Despite the reconsideration, no final decision whether to construct the nuclear power plant in the country has been taken yet. The project is still in the first phase (2008 - 2010), which deal mainly with feasibility studies and public relations (Pachaly, 2011). Regarding this idea, there have been critics whether to build nuclear power plants in Thailand. Environmentalists and local villagers living in the provinces listed as potential sites for nuclear power plant construction have formed an alliance called the *Network of People against Nuclear Power Plants* to protest against the planned construction of nuclear power plants in the country (Wipatayotin and Praiwan, 2011). On 15 March 2011, about 2,000 people from 18 districts of Kalasin Province in Thailand rallied outside the city hall to protest against the EGAT's plan of building a nuclear plant in their province. On 26 March 2011, according to the Assumption Business Administration College (ABAC) poll at the Assumption University, over 80 % of the respondents (83.4 %) disagreed with the plan to construct nuclear power plants in the country. The poll involved 3,807 people aged 18 up in 17 provinces. It was conducted from March 1 to 25, 2011. Bangkok residents had the largest percentage of the objection of 95.2 % followed by those in southern region (91.5 %), the central (91.1 %), the North (90.0 %) and the Northeast (85.8 %) (Wikipedia, 2012a).

4.6. Growth and Development of Electricity Trade between Laos and Thailand

The limited natural resources used in industrial sectors of the advanced neighboring countries specifically Thailand have gradually decreased while the abundant natural resources in Laos such as forest, water and other resources have not been completely utilized yet. These natural resources are the potentials of Lao exports due to the increasing demands of natural resources used in the industries such as lignite, hydropower, using in the industries. Laos,

historically one of the poorest countries in Asia and the Pacific region, has made impressive progress in developing its economy and reducing poverty spearheaded by the development of mining and hydropower sectors. The averaged 7 % of annual GDP growth supported by these sectors helped halve the share of population below the national poverty line to less than 25 % (IMF, 2011a).

Among the Greater Mekong Subregion (GMS) members, Laos, Myanmar, Yunnan province of China, and Vietnam have energy sources to be self-sufficient while Thailand is energy deficient and is likely to increasingly rely on imports in spite of its considerable gas, oil, and lignite reserves in the country. However, lignite deposits in Thailand are unlikely to be further exploited due to the economic and environmental reasons, unless its cost-efficient emission control technologies are advanced (Lahmeyer, 2004). The opposite way between its economic development and sources of energy makes Thailand to be a largest importer of energy in the GMS (ADB, 2009a).

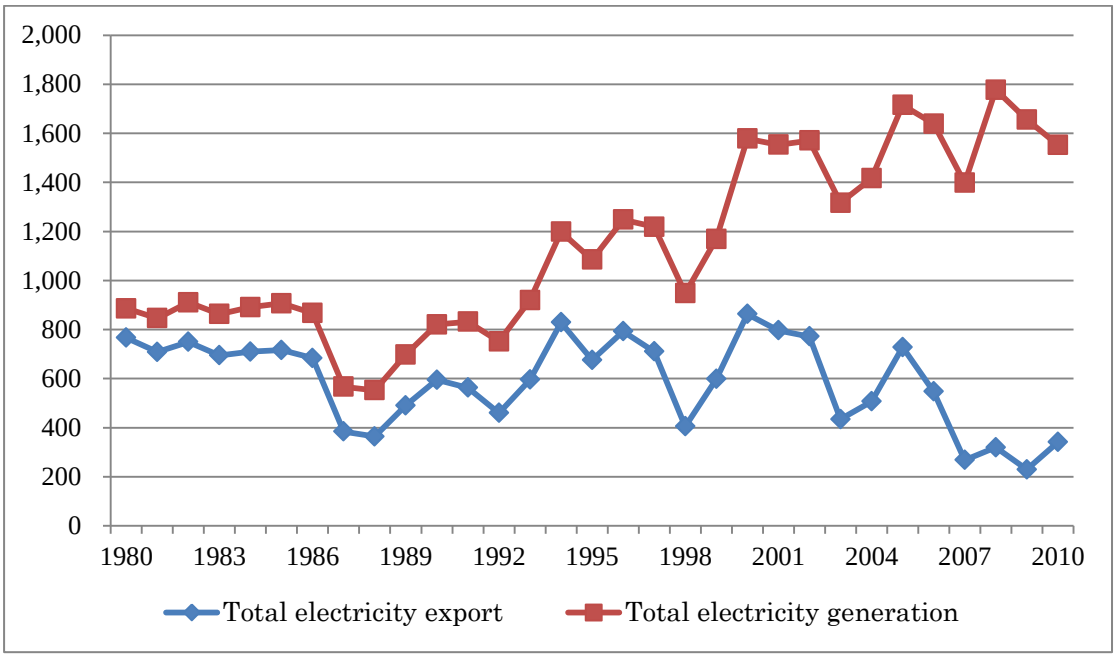
Electricity supply in Laos was primarily focused on serving domestic demand by the first hydropower plant named Nam Ngum 1 power station built in 1971. The surplus was sold to the Electricity Generating Authority of Thailand (EGAT) since the commission of this station, and has continued to supply the large amount of electricity to Thailand since then. Thailand has long been the biggest electricity importer from Laos accounted with about 90 % of total electricity export (Watcharejyothin, 2007).

Due to the increasing demand from Thailand, in June 1993, the Lao and Thai governments agreed to sign the first Memorandum of Understanding (MOU) to support the development of power projects in Laos through the supply of up to 1,500 MW of electricity to Thailand. Prior to 1993, there were only three power plants developed, and brought into operation. In order to accommodate the steady increase in electricity demand of Thailand, the governments of two countries extended the MOU several times up to December 2007. The Lao government agreed to supply electricity to Thailand with the amount of 5,000 MW by 2015 and 7,000 MW by 2020 (EPD, 2009). Thailand is likely to gradually raise the import of electricity from Laos since the expansion of power plants in Laos mostly come from hydropower based plants which have less environmental issues. Not only the benefit for Laos, but this is also a significant benefit for Thailand in terms of reduction of Carbon Dioxide (CO_2) emission. Import of electricity from Laos also provides political, and fuel diversity to balance Thailand's reliance on gas import from its neighboring country such as Myanmar.

To serve the increasing demand in the country as well as demand from neighboring countries especially Thailand, there are a number of power plants generating significant amount

of electricity as shown in Figure 4.6. Electricity produced in the country is for export, and some accounted for about 10 % is for domestic consumption. In addition to the 10 % of total capacity that was to be made available for domestic supply through independent power plants (IPP), several medium sized IPP projects have been nominated in order to meet the increasing demand in the country as well as the increasing demand from neighboring countries (EPD, 2009).

Figure 4.6: Total Electricity Generation and Export (in Gwh)



Source: Electricité du Laos (EDL, 2010).

About three-fourth of total electricity generation in Laos would be exported to Thailand while the remaining of about 10 % will be served to domestic demand, and 13 % will be exported to Vietnam, and Cambodia by 2035 (Watcharejyothin and Shrestha, 2009). After the final concession agreements, and power purchase agreements between Laos and Thailand, there are five projects after several studies in respect of feasibility, capacity as well as social and environmental impact, the Lao government agrees to export electricity to Thailand.

For years, the potential electricity of the Nam Theun River in Laos had been proposed. Eventually, in 1991, the Lao government began to study and identified a suitable project in the center of the country to export electricity generated from this hydropower plant to Thailand, and provide local supply. The Nam Theun 2 hydroelectric project (NT2) which began to be on commercial operation in March 2010 is the largest of its kind in Laos so far. It has capability to

produce 1,070 MW, and generate 235 million USD in gross revenues from yearly sales to Thailand (Revenues from export to Thailand will be partially in USD and partially in Thai Baht). Only this power plant, it is unable to accommodate the significant demand, therefore other power plants have also been considered to serve domestic consumption as well as demand from Thailand. After the final concession agreements and power purchase agreements between the Lao and Thai governments, there are five projects that the Lao government agrees to export electricity to Thailand with the purpose of mutual benefits in terms of revenue from export of electricity from Laos to Thailand as well as more electrification with less environmental impact in Thailand. These projects are in the pipeline, aiming to supply electricity to Thailand as scheduled (Phomsoupha, 2009).

Chapter 5

Development of Analytic Method for Natural Resources Research

Introduction

Several advanced researches either in social science or in natural science made an extensive use of an analytic method as the prime tool for quantitative verification and testing in order to obtain quantitative results. The primary objective of this study is to build small macroeconometric models of Laos and Thailand, and combine them into one model in order to quantitatively see the interrelationship between two economies through trade in electricity. Macroeconomic model is widely used in academia, teaching, and research. It is also widely used by large corporations, national governments, international organizations, as well as economics consultants. Large macroeconometric model is often used for quantitative policy, forecasting, and macroeconomic analysis. Applying this method, a model is also estimated for quantitative analysis of monetary and fiscal stabilization policies.

The basic macroeconometric model consists of a simultaneous system of linear, dynamic, and stochastic equations. In econometrics, simultaneous equation model (also called structural equation model) is one of the most remarkable developments in statistical analysis of economic data. It is a form of statistical model in the form of a set of linear simultaneous equations. Unlike the more traditional linear model, the response variable in one regression equation in a simultaneous equation model may also appear as a predictor in another equation in the model. Variables in a simultaneous equation model may influence one-another reciprocally.

It is well-known that the simplest and the most common estimation method for simultaneous equations model is the so-called Two-Stage Least Squares (2SLS). This method is used to obtain consistent structural parameter inferences and asymptotically valid inference results where one or more explanatory variables is correlated with the model error term due to endogeneity problem, measurement error, and etc. The 2SLS as one of the computational methods used to calculate instrumental variables estimates is an equation-by-equation technique, where endogenous variables on the right-hand side of each equation in the model are being instrumented with variables X from all other equations. As its name indicates, this method conducts estimation in two steps as explained in this chapter.

The combined macroeconometric model estimated by the 2SLS is finalized by simulation method. This method is the imitation of the operation of a real-world process or system over time. The model (i.e. macroeconometric model) represents the system itself, whereas the simulation represents the operation of system over time. Computer simulation has become an important part of model estimation in economics as social science, engineering, biology, chemistry, physics, and etc. In the field of economics, especially macroeconomics, the effects of proposed monetary or fiscal policy changes are usually simulated to judge their desirability. Based on historical economic data, a mathematical model of the economy is used as a proxy for actual economy. In the simulation estimation, proposed values of taxation, government spending, and etc are applied as inputs while the government budget deficit, unemployment rate, inflation rate, balance of trade deficit, and etc are the examples of outputs of the simulation. The example of the input in this study is the decrease or increase in volume of electricity export from Laos to Thailand while the output of is the decrease or increase in gross domestic product, and etc.

This chapter presents the early stage of analytic methods applied in this study including explanation of simultaneous equations models, developments of 2SLS, macroeconometric model, and simulation methods. The main objective of this chapter is to describe data collection, methodology as well as the development of models for both supply and demand sides of Laos' electricity trade with Thailand.

5.1. The Early Stage of Analytic Method for Natural Resources

5.1.1. Simultaneous Equations Models

Simultaneous equation models are referred as a form of statistical model in the form of a set of linear simultaneous equations. They are often applied in econometrics. In regression analysis, the application of ordinary least squares (OLS)[24] is unlikely to be appropriate in the simultaneous equation systems, since it produces biased parameter estimates. In order to see the problem, the following simple two-equation structural model is illustrated.

$$y_1 = \alpha_1 y_2 + \beta_1 z_1 + u_1 \qquad (5.1a)$$

$$y_2 = \alpha_2 y_1 + \beta_2 z_2 + u_2 \qquad (5.2a)$$

The variables z_1 and z_2 are exogenous, each of them is therefore uncorrelated with the error terms, u_1 and u_2.

To see the correlation between y_2 and u_1, both equations are solved for y_2 in terms of exogenous variables and the error term by plugging the right-hand side of (1) in for y_1 in (2).

$$y_2 = \alpha_2(\alpha_1 y_2 + \beta_1 z_1 + u_1) + \beta_2 z_2 + u_2$$

or

$$(1-\alpha_2\alpha_1)y_2 = \alpha_2\beta_1 z_1 + \beta_2 z_2 + \alpha_2 u_1 + u_2 \qquad (5.3a)$$

In order to solve for y_2, the parameters $\alpha_2\alpha_1$ is assumed to be different from 1

$$\alpha_2\alpha_1 \neq 1 \qquad (5.4a)$$

Provided condition (5.4a) holds, both sides of equation (5.3a) can be divided by $(1-\alpha_2\alpha_1)$ and write as

$$y_2 = \pi_{21} z_1 + \pi_{22} z_2 + v_2 \qquad (5.5a)$$

[24] According to Bretscher (1995), the least-squares method was first described by Carl Friedrich Gauss around 1974. His famous work is Gauss–Markov theorem.

Where $\pi_{21} = \alpha_2\beta_1/(1-\alpha_2\alpha_1)$, $\pi_{22} = \beta_2/(1-\alpha_2\alpha_1)$ and $v_2 = (\alpha_2 u_1 + u_2)/(1-\alpha_2\alpha_1)$. Equation (5.5a) which expresses y_2 in terms of exogenous variables and error terms is the reduced form equation for y_2 where the parameters π_{21} and π_{22} are the reduced form parameters. Because u_1 and u_2 are each uncorrelated with z_1 and z_2, the reduced form error, v_2 is therefore uncorrelated with z_1 and z_2.

In equation (5.5a), y_2 and u_1 are correlated if and only if v_2 and u_1 are correlated. Due to the fact that v_2 is a linear function of u_1 and u_2, it is generally correlated with u_1.

When y_2 is correlated with u_1 because of simultaneity, OLS is said to suffer from simultaneity bias[25]. As a result, the statistical tests using OLS will be invalid. This is a problem in most of simultaneous equations models. However, this problem can be solved by using econometric instruments such as instrumental variables (IV), two-stage least squares (2SLS), three-stage least squares (3SLS), and etc (see, Wooldridge, 2006, Dougherty, 2007 and Verbeek, 2008). Among them, the 2SLS method is the simplest and the most common estimation technique for simultaneous equations model (Greene, 2003). This method is also applied in this study.

According to Oczkowski (2003), the advantages of using 2SLS for simultaneous equations model (SEM) over other methods such as the more conventional maximum likelihood (ML) method are as follows:

- The 2SLS does not require any distributional assumptions for right-hand side independent variables. Therefore, they can be non-normal, binary, and etc.
- This method permits the routine use of often ignored diagnostic testing procedures for such problems as heteroscedasticity and specification error (Pesaran and Taylor, 1999).
- It easily caters for non-linear and interactions effects (Bollen and Paxton, 1998).

[25] For more details, see Wooldrige (2006).

- In the context of a multi-equation non-recursive SEM, it isolates specification errors to single equations (Bollen, 2001).
- The 2SLS is computationally simple and does not require the use of numerical optimization algorithms.
- Several simulation evidences from econometrics often suggest that 2SLS may perform better in small samples than ML (Bollen, 1996).

5.1.2. Development of Two Stage Least Squares Method

In econometrics, standard linear regression model is assumed that error terms in the dependent variable are uncorrelated with the independent variable(s). However, when this is not the case, ordinary least squares (OLS) applied in linear regression no longer provides optimal model estimates. The more appropriate technique is the so-called Two Stage Least Squares (2SLS). The 2SLS is a technique of extending regression to cover models which violate OLS regression's assumption of recursively, specifically models where one or more predictor variables must be assumed to be correlated with the error terms (disturbance terms) of the dependent variable. This technique is a special case of instrumental variable technique in which the "best" instrumental variables[26] are used (see Kenedy, 2003; Wooldridge, 2006). As also asserted in theorem 5.3 in Wooldridge (2006), it is the most efficient instrumental variable estimator. The 2SLS estimator is obtained by using all instrumental variables simultaneously in the regression. The regression using 2SLS technique uses instrumental variables that are uncorrelated with error terms to compute estimated values of the problematic predictor(s). On the next stage, it then uses the computed values in the first stage to estimate a linear regression model of the dependent variable. Since the results obtained from the second estimation are based on variables that are uncorrelated with the errors, the results obtained from the 2SLS are said to be optimal.

Since all of exogenous variables are good candidates for instrumental variables in the system, a natural suggestion is to combine all of them to create a combined variable to act as a "best" instrumental variable. A good instrumental variable is one that is highly correlated with the independent variable for which is acting as an instrumental variable. This technique

[26] According to Stock et and Trebbi (2003), the theory of instrumental variables was first derived by Wright (1928).

suggests regressing each endogenous variable being used as an independent variable on all endogenous variables in the whole system and using the estimated values of these endogenous variables as the required instrumental variables. Each estimated value is the "best" instrumental variable in the sense that, of all combinations of the endogenous variables, it has highest correlation with endogenous variable. As indicated by its term, the 2SLS consists of two stages of which the first stage constructs the instrumental variables, and the second stage constructs the instrumental variables estimators of the parameters of interest. The procedure of this technique is as follows:

Stage 1: regress each endogenous variable acting as an independent variable in the equation of interest being estimated on all exogenous variables in the system (i.e. estimate the reduced form) and calculate the estimated values of these endogenous variables. The predicted values from these regressions are then obtained.

Stage 2: the equation of interest is regressed as usual. However, on this stage, the estimated values are used as instrumental variables for these endogenous variables or simply use these estimated values and the included exogenous variables as independent variables in an OLS regression.

To find the best instrumental variables, the following equation is considered.

$$y_1 = \beta_0 + \beta_1 y_2 + \beta_2 z_1 + u_1 \qquad (5.6a)$$

Where y_1 is clearly endogenous as it is correlated with u_1. The variables y_2 and z_1 are the explanatory variables, and u_1 is the error term. The assumption is that the expected values of u_1 is zero: $E(u_1) = 0$. The variable z_1 is used to indicate that this variable is exogenous so that it is uncorrelated with u_1, while y_2 is used to indicate that this variable is suspected of being correlated with u_1.

If (5.6a) is estimated by OLS, all of the estimators will be biased and inconsistent. Thus, instrumental variable is needed for y_2. Since z_1 itself appears as an explanatory variable in (5.6a), it cannot serve as an instrumental variable for y_2. Other exogenous variables are therefore needed. The exogenous variables, say z_2 and z_3, that do not appear in (5.6a) are used as new exogenous variables. Therefore, the key assumptions are that z_1, z_2 and z_3 are uncorrelated with u_1. We also assume that u_1 has zero expected value:

$$E(u_1) = 0, Cov(z_1, u_1) = 0, Cov(z_2, u_1) = 0, \text{ and } Cov(z_3, u_1) = 0 \qquad (5.7a)$$

We still need z_2 and z_3 to be correlated with y_2, but the sense in which these three variables must be correlated is complicated by the presence of z_1 in (5.6a). The assumption in terms of partial correlation is needed. The easiest way to state the condition is to write the following equation:

$$y_1 = \pi_0 + \pi_1 z_1 + \pi_2 z_2 + \pi_3 z_3 + v_2 \qquad (5.8a)$$

Where $E(v_2) = 0, Cov(z_1, v_2) = 0, Cov(z_2, v_2) = 0, Cov(z_3, v_2) = 0$ and π_j are unknown parameters. The key identification is that

$$\pi_2 \neq 0 \text{ and } \pi_3 \neq 0 \qquad (5.9a)$$

If z_2 and z_3 are both correlated with y_2, each of them could just be used as an instrumental variable. But then there would be two instrumental estimators and neither of them would be efficient. Since each of z_1, z_2 and z_3 is uncorrelated with u_1, any linear combination is also uncorrelated with u_1 and therefore any linear combination of the exogenous variables is a valid instrumental variable.

To find the "best" instrumental variable, linear combination that is the most highly correlated with y_2 is chosen.

Then the best instrumental variable for y_2 in the linear combination of the z_j in (5.8a) is called y_2^*:

$$y_2^* = \pi_0 + \pi_1 z_1 + \pi_2 z_2 + \pi_3 z_3 \qquad (5.10a)$$

The identification is that at least π_2 or π_3 is different from zero for this instrumental variable not to be perfectly correlated with z_1.

$$\pi_2 \neq 0 \text{ and } \pi_3 \neq 0 \qquad (5.11a)$$

As mentioned above, since the OLS is not capable to delivery consistent parameter estimates in the simultaneous equations model, there is a need to find a solution to solve the problem of endogenous regressors in the model. The best known and common used instrument

to take into account this problem is the 2SLS. The above equation proves that using the OLS is not appropriate while the 2SLS is. This is due to the fact that the instrumental variables obtained from the first stage being used in the second stage of regression are not correlated with the error terms (disturbance terms) in simultaneous equations system.

5.1.3. Development of Macroeconometric Model

To forecast policy impact evaluation or future performance of the economy, a common instrument to be applied in the analysis is Macroeconometric Model (sometimes called Macroeconomic Model or abbreviated to Macro Model). Several goals of cohesion policy are defined at the macroeconomic level. The estimated results from a macroeconomic model are therefore generally consistent with requirements. In other words, it is an important instrument in establishing whether Cohesion Policy has achieved its macroeconomic goals (Evalsed, 2009). The application of macroeconometric for policy assessment and forecasting has a tumultuous history since World War II. According to Lawrence (2004), macroeconometric model was first built for the Netherlands in 1936 by Dutch economist—Jan Tinbergen. He later applied the same modeling structure to the economies of the United States and the United Kingdom. He is also well known for his seminal work in the following 3 years (1939) on business cycle analysis of the US economy (Bodkin et al, 1991).

Macroeconometric model is still common applied in the recent economic analysis as shown in the application of a macroeconometric model to examine possible causes of the 2008 - 2009 US recession by Fair (2009). It is an analytical instrument built with the aim to describe the operation of the economy of an individual country as well as a region. The ability in using data to inform the structure of the model is a key strength of a macroeconomic model. According to Wikipedia (2012b), Macroeconometric models may be mathematical, logical, and/or computational. Different kinds of macroeconometric models are designed depending on purposes of the study. This tool may also be applied to illustrate and clarify basic theoretical principles. Most of macroeconometric models are applied for forecasting the effects of changes fiscal, monetary, and other macroeconomic policies. Therefore, in teaching and research or academia, macroeconometric models approaches are widely applied. They are also broadly applied by economics consultants, larger corporations, national governments as well as by international organizations.

Macroeconometric model is usually built to examine the dynamics of aggregate quantities including, for example, total income earned, total amount of goods and services

produced, price levels, and level of employment. This kind of analytical model is widely used in various purposes. They are used to test, compare, and quantify different theories of economy. They are also used to produce "what if" scenarios, and generate economic forecast. The impacts of changes in policy, trade, finance, investment, and various macroeconomic variables called for a methodological approach to provide quantitative assessments of the impacts on the economy in the form of quantitative values. Macroeconometric model is widely used as a tool designed to manage the country based on various purposes. There has been vast amount of works either in developed or developing or underdeveloped countries examining how the changes in policy, trade and other economic factors or economic trend affect the economy by applying macroeconometric modeling as a tool for assessment. A variety of macroeconometric models applied in these countries include models from the classical Klein-Goldberger model[27] to recent ones. The flowing studies are some of recent literatures concerning the application of macroeconometric models in various economies. The uses of macroeconometric model in developed countries are found in Aggarwal (2004), Baumgartneret al (2004), Neumeyer and Perri (2005), Cagas et al (2006), Fair (2009). In developing countries, the applications of macroeconomic model are referred to Shourie (1992), Haque et al (1990), Khan et al (1991), Murshed (1999), Schineller (1997), Yap (2002), Jha (2003), Bank of Thailand (2001a), Davies (2004), Agosin and Machado (2005), Neumeyer and Perri (2005), Mcdonald et al (2008), Cagas et al (2008), Adam (2009). The application in the underdeveloped countries can be found in Kyophilavong (2003, 2009), Gerxhani (2004), Kyophilavong and Toyoda (2004b, 2008a, 2008b), Ra and Rhee (2005). Due to the different in economies and different purposes of study, the structures of their macroeconometric models are varied country by country.

Depending on economic situation and data availability, macroeconometric models are used in a variety of purposes. The application of macroeconometric models in developed countries such as the recent study of Fair (2009) is to analyze various questions about the U.S recession that began in 2008. Using data from the first quarter of 1954 to the fourth quarter of 2008, there are 30 estimated equations, and 100 identities included in the model. The estimation method applied in the study is two stage least squares (2SLS) technique. In the model, there are seven estimated demand equations explaining durable consumption expenditures, nondurable consumption expenditures, service consumption expenditures, housing investment, plant and equipment investment, inventory investment, and imports using four quarterly data of 2008. The analysis was also conducted to estimate how different the US economy would have been in 2008 had shocks (fall in equity values, fall in housing values, price shocks, and exports) been

[27] Klein-Goldberger model is a macroeconometric model based on foundations laid by Professor Jan Tinbergen of the Netherlands.

zero. Based on the assumption, the results showed that there would have been no recession indicated by the predicted outcome showing that, for example, unemployment rate in the fourth quarter of 2008 would have been 5.2 % instead of the actual value of 6.9 %, real GDP would have been 4.9 % larger than the actual value. Fair (2009) found that the US recession in 2008 was due to random consumption shocks, housing prices, stock prices, import prices, and at least part of exports.

5.1.4. Development of Simulation Method

Simulation is applied in several areas including economics, finance, automobile, engineering, production, weather, and etc. It is the imitation of the operation of a real-world process or system over time (Banks et al, 2001, pp. 3). It can be applied to express the eventual real effects of alternative conditions and courses of action. In addition, it is applied when the real system cannot be engaged because it may be dangerous or unacceptable to engage, or it may not be accessible, or it may simply not exist, or it is being designed but not yet built (Sokolowski and Banks, 2009, pp. 6).

In economics particularly macroeconomics, the effects of possible actions such as monetary policy changes, or fiscal policy changes, or such possible actions that may occur in Laos' electricity trade as in this study are simulated to judge their desirability. A macroeconometric model of the economy is applied as a proxy for the actual economy. In the simulation estimation, proposed values of taxation, government spending, and etc are applied as inputs while the government budget deficit, unemployment rate, inflation rate, balance of trade deficit, and etc are the examples of the outputs of the simulation. The example of the input in this study is the decrease or increase in volume of electricity export from Laos to Thailand while the output of the simulation is the decrease or increase in gross domestic product, and etc. The estimated values of the variables of interest obtained from the simulation are used to predict the economy.

There are several approaches of simulation using in different fields. In this study a Monte Carlo simulation approach—coined in the 1940s by John von Neumann, Stanislaw Ulam and Nicholas Metropolis (Metropolis, 1987)—is applied since the model is solved many times with pseudo-random numbers substituted for the unknown errors at each repetition. The Monte Carlo simulation applies repeated sampling to determine the properties of some phenomenon or behavior. It samples probability distribution for each variable to produce hundreds or thousands of possible outcomes. The estimated results obtained from this approach

are analyzed to get probabilities of different outcomes occurring (Vose, 2008, pp. 16). Although this method provides approximate results, as the number of repetitions is increased, the results are expected to approach their true values (see Sawilowsky and Fahoome, 2003 for more detail about this approach). Due to the repetition of algorithms and the large number of calculations involved, Monte Carlo simulation is an approach appropriate to calculation using a computer. Furthermore, it is likely to be used in the estimation when there is infeasibility to compute an exact result with a deterministic algorithm (Hubbard, 2007, pp. 46). Selecting this approach, Pengelly (2002) gave two main reasons why the Monte Carlo simulation is used in his study. The first reason is due to their anti-aliasing properties, and the second reason is due to their ability to approximate quickly an answer that would be time-consuming to find out the answer.

5.2. Data Collection and Methodology of Model for Electricity Trade of Laos with Thailand

5.2.1. Data Collection

The analysis in this study is conducted by applying solely secondary data. As suggested by Crawford (1997), while conducting a research study, having multiple sources data are important so that one source can be cross-checked for consistency with another. Due to the fact that sometimes data from one source is misleading, having data from various sources is helpful for filtering unnecessary and misleading data. In such internet era, everything is likely to be easily obtained including the important information and data supporting the analysis in this study. Various data applied in this study are obtained through the internet whereas some data unavailable are obtained from local organizations. The information or data are either in the form of soft-hard copies, books, journals, CD-ROMs, and etc.

Regarding the data of Laos, most of them are obtained from international organizations through the internet composing of data from Asian Development Bank (ADB), International Energy Agency (IEA), International Monetary Fund (IMF), United Nations (UN), United Nations Conference on Trade and Development (UNCTAD), World Bank (WB), and etc. Through their websites, the data are also obtained from the country's organizations such as data from websites of Ministry of Energy and Mines (MOE), Electricite du Laos (EDL), the Ministry of Industry and Commerce (MIC), National Statistic Center (NSC), and etc. However, some data unavailable on the internet are obtained from the local authorities in Laos.

Due to the fact that there is a plenty of important information and data available on the internet, most of information about Thailand as well as data of Thailand are obtained from the abovementioned international organizations. Although some data are not available in these abovementioned main sources, reliable data can be obtained from the Thai authorities through their websites. The data of Thailand applied in this study are mainly obtained from the Electricity Generating Authority of Thailand (EGAT), the Energy Policy and Planning Office (EPPO), Department of Alternative Energy Development and Efficiency (DEDE), and the Ministry of Foreign Affairs (MOFA). Some important information about Thailand-side and data are translated into English in the case that there is only Thai version available.

Basically, the data of Vietnam are obtained from international organizations through the internet including data from Asian Development Bank (ADB), International Energy Agency (IEA), International Monetary Fund (IMF), United Nations (UN), United Nations Conference on Trade and Development (UNCTAD), and World Bank (WB). Some data and information are also obtained from the Vietnamese authorities through their websites such as Ministry of Foreign Affairs (MOFA), and The Ministry of Science and Technology.

Prior to the estimation stage, all of the data of both supply-side and demand-side namely Laos, Thailand and Vietnam are repeatedly checked in order to achieve accurate results. After cross-checking and filtering the data for the consistency as well as the accuracy, the estimation is conducted. Since the data obtained from the aforementioned sources are systematically estimated, all of variables must have the same time period. The time series data applied in this study are in annual forms. Due to the inconsistency and lack of some data periods, the models in this study are calculated using data from the year of transition from a centrally-planned to a market-oriented economy until the most recent data available during the study period. In other words, the models calculation is conducted using time series data from 1986 - 2010 or 25 years. Although macroeconomic data are available in several sources either in the international organization's or country's websites, in order to optimize the accuracy in calculation, all of the same data available on the internet such as GDP, consumption, investment, export, import, gross domestic product (GDP) deflator, and etc are obtained from the same sources. These data are obtained particularly from the websites of the Asian Development Bank (ADB), International Monetary Fund (IMF), United Nations (UN), United Nations Conference on Trade and Development (UNCTAD), and World Bank (WB). Some data especially the data form country's authorities are available only in the form of national currency. For the sake of consistency, the data in national currency units are converted into the internationally acceptable currency—US dollar (USD).

Rather than nominal values, the data applied in the analysis are in the form of real values in order to see real effect on the economy. For example, real GDP takes out the effects of price increases allowing the comparison of the economy's production more accurately. Otherwise, it might seem like the economy is producing more when it is just higher prices. However, in the case that data are available only in nominal values, they are adjusted into real values using GDP deflator (also called implicit price deflator for GDP). To obtain the data in real values, the data in nominal values are divided by GDP deflator and multiplying them by 100 (see BEA, 2009). The units of some data that are not in currency such as amount of electricity export - import, electricity consumption, electricity production are used in kilowatt hour (KWh), interest rate is in percent (%), and other data are used in their own general units. Since these data are not in the currency, units they are not necessary to be deflated by GDP deflator. Based on these filtered data, the quantitative estimation is conducted using econometrics method.

Due to the limited time series data available, there are 25 samples of time series data of both supply-side and demand-side consisting of data of Laos, Thailand and Vietnam from 1986 to 2010. The quantitative estimation in this study is in the form of Simultaneous equations model showing interrelation between the Lao, Thai and Vietnamese economies. Prior to the simulation stage, model is estimated using the Two Stage Least Squares (2SLS) method to see how variables in the model are related. This 2SLS method, developed independently by Theil (1953) and Basmann (1957), is the most common estimation technique for simultaneous equations model (Greene, 2003, pp. 399). In simultaneous equations model, 2SLS approach has been widely used to take account of the fact that endogenous variables are, in general, jointly determined (see Wooldridge, 2006). Most of simultaneous equations estimated by ordinary least squares (OLS) are likely to be biased and inconsistent and that the statistical tests will be invalid. These problems can be solved by using instrumental variables, two-stage least squares (2SLS), three-stage least squares (3SLS), and etc (see, Wooldridge, 2006, Dougherty, 2007 and Verbeek, 2008).

Evidence from econometrics found in Oczkowski (2003) suggests that, comparing between two approaches, 2SLS may perform better in small samples than Maximum Likelihood (see also Bollen, 1996, pp. 120-121). This approach is suitable with the analysis in this study since the sample size of 25 is not so large. The 2SLS estimator is consistent, since it is a legitimate instrumental variable estimator. The interpretation of 2SLS approach is that the same estimator can be obtained in two steps, both which can be estimated by ordinary least squares (OLS). The first step is to estimate reduced form of the equation by OLS. Then, in the second step, the original structural equations are estimated by OLS while replacing all

endogenous variables on the right-hand side with the estimated values from the reduced form (see Verbeek, 2008). In addition, 2SLS estimator has been most popular of all simultaneous equations estimators because of its low computable cost (Kenedy, 2003).

After estimating the simultaneous equations model using 2SLS method, the estimated results are then applied in simulation estimation. In the simulation stage, data from 1986 to 2010 are all estimated. Due to the change in the Lao economy in each period since 1986 to 2010, data in the interpretation of simulation stage is, however, divided into three main periods according to the change of economic situation in each period. The period division of the data is based on the previous studies of Warr (2006), and Kyophilavong and Toyoda (2008a). Following them, the first period: 1987 - 1996 is named "Post-Reform Adjustment Period" which is the period after the new economic mechanism introduced in 1986. During 1997 - 1999, the impact of Asian financial crisis had severe impact on many Asian countries particularly Thailand affecting directly the Lao economy, the second period: 1997 - 1999 is named: "Asian Crisis Period". The third period: 2000 - 2010 is called "Sustained Growth and Foreign Capital Inflows Period"[28] since it is a high growth period with substantial foreign capital inflows into the country.

5.2.2. Variables Description in the Model

The macroeonometric models of three countries are combined into one model in order to see the effect of the change in one economy on the other economies simultaneously. In the analysis, there are both endogenous and exogenous variables included in these mentioned models.

Endogenous variable is a classification of a variable determined by a statistical model that is explained by the relationships between functions within the model. This variable is related but non-equivalent distinctions are those between dependent and independent variables. The specification whether variable is endogenous is only relative to a model representing the causal relationships between the outcome y and a set of causal factors X (x1, x2, …, xk). A variable xj is said to be endogenous, if its value is influenced or generated by one or more of the independent variables X within the model (see Hendry, 1995; Pearl, 2000)

[28] They used the data from 2000 - 2006 for the so called "Sustained Growth and Foreign Capital Inflows Period".

Contrasted with an endogenous variable, exogenous variable is an independent variable that determines a model without being determined by other variables within the model. Its value is determined or influenced by factors or variables outside the causal system. By definition, exogenous variable is an independent variable whose value is wholly causally independent from other variables in the model. Its status is relative to the specification of a particular model, and causal relations among the independent variables in the system (see Engle et al, 1983; Woodward, 1995; Pearl, 2000).

In this study, there are a number of endogenous variables and exogenous variables in the system. In order to understand easily, endogenous variables as well as exogenous variables in each model are separately shown in each table from Table 5.1 to Table 5.4. In this study, there are 12 endogenous variables in Laos-side model, 11 endogenous variables in Thailand-side model, and 8 endogenous variables in Vietnam-side model as illustrated in Table 5.1. Regarding the exogenous variables, there are 6 exogenous variables in Laos-side model, 2 exogenous variables in Thailand-side model, and 2 exogenous variables in Vietnam-side model as shown in Table 5.2. In case of the integrated model, the number of both variables is relatively high, since it combines variables in both Laos-side model, Thailand-side model and Vietnam-side model. In this model, there are 30 endogenous variables in the system including 12 Laos-side variables, 10 Thailand-side variables, and 8 Vietnam-side variables as shown in Table 5.3. Regarding the number of exogenous variables in the integrated model, there are 9 exogenous variables consisting of 5 Laos-side variables, 2 Thailand-side variables, 2 Vietnam-side variables as shown in Table 5.4 below.

Table 5.1: Endogenous Variables for Laos, Thailand and Vietnam Model

Laos		**Thailand and Vietnam**	
Variable	Meaning	Variable	Meaning
CE_L	Consumption of Electricity	CP_T	Private Consumption
CEN_L	Consumption of Non-Electricity	CE_T	Consumption of Electricity
CP_L	Private Consumption	CEN_T	Consumption of Non-Electricity
EG_L	Electricity Generation	CP_T	Private Consumption
EX_L	Export	GDP_T	Gross Domestic Product
EXE_L	Export of Electricity	I_T	Investment
EXE_L^T	Export of Electricity to Thailand	IM_T	Import
GDP_L	Gross Domestic Product	$IMEN_T$	Import of Energy
I_L	Investment	$IMEN_T^L$	Import of Energy from Laos
IM_L	Import	$IMEN_T^{LN}$	Import of Energy from Non-Laos
IME_L	Import of Electricity	$IMENN_T$	Import of Non-Energy Products
$IMEN_L$	Import of Non-Electricity	CP_V	Private Consumption
		CE_V	Consumption of Electricity
		CEN_V	Consumption of Non-Electricity
		CP_V	Private Consumption
		GDP_V	Gross Domestic Product
		I_V	Investment
		IM_V	Import
		$IMEN_V^L$	Import of Electricity from Laos

Source: Author.

Table 5.2: Exogenous Variables for Laos, Thailand and Vietnam Model

Laos		Thailand and Vietnam	
Variable	Meaning	Variable	Meaning
$CAPE_L$	Installed Capacity of Electricity	G_T	Government Expenditure
G_L	Government Expenditure	EX_T	Export
EXE_L^{TN}	Export of Electricity to Non-Thailand	G_V	Government Expenditure
$EXEN_L$	Export of Non- Electricity	EX_V	Export
GDP_T	Gross Domestic Product		
$IMEN_L$	Import of Non-Electricity		

Source: Author.

Table 5.3: Endogenous Variables for the Integrated Model

The Integrated Model			
Variable	Meaning	Variable	Meaning
CE_L	Consumption of Electricity	GDP_V	Gross Domestic Product
CE_T	Consumption of Electricity	I_L	Investment
CE_V	Consumption of Electricity	I_T	Investment
CEN_L	Consumption of Non-Electricity Products	I_V	Investment
CEN_T	Consumption of Non-Electricity Products	IM_L	Import
CEN_V	Consumption of Non-Electricity Products	IM_T	Import
CP_L	Private Consumption	IM_V	Import
CP_T	Private Consumption	IME_L	Import of Electricity
CP_V	Private Consumption	IME_V^L	Import of Electricity from Laos
EG_L	Electricity Generation	$IMEN_L$	Import of Non-Electricity Products
EX_L	Export	$IMEN_V$	Import of Non-Electricity Products
EXE_L	Export of Electricity	$IMEN_T$	Import of Energy
EXE_L^T	Export of Electricity to Thailand	$IMEN_T^L$	Import of Energy from Laos
GDP_L	Gross Domestic Product	$IMEN_T^{LN}$	Import of Energy from Non-Laos
GDP_T	Gross Domestic Product	$IMENN_T$	Import of Non-Energy Products

Source: Author.

Table 5.4: Exogenous Variables for the Integrated Model

The Integrated Model	
Variable	Meaning
G_L	Government Expenditure
G_T	Government Expenditure
G_V	Government Expenditure
EX_T	Export
EX_V	Export
EX_L^{TN}	Export to Non-Thailand Countries
EXE_L^{TN}	Export of Electricity to Non-Thailand Countries
$EXEN_L$	Export of Non- Electricity

Source: Author.

All of the above endogenous as well as exogenous variables are applied in the estimation of macroeconomietric models. The estimation is mainly based on the LAOMACROMODEL-1 built by Kyophilavong (2003), and LAOMACROMODEL-2 by Kyophilavong (2009). Their models are developed in this study by including some equations or functions or even more variables in order to support the purpose of this study. Some unrelated parts or variables in their models are not included in this study due to the difference in purpose of the study. In other words, this study is aimed to find the impacts of the Thai economy on both countries simultaneously through the change in electricity exports while their purposes of study are to analyze the impact of joining Association of Southeast Asian Nations Free Trade Area (AFTA) on the Lao economy, and the impact of mixed-policy on the Lao economy, respectively.

5.2.3. Data Analysis Method

In econometrics, there are two common approaches applied to estimate the model equations (Minh, 2006). A simple approach is to estimate each equation in the system separately, and another approach is to estimate simultaneously the complete set of parameters of the equations in the system. In this study, the latter approach is applied. Since this study is concerned with simultaneous equations system, the former approach is likely to be

inappropriate. In the analysis stage, simultaneous estimation is conducted by using the two-stage least squares (2SLS) technique. This is due to the fact that estimating each equation in the system separately by using ordinary least squares (OLS) method in a simultaneous equations system generally produces biased, and inconsistent estimates (see Wooldridge, 2006; Dougherty, 2007; Verbeek, 2006; Bullock et al, 2010). This is because an explanatory variable that is determined simultaneously with the dependent variable is generally correlated with the error terms, hence, the bias and inconsistency in OLS. This problem is eliminated (or at least mitigated) when a suitable proxy variable is given for an unobserved explanatory variable using 2SLS technique (Wooldridge, 2006, pp. 461).

The final stage of this study is to analyze various impacts on individual country or the impacts from one country on another country simultaneously by using simulation estimation. After obtaining the results from the 2SLS method, the data is finally analyzed using simulation of 4 cases based on the purpose to see the impact from the some changes on the model. Based on the trend of electricity demand from Thailand in the future, the first case is decreasing import of electricity from Laos to Thailand by 10 %. Following the assumption in the first case of simulation, the second case is increasing electricity export to non-Thailand countries by 10 %. Since the trend of Thailand in the future may be opposite with the first assumption, the third case of simulation is conducted by is increasing export of electricity from Laos to Thailand by 10 %. All of the cases of simulation show the interdependency between two countries. Based on the assumption that the Lao government promotes electricity export sector by facilitating infrastructure, increasing number of power plants in order to increases capacity of electricity production in the country, the electricity generation is assumed to increase by 10 % in the fourth case of simulation.

5.3. Development of Model for Laos' Electricity Trade

All of the equations in the system are estimated by using the two-stage least squares (2SLS) method to see the relationship between dependent variables and independent variables in the behavioral equations. In econometric, the ordinary least square (OLS) is a common tool applied to estimate the behavioral equations. However this tool is unlikely to be applicable to the simultaneous equations system. This is due to the fact that, in equations, the OLS generally produces biased and inconsistent estimates while the 2SLS method does not. The latter method is therefore applied in the estimation in this study. The simulation is implemented in the final stage after obtaining results from using the 2SLS method. The computable instrument of each method is the time series oriented economic analysis software called EViews (Econometric

Views) version 7 which is the latest version of this software during the time of this study conducted. It is a statistical program used mainly for such time series oriented econometric analysis as in this study.

Prior to the simulation stage, the following macroeconometric model showing the combination between the Lao economy and the Thai economy is built. In order to distinguish the difference between each variable in the model, and to easily understand, the symbols, superscripts, and subscripts are used in each equation. The plus sign (+) means the explanatory variable has positive relationship with the dependent variable. On the other hands, the minus sign (-) means the explanatory variable has negative relationship with the dependent variable. The meanings of all variables are shown in Appendix 7, and Appendix 8.

5.3.1. The Supply-side of Electricity Export (Laos)

Gross domestic product equation for Laos in this study is based on expenditure method involving private consumption, gross investment, government spending, and net export (export minus import) as shown in the following equation:

$$GDP_L = C_L + I_L + G_L + (EX_L - IM_L) \qquad (5.1b)$$

Depending on the objective of the study, consumption is either not divided or divided into more components. Since the purpose of this study is to analyze about electricity trade industry, consumption is divided into consumption of electricity and consumption of non-electricity products. In Kyophilavong (2009), consumption equation in his macroeconometric model is not divided due to the different purpose of the study. In this model, consumption equation is defined as follows:

$$C_L = CE_L + CEN_L \qquad (5.2b)$$

In some studies (i.e. Bradford and Chakwin, 1993), export is considered exogenous in the model while some studies (i.e. Dimitrova, 2005), it is considered endogenous. Since the objective of the study is to analyze specifically the economic impact on export of electricity of Laos, export of electricity is divided as a component of the whole export against export of other products that are not electricity (non-electricity products). In other words, export equation of Laos consists of export of electricity and export of non-electricity products as follows.

$$EX_L = EXE_L + EXEN_L \qquad (5.3b)$$

Electricity generated in Laos is mostly for export to neighboring countries such as Thailand, and Vietnam. Most of the exports of electricity from Laos are forwarded to Thailand, export of electricity equation is therefore set to consist of export of electricity to Thailand and export of electricity to Vietnam. In addition, export of electricity to Thailand is assumed to cover 90 % of total electricity export of Laos while the left share of exports is for exporting to Vietnam. Electricity export equation is therefore structured as follows:

$$EXE_L = EXE_L^T + EXE_L^V \qquad (5.4b)$$

Since the simulation is to see the impact in terms of currency, electricity generation in Laos applied in the estimation is in the form of currency. The value of electricity production is the sum of all revenues from electricity sale in domestic and the revenues from electricity exports minus the value of import of electricity from other countries as show in the following equation[29] :

$$EG_L = CE_L + EXE_L - IME_L \qquad (5.5b)$$

Although Laos is a major exporter of electricity in the Greater Mekong Subregion (GMS) as well as in Asia due to its abundant of hydropower, it still needs to import some amount electricity from its neighboring countries (Thailand, Vietnam and China) to accommodate the increasing consumption of electricity in the country especially the rural area where the national grid cannot penetrate. This is due to the fact that is a cheaper alternative than to extend the national grid to each corner of the country (the 22 KV transmission lines cost between 10,000 USD and 15,000 USD per Km, depending on the accessibility of the road). It is thus interesting to see the behavior of not only exports to, but also imports of electricity from other countries. Since the import of electricity is included in aggregate import, import of goods and services is divided into import of electricity and import of non-electricity as shown in the following equation:

$$IM_L = IME_L + IMEN_L \qquad (5.6b)$$

As being well known that in economics, consumption function is used to express consumer spending developed by Keynes (1936) in his famous book titled The General Theory of Employment, Interest, and Money. This study is based on his consumption function that consumption is a simple function of disposal income. However, due to the lack of data on

[29] It is assumed that the electricity production in demand side is equal to the electricity production in supply side.

disposal income, consumption of electricity in this study is simply specified as a function of real gross domestic product of Laos[30]. Thus, consumption function of electricity in Laos is illustrated as follows:

$$CE_L = f(\overset{+}{GDP_L}) \qquad (5.7b)$$

Similar to consumption of electricity function that consumption is simply a function of gross domestic product instead of disposal income due to the short of this data for Laos. The following function of consumption of non-electricity products is also assumed to be influenced by gross domestic product as shown below:

$$CEN_L = f(\overset{+}{GDP_L}) \qquad (5.8b)$$

Interest rate is one factor that has effect on investment. However, in the case of Laos, due to the short of data on interest rate from 1985 to 199031while the data applied in the analysis in this study are from 1986 to 2010 , interest rate is not included in investment function. However, exchange rate is applied instead of interest rate since it has direct effect on interest rate. In theory, according to Harchaoui et al (2005), changes in exchange rate have two opposite effects on investment. For example, when the value of domestic currency depreciates, the marginal profit of investing an additional unit of capital is likely to increase since the investor will get higher revenues from both domestic and foreign sales. Yet, the positive effect of the depreciation in domestic currency is counterbalanced by the rising variable cost and the higher price for imported capital. In other words, a depreciation in exchange rate stimulates investment by increasing demands in both domestic and export markets, but it decreases investment due to the increasing cost of imported intermediate goods and the user cost of capital. The indication as to which effect is dominant is different from country to country. Since most of Laos's exports are primary products such as wood, electricity, coffee, and etc, the latter effect of exchange rate depreciation on importing capital is unlikely to dominate. Therefore, the former effect that the deprecation in domestic currency (increase in exchange rate) stimulates investment is assumed to dominate. In other words, exchange rate is expected to have positive effect on investment in Laos. Investment function of Laos is thus as illustrated as follows:

[30] Using GDP instead of disposal income is also applied in, for example, Kyophilavong (2003, 2009), Kyophilavong and Toyoda (2004b, 2008a, 2008b).

[31] The data of interest rate is available only from 1990 onwards.

$$I_L = f(\overset{+}{GDP_L}, \overset{+}{EXR_L}) \quad (5.9b)$$

The urbanization rate in Laos is forecasted to have a gradual increase from 22 % in 2005 to 36 % by 2035 (Watcharejyothin, 2009). This shows the increasing trend of electricity consumption in Laos as a change in living style. In addition, the Lao government's poverty reduction plan in terms of increasing rural electrification from the current level of 45 % of households electrified in 2005 to 70 % by 2010, and 90 % by 2020 indicates that domestic consumption is also important for the country. This implies that when consumption of electricity increases, for example, export of electricity to Thailand has to be reduced. It is therefore expected that export of electricity from Laos to Thailand has negative relationship with domestic consumption of electricity in Laos. Export of electricity from Laos to Thailand is also assumed to have positive impact from gross domestic product of Thailand. Different from those of other products, price of electricity trade between Laos and Thailand are set in long term through the Memorandum of Understandings (MOUs). Price of electricity for exports to Thailand is therefore assumed to be constant and that it is not included as an independent variable in export of electricity from Laos to Thailand function. Thus the function of export of electricity from Laos to Thailand is constructed in the following form:

$$EXE_L^T = f(\overset{-}{CE_L}, \overset{+}{GDP_T}) \quad (5.10b)$$

Poverty reduction through the adequate electrification is central to the national development agenda of Laos. The increase in consumption of electricity leads to the increase in electricity generation to fulfill the demand in the country implied by the increasing number of power plants in the country. In order to meet the electricity demand, currently the Lao government is increasing the number power plants with total installed electricity generation capacity of 2,865 MW to server both domestic consumption, and exports to Thailand and Vietnam. This implies that electricity generation in the country is influenced by both domestic consumption as well as export of electricity. It is thus assumed that electricity generation is positively affected by consumption of electricity as well as export of electricity. The function of electricity generation is therefore in the following structure.

$$EG_L = f(\overset{+}{CE_L}, \overset{+}{EXE_L}) \quad (5.11b)$$

Gross domestic product of Laos is assumed to have positive effect on the import of electricity from other countries. Since rural electrification is one of the major goals for Laos to achieve the poverty alleviation as well as sustainable development plan, the area where national

grid does not reach is electrified by importing from neighboring countries. When the demand for electricity to consume in the country increases, it is assumed that there is an increase in import of electricity. Domestic consumption of electricity is therefore assumed to play a role in import of electricity function. Nevertheless, when generation of electricity in Laos is not available to provide adequate electricity, Laos has to import from its neighboring countries. Generation of electricity is thus assumed to have impact on import of electricity. Therefore, import of electricity function is structured in the following form:

$$IME_L = f(\overset{+}{GDP_L}, \overset{+}{CE_L}, \overset{-}{EG_L}) \quad (5.12b)$$

Import of non-electricity products is also an endogenous variable in the model. In the case of import of non-electricity products, it is assumed to be simply dependent on gross domestic products of Laos as illustrated in the following equation:

$$IMEN_L = f(\overset{+}{GDP_L}) \quad (5.13b)$$

Based on the above assumption, Laos-side model is structured in the following form:

Identity Equations

$$GDP_L = C_L + I_L + G_L + (EX_L - IM_L) \quad (5.14b)$$

$$C_L = CE_L + CEN_L \quad (5.15b)$$

$$EX_L = EXE_L + EXEN_L \quad (5.16b)$$

$$EXE_L = EXE_L^T + EXE_L^V \quad (5.17b)$$

$$EG_L = CE_L + EXE_L - IME_L \quad (5.18b)$$

$$IM_L = IME_L + IMEN_L \quad (5.19b)$$

Behavioral Equations

$$CE_L = \alpha_1 + \beta_{11} GDP_L + \varepsilon_1 \quad (5.20b)$$

$$CEN_L = \alpha_2 + \beta_{21} GDP_L + \varepsilon_2 \quad (5.21b)$$

$$I_L = \alpha_3 + \beta_{31} GDP_L + \beta_{32} EXR_L + \varepsilon_3 \quad (5.22b)$$

$$EXE_L^T = \alpha_4 + \beta_{41} CE_L + \beta_{42} GDP_T + \varepsilon_4 \quad (5.23b)$$

$$EG_L = \alpha_5 + \beta_{51} CE_L + \beta_{52} EXE_L + \varepsilon_5 \quad (5.24b)$$

$$IME_L = \alpha_6 + \beta_{61} GDP_L + \beta_{62} CE_L + \beta_{63} EG_L + \varepsilon_6 \quad (5.25b)$$

$$IMEN_L = \alpha_7 + \beta_{71} GDP_L + \varepsilon_7 \quad (5.26b)$$

In Laos-side model, there are 6 identities, and 7 behavioral equations. All of the above identities and behavioral equations in the macroeconometric model are systematically estimated using the two-stage least squares (2SLS) method.

5.3.2. The Demand-side of Electricity Export (Thailand)

Gross domestic product in Thailand-side model is similar to the one in Laos-side model that it is, based on expenditure, sum of private consumption, total investment, total government expenditure, and net export (export minus import). Gross domestic product of Thailand is structured in the following form:

$$GDP_T = C_T + I_T + G_T + (EX_T - IM_T) \quad (5.27b)$$

Based on the purpose of the study involving the analysis about electricity industry in both Laos and Thailand, total consumption in Thailand-side model is also assumed to be divided into consumption of electricity and consumption of other products. Consumption of electricity in Thailand is separated as a part of total consumption, since the electricity imported to Thailand either from Laos or other countries is consumed in both private and government sector. In other word, export of electricity from Laos to Thailand is related to electricity consumption in Thailand. The following equation is the structure of consumption in the model:

$$C_T = CE_T + CEN_T \quad (5.28b)$$

Similar to many countries, import of all goods and services into Thailand consists of various goods and services such as electricity, clothes, wood products, foods, and etc. Depending on the purpose of the study, import equation in the macroeconometric model is not divided or divided. Since the purpose of this macroeconometric model is to study about

electricity sector, import equation in the model is divided into import of electricity and import of non-electricity products. The divided equation is structured as follows:

$$IM_T = IME_T + IMEN_T \tag{5.29b}$$

Import of electricity included in import equation is specified as the sum of import of electricity from Laos and import of electricity from non-Laos countries. Import of electricity from non-Laos countries is mostly from its neighbors such as the Greater Mekong Subregion (GMS) countries due to the low cost of transmission. The following equation is assumed to be the structure of import of electricity in Thailand-side model.

$$IME_T = IME_T^L + IME_T^{LN} \tag{5.30b}$$

In consumption of electricity function, it is assumed that not only gross domestic product is a factor affecting electricity consumption behavior in the country. Since Thailand is the largest consumer of electricity in the Greater Mekong Subregion (GMS), it relies on electricity imports from other GMS members such as Laos, Yunnaprovince of China and others in order to meet its increasing demand. In addition to gross domestic product, consumption of electricity in Thailand is assumed to be determined by import of electricity. The function of electricity consumption is therefore is illustrated as follows:

$$CE_T = f(\overset{+}{GDP_T}, \overset{+}{IME_T}) \tag{5.31b}$$

Consumption of non-electricity is divided from the total consumption equation. Similar to consumption of non-electricity products function in Laos-side model, consumption of non-electricity products in Thailand is assumed to be positively affected by gross domestic product. In other words, consumption of non-electricity in Thailand is also assumed to increase as a result of the increase in gross domestic product, and vice versa. Consumption of non-electricity function is specified as illustrated in the following form.

$$CEN_T = f(\overset{+}{GDP_T}) \tag{5.32b}$$

Investment function in Thailand-side model is also assumed to be similar to investment function in Laos-side model that it increases when gross domestic product increases, and vice versa. As in an example that the depreciation in exchange rate increases investment by increasing demands in both domestic and export markets, but it reduces investment due to the increasing cost of imported intermediate goods and the user cost of capital. Among these

two effects, which effect is dominant is different from country to country. In the case of Thailand, most of its imports are capital goods, intermediate goods, raw materials, oil, and etc (Wikipedia, 2012a); the latter effect of exchange rate depreciation on importing capital is likely to dominate. In other words, investment in Thailand is assumed to be negatively affected by exchange rate. In addition, since to the Asian Financial Crisis began from Thailand in 1997 and recovered by 1999, Thailand was one of the countries that were most affected by the crisis (Pempel, 1999, pp. 118-143), the dummy variable to capture Asian Financial Crisis is applied in investment function in Thailand-side model. The dummy variable from 1997 to 1999 is defined as 1, and otherwise is 0. Investment function in Thailand-side is thus defined as follows:

$$I_T = f(\overset{+}{GDP_T}, \overset{-}{EXR_T}, \overset{+}{DUM_T}) \qquad (5.33b)$$

Since the amount of Laos's electricity exports to Thailand is almost the same as Thailand's electricity imports from Laos (Hamanaka and Tafgar, 2010, pp. 13), it is assumed that import of electricity of Thailand from Laos equals to export of electricity from Laos to Thailand. Therefore, the function of import of electricity from Laos to Thailand is specified as the same as the function of export of electricity from Laos to Thailand. In other words, Thailand's import of electricity from Laos is assumed to have positive relationship with gross domestic product of Thailand, while it is also assumed to have negative relationship with domestic consumption of electricity in Laos. The function of import of electricity from Laos in Thailand-side model is thus in specified in the following form.

$$IME_T^L = f(\overset{-}{CE_L}, \overset{+}{GDP_T}) \qquad (5.34b)$$

According to the mentioned assumption, Thailand-side model is structured as follows:

Identity Equations

$$GDP_T = C_T + I_T + G_T + (EX_T - IM_T) \qquad (5.35b)$$

$$C_T = CE_T + CEN_T \qquad (5.36b)$$

$$IM_T = IME_T + IMEN_T \qquad (5.37b)$$

$$IME_T = IME_T^L + IME_T^{LN} \qquad (5.38b)$$

Behavioral Equations

$$CE_T = \alpha_8 + \beta_{81} GDP_T + \beta_{82} IME_T + \varepsilon_8 \quad (5.39b)$$

$$CEN_T = \alpha_9 + \beta_{91} GDP_T + \varepsilon_9 \quad (5.40b)$$

$$I_T = \alpha_{10} + \beta_{101} GDP_T + \beta_{102} EXR_T + \beta_{103} DUM_T + \varepsilon_{10} \quad (5.41b)$$

$$IME_T^L = \alpha_{11} + \beta_{111} CE_L + \beta_{112} GDP_T + \varepsilon_{11} \quad (5.42b)$$

In Thailand-side model, there are 4 identities, and 4 behavioral equations. Similar to the case of Laos-side model, all of the above behavioral equations and identities in the macroeconometric model are estimated using the two-stage least squares (2SLS) method.

5.3.3. The Demand-side of Electricity Export (Vietnam)

Similar to both Laos-side and Thailand-side, gross domestic product in Vietnam-side is composition of private consumption, total investment, total government expenditure, and net export. The structure of gross domestic product of Vietnam is therefore structure as follows:

$$GDP_V = C_V + I_V + G_V + (EX_V - IM_T) \quad (5.43b)$$

Total consumption in Vietnam-side is also divided into consumption of electricity and consumption of other products (non-electricity products) as follows:

$$C_V = CE_V + CEN_V \quad (5.44b)$$

Import of Vietnam, similar to other countries, consists of various goods and services such as foods, garment, oil, electricity, and etc from different trading partners. Import equation is divided or not divided depending on the purpose of study. Since the purpose of this model is to show the effect on import of electricity from Laos on Vietnamese economy, import equation is divided into import of electricity from Laos and import of non-electricity from Laos as follows:

$$IM_V = IME_V^L + IMELN_V \quad (5.45b)$$

It is assumed that consumption of electricity in Vietnam is determined by gross domestic product as well as electricity generation in Vietnam as structured in the following equation:

$$CE_V = f(\overset{+}{GDP_V}, \overset{-}{EG_V}) \quad (5.46b)$$

Similar to consumption of non-electricity products functions in Laos-side and Thailand-side, consumption of non-electricity products functions in Vietnam is simply assumed to have positive relationship with gross domestic product as follows:

$$CEN_V = f(\overset{+}{GDP_V}) \quad (5.47b)$$

Due to the similar problem to Laos-side case, interest rate is not included in function of investment in Vietnam. Although interest rate is expected to have impact on investment, due to the lack of data on Vietnam's interest rate from 1985 to 1992 while the data applied in the analysis in this study are from 1986 to 2010, it is excluded from the model. Investment function of Vietnam is thus assumed to be simply determined by gross domestic product as shown in the following equation:

$$I_V = f(\overset{+}{GDP_V}) \quad (5.48b)$$

Similar to the case of Laos' export of electricity to Thailand, in Vietnam-side, import of electricity from Laos to Vietnam is assumed to be equal to export of electricity from Laos to Vietnam. Therefore, function of import of electricity from Laos is the same as function of export of electricity from Laos to Thailand that it is assumed to be determined by gross domestic product of Vietnam, consumption of electricity in Laos, and consumption of electricity in Vietnam. Function of Vietnam's import of electricity from Laos is thus specified as follows:

$$IME_V^L = f(\overset{+}{GDP_V}, \overset{-}{CE_L}, \overset{+}{CE_V}) \quad (5.49b)$$

Following the above assumption, Thailand-side model is structured in the following form:

Identity Equations

$$GDP_V = C_V + I_V + G_V + (EX_V - IM_V) \quad (5.50b)$$

$$C_V = CE_V + CEN_V \quad (5.51b)$$

$$IM_V = IME_V^L + IMELN_V \quad (5.52b)$$

Behavioral Equations

$$CE_V = \alpha_{12} + \beta_{121} GDP_V + \beta_{122} EG_V + \varepsilon_{12} \quad (5.53b)$$

$$CEN_V = \alpha_{13} + \beta_{131} GDP_V + \varepsilon_{13} \quad (5.54b)$$

$$I_V = \alpha_{14} + \beta_{141} GDP_V + \varepsilon_{14} \quad (5.55b)$$

$$IME_V^L = \alpha_{15} + \beta_{151} GDP_V + \beta_{152} CE_L + \beta_{153} CE_V + \varepsilon_{15} \quad (5.56b)$$

In Vietnam-side model, there are 3 identities, and 4 behavioral equations. All of the behavioral equations and identities in Vietnam-side model are estimated using two-stage least squares (2SLS) method as also used in the case of Laos-side and Thailand-side models.

It is interesting that not only estimating individual macroeconomic model of each country, but all of macroeconometric models in Laos-side, Thailand-side, and Vietnam-side are integrated in order to see the impact of the changes in one economy on all of three economies simultaneously. The integrated model is built to show the significant interrelation between Laos and Thailand as well as Vietnam in electricity trade sector. In order to see the real effect on the economies, the data applied in the estimation are in the form of real values, rather than nominal values. However, in the case that the data are available only in nominal values, they are converted into real values by dividing them by gross domestic product (GDP) deflator and multiplying them by 100. The obtained data are then said to be in real values.

Chapter 6

Two Stage Least Squares Method in the Analysis of Laos' Electricity Trade with Thailand

Introduction

Since this study involves simultaneous equations models, application of ordinary least squares (OLS) is likely to be inappropriate due to the fact that it generates biased parameter estimates leading to the less accurate results. The alternative estimation method for the model is the two-stage least squares (2SLS). The 2SLS is a technique of extending regression to cover models which violate the OLS regression's assumption of recursively, specifically models where the one or more predictor variables must be assumed to be correlated with the disturbance terms. The 2SLS estimator is obtained by applying all instrumental variables simultaneously in the regression. The estimation using the 2SLS technique uses instrumental variables that are uncorrelated with the error terms to compute estimated values of the problematic predictor(s). The results obtained from the 2SLS estimation are based on variables that are uncorrelated with the error terms, the results obtained from the 2SLS are therefore said to be optimal. Thus, the 2SLS method is preferred to apply in this study.

Prior to the simulation estimation stage, the relationship of independent variables on dependent variables in the behavioral equations is estimated. This study is aimed to show the results obtained from the 2SLS approach applied in both demand and supply-sides of electricity export from Laos. It is interesting that, based on the estimation, their relationship is not only qualitatively but also quantitatively explained. In this stage, the explanation of variables is essential. It is noted that in Laos-side model, the variable GDP_T (gross domestic product of Thailand) in the system is specified as exogenous variable when the macroeconometric model of Thailand is not integrated with the macroeconometric model of

Laos. However, in the Thailand-side model, and the integrated model, it is specified as an endogenous variable. In Laos-side model, there are 7 behavioral equations consisting of domestic consumption of electricity, consumption of non-electricity products, investment, export of electricity to Thailand, electricity production, import of electricity function, and import of non-electricity products. In Thailand-side model, there are 4 behavioral equations including domestic consumption electricity, consumption of non-electricity products, investment, and import of electricity from Laos function, and import of non-electricity products. The difference of this estimation method from the OLS method is that all equations are estimated simultaneously.

In order to understand the meanings from the following models, the following explanations are provided. To understand easily, the less value of significance level the better. Specifically, 1 % significance level is better than 5 % and 10 %. The symbol "*", "**", and "***" in each bracket indicates the significance level of 10 %, 5 %, and 1 %, respectively.

- The number in each bracket is the t-statistic value. A t-test introduced by William Sealy Gosset in 1908 (Mankiewicz, 2001, pp. 158) is any statistical hypothesis test in which the test statistic follows a Student's t distribution if the null hypothesis is supported. In the least squares regression, the high t-statistic value implies that the coefficient is able to be estimated with a fair amount of accuracy. To understand easily, the higher number of "*" in each bracket, the more significant impact of the independent variable (on the right hand-side) on the dependent variable (on the left hand-side).

- F-statistic developed by Ronald A. Fisher in 1920s (Lomax, 2007, pp. 10) is used to test the hypothesis that all coefficients (except the intercept) are equal to zero. Its "p-value" (Prob (F-statistic)) indicates probability that the hypothesis is indeed true. To understand easily, the higher number of "*" on the "F-statistic" the higher ability of all coefficients to explain the independent variable.

- Adjusted R-squared (adjusted R^2) is the coefficient of determination indicating goodness-of-fit of the regression. Adjusted R^2 value equals to one if fit is perfect, and to zero when the regressors (on the right hand-side) have no explanatory power whatsoever.

- Durbin–Watson statistic introduced by Durbin and Watson (1950) is a test statistic used to detect the presence of autocorrelation in the residuals from a

statistical regression analysis. The value of Durbin-Watson statistic is always between 0 and 4. A value of 2 means that there is no autocorrelation in the sample. Small value of Durbin–Watson statistic indicates that successive error terms are, on average, close in value to one another, or positively correlated. On the other hands, if the value of Durbin–Watson statistic is greater than 2, there is an indication that successive error terms are, on average, much different in value to one another, or negatively correlated. As a rough rule of thumb, if Durbin–Watson statistic is less than 1.0, there may be cause for autocorrelation issue in the sample.

6.1. Supply-side of Electricity Export (Laos)

6.1.1. Laos' Consumption of Electricity Function

$$CE_L = \text{-}31{,}528{,}912 + 0.0268 GDP_L$$

(-9.2655)*** (20.8845)***

Table 6.1: Estimation Result of Electricity Consumption Function

Dependent Variable: CE_L
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-31,528,912	3,402,801	-9.2655	0.0000
C(2)	0.0268	0.0012	20.8845	0.0000

R-squared	0.9515	Mean dependent var	31,201,275
Adjusted R-squared	0.9493	S.D. dependent var	35,540,740
S.E. of regression	7,995,360	Sum squared resid	1.47E+15
F-statistic***	436.1635	Durbin-Watson stat	0.6638
Prob(F-statistic)	0.0000	Second-Stage SSR	2.43E+15

Source: Author.

Although the demand is forecasted to be high, electricity consumption in Laos is still relatively low compared to that in other Asian countries. Electrification is one of the important goals of poverty reduction in the country. In accordance with the government's poverty reduction agenda in terms of rural electrification, domestic consumption of electricity in Laos been growing rapidly. The governmental agenda is to increase the electrification ratio in the country from 45 % of households electrified in 2005 to 70 % by 2010, and 90 % by 2020 (Vientiane Times, 2008). In addition, most of electricity consumption is in mining industry, manufacture, and business. The average growth of domestic consumption of electricity is expected to be in high level in due to the frequently changed lifestyles in accordance with the higher income.

Since consumption is the value of goods and services bought by people, current income is the most relevant determinant whether people can buy goods and services to consume. Put

differently, when their income increases, people can buy more goods and services. This shows positive relationship between consumption and income. Similar to consumption of other goods and services, current income indicated by gross domestic product has positive relationship with the consumption of electricity in this function. According to the estimated result using the two stage least square method, the elasticity of 0.02 indicates that consumption of electricity increases by 2 million USD when gross domestic product increases by 200 million USD. Although value of Durbin–Watson statistic of 0.66 is not high, the values of t-statistic, adjusted R^2 as well as F-statistic are significantly high indicating favorable result from the estimation. The t-value of gross domestic product variable is significant at 1 % indicating that it explains the independent variable—consumption of electricity well. Since the closer adjusted R^2 value is to 1, the greater the ability of that model to predict a trend, the high adjusted R^2 value of 0.94 indicates that this model predicts the trend well. Moreover, the high value of F-statistic implies that the variable gross domestic product predicts consumption of electricity well.

6.1.2. Laos' Consumption of Non-Electricity Products Function

$$CEN_L = 630{,}000{,}000 + 0.4526 GDP_L$$

(3.8506)*** (7.3154)***

Table 6.2: Estimation Result of Consumption of Non-Electricity Products Function

Dependent Variable: CEN_L
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	630,000,000	164,000,000	3.8506	0.0008
C(2)	0.4526	0.0618	7.3154	0.0000

R-squared	0.6849	Mean dependent var	1690,000,000
Adjusted R-squared	0.6712	S.D. dependent var	671,000,000
S.E. of regression	385,000,000	Sum squared resid	3.40E+18
F-statistic***	53.5158	Durbin-Watson stat	1.3114
Prob(F-statistic)	0.0000	Second-Stage SSR	2.88E+18

Source: Author.

Similar to consumption of electricity, gross domestic product has positive effect on consumption of non-electricity products as assumed. The values of t-statistic and F-statistic are significant at 1 % indicating that gross domestic product predicts the trend of consumption of non-electricity products well. It has relatively high effect on consumption of non-electricity products indicated by the high elasticity of 0.45. Moreover, the t-statistic value in this model also has 1 % level of significance of 99 % level of confidence. In addition, the value of Durbin–Watson statistic of 1.31 which is near 2 indicates that the independence assumption is valid. According to the estimation, consumption of non-electricity products increases by about 5 million USD when gross domestic product increases by 10 million USD.

6.1.3. Laos' Investment Function

$$I_L = -3.955896 + 0.9322 GDP_L + 0.4674 EXR_L$$

(-0.8873) (3.9753)*** (4.6885)***

Table 6.3: Estimation Result of Investment Function

Dependent Variable: I_L
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-3.9558	4.4580	-0.8873	0.3845
C(2)	0.9322	0.2345	3.9753	0.0006
C(3)	0.4674	0.0997	4.6885	0.0001

R-squared	0.8932	Mean dependent var	19.6551
Adjusted R-squared	0.8835	S.D. dependent var	0.9915
S.E. of regression	0.3382	Sum squared resid	2.5178
F-statistic***	84.3690	Durbin-Watson stat	0.8379
Prob(F-statistic)	0.0000	Second-Stage SSR	4.2829

Source: Author.

In Laos, the average private domestic investment is approximately 5.3 % of GDP, three times less than foreign direct investment (FDI) (World Bank, 2011). The low domestic private

investment is due to the low social returns to economic activity, poor intermediation, and lagging regulatory reforms, particularly with the implementation of legislation. However, the country is promoting both domestic and foreign investments indicated by the revised General Tax Law approved by the National Assembly in June 2011 abolishing the minimum taxation. This contributes to an improvement in investment climate in the country. The new law also abolishes lengthy and cumbersome licensing approval procedures, creates a level playing field for domestic as well as foreign investors by harmonizing business entry procedures and investment incentives. Mostly, inward investment flowed into mostly the natural resources sectors, particularly hydroelectric power and mining sectors.

The estimated result follows the assumption that gross domestic product and exchange rate have positive effects on investment in Laos. According to the result, despite the relatively small value of Durbin–Watson statistic, there is unlikely to have any problem with this model since the adjusted R^2 value is relatively close to 1, and the F-statistic value as well as the values of the t-statistic of both gross domestic product and exchange rate are significant at 1 %. Gross domestic product plays significant role in investment indicated by the high elasticity of 0.93. This elasticity shows that when gross domestic product increases by 10 million USD, the investment increases by about 9 million USD.

The change in exchange rate has two opposite relationships with investment. The depreciation of domestic currency (increase in exchange rate), for example, causes the marginal profit of investing an additional unit of capita to increase, since the investor gets higher revenues from both domestic and foreign sales due to the cheaper price. However, this effect is counterbalanced by the rising variable cost and the higher price for imported capital. The former effect seems to dominate in the case of Lao economy since large share of investment in Laos is the export focused sectors including high value processed and fresh vegetables, fruits and other consumable agricultural products which need less imports of capital (Richard and Nghardsaysone 2010a, 2010b). The estimate result shows that 10 % depreciation in exchange rate results in an average increase in investment by about 5 %.

6.1.4. Laos' Export of Electricity to Thailand Function

$$EXE_L^T = 4{,}990{,}104 + 0.00005GDP_T - 0.1371CE_L$$

(0.7725) (1.6562) (-2.3848)**

Table 6.4: Estimation Result of Export of Electricity to Thailand Function

Dependent Variable: EXE_L^T
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	4,990,104	6,459,466	0.7725	0.4484
C(2)	0.0000	0.0000	1.6562	0.1125
C(3)	-0.1371	0.0575	-2.3848	0.0266

R-squared	0.6139	Mean dependent var	20,478,398
Adjusted R-squared	0.5588	S.D. dependent var	7,941,854.
S.E. of regression	5,274,956	Sum squared resid	5.84E+14
F-statistic***	10.9611	Durbin-Watson stat	2.0931
Prob(F-statistic)	0.0001	Second-Stage SSR	5.99E+14

Source: Author.

Export of Laos in 2010 reached over 2 billion USD. The goods of from Laos are often sold to Thailand, China, and Vietnam sharing about 33 %, 24 %, and 11 % in 2010. The main products exported to these countries are electricity, copper, tin, gold, woodcrafts, and agricultural products. Electricity has long been a major export since the construction of large-scale hydropower projects in the country. About 90 % of electricity generated in the country is exported to Thailand (Patel, 2011). Among the Greater Mekong Subregion (GMS), Thailand is a net electricity import country with energy import dependency of 50 % in 2000, and is estimated to import about 60 % to 70 % of its energy needs by 2030, and about 80 % to 89 % by 2050. The significant demand is due mainly to the growing demand in industrial sector, and the limited domestic energy resources availability in the country. Due to the increasing demand, Thailand has therefore imported from its neighboring countries such as Laos. To accommodate the steady increase in demand for electricity in Thailand, the Lao and Thai governments have extended the Memorandum of Understandings (MOUs) several times since 1993 with the purpose to increase export of electricity from Laos to Thailand. The MOU signed in 2007 saw the power purchase agreement expanded to cover electricity supply of 7,000 MW of electricity from Laos to Thailand by 2020 (Phomsoupha, 2009).

Since electricity trade between Laos and Thailand are in the form of memorandum of understandings (MOUs) which is a long term agreement, gross domestic product does not show

high effect on electricity export from Laos to Thailand. Furthermore, the significantly increasing demand in Thailand indicated by the extension of MOU for increasing electricity from Laos also implies that Thailand can import more electricity from Laos as much as Laos can supply to Thailand. However, since the Lao government recognizes the importance of poverty reduction goal through domestic consumption of electricity, export of electricity to Thailand rather depends on consumption of electricity in Laos. In other words, the estimated result shows that when the value of consumption of electricity in Laos increases by 10 million USD, electricity export to Thailand is reduced by 1.3 million USD. Different from other goods, the value of electricity export to Thailand is assumed not to have impact from the price, since electricity export from Laos to Thailand is in the form of MOU which specifies the constant price for long term (or at least unchanged much price in the case that there is a renegotiation between two countries) (United Nations ESCAP, 2007).[32] The change in value of electricity from Laos to Thailand is rather affected by the change in amount of electricity that Laos exports to Thailand. For example, the increase in consumption of electricity in Laos causes the amount of electricity produced for exporting to Thailand to be reduced. The value of electricity export to Thailand therefore decreases while the price of electricity is constant. The result shows the expected relationship between the dependent variable and the independent variables with 5 %, and 1 % significant level in consumption of electricity. The 1 % significant level of F-statistic value generally shows the higher ability of all independent variables to explain the independent variable. Furthermore, the Durbin–Watson statistic of 2.09 indicates that the samples give us enough information to make a precise determination.

6.1.5. Laos' Electricity Generation Function

$$EG_L = 1{,}972{,}138 + 0.8368 CE_L + 0.0637 EXE_L$$

(0.1933) (11.5427)*** (0.1770)

[32] The export price of electricity is in the Appendix 5.1, and Appendix 5.2.

Table 6.5: Estimation Result of Electricity Generation Function

Dependent Variable: EG_L
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1,972,138	10,199,894	0.1933	0.8485
C(2)	0.8368	0.0724	11.5427	0.0000
C(3)	0.0637	0.3601	0.1770	0.8611

R-squared	0.9437	Mean dependent var	29,533,508
Adjusted R-squared	0.9385	S.D. dependent var	30,170,125
S.E. of regression	7,476,989	Sum squared resid	1.23E+15
F-statistic***	177.8920	Durbin-Watson stat	1.4071
Prob(F-statistic)	0.0000	Second-Stage SSR	1.96E+15

Source: Author.

Since the first commission of the first hydropower plant in 1972, electricity generated in Laos was primarily for domestic consumption whereas the surplus of electricity was exported to particularly Thailand. Currently, Thailand is the biggest electricity importer from Laos accounted with about 90 % of total electricity export along with Vietnam. The rise in both domestic and foreign demands stimulates the promotion of electricity generation in Laos.

According to the estimated result, both domestic consumption of electricity and export of electricity have positive impacts on electricity generation in Laos. As shown in Table 6.5, the ability of domestic consumption of electricity to explain the trend of electricity generation in Laos is superior to that of export of electricity indicated by the higher t-statistic value of domestic consumption of electricity. According to the estimation, the increase in the value of domestic consumption of electricity by 10 million USD increases the value of electricity generation by 8 million USD. This shows the large impact of domestic consumption of electricity on electricity generation, since the Lao government's National Growth and Poverty Eradication Strategy (NGPES) is also focused on promoting adequate electrification in the country. In order to achieve the target that 90 % of households would be electrified by 2020 (Watcharejyothin, 2009), the government is promoting electricity generation sector indicated by the increase in number of power plants. Currently, Laos has 16 operational power plants most of which are primarily focused on exporting to Thailand. In order to meet the increasing

demand, at the present, the government is planning to build 10 more hydropower plants which have capacity to generate approximately 5,015 MW of electricity (Lao Voice, 2011). Although the low level of significance, export of electricity shows positive effect on electricity generation indicated by the increase in electricity generation by 6 million USD when export of electricity increases by 100 million USD. The closer to 2 of Durbin–Watson statistic value indicates that the samples employed in the estimation give enough information for the forecast. The 1 % level of significance of the F-statistic, and high value of the adjusted R^2 implies the fit of model.

6.1.6. Laos' Import of Electricity Function

$$IME_L = 12{,}104{,}036 + 0.0131GDP_L + 0.4620CE_L - 1.1101EG_L$$

(2.1604)** (2.9071)*** (2.1387)** (-5.0189)***

Table 6.6: Estimation Result of Import of Electricity Function

Dependent Variable: IME_L
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	12,104,036	5,602,473	2.1604	0.0424
C(2)	0.0131	0.0045	2.9071	0.0084
C(3)	0.4620	0.2160	2.1387	0.0444
C(4)	-1.1101	0.2211	-5.0189	0.0001

R-squared	0.6584	Mean dependent var	24,421,542
Adjusted R-squared	0.6096	S.D. dependent var	8,969,354
S.E. of regression	5,604,025	Sum squared resid	6.60E+14
F-statistic***	9.5064	Durbin-Watson stat	1.3782
Prob(F-statistic)	0.0003	Second-Stage SSR	1.04E+15

Source: Author.

Laos not only exports electricity to its neighboring countries, but also imports some amount of electricity from its neighbors (Thailand, Vietnam and China) to serve the increasing consumption of electricity in the country especially the rural area, since it is a cheaper than to

extend the national grid to each corner of the country (the 22 KV transmission lines cost between 10,000 USD and 15,000 USD per Km, depending on the accessibility of the road). Import of electricity is to follow the national poverty alleviation plan in terms of the adequate electrification in the country. As domestic consumption of electricity increases by 10 million USD, the estimated result shows that import of electricity increases by about 5 million USD. The estimation using two-stage least squares (2SLS) shows the expected sign of each variable on import of electricity variable with the level of significance from 5 % to 1 %. The relatively high values of F-statistic as well as adjusted R^2 indicate the favorable fit of model. Regarding autocorrelation test, there is unlikely to have problem with the samples since the Durbin–Watson statistic value is close to 2.

With elasticity of 0.01, gross domestic product shows moderate influence on import of electricity. This elasticity indicates the increase in import of electricity by 1 million USD in parallel with the increase in gross domestic product by 100 million USD. The ability of electricity generation in the country is assumed to be one of the main decisions of importing electricity. As the domestic demand increases while the ability to generate electricity to meet the demand is inadequate, the country needs to import from neighboring countries such as Thailand, Vietnam and China. With 1 % significant level, the decrease in value of electricity generation in the country by 1 million USD leads to the increase in import of electricity by about 1 million USD.

6.1.7. Laos' Import of Non-Electricity Products Function

$$IMEN_L = -577{,}000{,}000 + 0.6449 GDP_L$$

(-6.1141)** (18.0850)***

Table 6.7: Estimation Result of Import of Non-Electricity Products Function

Dependent Variable: $IMEN_L$
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-577,000,000	94,348,927	-6.1141	0.0000
C(2)	0.6449	0.0356	18.0850	0.0000

R-squared	0.9327	Mean dependent var	929,000,000
Adjusted R-squared	0.9297	S.D. dependent var	837,000,000
S.E. of regression	222,000,000	Sum squared resid	1.13E+18
F-statistic***	327.0695	Durbin-Watson stat	1.0845
Prob(F-statistic)	0.0000	Second-Stage SSR	7.27E+17

Source: Author.

Three main trading partners for both export and import are the Greater Mekong Subregion members such as Thailand, China, and Vietnam. Among them, Thailand is the largest importing partner sharing 67 % of total Laos's imports, along with China, and Vietnam sharing 15 %, and 6 % in 2010, respectively (ADB, 2011c). Since Laos is not specialized in producing machinery and equipment, vehicles, and fuel, it has imported from its trading partners while most of the country's contributed exports are wood products, electricity, garments, coffee, tin, copper, gold, and agricultural products. The products prohibited to be imported into Laos are all kind of war arms, illegal drugs, hazardous materials, pornography, toxic chemicals, and agricultural produce which is grown domestically in sufficient quantities such as chilies, bananas, tomatoes, lemons, eggplant, and etc (AE, 2005).

In the function of import of non-electricity products, the F-statistic value and the t-statistic value of all coefficients are significant at 1 % level implying that there is unlikely to have any problem with the model. Furthermore, the adjusted R^2 value is close to 1 indicating the fit of the model. The value of Durbin–Watson statistic is not so far from 2 showing that there is no sever serial correlation. The estimated result illustrates the high effect of gross domestic product on the import of non-electricity products implied by the elasticity of 0.64. According to the result, import of non-electricity products increases by about 6 million USD when there is an increase in gross domestic product by 10 million USD.

6.2. Demand-side of Electricity Export (Thailand)

6.2.1. Thailand's Consumption of Electricity Function

$$CE_T = -4{,}100{,}000{,}000 + 0.1154 GDP_T + 0.7576 IME_T$$

(-3.8193)*** (12.0776)*** (12.0473)***

Table 6.8: Estimation Result of Electricity Consumption Function

Dependent Variable: CE_T
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-4,100,000,000	1,070,000,000	-3.8193	0.0009
C(2)	0.1154	0.0095	12.0776	0.0000
C(3)	0.7576	0.0628	12.0473	0.0000

R-squared	0.9897	Mean dependent var	2.27E+10
Adjusted R-squared	0.9887	S.D. dependent var	1.25E+10
S.E. of regression	1,320,000,000	Sum squared resid	3.84E+19
F-statistic***	1028.2320	Durbin-Watson stat	1.7767
Prob(F-statistic)	0.0000	Second-Stage SSR	1.40E+20

Source: Author.

Thailand is the largest electricity consumer among the Greater Mekong Subregion economies. The increasing demand of electricity in Thailand is in parallel with a rapid industrialization of the country leading to high economic growth. In consequence with a rapid growth, demand for electricity in the industrial sector has particularly been growing rapidly. Over the past decade, the increasing demand in Thailand is strongly influenced by the rapid growth in industrial consumption in the country. In 2010, electricity consumption in industrial sector covered the largest share total electricity consumption in the whole country with the share of 44.35 %, followed by business sector, and residential sector covering 24.20 %, and 22.33 % of total electricity consumption in the whole country, respectively.

Using the two-stage least squares (2SLS) method to estimate the relationship between domestic consumption of electricity and gross domestic product, and import of electricity, domestic consumption of electricity in Thailand is largely influenced by import of electricity. The estimated result shows that 10 million USD increase in import of electricity rises consumption of electricity by about 7 million USD. The result implies that import of electricity is essential for Thailand in order to serve the significant demand while the resources availability in the country is limited. According to the data obtained from EPPO (2012c), Thailand consumed about 103,508 Gwh of electricity in 2010 while Laos consumed 2,228 Gwh of electricity in the same year. This relatively large number shows the tremendous consumption of electricity in Thailand.

Similar to consumption function of other goods and services, income indicated by gross domestic product plays a role in consumption of electricity function. The estimation indicates that with 1 % level of significance, gross domestic product shows positive effect on consumption of electricity as expected. According to the estimated result, the value of consumption of electricity increases by 1 million USD when gross domestic product increases by 10 million USD. The ability of all coefficients in explaining the trend of consumption of electricity is high indicated by the 1 % significance level of the F-statistic. The Durbin–Watson statistic value of 1.77 indicates that the information obtained from the samples has adequate ability to make determination. Furthermore, t-statistic in each bracket is significant at 1 %, and the adjusted R^2 value of 0.98 is relatively high.

6.2.2. Thailand's Consumption of Non-Electricity Products Function

$$CEN_T = 17{,}500{,}000{,}000 + 0.3068 GDP_T$$

(8.6350)*** (25.9303)***

Table 6.9: Estimation Result of Consumption of Non-Electricity Products Function

Dependent Variable: CEN_T
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.75E+10	2,030,000,000	8.6350	0.0000
C(2)	0.3068	0.0118	25.9303	0.0000

R-squared	0.9678	Mean dependent var	6.74E+10
Adjusted R-squared	0.9664	S.D. dependent var	1.74E+10
S.E. of regression	3,190,000,000	Sum squared resid	2.34E+20
F-statistic***	672.3820	Durbin-Watson stat	0.590341
Prob(F-statistic)	0.0000	Second-Stage SSR	4.28E+20

Source: Author.

The current income represented by gross domestic product is assumed to be a good determinant of consumption function. Similarly, it is assumed to have positive impact on consumption of non-electricity products in this model. In other words, the increase or decrease in consumption of non-electricity products is assumed to be determined by the increase or decrease in gross domestic product. The estimated result indicates, regardless of low Durbin–Watson statistic, the 1 % significant level of the values of F-statistic and t-statistic proving that gross domestic product explains the trend of consumption of non-electricity products well. In addition, the goodness of fit indicated by the 0.96 adjusted R^2 shows that this regression fits the data well. The elasticity of 0.3 indicates the relationship between gross domestic product and consumption of non-electricity products in numerical term. Put differently, there is an increase in consumption of non-electricity products by 3 million USD if there is an increase in gross domestic product by 10 million USD.

6.2.3. Thailand's Investment Function

$$I_T = -0.033602 + 1.1645 GDP_T - 1.5695 EXR_T$$

(-0.0113) (9.9932)*** (-4.1568)***

Table 6.10: Estimation Result of Investment Function

Dependent Variable: I_T
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.0336	2.9563	-0.0113	0.9910
C(2)	1.1645	0.1165	9.9932	0.0000
C(3)	-1.5695	0.3775	-4.1568	0.0004

R-squared	0.8202	Mean dependent var	24.5320
Adjusted R-squared	0.8038	S.D. dependent var	0.4365
S.E. of regression	0.1933	Sum squared resid	0.8221
F-statistic***	51.3676	Durbin-Watson stat	0.3840
Prob(F-statistic)	0.0000	Second-Stage SSR	0.7340

Source: Author.

With its growing economy in the Greater Mekong Subregion (GMS) as well as in Asia, a rock-solid industrial sector in Thailand remains a highly attractive investment destination to overseas investors (OBG, 2010). It is listed as one of the top 15 most attractive investment destinations globally (UNCTAD, 2010). Most attractive business sectors for investment in Thailand, in terms of number and value, are production of metal products, machinery, and transport equipment (44 projects with total investment value of 14.42 billion Thai Baht), and service and public utility (42 projects with an investment value of 10.34 billion Thai baht) (Singh, 2010). Thailand is presently a newly industrialized country which is heavily export-dependent, with exports accounting for more than two thirds of its gross domestic product. Its major export products are Thai rice, textiles and footwear, jewellery, cars, computers, and electrical appliances while its major import products are capital and intermediate goods, raw materials, fuel, and consumer goods (Wikipedia, 2012a).

Considering its major import products, exchange rate is likely to have negative impact on investment in Thailand. According to Harchaoui et al (2005), changes in exchange rate have two opposite effects on investment. However, which effect dominates is different from country to country. When domestic currency depreciates, for example, investment is likely to increase since the investor will get higher revenues from the sale. However, this positive effect is counterbalanced by the increasing variable cost and the higher price for imported capital. The

latter effect is likely to dominate in the case of Thailand, since most of its imports are capital and intermediate goods, raw materials, and etc. The result supports the assumption that exchange rate has negative effect on investment in Thailand side model. In numerical term, the increase in Thai exchange rate by 1 % leads to the decrease in investment by 1.5 %. The t-Statisitc values of both gross domestic product and exchange rate are significant at 1 %. The gross domestic product shows positive effect on investment that there is an increase in investment by 1 million USD, if there is an increase in gross domestic product by 1 million USD. Both exchange rate and gross domestic product show high ability to predict investment indicated by the 1 % significant level of the F-statistic. Although the value of Durbin–Watson statistic is relatively low, the high adjusted R^2 value of 0.80 shows that this regression fits the data well.

6.2.4. Thailand's Import of Electricity from Laos Function

$$IME_T^L = 4{,}990{,}104 + 0.00005GDP_T - 0.1371CE_L$$

(0.7725) (1.6562) (-2.3848)**

Table 6.11: Estimation Result of Import of Electricity from Laos Function

Dependent Variable: IME_T^L
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	4,990,104	6,459,466	0.7725	0.4484
C(2)	0.0000	0.0000	1.6562	0.1125
C(3)	-0.1371	0.0575	-2.3848	0.0266

R-squared	0.6139	Mean dependent var	20,478,398
Adjusted R-squared	0.5588	S.D. dependent var	7,941,854
S.E. of regression	5,274,956	Sum squared resid	5.84E+14
F-statistic***	10.9611	Durbin-Watson stat	2.0931
Prob(F-statistic)	0.0001	Second-Stage SSR	5.99E+14

Source: Author.

In parallel with rapid industrialization of the country, demand of electricity in particularly the industrial sector in Thailand has been growing rapidly. Over the past decade, the rising demand in Thailand is significantly influenced by the rapid growth in consumption of electricity in this sector. The opposite direction between its economic development and sources of energy leads Thailand to be a largest importer of electricity in the Greater Mekong Subregion (GMS). In other words, while the economy is growing, the electricity sources to support the growth are declining (ADB, 2009a). Thailand is an energy importing country with energy import dependency of 50 % in 2000, and the import is estimated to reach about 80 % to 89 % by 2050 (Shrestha et al, 2007). In order to meet the increasing demand, Thailand has imported significant amount of electricity from other countries especially member countries of the GMS including Laos. Presenting a long-term viable customer for electricity generated from Laos, since the first commission of Laos's hydropower plant in 1972, Thailand is the largest electricity exporting market for Laos sharing about 90 % of total electricity export (Watcharejyothin, 2007). Since electricity generated in Laos mostly comes from hydropower based plants which have less environmental issues, Thailand is likely to increase the import electricity from Laos. Import of electricity from Laos also provides political relationship between two countries.

Due to the significant increasing demand in the country, Thailand is likely to import more electricity from Laos as much as Laos can supply to Thailand implied by the frequent extension of Memorandum of Understandings (MOUs) for increasing electricity from Laos. In this model, gross domestic product of Thailand is therefore assumed not to have significant impact on electricity export from Laos to Thailand. Nevertheless, since the national poverty reduction through increasing electrification rate in the country is seen as the essential goal of the Lao government, export of electricity from Laos to Thailand is assumed to be rather affected by consumption of electricity in Laos. In other words, when consumption of electricity in Laos increases or decreases export of electricity from Laos to Thailand is expected to decrease or increase all other things being equal. The estimated result using two-stage least squares (2SLS) method supports this assumption by showing that export of electricity from Laos to Thailand decreases by 1.3 million USD when consumption of electricity in Laos increases by 10 million USD. As the result indicates, the F-statistic is significant at 1 % indicating that all of the independent variables explain the dependent variable well. Moreover, there is unlikely to have problem of serial correlation since the value of Durbin–Watson statistic is relatively close to 2. In addition, with 5 % significant level, consumption of electricity has the expected relationship with export of electricity from Laos to Thailand. These high level of significance indicate that this variable predict the trend of the

dependent variable in this model well. Despite the less level of significant, gross domestic product shows the positive effect on export of electricity from Laos to Thailand.

6.2.5. Thailand's Import of Electricity from Non-Laos Countries Function

$$IME_T^{LN} = -29{,}500{,}000 + 0.6553GDP_T$$

(-3.8636)*** (14.67105)***

Table 6.12: Estimation Result of Import of Electricity from Non-Laos Function

Dependent Variable: IME_T^{LN}
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-2.95E+10	7,650,000,000	-3.8636	0.0008
C(2)	0.6553	0.0446	14.6710	0.0000

R-squared	0.9040	Mean dependent var	7.70E+10
Adjusted R-squared	0.8998	S.D. dependent var	3.80E+10
S.E. of regression	1.20E+10	Sum squared resid	3.33E+21
F-statistic***	215.2399	Durbin-Watson stat	0.5975
Prob(F-statistic)	0.0000	Second-Stage SSR	3.53E+21

Source: Author.

Due to the increasing demand in Thailand in accordance with its economic growth, only hydropower from Laos is inadequate to meet the demand in the country. Therefore not only Laos, Thailand has also increasingly favored importing electricity from its neighboring countries such as Cambodia, Malaysia, and Myanmar to fulfill the demand (Sarntijaree, 2009). Thailand is capable to avoid the increasing power import dependency if it successes in building nuclear power plants in the country which has cumbersome feasibility of construction due to the controversy of ability whether Thailand can build nuclear power plants in the country. Regarding the nuclear power projects in Thailand, there have been oppositions by the environmentalists and local villagers living in the provinces listed as potential sites for nuclear power plant construction due to the potential risk from nuclear power plants. Since the

incidence of damages of nuclear power plants in Japan caused by the earthquakes and tsunamis that struck the northeastern coastline of Japan on 11 March 2011, the feasibility whether to build nuclear power plant in Thailand became more unclear. Other than nuclear power, coal and natural gas resources form large a part of the generating portfolio. Furthermore, renewable potential in Thailand appears to be less significant in comparison with other Asian countries (Dublin, 2012). The mentioned issues imply that the better option to accommodate the increasing demand in Thailand is likely to be importing from its neighbors.

This function is structured to show the trend of Thailand's import of electricity from non-Thailand countries using the two-stage least squares (2SLS) method. Import of electricity from non-Laos countries function is assumed to have positive relationship with gross domestic product of Thailand. According to the estimated result, with the 1 % significant level gross domestic product appears to have large impact on import of electricity from non-Laos countries indicated by the elasticity of 0.65. The result shows that other things being constant, import of electricity from non-Laos countries increases by about 7 million USD if gross domestic product of Thailand increases by 10 million USD. Despite the relatively low value of Durbin–Watson statistic, the high values of the adjusted R^2 and the F-statistic imply that there is unlikely to have any problem with this model.

6.2.6. Thailand's Import of Non-Electricity Products Function

$$IMEN_T = -10{,}700{,}000{,}000 + 0.1305 GDP_T$$

(-3.0713)*** (6.4203)***

Table 6.13: Estimation Result of Import of Non-Electricity Products Function

Dependent Variable: $IMEN_T$
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-1.07E+10	3,480,000,000	-3.0713	0.0054
C(2)	0.1305	0.0203	6.4203	0.0000

R-squared	0.6337	Mean dependent var	1.05E+10
Adjusted R-squared	0.6178	S.D. dependent var	8,860,000,000
S.E. of regression	5,480,000,000	Sum squared resid	6.90E+20
F-statistic***	41.2211	Durbin-Watson stat	0.3693
Prob(F-statistic)	0.0000	Second-Stage SSR	6.47E+20

Source: Author.

Thailand which is the most economy in the Greater Mekong Subregion (GMS) is a heavily export-dependent economy with the volume of exports accounting for more than two thirds of country's gross domestic product. The trade pattern of Thailand is different from other GMS countries in the sense that its major sources of export income are from the exports of machines and equipment. In addition, export of agricultural products, particularly Thai rice is also one of the most important sectors in the country. Thailand is among the top 10 rice producing countries in the world (Baldwin and Childs, 2011). Regarding the structure of export destinations, major trading partners of Thailand are the United States, Japan, and China. Regarding the structure of importing partners, its primary sources of imports are Japan, followed by China, and the United States. According to the Asian Development Database in 2010, Japan was the largest source of Thailand's imports accounting for 21 % of its total imports, along with China and the United States accounting for 13 % and 6 % of its total imports, respectively. Major commodities imported from these countries are electronic integrated circuits, machinery and parts, vehicles, chemicals, iron and steel, and fuels and crude oil.

Applying the two-stage least squares (2SLS) method, this function is formed to estimate the trend of Thailand's import of non-electricity products. Similar to that in Laos-side model, import of non-electricity products is assumed to be positively affected by

gross domestic product. Without regard to the low value of Durbin–Watson statistic, the value of the F-statistic and the values of the t-statistic in both constant term and gross domestic product variable indicate that import of non-electricity products is well predicted by gross domestic product. Specifically stating in numerical term, 10 million USD increase in gross domestic product leads to the increase in import of non-electricity products by 1 million USD, ceteris paribus. In contrast, import of non-electricity products decreases by 1 million USD if there is a decrease in gross domestic product by 10 million USD given other things being equal.

6.3. Demand-side of Electricity Export (Vietnam)

6.3.1. Vietnam's Consumption of Electricity Function

$$CE_V = 277{,}000{,}000 - 0.0150GDP_V + 0.0396EP_V$$

(0.9417) (-0.9767) (2.9170)***

Table 6.14: Estimation Result of Electricity Consumption Function

Dependent Variable: CE_V
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	277,000,000	294,000,000	0.9417	0.3566
C(2)	-0.0150	0.0153	-0.9767	0.3393
C(3)	0.0396	0.0135	2.9170	0.0080
R-squared	0.5800	Mean dependent var		908,000,000
Adjusted R-squared	0.5419	S.D. dependent var		891,000,000
S.E. of regression	603,000,000	Sum squared resid		8.00E+18
F-statistic***	17.0084	Durbin-Watson stat		1.697151
Prob(F-statistic)	0.0000	Second-Stage SSR		6.69E+18

Source: Author.

Over the last decades, Vietnam's economy has grown, on average, by 7.3 % annually. Along with rapid economic growth, domestic consumption of energy has significantly

increased. In Vietnam, half of domestic energy consumption comes from oil, followed by hydropower (20 %), coal (18 %), and 12 % comes from natural gas. Over two decades, Vietnam has emerged as one of the key regional producer of oil and natural gas in Southeast Asia. The country has promoted oil and natural gas production by introducing market reform, allowing greater foreign company involvement in these sectors with the aim to meet domestic consumption as a result of rapid economic growth.

In order to meet the increasing demand, Vietnam has imported electricity from China with the purpose to prevent electricity shortages especially in the north, and some from Laos. In addition, to diversify the country's energy supply, Vietnam has reportedly considered adding nuclear power to its generation mix. Although per capita electricity consumption in Vietnam is ranked among the lowest in Asia, its demand for electricity has risen in recent years due mainly to the rapid commercial sector growth, and elevated living standards.

Statistically estimating, consumption of electricity in Vietnam, similar to consumption of other goods and services, shows positive relationship with income indicated by gross domestic product. In addition, when Vietnam can produce more electricity, consumption of electricity in the country also increases. According to the estimated result using two-stage least squares method, the elasticity of 0.03 in the variable electricity generation with 1 % significance level of t-value shows that, ceteris paribus, when value of electricity generation in the country increases by 100 million USD, consumption of electricity in Vietnam tends to increase by about 3 million USD. The favorable values of F-statistic, Durbin–Watson statistic, and adjusted R^2 confirm the validity of this model.

6.3.2. Vietnam's Consumption of Non-Electricity Products Function

$$CEN_V = -1{,}740{,}000{,}000 + 0.6305 GDP_V$$

(-0.5367) (8.9951)***

Table 6.15: Estimation Result of Consumption of Non-Electricity Products Function

Dependent Variable: CEN_V
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-1,740,000,000	3250,000,000	-0.5367	0.5966
C(2)	0.6305	0.0700	8.9951	0.0000

R-squared	0.7609	Mean dependent var	23,800,000,000
Adjusted R-squared	0.7505	S.D. dependent var	15,800,000,000
S.E. of regression	7,910,000,000	Sum squared resid	1.44E+21
F-statistic***	80.9124	Durbin-Watson stat	0.411021
Prob(F-statistic)	0.0000	Second-Stage SSR	9.57E+20

Source: Author.

In consumption of non-electricity products function in Vietnam-side is similar to those of Laos-side and Thailand-side that income represented by gross domestic product shows positive effect on consumption of non-electricity products. Although the value of Durbin–Watson statistic applied to examine autocorrelation is not high, the high adjusted R^2 value indicates that this model predicts the trend of Vietnam's consumption of non-electricity products well. Furthermore, the t-statistic and F-statistic in the model have 1 % significance level or 99 % confidence level implying that the variable gross domestic product explains the trend of consumption of non-electricity products well. The estimated result obtained from the two-stage least squares estimation shows that gross domestic product has significant impact on consumption of non-electricity products in the country indicated by the high elasticity of 0.63. In other words, consumption of non-electricity products increases by about 6 million USD when gross domestic product increases by 10 million USD.

6.3.3. Vietnam's Investment Function

$$I_V = -11{,}500{,}000{,}000 + 0.2530 GDP_V + 1{,}057{,}446 EXR_V$$

(-8.7764)*** (8.6039)*** (7.1356)***

Table 6.16: Estimation Result of Investment Function

Dependent Variable: I_V
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-11,500,000,000	1,310,000,000	-8.7764	0.0000
C(2)	0.2530	0.0294	8.6039	0.0000
C(3)	1,057,446	148,192	7.1356	0.0000

R-squared	0.9491	Mean dependent var	11,100,000,000
Adjusted R-squared	0.9444	S.D. dependent var	9,960,000,000
S.E. of regression	2,350,000,000	Sum squared resid	1.21E+20
F-statistic***	211.5739	Durbin-Watson stat	0.7140
Prob(F-statistic)	0.0000	Second-Stage SSR	5.03E+19

Source: Author.

Over the past 25 years, investment has played a key role in Vietnam's economy. Foreign-invested sector, accounting for about a quarter of Vietnam's total investment, has particularly played an important role as the country is currently restructuring the economy and cutting down on public investment. It has seen rapid growth, gradually asserting itself as a dynamic component of Vietnam's economy, and has made an important contribution to enhancing the economy's competitiveness and efficiency. This sector also helps develop the national economy by creating businesses that use high and environmentally-friendly technology and have good management experience, as well as supporting the country's international integration process.

In accordance with the country's socio-economic development strategy, the Vietnamese government is currently aiming to attract more foreign investment through accession to World Trade Organization (WTO) and other international organization. As a result, there are now 82 countries and territories mostly from Asia, followed by Europe, and America that have made an investment in Vietnam. Among them, major foreign investors to Vietnam are Singapore, Hong Kong, Japan, Netherlands, and the Republic of Korea.

The Vietnamese government encourages investors to invest in labor intensive industries, manufacture of new materials and production of new energy, manufacture of high-tech products, utilization of high technology and advanced techniques,

development and creation of high-technology, protection of the ecological environment and research, breeding, rearing, growing and processing of agricultural, forestry and aquaculture products, development of traditional crafts and industries, construction and development of infrastructure facilities and important industrial large-scale projects, development of education, training, health, physical education and culture, and other sectors which require encouragement.

Regarding the determination of investment in Vietnam, it is assumed that investment is determined by gross domestic product, and exchange rate. According to the result obtained from 2SLS estimation, there is unlikely to have any problems with the model since the adjusted R^2 value of 0.94 is close to 1. Furthermore, the F-statistic value as well as t-statistic value in each variable is significant at 1 % showing the favorable result, regardless to the low value of Durbin–Watson statistic used to test for serial correlation in this regression. Similar to other countries, gross domestic product plays important role in investment in Vietnam. The elasticity of 0.25 in gross domestic product indicates that investment volume increases by about 3 million USD when gross domestic product increases by 10 million USD. Similar to Laos-side model, exchange rate in Vietnam statistically has the same direction with investment. The estimated result shows that if exchange rate is increased (exchange rate depreciation) by 1 USD, investment volume will increase by 1 million USD.

6.3.4. Vietnam's Import of Electricity from Laos Function

$$IME_V^L = 2{,}504{,}261 + 0.00001GDP_V - 0.0285CE_L + 0.0001CE_V$$

(5.5011)*** (0.6963) (-1.9576) (0.4879)

Table 6.17: Estimation Result of Import of Electricity from Laos Function

Dependent Variable: IME_V^L
Method: Two-Stage Least Squares
Sample (adjusted): 1986 2010
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	2,504,261.	455,228.8	5.5011	0.0000
C(2)	0.0000	0.0000	0.6963	0.4938
C(3)	-0.0285	0.0145	-1.9576	0.0637
C(4)	0.0001	0.0003	0.4879	0.6306

R-squared	0.4038	Mean dependent var	2,275,378.
Adjusted R-squared	0.3186	S.D. dependent var	882,428.2
S.E. of regression	728,382.8	Sum squared resid	1.11E+13
F-statistic***	5.6915	Durbin-Watson stat	1.3054
Prob(F-statistic)	0.0051	Second-Stage SSR	9.63E+12

Source: Author.

In Vietnam, hydropower is abundant in the north while the south still has to rely on diesel-fired generation. Although the country basically emphasizes self-sufficiency in energy supply, cross-border trade in electricity seems to have a significant role for Vietnam in terms of lower cost. In a bid to meet shortfalls in national power production, Vietnam has imported significant amounts of electricity from Cambodia, China, and Laos in addition to its domestic hydropower resources. For example, with the great support from Asian Development Bank's Mekong Power Grid plan, a number of hydropower projects on the lower Sesan River in Cambodia and in Southern Laos have been planned to be exported to Vietnam, and some have been already on commercial operation.

In addition to pure imports of electricity, Vietnam are currently getting more involved with investing in neighboring countries' energy industries such as investment in building hydropower plants in Laos by the Viet-Lao Electricity Development and Investment Joint Stock Company. Due to the increasing demand, Vietnam has repeatedly signed agreements on increasing electricity import from Laos. Electricity supply is transmitted from power stations in Laos' Savannakhet and Huaphan provinces to central Vietnam's Ha Tinh province and central highlands city of Pleiku.

The trend of Vietnam's import of electricity from Laos is assumed to be affected by Vietnam's gross domestic product, consumption of electricity in Laos as well as consumption of electricity in Vietnam. As shown in table 6.17, all of variables have the assumed relationships with import of electricity from Laos despite the low significance level of variable consumption of electricity in Laos, and insignificance in other variables.

The F-statistic value in this regression is significantly high with the significance level of 1 %. Although adjusted R^2 value is not significantly high, it is still considered favorable. There is unlikely to have severe serial correlation in this regression, since the value of Durbin–Watson statistic is not far from 2. As illustrated in the table, Vietnam's gross domestic product and consumption of electricity in Vietnam do not show significant effects on importing electricity from Laos. Vietnam's import of electricity from Laos (Laos' export of electricity to Vietnam) is rather affected by consumption of electricity in Laos. In Laos, electricity generating company is controlled by the government. Therefore, the amount of electricity for exports to any countries is managed by the government. In addition, improving electrification in the country is considered important for Laos in achieving national goal of poverty reduction in terms of electrification. When consumption of electricity in the country increases, for example, Lao government attempts to control the exports of electricity in order to meet domestic demand, and vice versa. According to the estimated result, Vietnam's import of electricity from Laos decreases by 2 million USD when consumption of electricity in Laos is increased by 100 million USD, other things being equal.

Chapter 7

Development and Analysis of a Simulation Model of Laos' Electricity Trade

Introduction

The primary aim of this study is to explore the effect of the change in one economy on all economies simultaneously through macroeconometric model of Laos, Thailand as well as Vietnam. To my knowledge, there is no study concerning such combining macroeconometric models of three countries, specifically macroeconometric models of Laos, Thailand and Vietnam as this study. In this study, the individual macroeconometric model of each country is integrated into one model with the aim to connect the effect of the change from one country to others. In other words, since the macroeconometric models of three countries are integrated into one model, the change in an exogenous variable in one country not only affects one economy, but also affects other economies at the same time. In this chapter, prior to the presentation of major findings from the simulation of Laos' electricity trade with Thailand and Vietnam, the development of macroeconoetric model and model performance evaluation are presented. Finally, in accordance with the trend of the economy or the potential possibility of the changes that will happen in the future, a number of simulations are conducted.

- The first scenario of simulation is decreasing the electricity export from Laos to Thailand by 10 %. This simulation is based on the assumption that agreements for power exchange among the member countries may cause Thailand to reduce the import of electricity from Laos if the price of electricity from Laos is less competitive. Another possibility that Thailand may decrease the import of the electricity from Laos is the project of construction of nuclear power plants in Thailand. In other words, if the nuclear power projects are realized, Thailand may be self-sufficient in electricity generation leading to the

reduction of electricity import from its neighboring countries as well as from Laos. The result from this simulation is expected to be negative impact on both Lao and Thai economies.

- The second scenario of simulation is increasing the electricity export to Non-Thailand Countries by 10 % while decreasing the electricity export to Thailand by 10 %. This scenario is based on the assumption that if the case of the decrease in electricity to Thailand as the largest purchaser of Laos' electricity becomes realized, Laos may have to increase the export of electricity to other countries in order to substitute the loss from the earning from the export of electricity to Thailand. It is expected that this effect has negative effect on the Thai economy due to the reduction in electricity consumption. In the Lao economy, it is expected to have positive effect due to the earnings from electricity export to other countries. However, the loss of earning from the electricity export to Thailand is expected to be superior to the earnings from electricity export to other countries. It is therefore assumed that there is also negative effect on the Lao economy.

- The third scenario is increasing the electricity export from Laos to Thailand by 10 %. This case of simulation is based on the possibility that the nuclear power projects in Thailand may be abolished due to several oppositions concerning this project. Furthermore, the recent damage of nuclear power plants in 2011 may reduce the possibility of building nuclear power plants in Thailand. As a result, there is a possibility that Thailand will increase import of electricity from Laos to meet its demand. In contrast to the first scenario, the estimated result from this scenario of simulation is anticipated to have positive effect on both Lao and Thai economies.

- The fourth scenario is increasing the electricity generation in Laos by 10 %. Due to the increase in domestic demand as well as demand from other countries, specifically the demand from the Greater Mekong Subregion countries, the Lao government has promoted electricity in the country by attracting more investment in electricity sector. As a result, there are more than 70 power projects in the country prepared to generate more electricity in order to meet the increasing demand. Based on the increasing number of power projects, electricity generation in Laos is therefore assumed to increase. From this simulation, all Lao, Thai and Vietnamese economies are expected to be positively affected by this change.

It is interesting that since the simulation results are in quantitative form, the effects of the change on the economies are expressed how much the economies are affected from the change in the form of values. After applying simulation estimation, the data are divided into three periods in order to see the effect of the changes on different periods. The division of data is based on the change in Lao economy from 1987 to 2010. The first period: 1987 - 1996 is termed "Post-Reform Adjustment Period" which is the period after the announcement of the transformation from centrally planned economy to market-oriented economy called *New Economic Mechanism* (NEM) introduced in 1986. This term is adopted from Warr (2006), and Kyophilavong and Toyoda (2008).[33] Due to the fact that during 1997 - 1999, many Asian countries particularly Thailand had suffered from the Asian financial crisis, the second period: 1997 - 1999 is named: "Asian Crisis Period". The Asian financial crisis which began in Thailand raised fears of a worldwide economic meltdown due to financial contagion. Since Lao economy predominantly relies on Thai economy, it was directly affected this crisis. Again, following Warr (2006), and Kyophilavong and Toyoda (2008b), the third period: 2000 - 2006 is called "Sustained Growth and Foreign Capital Inflows Period".[34] This period is recognized as the high growth in the Lao economy with large foreign capital inflows into the country particularly the natural resources sectors such as hydropower and mining industries.

[33] This term is adopted from Warr (2006), and Kyophilavong and Toyoda (2008b). They used the data from 1989 - 1996 for the so called "Post Reform Adjustment Period".

[34] They used the data from 2000 - 2006 for the so called "Sustained Growth and Foreign Capital Inflows Period".

7.1. Development of the Model

Trade and budget deficits, stagflation, and enormous debt burdens are one of the major persistent economic predicaments in many developing and underdeveloped countries. These issues call for quantitative assessments using macroeconometric model to assist the government in appropriately implementing their economic policies. The economic instability in Laos, as an example of the impact of Asian financial crisis in 1997 - 1998 that Laos spent over four years to recover in 2002 (Kyophilavong, 2009), is not caused only by the crisis, but also by the poor economic management of the country (Okonjo-Iwaela et al, 1999). Therefore, macroeconomic instability is one of the important priorities needed for Laos. In order to sustain the economic growth and improve the macroeconomic management in the right way, the quantitative analysis is important for the country. However, due to the limitation of data in Laos, there are only a few studies concerning macroeconomic modeling of Laos. In 1998, Keola built a two-sector model consisting of six estimate equations and two definition equations using 11 samples of time series data from 1985 to 1995 for the estimation. Another model is built by Aotsu (2000) which is a demand-side model consisting of eight estimate equations and one definition equation using the time series data from 1988 to 1997. However, according to Kyophilavong (2004), these two studies have not been published. The recent studies regarding macroeconometric model analysis for Laos are found in Kyouphilavong (2003, 2009), Kyophilavong and Toyoda (2004b, 2008a, 2008b) and Toyoda and Kyophilavong (2005, 2007).

The application of macroeconometric model on the Laos' electricity trade is based on the LAOMACROMODEL-1, and LAOMACROMODEL-2, initiated by Kyophilavong (2003), and Kyophilavong (2009), respectively. Although the macroeconometric modeling approach was introduced in 1930s, and has been widely applied in many countries, due to the lack of macroeconomic data, the quantitative macroeconomic frameworks for Laos have just been introduced in the past decade. Kyophilavong (2003), to my knowledge, built an initial macroeconometric model for Laos called LAOMACROMODEL-1 which has more equations, and more number of data than the previous studies. In his study, he applied the macroeconometric model approach to analyze the potential effect of joining Association of South East Asian Nations Free Trade Area (AFTA) on the Lao economy. In his study, there are 15 structural equations, and 17 definition equations. Not only considering one side, but his model also took both the supply and demand sides into consideration. Some characteristics in his model are that trading partners of Laos is divided into Thailand and other trading partners. This is due to the fact that Thailand is the main trading partner of Laos covering about 33 %, for example, of Laos' export in 2010, followed by China, and Vietnam which are the second,

and third main trading partners of Laos, respectively. Moreover, the model also includes some important dummy variables to consider the economic structural changes in Laos such as the Asian financial crisis, the exclusion of Generalized System Preferences (GSP), and the trade liberalization policy. The main policy variables in his macroeconomic model are government investment, money supply, exchange rate, and foreign direct investment (FDI). Gross domestic product (GDP), private consumption, domestic investment, general price, export, and import are the main target variables. These variables were expected to have significant effects on the Lao economy. Due to the inconsistency and lack of data availability of Laos, the sample applied for the estimation is a set of time series data from 1988 to 2000. On the estimation stage, two respective approaches were applied. Put differently, he used two methods including ordinary least squares (OLS) method to estimate the structural equations, and the Newton method to simulate the model. The OLS was first applied on each behavioral equation in the system to see the effects of dependent variables on the dependent variable. The results from the OSL estimation were applied in the simulation estimation using Newton method.

LAOMACROMODEL-1 was further modified and updated by Kyophilavong and Toyoda (2004b) called LAOMACROMODEL-2. The main development from the previous model is the increase in sample size, number of equations, new variables and the improvement in the estimation approach. The LAOMACROMODEL-2, generally based on the LAOMACROMODEL-1, consists of not only the 32 original equations, but also three additional statistic equations. Some change in the LAOMACROMODEL-1 is that Thailand and Vietnam were grouped as a main trading partner of Laos against other trading partners whereas the previous model divided trading partner into only Thailand and other countries. This is due to the fact that during his study not only Thailand, but Vietnam was also one of the major trading partners of Laos. The purpose of LAOMACROMODEL-2 is to analyze the impact of macroeconomic policies and the official development assistance (ODA) on the Lao economy. The improvement in the LAOMACROMODEL-2 traces the way for the following quantitative analysis using macroeconometric modeling frameworks for Laos. In 2009, for example, based on LAOMACROMODEL-2, Kyophilavong (2009) evaluated the impact of macroeconomic policy on the Lao economy. The study is distinguished from Kyouphilavong (2003), and Kyophilavong and Toyoda (2004b) by focusing on the impact of mixed-policy combining monetary policy, exchange rate policy and fiscal policy together, on Lao economy. In order to obtain better results, the evaluation was implemented using the two-stage least squares (2SLS) technique in the system, rather than using the ordinary least squares (OLS). The total 11 behavior equations in the system were all estimated simultaneously. As did in the previous macroeconometric models, final stage was conducted using the Newton method to solve the models. Prior to the forecasting, final test result showed the low percentages of Root Mean

Squared Percent Error (RMSPE) in the important variables such as GDP, and price confirming the reliability of these variables implying the good results in the simulation. In their study, the scenario of stability-priority policy—increasing government investment by 100 billion Kip, decreasing money supply by 100 billion Kip, and exchange rate Kip per USD appreciation by 5 %—exerts the highest impact on increased GDP indicating that the government could give the priority stability. In contrast, the scenario of growth-priority policy—increasing government investment by 100 billion Kip, decreasing money supply by 100 billion Kip and exchange rate depreciation by 5 %—has a negative impact on GDP rendering GDP to decrease while the price increases. The result indicates that the growth-priority policy surprisingly has the negative impact while the stability-priority policy gives the highest positive impact on Lao economy. Similar to his previous studies, the results obtained from each simulation is regarded as relatively reliable due to the preferable values of adjusted R^2, t-values and other statistical tests.

The development from the LAOMACROMODEL-1 to LAOMACROMODEL-2 paves the way for the new quantitative analysis for the Lao economy using macroeconometric model approach as a basis of the estimation. The model development in this study is also based on their models. The results from the estimation using macroeconometric model are helpful for the government policy makers, financial commentators, macroeconomic consultants, and various sectors in such country that have very few number of researches using this kind of approach.

7.2. Model Performance

Prior to the simulation, the model performance appraisal is conducted. There are several types of measurement to evaluate whether the model performs well, given a set of observations. In this study, the root mean square error (RMSE) or the root mean square deviation (RMSD) is applied as a tool for measuring the performance of the model in order to ensure that the estimated results are accurate enough. The root mean squared error (RMSE) is one of many ways to analyze the model performance. It is a criterion frequently used to evaluate the forecasting performance of the models. It is usually used to measure the differences between the values predicted by a model (an estimator) and the values actually observed (actual value) in the model. The RMSE measures the average of the errors produced in the model. The error is the amount by which the value predicted by the estimator is different from the quantity to be estimated. The differences appear because of randomness or because the

estimator in the model does not account for information that could produce a more accurate estimate (Lehmann and Casella, 1998).

The RMSE is simply obtained by taking the square root of mean square error (MSE). In most studies, it is usually best to report the root mean squared error (RMSE) rather than mean squared error (MSE), since the RMSE is measured in the same units as the data being estimated rather than in squared units. Generally, the RMSE is directly interpretable in terms of measurement, and is thus a better measurement of goodness of fit of the model (Vernier, 2012). The formula of the RMSE is as follows:

The RMSE of an estimator $\hat{\theta}$ with respect to the estimated parameter θ is defined as follows:

$$RMSE(\hat{\theta}) = \sqrt{MSE(\hat{\theta})} = \sqrt{E((\hat{\theta}) - \theta)^2)}$$

In some disciplines, the RMSE is used for the comparison of the differences between things that may vary, neither of which is accepted as the standard. For example, when measuring the average distance between two objects expressed in the form of random vectors as shown below:

$$\theta_1 = \begin{bmatrix} x_{1,1} \\ x_{1,2} \\ \vdots \\ x_{1,n} \end{bmatrix} \quad \text{and} \quad \theta_2 = \begin{bmatrix} x_{2,1} \\ x_{2,2} \\ \vdots \\ x_{2,n} \end{bmatrix}$$

The formula of the RMSE becomes:

$$RMSE(\theta_1, \theta_2) = \sqrt{MSE(\theta_1, \theta_2} = \sqrt{E((\theta_1) - \theta_2)^2)} = \sqrt{\frac{\sum_{i=1}^{n} (x_{1,i} - x_{2,i})^2}{n}}$$

The RMSE value can take on any positive value. In the unbiased model, the smaller RMSE value the higher performance of the model, and vice versa. In this study, the RMSE values of all variables in the model are shown in Table 7.1:

Table 7.1: Root Mean Squared Error (in %)

Variable (Laos)	RMSE Ratio (%)	Variable (Thailand)	RMSE Ratio (%)	Variable (Vietnam)	RMSE Ratio (%)
C_L	0.0787	C_T	0.0929	C_V	3.7752
CE_L	0.9446	CE_T	0.2402	CE_V	9.6037
CEN_L	0.0831	CEN_T	0.0700	CEN_V	4.2326
EP_L	0.9551	GDP_T	0.1086	GDP_V	9.5549
EX_L	0.0008	I_T	0.3139	I_V	14.6222
EXE_L	0.3362	IM_T	1.1704	IME_V^L	4.4847
EXE_L^T	0.4150	IME_T	0.7108		
GDP_L	0.0280	IME_T^L	0.4150		
I_L	0.6219	IME_T^{LN}	0.7158		
IM_L	0.3836				
IME_L	0.3945				
$IMEN_L$	0.5392				

Source: Authors.

As illustrated in Table 7.1, the small value of the RMSE in each variable implies that there is unlikely to have any problem with variables in both Laos-side and Thailand-side model. Since the smaller value of the RMSE, the closer estimator is to the actual data, the small values of the RMSE in this study ranging from 0.0008 to 14.62 implies the more accuracy of the randomness reflecting the data. In Laos-side, the RMSE values of some variable such as electricity consumption (CE_L), export of electricity to Thailand (EXE_L^T), gross domestic product (GDP_L), investment (I_L), and import of electricity (IME_L) are only 0.94, 0.41, 0.02, 0.62, and 0.39 respectively. Among Laos-side variables, export (EX_L) has the smallest RMSE value of only 0.0008. In Thailand-side, the RMSE values of electricity consumption (CE_T), import of electricity from Laos ($IMEN_T^L$), gross domestic product (GDP_T), and investment (I_T), are also small with the values of only 0.24, 0.41, 0.10, and 0.31, respectively. Among Thailand-side variables, consumption of non-electricity products (CEN_T) has the smallest RMSE value of only 0.07. Although the RMSE values in Vietnam-side are higher in comparison with those in Laos-side and Thailand-side, they are still relatively low and acceptable. For example, the RMSE values of electricity consumption (CE_V), import of

electricity from Laos (IME_V^L), gross domestic product (GDP_V), and investment (I_V) in Vietnam-side are only 9.60, 4.48, 9.55, and 14.62 respectively. Among Vietnam-side variables, consumption (C_V) has the smallest RMSE value of 3.77. These significantly small values of RMSE in all Laos-side, Thailand-side, and Vietnam-side variables indicate that the estimators are relatively close to the actual values implying the favored performance of the model.

7.3. Major Findings from the Simulation of Laos' Electricity Trade with Thailand

7.3.1. Decrease in Electricity Export from Laos to Thailand

The Greater Mekong Subregion (GMS) has led to the international recognition as one of the fastest growing subregions in the world (AusAID, 2007). One of the most important subregional aims is to implement subregional power trade, facilitating and promoting effective cooperation among member countries for the development of a power market in the subregion. This is to ensure the sufficient supply of electricity for the increasing demand among all member countries in the subregion. Among the GMS countries, some countries especially Laos, Myanmar, and Yunnan province of China are extraordinary rich in hydropower power potential while some particularly Thailand and Vietnam have abundance of coal, and gas reserve as the main sources of electricity, but have still facing the increasing demand in the countries. Thus, demand for electricity in Thailand and Vietnam has grown more rapidly than other GMS countries, being the key electricity customers in the subregion. Thailand's average demand growth, for example, is about 5.56 % (Kessels, 2012). In comparison, the forecasted demand, on average, in Thailand is around 77 folds of demand in Laos due to the tremendous rise in consumption particularly in industries in Thailand (Nordconsult, 2002).

In order to fulfill the increasing demand and strengthen more cooperation among the member countries, power trade is essential for the subregion. In addition, due to the electricity supply by Laos, Myanmar, and Yunnan province of China, for example, is in the form of hydropower, the subregion is assured to benefit by having more reliable, secure, efficient, and environmentally friendly electricity supply. Expanding cross-border power grids in the GMS will therefore assure promoting economic and environment benefits of the subregion. To realize this program, all six member countries of the GMS—Cambodia, Laos, Myanmar, Thailand, Vietnam, and Yunnan Province of China—signed the agreements for power exchange among the member countries. This agreement implies that there is a possibility that Thailand as the largest electricity market of Laos as well as of the GSM will import more

electricity from other countries and may reduce the import of electricity from Laos if the price of electricity from Laos is less competitive.

Another possible challenge for Laos' electricity industry is that Thailand may reduce the import of electricity from Laos if the nuclear power plants in Thailand are completed. In 2007, the Thai Cabinet had approved the Nuclear Power Infrastructure Establishment Plan—a roadmap for nuclear power program development to meet a target commercial date in 2020. As specified in the Thailand Power Development Plan 2010 - 2030, there will be five units of a 1,000 MW nuclear power plant beginning to be in commercial operation in 2020 (Parchitmpattapong, 2010). Nuclear power is expected to reduce Thailand's natural gas consumption in power generation from 70 % to 40 % (Thongrung, 2011). If it is the case, Thailand, as the largest electricity market for Laos, may tend to reduce the import of electricity from Laos. If Thailand decreases its demand of electricity from Laos, it is expected to be a large impact on the Lao electricity export sector. The result of this simulation is illustrated in Table 7.2.

Table 7.2: Estimation Result of Decreasing the Import of Electricity from Laos to Thailand (in Million USD)

		10% Decrease in IME_T^L		
Country	**Variable**	**1987-1996**	**1997-1999**	**2000-2010**
Laos	CE_L	-0.2000	-0.2545	-0.1645
	EXE_L^T	-1.7171	-2.1848	-1.4124
	GDP_L	-7.4487	-9.4773	-6.1265
	I_L	-2.1599	-2.7482	-1.7766
Thailand	CE_T	-3.0170	-3.8433	-2.4811
	IME_T^L	-1.7171	-2.1848	-1.4124
	GDP_T	-8.0000	-10.1666	-6.5918
	I_T	-2.5330	-3.2266	-2.0840

Source: Author.

According to the simulation result, in Thailand-side, the decrease in import of electricity from Laos to Thailand negatively affects the Thai economy indicated by the reduction of electricity consumption in the first (1987 - 1996), second (1997 - 1999), and third (2000 - 2010) period by 3.01, 3.84, and 2.48 million USD, respectively. Since consumption of electricity is a component of consumption, when it decreases the whole consumption also

decreases. The decrease in consumption then directly leads to the large decrease in Thailand's gross domestic product. The change of Thailand's gross domestic product not only has direct impact on the whole Thai economy, but it also has impact on the Lao economy simultaneously through the change in export of electricity from Laos to Thailand.

Similar to other economies, in Thailand it is generally accepted that electricity is a main driving force of the country's socio and economic development as well as improving people's living status. Given the successive high economic growth of the country in the past decades, Thailand's annual electricity demand, according to the data from EPPO (2012c), has dramatically increased to approximately 150,000 Gwh in 2011 with an average growth of about 8 % per year. In the same year, industrial sector dominated the largest share of total electricity consumption in the country accounted for approximately 46 % of total electricity consumption. Recently this sector, particularly food processing, automotive and auto parts, electrical appliances and electronic equipment, and petrochemicals industry, has substantially contributed to the rapid economic growth of Thailand (BOI, 2011).

In addition to the industrial sector, as a result of country's economic development, consumption of electricity in the business sector as well as residential sector in Thailand has grown rapidly driven by the improvement in income levels of consumers whose consumption characteristics have shifted towards modernization and improved lifestyles. Consumption of electricity in the residential sector, and business sector shared about 22 %, and 15 % of Thailand's total electricity consumption in 2011, respectively.

As aforementioned, the sharp increase in electricity consumption is mainly due to the increase demand in the industrial sector as a consequence of the Thai government's policy to improve its economy through stimulating investment in the country. The policy is mainly focused on improving the number of investments in particularly industrial sector in the country. Thailand's major industries are based on electric appliances and components, cement, computers and parts, furniture and plastics. Rubber products, textile, drink, crops, tobacco processing, foods, and tourism are also important industries in the country.

As being the major contributor of Thailand's economic growth, the decrease in consumption of electricity particularly in the industrial sector is assumed to have large negative impact on the Thai economy. According to the simulation result, the decrease in consumption of electricity which is largely dominated by consumption in industrial sector leads to the large decrease in Thailand's gross domestic product by 8.00, 10.16, and 6.59 million USD in the first, second, and third period respectively. Since gross domestic product is a function of investment,

the decrease in Thailand's gross domestic product leads to the decrease in investment as illustrated in the Table 7.2.

Not only having negative impact on the Thai economy, the decrease in import of electricity from Laos also has negatively large impact on the Lao economy indicated by the large decrease in the value of export of electricity to Thailand. This large decrease is due to the reduction in Thailand's gross domestic product. The decrease in export of electricity to Thailand leads to the decrease in aggregate export. As the aggregate export decreases, Laos' gross domestic product is consequently affected implied by its large decrease in each period. As shown in Table 7.2, the reduction of gross domestic product then has negative impact on the whole economy indicated by the decreases in consumption of electricity as well as investment.

The main export products of Laos are similar to most developing countries in terms of the concentration on agricultural and primary products. The key export items are mining products (copper and gold), electricity, forest products (wood, bastard cardamom, flour, and rattan), garments, and agricultural products (coffee, rice, maize and other crops). These products are mainly exported to Thailand, China, Vietnam, United Kingdom, United States, and other countries in Asia and Europe. According to the data from ADB (2011), the main export markets of Laos in 2010 were Thailand which is the largest export market of Laos dominating the largest proportion of total export values accounted for 33.03 % of total export values, followed by China as the second largest exporting partner accounted for 24.47 % of total export values, along with Vietnam, United Kingdom, and United states sharing 11.11 %, 3.34 %, and 2.69 % of total export values in 2010, respectively.

Recently, much of the expansion in exports in Laos has been focused in the country's abundant natural resources exploitation particularly hydroelectricity and mining. At the present, hydroelectricity and mining sectors dominate the largest share of the overall export items, and are expected to reach as much as 70 - 80 % of the country's total export (GTZ, 2010). The country's trade balance has gradually improved as a result of the decline in the reliance on imports and fairly stable exports driven mainly by hydroelectricity and mining sectors which are expected to further growth by approximately 33 % (World Bank, 2010b).

Hydroelectricity sector is one of the major contributors on Laos' economic growth playing an essential role on the country in terms of foreign earnings from electricity export to its neighboring countries. The value of electricity export has assisted the country reducing its trade deficit which is one of the most severe issues of Laos. Most of the electricity generated for exports, which is aimed to boost its economy and infrastructure development, is principally concentrated on Thailand which is the largest market of Laos's electricity export along with

Vietnam. Since Thailand is the largest importer of Laos' electricity, the change in import of electricity from Thailand is assumed to have direct impact on electricity export from Laos to Thailand.

As shown in Table 7.2, export of electricity from Laos to Thailand decreases by 1.71, 2.18, and 1.41 million USD in the first, second, and third period respectively as a result of the decrease in Thailand's gross domestic product. Due to the decrease in electricity export to Thailand, aggregate electricity export also decreases leading to the reduction in aggregate export. According to the simulation result, there is a considerably large reduction in Laos' gross domestic product by 7.44, 9.47, and 6.12 million USD in the first, second, and third period respectively due to the reduction of aggregate export. As a result of the decrease in Laos' gross domestic product, other sectors that are assumed to be determined by gross domestic product such as consumption of electricity and investment are also negatively affected. The simulation result shows that consumption of electricity in Laos decrease by 0.20, 0.25, and 0.16 million USD in the first, second, and third period, respectively.

Besides the negative impact on consumption of electricity, the effect of the reduction of gross domestic product is likely to be relatively large on the investment sector indicated by the decrease in investment in a large value of 2.15, 2.74, and 1.77 million USD in the first, second, and third period, respectively. Investment is an essential sector for Laos contributing to strengthening the economic development, and poverty reduction implied gradually improvement of people's living conditions in the country. As stated in the 2009 Law on Investment Promotion of Lao PDR (LIP 2009), investment is essentially to serve the "continuous and sustainable economic growth of the country". Being considered one of the most important sectors, foreign investment has grown significantly due to the national policy of promoting foreign direct investments (FDI). Because of its abundant natural resources and its strategic location in the Greater Mekong Subregion (GMS) as well as in South-East Asia, the value of investment in Laos has gradually increased. Furthermore, other important factors attracting foreign investment are a considerably low labor cost, 100 % foreign ownership acceptance, simple tax regimen, and a stable political condition (United Nations, 2002).

The country's significant economic growth mainly contributed by foreign investment in natural resources sector has reduced country's official poverty rates from 46 % in 1992 to 26 % in 2010 (CIA, 2012). At the present, most of the country's sources of investment have been the members of the GMS as well as the Association of Southeast Asian Nations (ASEAN) concentrating to fundamentally hydroelectricity, mining, telecommunications, hotel, forestry, tourism, telecommunications, garment, and wood industries (Gunawardana, 2008). Among

them, hydroelectricity and mining sectors have predominantly contributed to the economy with approximately 80 % of all foreign direct investment (FDI) in 2008 (IUCN, 2011).

Finding from this simulation clearly shows that the decrease in import of electricity from Laos to Thailand not only has negative impact on the Thai economy, but also has largely negative impact on the Lao economy. Since most of electricity in Thailand is consumed in industrial sector which is the main driving force of the Thai economy, the decrease in import of electricity from Laos has negative impact on this sector implied by the reduction of electricity in Thailand. The reduction of electricity consumption which is the essential factor of the industrial sector negatively affected the Thai economy in terms of the reduction in Thailand's gross domestic product. The inverse effect is also connected to the impact on the Lao economy. In other words, the consequent decrease in Thailand's gross domestic product leads to the negative impact on electricity export in Laos. As a result of the decrease in electricity export to Thailand, Laos' gross domestic product significantly decreases.

7.3.2. Increase in Electricity Export to Non-Thailand Countries

After the introduction of the New Economic Mechanism (NEM) in 1986, Laos has gradually increased bilateral as well as multilateral trade with many countries either in Asia or outside Asia. Except for Thailand which is the major trading partner of Laos, Vietnam is one of the three principle trading partners of Laos covering large share of investment projects in Laos. From 2000 to 2010, it has become the top foreign investor in Laos for the first time in a decade followed by China, and Thailand. The number of Vietnamese firms invested in Laos total 252 investment projects with the value of 2.77 billion USD (Vientiane Times, 2011d). Most of Vietnamese firms have also embarked on a number of hydropower, and mining projects which are the recently most attractive sectors in Laos.

In response to the bilateral trade agreement between Laos and Vietnam, trade volume is expected to reach 2 billion USD by 2015, and 5 billion USD by 2020 (Vientiane Times, 2011d). Most of commodities imported from Vietnam to Laos are consumer goods and machinery while most the commodities exported from Laos to Vietnam are electricity, timber, and mining products. Regarding electricity export from Laos to Vietnam, since 1990s Thailand and Vietnam have been the first and second primary markets for Laos' electricity export, respectively. At the present, the energy use in Vietnam is increasing in the faster rate than its gross domestic product. Annually, Vietnam's energy use grew at the average rate of 12 % between 1998 and 2008 while its grew at the average rate of 7.3 % (BEH, 2011). Imports of

hydroelectricity from its neighboring countries including Laos, and China are important for Vietnam as its electricity demand is in the increasing trend.

In the next three decades, electricity demand in Vietnam is expected to triple as a result of the expected rapid economic growth (BEH, 2011). To promote the electricity trade between Laos and Vietnam, both countries planned to build a cross-border power transmission line in order to comfort the electricity export from Laos to Vietnam (BIA, 2011). The strong trade relationship between Laos and Vietnam in specifically electricity sector implies that when import of electricity from such largest market as Thailand is inevitably to decrease, Vietnam as the second largest market of Laos' electricity export may be the principal alternative. The following scenario of simulation is increasing the export of electricity to non-Thailand countries while decreasing the export of electricity to Thailand. Since most of Laos' electricity exports are destined to Thailand and Vietnam while the export to other countries including Cambodia, and China cover relatively small proportion, export of electricity to non-Thailand countries is assumed to be equivalent to export of electricity to Vietnam. The result of simulation is illustrated in Table 7.3 as follows:

Table 7.3: Estimation Result of Increasing the Export of Electricity from Laos to Non-Thailand (in Million USD)

		10% Increase in EXE_L^V and 10% Decrease in EXE_L^T		
Country	**Variable**	**1987-1996**	**1997-1999**	**2000-2010**
Laos	CE_L	-1.3500	-1.4536	-1.619
	EXE_L^T	-0.9100	-0.9524	-0.9496
	GDP_L	-2.8162	-3.0320	-3.3783
	I_L	-0.8167	-0.8792	-0.9795
Thailand	CE_T	-1.5990	-1.6733	-1.6696
	IME_T^L	-0.9100	-0.9524	-0.9496
	GDP_T	-4.2400	-4.500	-4.4381
	I_T	-1.3440	-1.4033	-1.4015
Vietnam	CE_V	0.6049	0.6053	0.5983
	IME_V^L	0.0015	0.0015	0.0015
	GDP_V	5.1961	5.1992	5.1392
	I_V	1.3150	1.3158	1.3006

Source: Author.

The increase in electricity export to Vietnam by 10 % has positive effect on the Lao economy in terms of foreign earnings from export. However, this positive effect is inferior to the negative effect as a result of the decreases in export of electricity to Thailand. In other words, the loss from income from electricity export to Thailand is higher than the gain from income from electricity export to other countries. This implies that electricity export to Thailand is essential for electricity industry in Laos. In the case that there is decrease in electricity export from Laos to Thailand by 10 % without increasing the export of electricity to other countries, gross domestic product of Laos significantly decreases by 7.44, 9.47, and 6.12 million USD in the first, second, and third period, respectively. In the case that there is a decrease in electricity export from Laos to Thailand by 10 % together with the increase in export of electricity to other countries by 10 %, gross domestic product of Laos still decreases but in the smaller amount due to the support from the earnings from electricity export to other countries. Despite the increase in the earnings from electricity export to other countries, the negative effect from the decrease in electricity export to Thailand remains superior implying the significantly high reliance of Lao electricity export on the Thai economy.

Thailand is the most significant purchaser of electricity generated in Laos and has agreed to buy at least 7,000 MW of electricity by the year 2020. So far Laos has sold about 1,300 MW of power to Thailand (Vientiane Times, 2012). It has been the significant electricity customer of Laos since the first commission of the first hydropower plant in Laos in 1971. In addition, Thailand is its largest foreign investor in electricity sector as well as other sectors in Laos. Not only electricity export, most of Lao economy is reliant on the Thai economy indicated by the data from ADB (2011) that the main export markets are Thailand which is the largest export market of Laos covering the largest proportion of 33.03 % of total export partners of Laos in 2010, along with China 24.47 %, and Vietnam 11.11 %.

In terms of electricity sector, Thailand also has significant influence on Laos's export of electricity. Given the 10 % increase in export of electricity from Laos to other countries, and 10 % decrease in export of electricity from Laos to Thailand, the negative effect of the decrease in export of electricity from Laos to Thailand dominates implied by the decrease in income from electricity export leading to the decrease in gross domestic product of Laos by 2.81, 3.03, and 3.37 million USD in the first, second, and third period, respectively. Consumption of electricity and investment which are assumed to be determined by gross domestic product also decrease in response to the decrease in gross domestic product.

In Thailand-side, the decrease in export of electricity from Laos to Thailand which is assumed to be the same as import of electricity from Laos to Thailand clearly has negative impact on the Thai economy indicated by the result shown in Table 7.3. There is a decrease in

consumption of electricity in Thailand by 1.59, 1.67, and 1.66 million USD in the first, second, and third period, respectively. The aggregate consumption which is one component of gross domestic product also decreases as a result of the decrease in consumption of electricity. This also leads to the decrease in gross domestic product affecting investment to decrease by 1.34, 1.40, and 1.40 million USD in the first, second, and third period, respectively.

Vietnam consumes more electricity as export of electricity from Laos to Vietnam (Vietnam's import of electricity from Laos) increases. According to the simulation result, consumption of electricity in Vietnam in all three periods increase by equivalently the same amount of 0.6 million USD. As consumption of electricity increases, aggregate consumption in Vietnam also increases, since it is a component of aggregate consumption. In terms of gross domestic product, the increase in export of electricity from Laos to Vietnam shows positive impact on Vietnamese economy indicated by the increase in Vietnam's gross domestic product. As a result of the increase in aggregate consumption, Vietnam's gross domestic product in the first, second, and third period increases by 5.19, 5.19, and 5.13 million USD, respectively. In addition, since Vietnam's investment is assumed to be positively affected by gross domestic product, investment also increases when gross domestic product increases. As illustrated in Table 7.3, Vietnam's investment increases by 1.31, 1.31, and 1.30 million USD in the first, second, and third period, respectively.

Increasing the export of electricity from Laos to Vietnam while decreasing the export of electricity to Thailand have positive effect on Vietnamese economy while it has largely negative effect on both Lao and Thai economies. The result from the simulation implies that Thailand is vital for Laos's export of electricity. Although increasing the export of electricity to other countries (Vietnam) to substitute the loss from the decrease in electricity export to Thailand, the negative impact from the reduction in electricity export to Thailand remains superior to the positive impact.

7.3.3. Increase in Electricity Export from Laos to Thailand

The idea about constructing of nuclear power in Thailand dates actually back to the 1960s, but has been actively pursued only since 2007. However no final decision whether to construct the nuclear power plant in the country has been taken yet. Currently, the project is still in the first phase (2008 - 2010), which dealt mainly with feasibility studies and public relations (Pachaly, 2011). Regarding this idea, there have been a variety of critics whether to build the nuclear power plants in Thailand. Environmentalists and local villagers living in the provinces

listed as potential sites for nuclear power plant construction have formed an alliance called the *Network of People against Nuclear Power Plants* to protest against the planned construction of nuclear power plants in the country (Wipatayotin and Praiwan, 2011). In addition, the earthquake and the subsequent nuclear disaster in Japan in March 2011 have opened up the discussion about the nuclear future of Thailand again.

Nuclear power was a national strategic priority in Japan contributing the Japanese economy, but there has been concern about the ability of Japan's nuclear plants to withstand seismic activity after the nuclear disaster resulting in the damage in the country. On 11 March 2011, the 9.0 magnitude earthquake, followed by severe tsunami caused the tremendous loss of Japan. The disaster caused severe damage of nuclear power plants in the country. On the same day, due to the failure of cooling systems at the Fukushima I Nuclear Power Plant, it was the first time a nuclear emergency had been declared in such high technology country as Japan. In order to avoid the effect from the nuclear, a large number of the residents totaling 140,000 people within 20 Km of the plant were evacuated (Weisenthal, 2001). According to the news released by The Guardian (2011), the World Bank estimated the cost of the nuclear crisis in Japan at 235 billion USD making it one of the world's most expensive disasters.

As a result of the Tohoku earthquake and tsunami in 2011, there have been several nuclear failures, partial meltdowns, or even shutdowns including Fukushima Daiichi Nuclear Power Plant, Fukushima II Nuclear Power Plant, Onagawa Nuclear Power Plant, Tokai Nuclear Power Plant, and Rokkasho Reprocessing Plant. Stabilizing the issue of Fukushima I Nuclear Power Plant has worsened the attitudes to nuclear power. After the accident of nuclear power plants, there were a number of protests activities against nuclear energy. According to Blair (2011), in June 2011, over 80 % of Japanese say they are anti-nuclear and distrust government information on radiation in the wake of the Fukushima nuclear disaster. As of September 2011, tens of thousands of people including company workers, students, and parents with children marched in central Tokyo to call on the Japanese government to abolish nuclear energy in the country (USA Today, 2011). Furthermore, on 14 - 15 January 2012, the streets of Yokohama were taken by thousands of demonstrators to show their opposition of nuclear energy in the country. The demand was for the protection of rights for those affected by Fukushima nuclear accident as a result of the disaster in March 2011, including safety, living standards, and basic health care (The Japan Times, 2012). These events were the largest demonstrations in Japan since the US - Japan security treaty protests during 1960s and 1970s (Slater, 2011).

After the awake of nuclear disaster in Japan in March 2011, on 15 March 2011, about 2,000 people from 18 districts of Kalasin Province in Thailand rallied outside the city hall to protest against the Electricity Generating Authority of Thailand's (EGAT) plan of building a

nuclear plant in their province. On 26 March 2011, according to the Assumption Business Administration College (ABAC) poll at the Assumption University, over 80 % of the respondents (83.4 %) disagreed with the plan to construct nuclear power plants in the country. The poll involved 3,807 people aged 18 up in 17 provinces. It was conducted from March 1 to 25, 2011. Bangkok residents had the largest percentage of the objection of 95.2 % followed by those in southern region (91.5 %), the central (91.1 %), the North (90.0 %) and the Northeast (85.8 %) (Wikipedia, 2012a).

As the incidence of severe leakage of radiation from Japanese nuclear-power facilities damaged by earthquake and tsunami in March 2011, domestic opposition to the project to develop nuclear power plants has increased. On 15 March 2011, a forum was organized by Sustainable Energy Network Thailand (SENT), Nuclear Monitor, MeeNET, Greenpeace Southeast Asia, Thailand and Heinrich Böll Stiftung to discuss the consequences of Japanese incident with representatives from the potentially affected communities. At the following press conference, the communities expressed the opposition that nuclear option has to be dropped from the Power Development Plan since the risk of nuclear energy is high. Instead of going nuclear the government should review the demand forecasts and invest in energy efficiency and the promotion of renewable energies in the country. This call was repeated at a rally of 500 people on the following day, which was organized by the Ubon Anti Nuclear Movement (Pachaly, 2011).

Due to the possibility that Thailand may quit the construction of nuclear power plant in the country, there is a possibility that Thailand may increase the import of electricity from Laos and its neighboring countries to meet the demand in the country. Therefore, the third case of simulation is that import of electricity from Laos to Thailand is assumed to be increased.

Table 7.4: Estimation Result of Increasing the Import of Electricity from Laos to Thailand (in Million USD)

		10% Increase in IME_T^L		
Country	**Variable**	**1987-1996**	**1997-1999**	**2000-2010**
Laos	CE_L	0.2000	0.2545	0.1645
	EXE_L^T	1.7171	2.1848	1.4124
	GDP_L	7.4487	9.4773	6.1265
	I_L	2.1599	2.7482	1.7766
Thailand	CE_T	3.0170	3.8433	2.4811
	IME_T^L	1.7171	2.1848	1.4124
	GDP_T	8.0000	10.1666	6.5918
	I_T	2.5330	3.2266	2.0840

Source: Author.

The simulation of this scenario presents the expected result in the sense that the increase of import demand for electricity from Thailand shows positive effect on both economies simultaneously as illustrated in Table 7.4. According to the result, when import of electricity from Laos to Thailand is assumed to increase by 10 %, Thailand benefits in terms of the increase in consumption of electricity in the country. In Thailand, industrial sector as the major driving force of the economic growth is the largest consumer of electricity in the country followed by the business, and residential sectors. When the industrial sector is boosted by the higher consumption of electricity, it implies the positive effect on the Thai economy. The simulation result shows that the increase in consumption of electricity stimulates the Thai economy. As expected, the positive effect on the Thai economy is considerably large indicated by the increase in Thailand's gross domestic product in the first, second, and third period by 8.00, 10.16, and 6.59 million USD, respectively. Due to the increase in gross domestic product, investment sector which is assumed to be positively affected by Thailand's gross domestic product is also positively affected. The simulation indicates that investment in Thailand increases by 2.53, 3.22, and 2.08 million USD in the first, second, and third period, respectively.

Since the model in this study is obtained from the integration of the macroeconometric models of Laos and Thailand, the effect of the change in one economy has impact on both economies, simultaneously. The simulation in this scenario shows that not only having positive

effect on Thailand-side through more consumption of electricity, increasing investment, and etc, the increase in import of electricity from Laos to Thailand also has positive effect on Laos-side due to the increase in Thailand's gross domestic product which is assumed to be a determinant of import of electricity from Laos to Thailand function. Since import of electricity from Laos to Thailand is assumed to equal to export of electricity from Laos to Thailand, when there is an increase in import of electricity from Laos to Thailand (export of electricity from Laos to Thailand) Laos' gross domestic product also increases. According to the simulation result, Laos' gross domestic product increases by 7.44, 9.47, and 6.12 million USD in the first, second, and third period respectively. The large increase in Laos' gross domestic product also positively affects other sectors such as electricity consumption and investment. As illustrated in Table 7.4, consumption of electricity which is assumed to have positive relationship with gross domestic product increases by 0.20, 0.25, and 0.16 million USD in the first, second, and third period respectively. Similarly, investment which is assumed to be positively affected by Laos' gross domestic product, also significantly increases with the amount of 2.15, 2.74, and 1.77 million USD, in the first, second, and third period, respectively.

This simulation implies that rather than decreasing, increasing the import of electricity from Laos to Thailand gives mutual benefits for both Thailand-side and Laos-side, in terms of more electricity to consume, the improvement in gross domestic product, and other sectors in both countries. Moreover, increasing the electricity trade between Laos and Thailand will also strengthen political and trade relationship between two countries. This is due to the fact that Laos considerably relies on products from Thailand indicated by the largest share of imports is dominated by the products from Thailand. As a land-locked country, cross-border trade with neighboring countries such as Thailand, Vietnam, China, and etc is vital for the Lao economy. Over three quarters of country's imports are sourced from its Association of Southeast Asian Nations (ASEAN) neighbors, with 69 % from Thailand which dominates the largest proportion (Word Bank, 2009).

The bilateral trade with particularly neighboring countries is considered the core for the country's economic development. At the present, Laos has signed a number bilateral trade arrangement with most of ASEAN members. Among them, Thailand is most important trading partner because of the similar customs and cultures, national boundaries, mutual economic interests, and cooperation in regional as well as subregional organizations. In terms of investment, Thailand has been the largest investor in Laos with total 241 investment projects valued 2,650 million USD (MIC, 2011a).

Laos and Thailand officially established diplomatic relations in 1950, and concluded a bilateral trade agreement on 20 June 1991 (MIC, 2011a). In terms of trade, Thailand is a key

trading partner for Laos. It is not only a major source of Laos's import products, but it is also principal destination for Laos's export product. Moreover, Laos has also received various assistances from Thailand for the development of the country. For example, in order to deepening relationship between two countries the Thai government provides opportunities to Lao companies and manufacturers to participate in international trade fairs organized in Bangkok annually. Thailand also provides technical assistance to improve the capacity of human resources in public and private sectors, sanitary and phytosanitary, trainings on agricultural product processing, marketing, and so on. For example, the Ratchaburi Electricity Generating Holding of Thailand has provided a grant of 20 million Thai baht to the Lao government to develop human resources in order to provide a skilled workforce to develop the power plants in Laos (MIC, 2011a). Since Laos and Thailand is primarily interdependent, strong cooperation is vital for both countries. Electricity trade between Laos and Thailand is one of the essential factors strengthening the relationship between two countries.

7.3.4. Increase in Electricity Generation in Laos

In Laos, electricity development is one of the principle tasks for sustainable economic development of the country. To this end, the country's development goal is to electrify 90 % of all households in the country by 2020. Electricity industry is a key sector serving two vital national priorities: (1) it promotes economic and socio advancement by providing reliable and affordable domestic power supply to society and industry, and (2) it earns foreign exchange from electricity exports to neighboring countries especially to Thailand.

At the present, domestic demand for electricity in Laos has been growing rapidly in accordance with the country's socio and economic development. The average growth of electricity consumption was expected to be in high level due to the increase of par capita energy consumption in accordance with people's frequently changed lifestyles. The urbanization rate in Laos is predicted to gradually rise from 22 % in 2005 to 36 % by 2035 together with the planned increase of electrification rate in rural area (Watcharejyothin, 2009). In order to fulfill the increasing demand, the Lao government's goal to increase the electrification ratio for the whole country is prepared to achieve through:

- On-grid household electrification—involving main transmission / distribution grid extensions to meet the 90 % target, after deduction of off-grid installations.

- Off-grid household electrification—an embryonic but successful program of electrification of off-grid households employing state, donor and private resources is underway in the country and targets electrification of 150,000 households by 2020. If this target is to be achieved by 2020, this program will need to be substantially scaled-up

The Greater Mekong Subregion (GMS) is facing the issue of continuously growing demand while potential expansion of hydropower in the subregion is increasingly limited. By 2025, electricity demand in the GMS is forecasted to reach about 237,000 MW which is a threefold increase compared to the 77,000 MW of electricity used in 2010 (Soussan et al, 2012). To meet the increasing demand, expansion of power generation is required. As a feasible *Battery of Asia*, Laos has shouldered the responsibility to harness part of its hydropower potential to meet electricity demand from other GMS members in particular Thailand, and Vietnam. Up to now, the Lao government has signed Memorandum of Understandings (MOUs) with Thailand and Vietnam to increase the export of electricity from Laos. Due to the increasing demand of both neighboring countries, Laos agreed to supply 7000 MW and 5000 MW of electricity to Thailand and Vietnam by 2020, respectively. However, the combined amount is more than 10 times of the capacity of the Nam Theun 2 hydropower plant (1,080 MW) which is the largest hydropower plant in Laos. This implies the significantly strong growth demand for electricity from Laos. If it is to be achieved, more power plants to boost more electricity generation are therefore vital.

Nature and climate in the country gives Laos opportunities to develop hydropower plants to accommodate domestic needs as well as the increased demand in the subregion. Over 3 decades, only less than 2 % of hydropower potential in Laos has been developed. However, hydropower industry has played a central role in the rapid economic growth during the last few years attracting a large number of investors. At the present, Laos has high voltage power grid of over 2,970 Km, a medium voltage one of 15,771 Km and a low voltage power line of 12,955 Km over the country. However, the demand for electricity in the country as well as from neighboring countries has still exceeded its supply. Therefore, Electricite du Laos (EDL) which is the state corporation of Laos that owns and operates the country's electricity generation, electricity transmission, and electricity distribution assets in Laos will focus on increasing electricity production to ensure adequate electricity supply. It also attempt to achieve the goal that at least 80 % of households access to electricity by 2015 as well as increasing the export of electricity to neighboring countries especially the GMS members (Phetsamone, 2012).

Annual electricity generation in the country is forecasted to increase at about 11 % for the period 2005 to 2025 with hydropower as the main source of the generation. The demand for

electricity is also predicted to increase from 2,638 MW in 2025 (Milattanapheng, 2010). In order to meet the demand, the government has attempted to increase the electricity generation in the country by promoting more investment in this sector. As a result, there are more than 70 power projects in the country prepared to generate more electricity in order to meet the increasing domestic demand as well as the demand from the GMS countries. The simulation of the increase in electricity generation shown in Table 7.5 is conducted to see the effect on all three economies namely Laos, Thailand, and Vietnam simultaneously. Electricity generation in Laos is assumed to increase by 10 %. Since the increase in the electricity generation is mainly to serve the electricity export to neighboring countries particularly to Thailand and Vietnam, it is also assumed that electricity exports to Thailand as well as to Vietnam are increased by 10 % as a result of the increase in electricity generation. This simulation is different from the case of increasing the import of electricity from Laos to Thailand or the export of electricity from Laos to Thailand that this case considers both the increase in electricity generation (supply side) and the increase in export of electricity from Laos to Thailand and Vietnam or import of electricity from Laos to Thailand and Vietnam (demand side) while the prior case considers only the increase in import of electricity from Laos to Thailand or export of electricity from Laos to Thailand (demand side) only.

Table 7.5: Estimation Result of Increasing the Electricity Generation (in Million USD)

		10% Increase in EG_L, EXE_L^T and EXE_L^V		
Country	**Variable**	**1987-1996**	**1997-1999**	**2000-2010**
Laos	CE_L	0.3154	0.3299	0.3300
	EXE_L^T	2.7072	2.8321	2.8323
	GDP_L	11.7431	12.2846	12.2851
	I_L	3.4052	3.5623	3.5627
Thailand	CE_T	4.7600	4.9800	4.9784
	IME_T^L	2.7072	2.8321	2.8323
	GDP_T	12.6300	13.2333	13.2354
	I_T	3.9960	4.1800	4.1729
Vietnam	CE_V	2.1805	1.5050	1.1298
	IME_V^L	0.0054	0.0037	0.0028
	GDP_V	18.7298	12.9274	9.7049
	I_V	4.7400	3.2716	2.4560

Source: Author.

As a result of the increase in electricity generation and the increase in export of electricity from Laos to Thailand and Vietnam, the simulation result shows that Laos' gross domestic product considerably increases. This increase is partly due to the increase in aggregate export boosted by the increase in export of electricity. When electricity generation is assumed to increase by 10 %, the value of Laos' import electricity from other countries to serve domestic consumption reduces since there is adequate amount of electricity to supply in the country.

Not only having exported to neighboring countries, Laos has also imported some amount of electricity from its neighboring country to electrify particularly in the rural areas where national grid has not penetrated. Since the target of electrifying 80 % and 90 % of total households by 2015 and 2020, respectively is recognized important in order to improve living conditions and alleviate poverty in the country, currently consumers in Phongsali province, Xaignabouli province and Huaphan province of Laos, for example, rely on the import of electricity from China, Thailand and Vietnam, respectively. The imports of electricity to these provinces are supplied at 22 kV with more expensive (0.08 USD per KWh) than the supply in the country (0.05 USD per KWh) (Phommachanh, 2011). Despite the high cost of import, it is a cheaper option than to extend the national grid to each corner of the country (The 22 KV transmission lines cost between 10,000 USD and 15,000 USD per Km, depending on the accessibility of the road). In addition, since during the rainy season (August - October) hydropower is normally abundantly available in the country, Laos has excess capacity to be exported to its neighboring countries. On the other hands, despite a number of hydropower plants, during the dry season (April - May) when hydropower plants are unable to generate enough electricity due to low reservoir levels, Laos also imports from its neighboring countries such as China, Thailand, and Vietnam.

As import of electricity decreases, aggregate import also decreases. According to the simulation result, gross domestic product considerably increases due to the increase in aggregate export together with the decrease in aggregate import. The simulation result presents the large increase in gross domestic product by 11.74, 12.28, and 12.28 million USD in the first, second, and third period respectively. Since consumption of electricity as well as investment in the model are both positively determined by gross domestic product, they also increase when gross domestic product increases. Investment, for example, increases in the first, second, and third period by 3.40, 3.56, and 3.56 million USD, respectively.

In Thailand-side, in response to the more import of electricity to consume in the country, Thailand also benefits implied by the more consumption of electricity in the country. According to the result, consumption of electricity in Thailand increases by 4.76, 4.98, and 4.97

million USD in the first, second, and third period, respectively. The increase in electricity import leads to the increase in aggregate import which decreases gross domestic product to decrease, given the constant export. However, the positive effect is superior to the negative effect implied by the increase in consumption as a result of the increase in consumption of electricity. As shown in Table 7.5, consumption of electricity increases by 4.76, 4.98, and 4.97 million USD in the first, second, and third period, respectively. Investment also increases as gross domestic product increases since it is assumed to be positively affected by gross domestic product

The increase in export of electricity from Laos to Vietnam, as a result of the increasing electricity generation in Laos, is likely to have favorable effect on Vietnamese economy indicated by the significant increase in its gross domestic product in each period. Regarding consumption of electricity, since Vietnam can import more electricity from Laos to consume in the country, consumption of electricity increases in a significant amount in each period. According to the simulation result, consumption of electricity in Vietnam in the first, second, and third period increases by 2.18, 1.50, and 1.12 million USD, respectively. Since consumption of electricity is a component of aggregate consumption, this increase directly leads to the increase in Vietnam's aggregate consumption. Concerning Vietnam's gross domestic product, since aggregate consumption is one component of gross domestic product, when it increases, gross domestic product also increases. As shown in Table 7.5, Vietnam's gross domestic product significantly increases by 18.72, 12.92, and 9.7 million USD in the first, second, and third period, respectively. Assuming that Vietnam's investment is a function of gross domestic product, it also considerably increases in the first, second, and third period by 4.74, 3.27, and 2.45 million USD, respectively when Vietnam's gross domestic product increases.

This simulation indicates that the increase in electricity generation together with the increase in export of electricity have positive effect on all three economies namely Laos, Thailand, and Vietnam. This effect is likely to be particularly much favorable for Vietnamese economy implied by the significant increase in its gross domestic product in each period. In order to promote more electricity generation to meet the demand for electricity, constructing more power plants in Laos is recommended. The Lao government is constructing a number of power grids and power substations from north to south and east to west to accommodate domestic consumption as well as exports of electricity to its neighbors such as Thailand and Vietnam whose demand has increased rapidly. At the present, Lao government is further promoting electricity industry in the country by attempting to open at least two new power plants each year until 2020 (Vientiane Times, 2011a).

Electricity industry is one of the top investment destinations in Laos as a country is rich in rivers for producing hydropower. Over a decade ago, it has become the largest investment sector attracting large number of foreign investors into the country. Due to the attraction of the electricity sector in the country, the Lao government has facilitated investments in hydropower plants from north to south and east to west around the country. To increase more investment in hydropower sector in the country, the Lao government has stimulated foreign investors by offering the project investors tax breaks on imported construction materials, vehicles, and other related equipment. Furthermore, in order to turn the country into the "Battery of Association of Southeast Asian Nations (ASEAN)", the Lao government has planned to build 10 more hydropower plants over the next 5 years. As a result of the foreign investment in power sector promotion over a decade ago, the approved investment value in electricity sector has reached about 4 billion USD (Vientiane Times, 2011c). Most of the investments in electricity sector in Laos are in the form of joint venture. According to Vientiane Times (2008), some joint venture projects are as follows:

- Nam Theun 2: The Lao government holds 25 % share in the 1.2 billion USD Nam Theun 2 hydropower project together with Electricite du France (France) with 35 %, Electricity Generating Public Company of Thailand (EGCO) (Thailand) with 25 %, and the remaining is the share of the Ital - Thai Development Public Company Limited.

- Nam Theun 1: The Lao government holds 20 % share in the 759.68 million USD Nam Theun 1 hydropower project in Borikhamxay province. Other shareholders in the venture are Gamuda (Malaysia) with 40 % and EGCO (Thailand) with also 40 % share. The project has about 523 MW. It is expected to generate electricity for sale by 2014.

- Nam Ngum 3: The Lao government holds 23 % share in the 779.6 million USD Nam Ngum 3 hydropower project in Vientiane province. Other shareholders are Greater Mekong Subregion Power (Thailand) with 27 %, Ratchaburi Electricity Generating Holding Public Co.,Ltd (RATCH) (Thailand) with 25 %, and Marubeni (Japan) with also 25 % share. The generating capacity of this project is approximately 440 MW which will be in operation by 2014.

- Nam Ngiemp 1: The Lao government holds 23 % share in the 477 million USD Nam Ngiemp 1 hydropower project, along with Kansai (Japan) with 45 % and Electricity Generating Authority of Thailand (EGAT) (Thailand) with 30 %

share. The project with 282 MW capacity is expected to be on operation in 2014.

- Xe Pian - Xe Namnoy: The Lao government holds 24 % share in the Xe Pian - Xe Namnoy hydroelectric power project located in the southern province of Laos, together with SK Engineering & Construction (Korea) with 26 %, Ratchaburi Electricity Generating Holding Public Co.,Ltd (RATCH) (Thailand) and Korea Western Power (KOWEPO) (Korea) with 25 % each. The project will generate electricity for sale in 2015 with the capacity of approximately 390 MW (Vientiane Times, 2011b).

In order to supply domestic consumption of electricity, the Lao government is also promoting investment in the construction of small and medium sized hydropower plants along the country. By 2015, the national electricity grid it planned to cover all districts with the aim to increase electricity access of at least 90 % of households in the country. At the present, with the Nam Theun 2 hydropower plant which is the largest plant in Laos, there are 11 plants in operation with total capacity of approximately 1,914 MW. The additional 7 projects are under construction, and 24 projects are in planning stage, and 42 projects are in feasibility stage (Smits, 2011).

Conclusion

Major Findings from the two-stage least squares method of Laos' Electricity Trade with Thailand

The estimated results obtained from two-stage least squares (2SLS) method show expected outcomes that all of independent variable(s) has assumed relationship with dependent variable in each function. Furthermore, values of adjusted R^2, and F-statistic used as determinants of model fit in all function are relatively high. In addition, most of t-statistic values are statistically significant at 1 % indicating that independent variable(s) explains dependent variable well.

In the export of electricity from Laos to Thailand (EXE_L^T) function, for example, Thailand's gross domestic product shows positive effect whereas consumption of electricity in Laos shows negative effect on export of electricity from Laos to Thailand as assumed. Since electricity trade between Laos and Thailand is in the form of memorandum of understandings (MOUs) which is a long term agreement, Thailand's gross domestic product does not show high effect on electricity export from Laos to Thailand. Furthermore, the significantly increasing demand in Thailand indicated by the extension of MOU for increasing electricity from Laos also implies that Thailand can import more electricity from Laos as much as Laos can supply to Thailand. However, since Lao government recognizes the importance of poverty reduction goal through domestic consumption of electricity, export of electricity to Thailand rather much depends on consumption of electricity in Laos. In other words, the estimated result shows that when value of consumption of electricity in Laos increases by 10 million USD, electricity export to Thailand is reduced by 1.3 million USD. Different from other goods, value of electricity export to Thailand is assumed not to have impact from the price, since electricity export from Laos to Thailand is in the form of MOU which specifies the constant price for long term (or at least unchanged much price in the case that there is a renegotiation between two countries).

Similarly, in the export of electricity from Laos to Vietnam (EXE_L^V) function, all of independent variables follow the assumed relationship with export of electricity from Laos to Vietnam despite the low significant level of some variables. Regarding determinants of model fit, F-statistic, for example, is significant at 1 %. According to the estimated result, Vietnam's gross domestic product does not show significant effect on export of electricity from Laos to Vietnam. Rather, export of electricity from Laos to Vietnam is affected by consumption of electricity in Laos. Due to the fact that in Laos, electricity generation is controlled by the government, the amount of electricity for exports to any countries is managed by the Lao government. Besides, promoting better electrification in the country is considered a particularly important task for Laos in achieving national goal of poverty eradication in terms of improved electrification in the country. When consumption of electricity in the country increases, for example, Lao government attempts to control the exports of electricity to its neighboring countries in order to meet domestic demand, and vice versa. The estimated result shows that, ceteris paribus, volume of Laos' electricity export to Vietnam decreases by 2 million USD when consumption of electricity in Laos increases by 100 million USD.

Major Findings from the Simulation of Laos' Electricity Trade with Thailand

Expanding cross-border power grids in the Greater Mekong Subregion (GMS) will assure promoting economic and environment benefits of the subregion. To realize this program, all member countries agreed to sign the agreements for power exchange among the member countries. This agreement implies a possibility that Thailand will import more electricity from other countries and may reduce the import of electricity from Laos if the price of electricity from Laos is less competitive. Another possible challenge for Laos' electricity industry is that Thailand may reduce the import of electricity from Laos if the nuclear power plants in Thailand are completed. As specified in the Thailand Power Development Plan 2010 - 2030, there will be five units of a 1,000 MW nuclear power plant beginning to be in commercial operation in 2020. Nuclear power is expected to reduce Thailand's natural gas consumption in power generation from 70 % to 40 %. If Thailand decreases its demand of electricity from Laos, it is expected to be a large impact on Laos' electricity export sector. In order to see the effect in volume term, the first scenario of decrease in the import of electricity from Laos to Thailand is therefore conducted.

The decrease in import of electricity from Laos to Thailand negatively affects the Thai economy in terms of the reduction of electricity consumption in the first (1987 - 1996), second (1997 - 1999), and third (2000 - 2010) period by 3.01, 3.84, and 2.48 million USD, respectively.

The decrease in consumption of electricity leads to the large decrease in Thailand's gross domestic product by 8.00, 10.16, and 6.59 million USD in the first, second, and third period respectively. The change of Thailand's gross domestic product not only has direct impact on the whole Thai economy, but it also has impact on the Lao economy simultaneously through the change in export of electricity from Laos to Thailand. Export of electricity from Laos to Thailand decreases by 1.71, 2.18, and 1.41 million USD in the first, second, and third period respectively. According to the simulation result, there is a large reduction in Laos' gross domestic product by 7.44, 9.47, and 6.12 million USD in the first, second, and third period respectively. The effect of the reduction of gross domestic product is likely to be relatively large on investment sector indicated by the decrease in investment in large value of 2.15, 2.74, and 1.77 million USD in the first, second, and third period, respectively.

If electricity export to Thailand is to be decreased, increasing electricity export to other countries may be the option for Laos. Therefore, the simulation of increasing export of electricity to non-Thailand countries is conducted. Since most of Laos' exports of electricity are destined to Thailand and Vietnam while exports to other countries including Cambodia and China cover relatively small share, Laos' export of electricity to non-Thailand countries is assumed to be equivalent to export of electricity to Vietnam. This scenario shows that Vietnam benefits in terms of the increase in consumption of electricity in the country indicated by about 0.6 million USD increase in consumption of electricity in each period. As a result of this increase, aggregate consumption which is a component of gross domestic product also increases supporting the favorable increases in Vietnam's gross domestic product. The increase in electricity export to Vietnam also has positive effect on the Lao economy in terms of foreign earnings from the export. However, this positive effect is inferior to the negative effect due to the decreases in export of electricity to Thailand. This implies that electricity export to Thailand is essential for electricity industry in Laos. In the case that there is decrease in electricity export from Laos to Thailand by 10 % without increasing the export of electricity to other countries, Laos' gross domestic product significantly decreases by 7.44, 9.47, and 6.12 million USD in the first, second, and third period, respectively. In the case that there is decrease in electricity export from Laos to Thailand by 10 % together with the increase in export of electricity to Vietnam by 10 %, Laos' gross domestic product still decreases but in the smaller amount due to the support from the earnings from electricity export to other countries. Laos' gross domestic product decreases by 2.81, 3.03, and 3.37 million USD in the first, second, and third period, respectively. In Thailand-side, there is a decrease in the consumption of electricity in Thailand by 1.59, 1.67, and 1.66 million USD in the first, second, and third period, respectively.

The idea about constructing of nuclear power plants in Thailand dates actually back to the 1960s, but has been actively pursued only since 2007. Regarding this idea, there have been several critics whether to build the nuclear power plants in Thailand. In addition, as the incidence of severe leakage of radiation from Japanese nuclear-power facilities damaged by earthquake and tsunami in March 2011, domestic opposition to the project to develop nuclear power plants has increased. Due to the possibility that Thailand may quit the construction of nuclear power plant in the country, there is a possibility that Thailand may increase the import of electricity from Laos and its neighboring countries to meet the demand in the country. The simulation of increasing import of electricity from Laos to Thailand is therefore built.

When import of electricity from Laos to Thailand is assumed to increase, Thailand benefits in terms of the increase in consumption of electricity in the country. The positive effect on the Thai economy is considerably large indicated by the significant increase in Thailand's gross domestic product in the first, second, and third period by 8.00, 10.16, and 6.59 million USD, respectively. When there is an increase in import of electricity from Laos to Thailand (export of electricity from Laos to Thailand) Laos' gross domestic product also increases. Laos' gross domestic product increases by 7.44, 9.47, and 6.12 million USD in the first, second, and third period respectively.

The Greater Mekong Subregion (GMS) is facing the issue of growing demand while potential expansion of hydropower in the subregion is increasingly limited. As a feasible *Battery of Asia*, Laos has provided the responsibility to harness part of its hydropower potential to meet the electricity demand from other GMS members in particular Thailand, and Vietnam. At the present, Laos has high voltage power grid of over 2,970 Km, a medium voltage one of 15,771 Km and a low voltage power line of 12,955 Km over the country. However, the demand has still exceeded its supply. The government has therefore attempted to increase the electricity generation in the country by promoting more investment in this sector. As a result, there are more than 70 power projects in the country prepare to generate more electricity. Following the potential increase in electricity generation in Laos, the scenario of increasing electricity generation in Laos is conducted in the simulation estimation.

As a result of the increase in electricity generation and the increase in export of electricity from Laos to Thailand and Vietnam, Laos' gross domestic product considerably increases by 11.74, 12.28, and 12.28 million USD in the first, second, and third period, respectively. In response to the more import of electricity to consume in the country, Thailand also benefits implied by the more consumption of electricity in the country. Consumption of electricity in Thailand increases by 4.76, 4.98, and 4.97 million USD in the first, second, and third period, respectively. The simulation shows that all countries benefit from the increase in

electricity generation in Laos. Among them, Vietnam is likely to have preferably much benefit implied by the significant increase in its gross domestic product of 18.72, 12.92, and 9.70 million USD in the first, second, and third period, respectively. Since this scenario not only shows positive effect on individual country, but it also shows favorable effect on all countries, namely Laos, Thailand, and Vietnam, improving the capacity of electricity generation in the country is essential for Laos. This simulation supports the Lao governmental plan in promoting more electricity generation in the country. In order to achieve the goal, the Lao government has promoted more investment in electricity industry in the country. As a result, there are more than 70 power projects in the country prepared to meet the increasing demand.

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Appendices

Appendix 1: World Natural Capital and Economic Growth in 2005 and 2011

	Population	Total Wealth (1000 USD)	Per Capita Natural Capital (1000 USD)	Natural Capital Share in Total Wealth (%)	Growth in 2005 (%)	Growth in 2011 (%)
Afghanistan					14.50	0.00
Albania	3,129,678	53.10	5.10	9.50	0.00	3.00
Algeria	32,853,798	30.20	15.80	52.30	5.90	2.50
American Samoa					4.20	0.00
Andorra					0.00	0.00
Angola	15,941,392	13.80	13.30	96.40	3.40	3.40
Antigua					3.20	-4.20
Argentina	38,747,148	71.30	10.30	14.40	2.00	8.90
Armenia	3,016,312	29.20	3.10	10.80	5.00	4.60
Aruba					13.30	0.00
Australia	20,329,000	518.80	40.00	7.70	0.00	1.80
Austria	8,233,300	570.70	9.10	1.60	1.40	3.10
Azerbaijan	8,388,000	15.30	11.70	76.40	11.20	1.00
Bahamas					3.90	1.60
Bahrain	726,617	201.80	83.70	41.40	3.20	0.00
Bangladesh	141,822,276	7.10	1.40	19.60	9.70	6.70
Barbados					2.60	0.00
Belarus	9,775,591	47.80	6.00	12.50	8.90	5.30
Belgium	10,478,650	562.40	4.90	0.90	0.00	1.90
Belize	291,800	64.50	23.70	36.80	0.00	2.00
Benin	8,438,853	9.50	2.60	27.60	2.00	3.10
Bermuda					0.00	0.00
Bhutan	637,013	16.40	14.00	85.30	-0.70	8.40
Bolivia	9,182,015	15.10	8.30	55.10	5.90	5.10
Bosnia					9.70	1.70
Botswana	1,764,926	58.90	5.40	9.20	0.30	5.10
Brazil	186,404,913	79.10	15.00	18.90	0.00	2.70
Brunei Darussalam	373,819	232.30	183.00	78.80	1.00	0.00
Bulgaria	7,740,000	64.00	5.60	8.70	9.90	1.70
Burkina Faso	13,227,835	8.70	1.30	15.50	4.80	4.20
Burundi	7,547,515	2.20	2.70	123.10	2.60	4.20
Cambodia					0.00	6.90
Cameroon	16,321,863	17.20	5.20	30.20	2.10	3.80
Canada	32,299,000	538.70	36.90	6.90	1.90	2.50

Source: World Bank (2005, 2010a)

Appendix 1: World Natural Capital and Economic Growth in 2005 and 2011 (Cont 1)

	Population	Total Wealth (1000 USD)	Per Capita Natural Capital (1000 USD)	Natural Capital Share in Total Wealth (%)	Growth in 2005 (%)	Growth in 2011 (%)
Cape Verde	506,807	41.40	0.90	2.20	4.20	5.00
Cayman Islands					0.00	0.00
Central African Rep	4,037,747	6.70	5.90	87.40	0.00	3.10
Chad	9,748,931	5.00	4.60	92.90	3.30	3.10
Channel Islands					0.00	0.00
Chile	16,295,102	101.90	18.90	18.50	5.50	6.00
China	1,304,500,000	19.20	4.00	20.90	2.90	9.10
Colombia	44,945,790	54.60	7.60	13.90	0.80	5.90
Comoros	600,490	14.50	1.80	12.20	7.60	2.20
Congo, Dem. Rep.	57,548,744	2.30	1.60	69.70	4.10	6.90
Congo, Rep.	3,998,904	6.00	14.70	244.00	2.30	4.50
Costa Rica	4,327,228	78.60	9.40	12.00	-1.40	4.20
Côte d'Ivoire	18,153,867	14.50	4.00	27.60	5.40	-4.70
Croatia	4,443,350	166.50	5.60	3.30	4.00	0.00
Cuba					5.40	0.00
Cyprus					0.00	0.50
Czech Republic	10,234,092	180.80	4.60	2.50	4.60	1.70
Denmark	5,415,978	743.00	19.60	2.60	7.40	1.00
Djibouti					6.20	0.00
Dominica	72,000	76.10	10.40	13.70	13.00	1.10
Dominican Republic	9,469,601	67.40	4.70	7.10	0.00	4.50
Ecuador	13,228,423	43.60	22.50	51.50	6.30	4.80
Egypt, Arab Rep.	74,032,884	21.30	4.70	21.90	5.60	1.80
El Salvador	6,880,951	52.90	3.90	7.40	7.80	1.50
Equatorial Guinea					7.00	7.10
Eritrea					0.90	8.70
Estonia					-2.00	7.60
Ethiopia	71,256,000	3.40	1.10	32.60	18.30	7.30
Faeroe Islands					3.60	0.00
Fiji	847,706	43.00	11.60	27.00	9.50	2.00
Finland	5,246,100	570.30	19.20	3.40	17.30	2.90
France	60,873,000	586.40	8.60	1.50	2.40	1.70
French Polynesia					8.80	0.00
Gabon	1,383,841	58.50	42.10	71.90	0.40	4.80
Gambia, The	1,517,079	5.80	1.20	21.10	26.40	5.00
Georgia	4,474,404	26.60	3.30	12.50	3.00	7.00
Germany	82,469,400	547.20	5.70	1.00	7.80	3.00
Ghana	22,112,805	9.50	2.70	28.00	5.60	14.40
Greece	11,104,000	392.80	8.00	2.00	10.60	-6.90

Source: World Bank (2005, 2010a)

Appendix 1: World Natural Capital and Economic Growth in 2005 and 2011 (Cont 2)

	Population	Total Wealth (1000 USD)	Per Capita Natural Capital (1000 USD)	Natural Capital Share in Total Wealth (%)	Growth in 2005 (%)	Growth in 2011 (%)
Greenland					-0.90	0.00
Grenada	106,500	78.00	2.10	2.70	6.30	1.10
Guam					6.30	0.00
Guatemala	12,599,059	43.50	16.70	38.40	3.50	3.90
Guinea	9,002,656	6.30	1.90	30.90	9.30	3.60
Guinea-Bissau	1,586,344	3.70	2.10	55.60	4.40	5.30
Guyana	751,218	19.20	21.90	113.90	7.10	0.00
Haiti	8,527,777	10.50	1.30	12.00	3.10	5.60
Honduras	7,204,723	25.40	12.00	47.30	4.60	3.40
Hong Kong, China	6,943,600	361.00	0.00	0.00	4.60	5.20
Hungary	10,087,050	173.00	6.00	3.50	5.10	1.70
Iceland	296,750	903.00	12.40	1.40	4.00	3.10
India	1,094,583,000	10.50	2.70	25.70	5.70	6.90
Indonesia	220,558,000	19.80	4.90	24.90	6.10	6.50
Iran, Islamic Rep.	68,251,085	33.40	17.90	53.60	3.50	0.00
Iraq					10.30	9.90
Ireland	4,159,100	599.10	11.20	1.90	6.40	-0.70
Isle of Man					7.80	0.00
Israel	6,923,600	327.50	4.80	1.50	7.30	4.70
Italy	58,607,050	498.30	7.50	1.50	-5.70	0.40
Jamaica	2,654,500	79.80	5.40	6.70	5.80	1.30
Japan	127,774,000	548.80	2.10	0.40	6.20	-0.70
Jordan	5,411,500	51.50	2.70	5.20	8.40	2.60
Kazakhstan					3.30	7.50
Kenya	34,255,722	10.70	2.70	25.60	3.00	4.50
Kiribati					9.00	1.80
Korea, Dem. Rep.					4.90	0.00
Korea, Rep.	48,294,143	248.20	2.60	1.10	7.20	3.60
Kuwait	2,535,446	326.30	213.10	65.30	2.60	8.20
Kyrgyz Republic	5,143,500	10.60	3.00	28.30	11.80	7.00
Lao PDR	5,663,910	8.10	4.40	55.10	5.40	8.00
Latvia	2,300,500	121.30	7.30	6.10	37.80	5.50
Lebanon					2.30	3.00
Lesotho	1,794,769	20.40	0.30	1.60	-0.20	5.80
Liberia	3,283,267	3.40	3.20	95.00	5.90	8.50
Libya					6.10	0.00
Liechtenstein					1.30	0.00
Lithuania	3,414,300	132.90	6.00	4.50	2.90	5.90
Luxembourg	456,710	917.50	6.10	0.70	7.70	1.60

Source: World Bank (2005, 2010a)

Appendix 1: World Natural Capital and Economic Growth in 2005 and 2011 (Cont 3)

	Population	Total Wealth (1000 USD)	Per Capita Natural Capital (1000 USD)	Natural Capital Share in Total Wealth (%)	Growth in 2005 (%)	Growth in 2011 (%)
Macao, China	460,162	189.90	0.00	0.00	0.70	20.70
Macedonia, FYR	2,034,060	57.80	3.60	6.30	10.50	3.00
Madagascar	18,605,921	3.50	1.90	55.00	2.50	1.00
Malawi	12,883,935	3.50	1.20	33.70	9.30	4.50
Malaysia	25,347,368	64.80	12.70	19.70	5.90	5.10
Maldives	329,198	26.60	1.00	3.70	5.70	7.50
Mali	13,518,416	6.90	1.90	27.60	4.50	2.70
Malta	403,500	258.00	4.30	1.70	5.20	2.10
Marshall Islands					7.50	5.00
Mauritania	3,068,742	11.00	4.00	36.50	2.70	4.80
Mauritius	1,243,253	84.20	9.40	11.10	9.60	4.10
Mayotte					5.30	0.00
Mexico	103,089,133	131.40	6.60	5.10	4.50	3.90
Micronesia, Fed. Sts.					0.30	1.40
Moldova	3,876,661	17.40	4.10	23.80	11.30	6.40
Monaco					4.60	0.00
Mongolia	2,554,000	13.40	5.50	40.90	5.30	17.30
Montenegro					6.00	2.50
Morocco	30,142,709	31.70	2.40	7.70	3.20	4.50
Mozambique	19,792,295	5.50	1.20	22.80	4.30	7.10
Myanmar					4.80	0.00
Namibia	2,031,252	59.60	5.20	8.70	1.20	3.80
Nepal	27,132,629	5.60	2.50	44.10	8.70	3.90
Netherlands	16,319,850	593.50	13.20	2.20	9.20	1.20
Netherlands Antilles					4.70	0.00
New Caledonia					-0.40	0.00
New Zealand	4,098,900	414.10	53.00	12.80	6.80	4.70
Nicaragua	5,149,311	19.60	4.70	24.10	4.30	2.30
Niger	13,956,977	4.50	1.40	31.60	2.60	6.70
Nigeria	141,356,083	11.00	6.00	55.00	9.60	1.80
Northern Mariana Islands					9.40	0.00
Norway	4,623,300	861.80	110.20	12.80	4.20	1.40
Oman	2,566,981	147.60	77.10	52.30	5.90	5.50
Pakistan	155,772,000	12.20	3.40	27.50	1.80	2.40
Palau					5.60	5.80
Panama	3,231,502	75.30	7.90	10.60	4.20	10.60
Papua New Guinea	5,887,138	9.00	8.60	95.30	1.20	9.00
Paraguay					13.90	4.00
Peru	27,968,244	44.90	5.80	13.00	7.20	6.90

Source: World Bank (2005, 2010a)

Appendix 1: World Natural Capital and Economic Growth in 2005 and 2011 (Cont 4)

	Population	Total Wealth (1000 USD)	Per Capita Natural Capital (1000 USD)	Natural Capital Share in Total Wealth (%)	Growth in 2005 (%)	Growth in 2011 (%)
Philippines	83,054,478	19.70	3.50	17.60	6.20	3.70
Poland	38,165,450	135.90	8.90	6.50	7.50	4.30
Portugal	10,549,450	305.80	4.20	1.40	5.50	-1.60
Puerto Rico					4.00	0.00
Qatar					1.60	18.80
Romania	21,634,350	80.90	9.10	11.20	2.50	-0.40
Russian Federation	143,113,650	73.20	31.30	42.80	6.40	4.30
Rwanda	9,037,690	5.30	2.90	55.30	3.00	8.60
Samoa					3.00	2.10
San Marino					3.60	0.00
São Tomé and Principe					9.30	4.90
Saudi Arabia	23,118,994	146.10	97.00	66.40	3.00	6.80
Senegal	11,658,172	13.70	1.60	11.90	1.00	2.60
Serbia					5.30	1.80
Seychelles	84,494	163.80	1.90	1.10	3.60	5.00
Sierra Leone	5,525,478	4.00	1.40	33.90	4.40	6.00
Singapore	4,341,800	301.00	0.00	0.00	10.60	4.90
Slovak Republic	5,387,000	142.40	5.00	3.50	8.10	3.30
Slovenia					2.10	-0.20
Solomon Islands					3.20	9.00
Somalia					8.40	0.00
South Africa	46,888,200	86.20	5.70	6.60	7.80	3.10
Spain	43,398,150	408.40	7.50	1.80	-6.80	0.70
Sri Lanka	19,625,384	21.60	2.10	9.60	6.70	8.30
St. Kitts and Nevis	48,000	132.20	4.40	3.30	4.00	-0.10
St. Lucia	164,791	92.10	0.00	0.00	2.90	0.70
St. Vincent and the Grenadines	119,051	59.60	3.10	5.10	4.30	0.00
Sudan	36,232,945	12.10	6.90	56.90	5.60	-4.90
Suriname					12.00	0.00
Swaziland	1,131,000	40.40	10.60	26.20	2.40	1.30
Sweden	9,024,040	627.90	15.70	2.50	6.80	3.90
Switzerland	7,437,100	736.80	9.40	1.30	3.20	2.10
Syrian Arab Republic	19,043,382	20.40	7.90	38.80	2.00	0.00
Tajikistan	6,550,213	6.70	1.80	26.30	6.50	7.40
Tanzania					2.30	6.30
Thailand	64,232,758	37.80	7.80	20.70	3.10	0.10
Timor-Leste					5.30	10.60
Togo	6,145,004	6.60	1.10	16.80	3.60	3.90
Tonga	102,311	55.90	32.90	58.90	3.70	1.20

Source: World Bank (2005, 2010a)

Appendix 1: World Natural Capital and Economic Growth in 2005 and 2011 (Cont 5)

	Population	Total Wealth (1000 USD)	Per Capita Natural Capital (1000 USD)	Natural Capital Share in Total Wealth (%)	Growth in 2005 (%)	Growth in 2011 (%)
Trinidad and Tobago	1,305,236	116.10	45.30	39.00	2.70	-1.40
Tunisia	10,029,000	47.40	4.40	9.30	2.40	-1.80
Turkey	72,065,000	114.80	5.40	4.70	0.90	8.50
Turkmenistan					4.90	9.90
Uganda	28,816,229	6.00	3.40	56.60	1.80	6.70
Ukraine	47,075,295	29.30	6.90	23.50	0.80	5.20
United Arab Emirates	4,533,145	349.70	121.00	34.60	7.20	4.90
United Kingdom	60,226,500	662.60	6.30	0.90	2.60	0.70
United States	296,410,404	734.20	13.80	1.90	7.50	1.70
Uruguay	3,305,723	86.70	8.30	9.60	4.00	5.70
Uzbekistan	26,167,369	5.30	7.70	144.00	0.70	8.30
Vanuatu	211,367	28.90	7.00	24.10	2.10	4.30
Venezuela, RB	26,577,000	69.80	30.60	43.80	1.80	4.20
Vietnam	83,104,900	9.40	3.60	38.70	5.40	5.90
Virgin Islands (U.S.)					1.30	0.00
West Bank and Gaza					4.30	0.00
Yemen, Rep.					7.10	-10.50
Zambia	11,668,457	9.70	2.10	22.10	7.40	5.90
Zimbabwe	13,009,534	5.00	2.00	39.40	8.50	9.30

Source: World Bank (2005, 2010a)

Appendix 2: Export of the Greater Mekong Subregion (1990 - 2010)

Unit: Million USD

	Cambodia		China		Laos		Myanmar		Thailand		Vietnam		GMS including China		GMS excluding China	
Year	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**
1990	16	42	1,151	62,760	50	64	83	409	395	23,072	85	2,525	1,780	88,872	629	26,112
1991	16	57	1,169	71,968	48	82	96	527	443	28,938	87	2,189	1,859	103,761	690	31,793
1992	91	165	1,300	85,622	48	103	119	684	649	32,474	190	2,918	2,397	121,966	1,097	36,344
1993	106	267	1,409	91,699	123	241	150	864	900	37,502	318	2,985	3,006	133,558	1,597	41,859
1994	134	243	1,942	120,873	167	300	159	940	1,736	46,694	492	4,054	4,630	173,104	2,688	52,231
1995	175	357	3,191	148,965	180	311	172	1,198	2,799	60,201	579	5,621	7,096	216,653	3,905	67,688
1996	69	293	2,709	151,171	255	321	126	1,183	3,073	57,214	572	7,463	6,804	217,645	4,095	66,474
1997	334	626	3,249	182,926	35	192	68	1,132	2,973	59,303	851	9,484	7,510	253,663	4,261	70,737
1998	295	934	2,858	183,751	155	371	57	1,139	3,038	56,294	886	9,307	7,289	251,796	4,431	68,045
1999	135	1,040	2,933	194,941	240	463	196	1,393	3,594	58,493	1,316	11,542	8,414	267,872	5,481	72,931
2000	69	1,123	4,476	249,223	171	391	350	1,980	4,876	68,964	2,127	14,483	12,069	336,164	7,593	86,941
2001	50	1,296	5,067	266,723	150	376	861	2,760	4,892	65,115	1,956	15,029	12,976	351,299	7,909	84,576
2002	49	1,489	6,140	325,783	151	386	961	2,756	5,743	68,852	1,996	16,706	15,040	415,972	8,900	90,189
2003	57	1,771	8,307	438,486	160	438	998	2,767	8,557	80,320	2,550	20,150	20,629	543,932	12,322	105,446
2004	72	2,188	11,552	593,770	183	535	1,436	3,158	10,879	96,216	3,884	26,485	28,006	722,352	16,454	128,582
2005	76	3,014	15,034	762,648	316	696	1,914	3,702	13,842	110,160	4,728	32,447	35,910	912,667	20,876	150,019
2006	106	3,562	19,305	969,698	673	1,178	2,424	4,520	17,932	130,556	5,065	39,826	45,505	1,149,340	26,200	179,642
2007	278	4,055	26,635	1,218,700	702	1,324	2,510	4,839	22,263	152,460	5,849	48,561	58,237	1,429,939	31,602	211,239
2008	198	4,350	34,002	1,429,340	958	1,609	4,101	6,664	26,031	173,235	7,863	62,685	73,153	1,677,883	39,151	248,543
2009	154	4,981	33,190	1,203,420	956	1,521	3,195	5,913	25,494	151,972	7,525	57,196	70,514	1,425,003	37,324	221,583
2010	312	5,571	48,181	1,580,400	1,467	2,196	3,557	6,465	33,873	195,360	10,291	69,820	97,681	1,859,812	49,500	279,412

Source: IMF (2012a), and author's calculation.

Appendix 3: Import of the Greater Mekong Subregion (1990 - 2010)

Unit: Million USD

	Cambodia		China		Laos		Myanmar		Thailand		Vietnam		GMS including China		GMS excluding China	
Year	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**
1990	14	56	489	53,810	106	149	157	668	1,386	33,421	33	2,842	2,185	90,946	1,696	37,136
1991	14	62	541	63,879	101	154	319	1,068	1,324	37,990	41	2,483	2,340	105,636	1,799	41,757
1992	93	751	632	81,872	181	258	285	1,046	1,434	40,687	87	3,027	2,712	127,641	2,080	45,769
1993	325	981	893	103,634	206	432	357	1,280	1,142	46,319	235	3,924	3,158	156,570	2,265	52,936
1994	410	1,152	1,204	115,708	316	564	406	1,538	1,654	55,790	491	5,826	4,481	180,578	3,277	64,870
1995	528	1,573	2,104	132,164	336	589	680	2,342	2,409	80,478	877	8,359	6,934	225,505	4,830	93,341
1996	578	1,632	2,350	138,949	362	690	574	2,678	2,135	76,542	910	11,285	6,909	231,776	4,559	92,827
1997	363	1,116	2,486	142,163	367	409	629	2,862	2,575	64,127	1,058	11,875	7,478	222,552	4,992	80,389
1998	355	1,129	2,758	140,385	512	645	588	2,358	2,113	44,297	1,363	11,310	7,689	200,124	4,931	59,739
1999	367	1,243	3,302	165,718	658	809	884	2,528	2,909	50,350	1,446	11,743	9,566	232,391	6,264	66,673
2000	426	1,425	5,500	225,175	538	690	1,107	3,040	4,048	61,924	2,359	15,637	13,978	307,891	8,478	82,716
2001	700	1,456	5,899	243,567	583	718	944	2,666	4,948	62,057	2,493	16,218	15,567	326,682	9,668	83,115
2002	535	1,675	6,884	295,440	575	722	1,161	2,970	6,188	64,721	3,248	19,746	18,591	385,274	11,707	89,834
2003	559	1,732	10,490	412,837	667	809	1,496	3,229	7,429	75,824	4,595	25,261	25,236	519,692	14,746	106,855
2004	742	2,075	14,265	560,811	825	1,058	1,713	3,459	10,116	94,407	6,678	31,969	34,339	693,779	20,074	132,968
2005	896	2,548	16,870	660,224	1,038	1,270	1,819	3,578	14,085	118,143	8,577	36,761	43,285	822,524	26,415	162,300
2006	1,210	2,985	20,785	791,795	1,416	1,652	2,184	3,913	17,617	130,605	10,826	44,891	54,038	975,841	33,253	184,046
2007	3,607	6,536	26,374	956,264	1,759	2,108	2,940	5,596	20,343	141,346	16,946	62,765	71,969	1,174,615	45,595	218,351
2008	2,103	4,420	30,811	1,131,920	2,405	2,837	3,663	6,977	25,809	178,526	21,448	80,714	86,239	1,405,394	55,428	273,474
2009	1,840	3,896	30,605	1,003,910	2,401	2,893	4,238	7,076	21,908	134,855	21,455	69,949	82,447	1,222,579	51,842	218,669
2010	2,362	4,892	41,790	1,393,920	3,092	3,575	6,163	9,948	29,765	184,630	26,292	83,365	109,464	1,680,330	67,674	286,410

Source: IMF (2012a), and author's calculation.

Appendix 4: Trade Balance of the Greater Mekong Subregion (1990 - 2010)

Unit: Million USD

	Cambodia		China		Laos		Myanmar		Thailand		Vietnam		GMS including China		GMS excluding China	
Year	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**	**GMS**	**World**
1990	2	-14	662	8,950	-56	-85	-74	-259	-991	-10,349	52	-317	-405	-2,074	-1,067	-11,024
1991	2	-5	628	8,089	-53	-72	-223	-541	-881	-9,052	46	-294	-481	-1,875	-1,109	-9,964
1992	-2	-586	668	3,750	-133	-155	-166	-362	-785	-8,213	103	-109	-315	-5,675	-983	-9,425
1993	-219	-714	516	-11,935	-83	-191	-207	-416	-242	-8,817	83	-939	-152	-23,012	-668	-11,077
1994	-276	-909	738	5,165	-149	-264	-247	-598	82	-9,096	1	-1,772	149	-7,474	-589	-12,639
1995	-353	-1,216	1,087	16,801	-156	-278	-508	-1,144	390	-20,277	-298	-2,738	162	-8,852	-925	-25,653
1996	-509	-1,339	359	12,222	-107	-369	-448	-1,495	938	-19,328	-338	-3,822	-105	-14,131	-464	-26,353
1997	-29	-490	763	40,763	-332	-217	-561	-1,730	398	-4,824	-207	-2,391	32	31,111	-731	-9,652
1998	-60	-195	100	43,366	-357	-274	-531	-1,219	925	11,997	-477	-2,003	-400	51,672	-500	8,306
1999	-232	-203	-369	29,223	-418	-346	-688	-1,135	685	8,143	-130	-201	-1,152	35,481	-783	6,258
2000	-357	-302	-1,024	24,048	-367	-299	-757	-1,060	828	7,040	-232	-1,154	-1,909	28,273	-885	4,225
2001	-650	-160	-832	23,156	-433	-342	-83	94	-56	3,058	-537	-1,189	-2,591	24,617	-1,759	1,461
2002	-486	-186	-744	30,343	-424	-336	-200	-214	-445	4,131	-1,252	-3,040	-3,551	30,698	-2,807	355
2003	-502	39	-2,183	25,649	-507	-371	-498	-462	1,128	4,496	-2,045	-5,111	-4,607	24,240	-2,424	-1,409
2004	-670	113	-2,713	32,959	-642	-523	-277	-301	763	1,809	-2,794	-5,484	-6,333	28,573	-3,620	-4,386
2005	-820	466	-1,836	102,424	-722	-574	95	124	-243	-7,983	-3,849	-4,314	-7,375	90,143	-5,539	-12,281
2006	-1,104	577	-1,480	177,903	-743	-474	240	607	315	-49	-5,761	-5,065	-8,533	173,499	-7,053	-4,404
2007	-3,329	-2,481	261	262,436	-1,057	-784	-430	-757	1,920	11,114	-11,097	-14,204	-13,732	255,324	-13,993	-7,112
2008	-1,905	-70	3,191	297,420	-1,447	-1,228	438	-313	222	-5,291	-13,585	-18,029	-13,086	272,489	-16,277	-24,931
2009	-1,686	1,085	2,585	199,510	-1,445	-1,372	-1,043	-1,163	3,586	17,117	-13,930	-12,753	-11,933	202,424	-14,518	2,914
2010	-2,050	679	6,391	186,480	-1,625	-1,379	-2,606	-3,483	4,108	10,730	-16,001	-13,545	-11,783	179,482	-18,174	-6,998

Source: IMF (2012a), and author's calculation.

Appendix 5: Bilateral Trade Agreements by Laos

	Countries	Signing date, (latest if many)	Validity	Key trade provisions
1	Argentina	11 Dec 2002	5 years, automatically renewed for another 5 years.	Trade cooperation.
2	Belarus	30 Aug 2001	1 year, automatically renewed annually.	MFN treatment in trade in goods, except in customs union or free trade areas or economic cooperation.
3	Cambodia	25 May 1998	1 year, automatically renewed annually.	MFN treatment in trade in goods, except in customs union or free trade areas or economic cooperation.
4	China	11 Jun 1997	5 years, automatically renewed annually.	MFN treatment in trade in goods, except in customs union or free trade areas or economic cooperation. Facilitating border trade.
5	EU	29 Apr 1997	5 years, automatically renewed annually.	MFN treatment to trade in goods, except in customs union or free trade areas, border trade and international commodity agreements. Protection of intellectual, industrial and commercial property rights Textiles and clothing
6	India	9 Nov 2000	5 years, automatically renewed for another 5 years.	MFN treatment to trade in goods, except in customs union or free trade areas, border trade, preferences among developing countries.
7	Indonesia	18 Oct 1994	5 years, automatically renewed annually.	Economic cooperation.
8	Korea	2 Jay 1997	5 years, automatically renewed annually.	MFN treatment in trade in goods, except in customs or free trade areas or economic cooperation.
9	Malaysia	11 Aug 1998	5 years, automatically renewed in every 5 years.	MFN treatment in trade in goods, except in border trade, customs union or free trade areas, and multilateral economic integration. Facilitating transit trade.
10	Mongolia	25 Dec 1990	5 years, renewed for 5 years	Economic cooperation.

Source: Foreign Trade Policy Department, MOIC.

Appendix 5: Bilateral Trade Agreements by Laos (Con 1)

	Countries	Signing date, (latest if many)	Validity	Key trade provisions
11	Myanmar	18 May 1995	1 year, automatically renewed annually.	MFN treatment in trade in goods, except in customs union or free trade areas or regional economic cooperation.
12	Philippines	18 Dec 1997	5 years, automatically renewed annually.	Economic cooperation.
13	Russia	22 Apr 1976		Outdated and there is a plan to review and renegotiate.
14	Thailand	20 Jun 1991	1 year, automatically renewed.	MFN treatment in trade in goods, except in GATT or regional association. Laos accorded preferential access for 23 products from Thailand.
15	Vietnam	9 Mar 1998	3 years, automatically renewed	MFN treatment in trade in goods and services (except items in exemption list), trade facilitation, and payments for foreign trade. On 28 Jul 2005, two trade ministers agreed to reduce tariffs at 0 % and 50 % on MFN or preferential rates, except items in exception list. This will be reviewed and improved every September.
16	United States	18 Sep 2003 Effective on 4 Feb 2005	Initially valid for 3 years, extended in a 3-year interval	MFN treatment in trade in goods, trade in services and intellectual property rights. Laos offers preferential market access to US goods, services and services providers while the US accords MFN status to Laos.

Source: Foreign Trade Policy Department, MOIC.

Appendix 6: Laos' Export Commodities to Major Trading Partners in 2010

Unit: Thousand USD

Export Commodities	Trading Partner			
	Thailand	**China**	**Vietnam**	**World**
Primary commodities, precious stones and non-monetary gold	714,432	614,713	180,800	1,408,050
Manufactured goods	57,220	4,628	8,513	337,154
Food and live animals	36,940	24,604	19,508	118,604
Beverages and tobacco	3,967	111	2,619	5,851
Crude materials, inedible, except fuels	62,637	522,619	80,031	594,373
Mineral fuels, lubricants and related materials	292,769	2,667	-	295,436
Animal and vegetable oils, fats and waxes	0.161	-	-	0.161
Chemicals and related products	1,341	2,723	2,036	23,901
Manufactured goods	322,365	65,180	79,314	404,244
Machinery and transport equipment	40,202	289	5,705	42,895
Miscellaneous manufactured articles	11,432	1,150	101	259,865
Commodities and transactions	-	-	11	1,200
Total all products	**771,652**	**619,342**	**189,324**	**1,746,370**

Source: United Nations Conference on Trade and Development (UNCTAD, 2012b).

Appendix 7: All Variables in Laos-side Model

Laos	
Variable	**Meaning**
$CAPE_L$	Installed Capacity of Electricity
CE_L	Consumption of Electricity
CEN_L	Consumption of Non-Electricity
C_L	Private Consumption
EG_L	Electricity Generation
EX_L	Export
EXE_L	Export of Electricity
EXE_L^T	Export of Electricity to Thailand
EXE_L^{TN}	Export of Electricity to Non-Thailand
$EXEN_L$	Export of Non- Electricity
G_L	Government Expenditure
GDP_L	Gross Domestic Product
I_L	Investment
IM_L	Import
IM_L	Import
IME_L	Import of Electricity
$IMEN_L$	Import of Non-Electricity

Source: Authors.

Appendix 8: All Variables in Thailand-side Model

Thailand	
Variable	**Meaning**
C_T	Private Consumption
CE_T	Consumption of Electricity
CEN_T	Consumption of Non-Electricity
$DUMMY_T$	Dummy of Asian Crisis (1997 – 1999)
EX_T	Export
G_T	Government Expenditure
GDP_T	Gross Domestic Product
I_T	Investment
IM_T	Import
$IMEN_T$	Import of Energy
$IMEN_T^L$	Import of Energy from Laos
$IMEN_T^{LN}$	Import of Energy from Non-Laos
$IMENN_T$	Import of Non-Energy Products

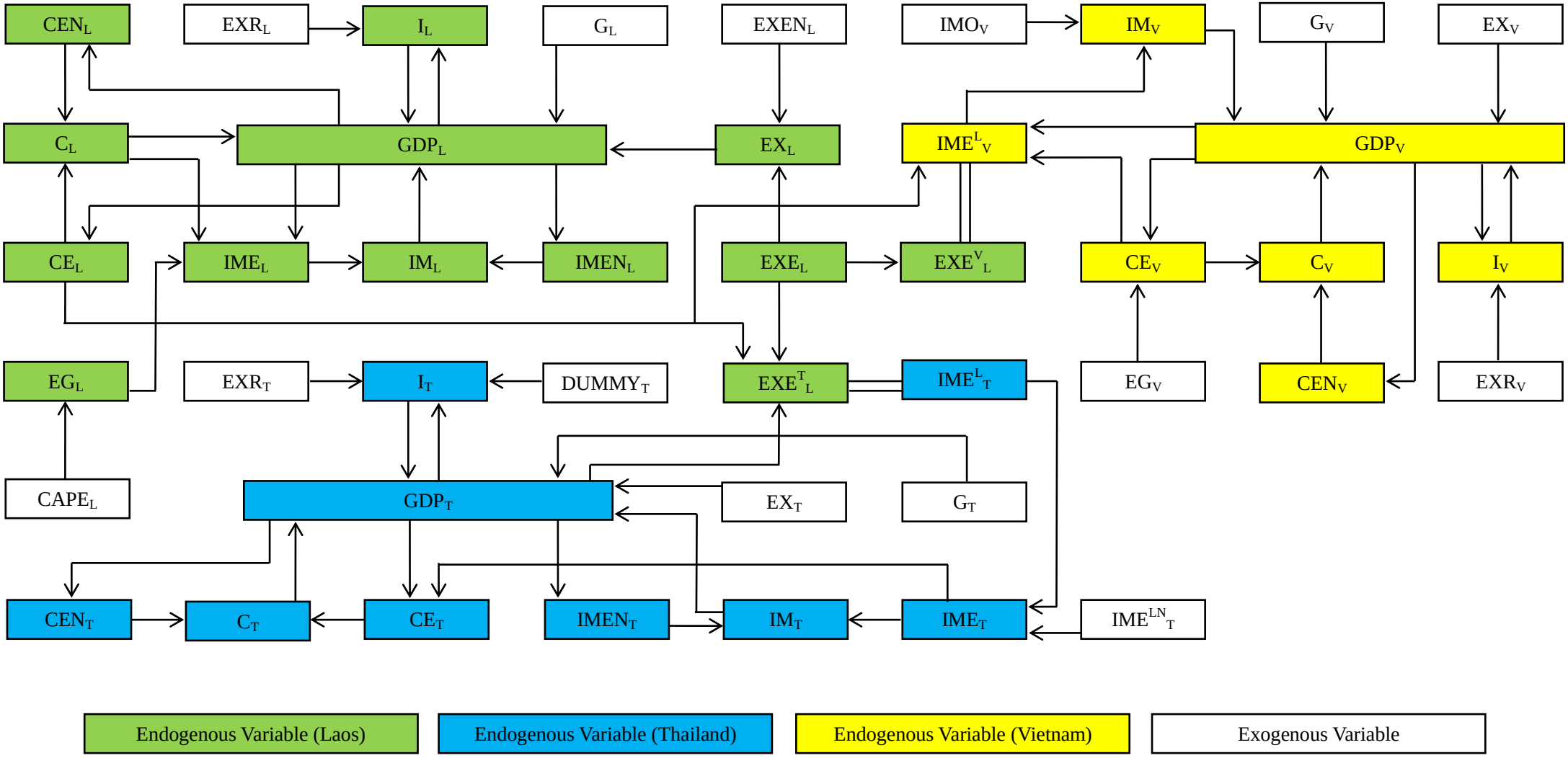
Source: Authors.

Appendix 9: All Variables in Vietnam-side Model

Vietnam	
Variable	**Meaning**
C_V	Private Consumption
CE_V	Consumption of Electricity
CEN_V	Consumption of Non-Electricity
EX_V	Export
G_V	Government Expenditure
GDP_V	Gross Domestic Product
I_V	Investment
IM_V	Import
IME_V^L	Import of Electricity from Laos
$IMELN_V$	Import of Non-electricity from Laos

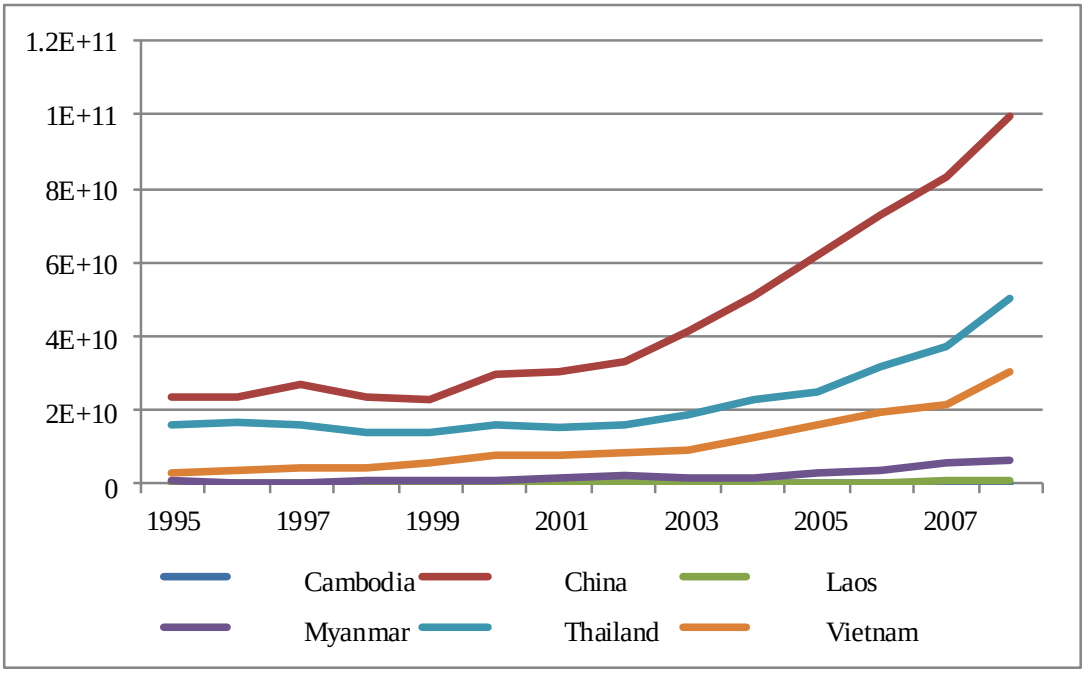
Source: Authors.

Appendix 10: Flowchart of Model



Appendix 11: Primary Commodities Export (1995 - 2008)

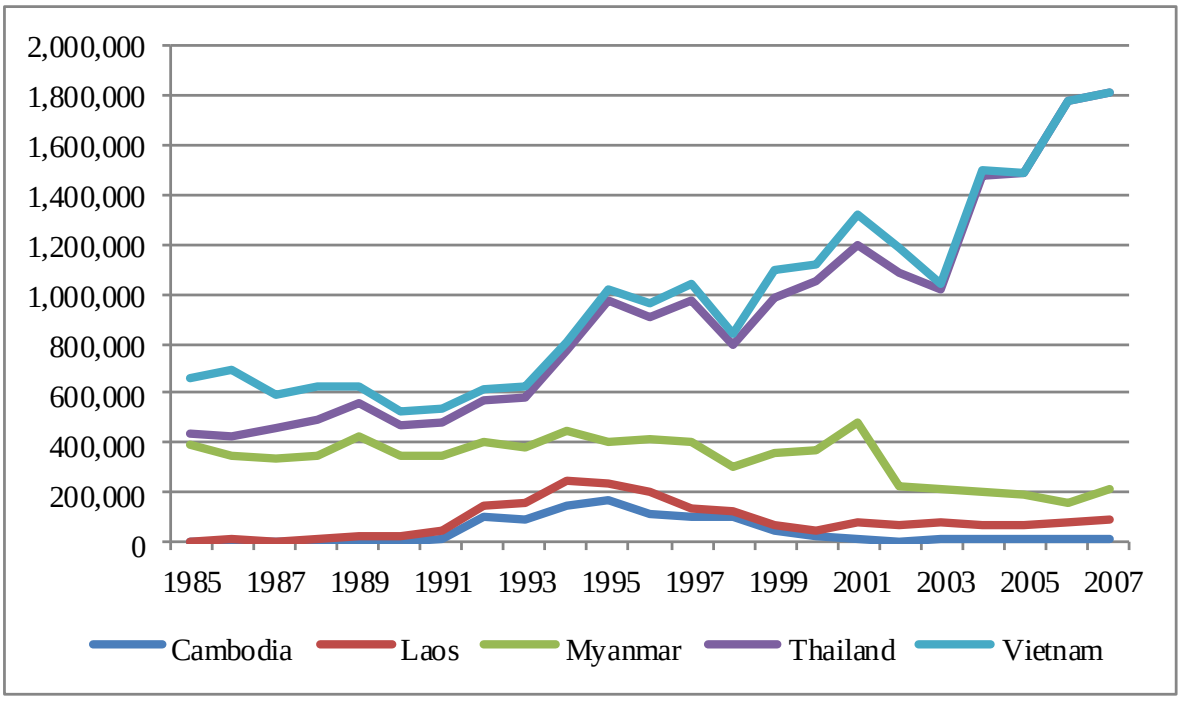
Unit: USD



Source: United Nations Conference on Trade and Development (ANCTAD, 2012b).

Appendix 12: Forest Products Exports (1985 - 2007)

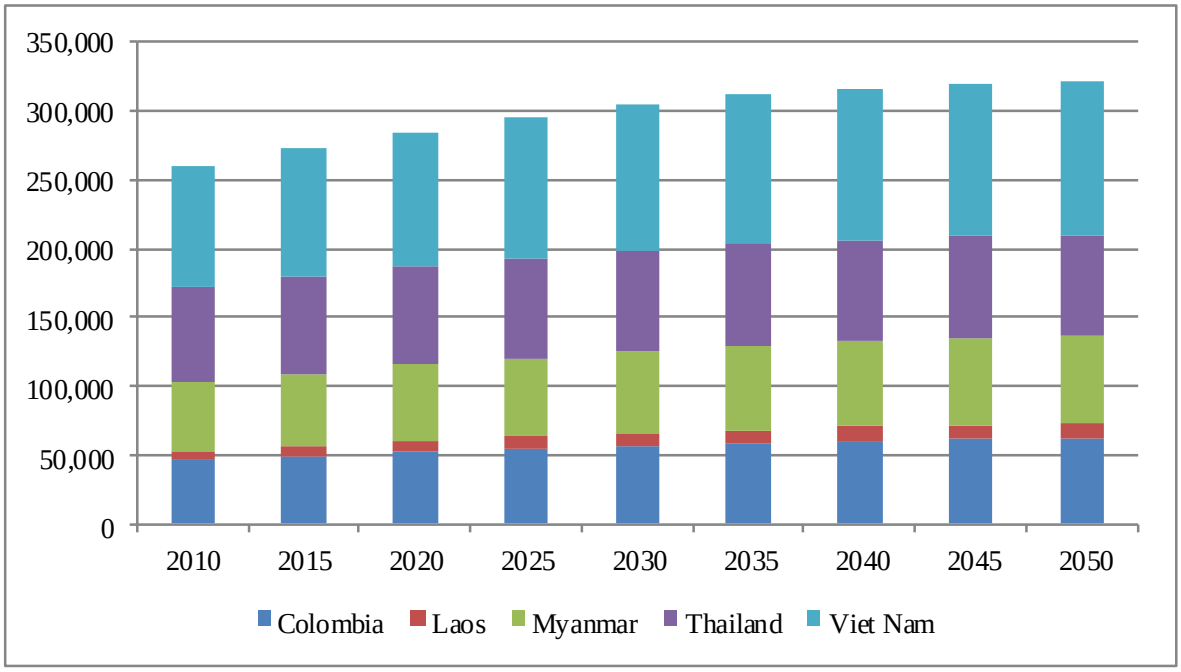
Unit: Thousand USD



Source: Food and Agriculture Organization (FAO, 2010).

Appendix.13: Population in the Greater Mekong Subregion (2010 - 2050)

Unit: Thousands



Source: United Nation (2008).

Appendix 14: Overall Economic Environment of GMS Countries

	Description		Cambodia	Laos	Myanmar	Thailand	Vietnam	China including Yunnan and Guangxi	
Macro-economic environment	Fiscal space (fiscal balance as % of GDP, 2002-2006 average)		-2.2%	-3.8%	-4.6%	-0.08%	-4.3%	-1.6%	
	Monetary stability (inflation rate)		4.4%	5%	40.2%	2%	8.1%	4.7%	
Investment environment	Foreign direct investment (3.9% of GDP) (FDI inflows US$ value and as % of GDP)		132 million (3.6% of GDP)	24 million (1.3% of GDP)	288 million (0.5% of GDP)	2,240 million (1.8% of GDP)	1,370 million (3.8% of GDP)	50,894 million (3.9% of GDP)	
								142 million (0.4%)	300 million (0.75%)
	PSP in energy	Enabled?	Yes	Yes with limits	Yes with limits	Yes	Yes with limits	Yes with limits	
		Current extent?	Medium	Medium	Low	High	High	Medium	
	Ability of local capital markets to finance large-scale investment		Low	Low	Low	High	Medium	High	
Business enabling environment	World Bank “Doing Business” report (ranking out of 178 countries)		145th	164th	N/A	15th	91st	83rd	
	Transparency International corruption perceptions index 2007 (ranking out of 180 countries)		162nd	168th	179th	84th	123rd	72nd	

Appendix 15: Ease of Doing Business Ranking in the GMS

		Country					
		Cambodia	Laos	Myanmar	Thailand	Vietnam	China
Ranking	**Ease of Doing Business**	147	171	-	19	78	79
	Starting a Business	170	93	-	95	100	151
	Dealing with Construction Permits	146	115	-	12	62	181
	Registering Property	117	163	-	19	43	38
	Getting Credit	89	152	-	72	15	65
	Protecting Investors	74	182	-	12	173	93
	Paying Taxes	57	116	-	91	124	114
	Trading Across Borders	118	170	-	12	63	50
	Enforcing Contracts	142	110	-	25	31	15
	Closing a Business	183	183	-	46	124	68

Source: www.doingbusiness.org.

Appendix 16: Plan of Action for GMS Development

	Priority Projects/ Activities	Indicative Timeline	Countries Involved	Estimated Total Cost ($M)	Financing ($M)	Remarks
Environment						
Strategic Thrust I: Establish common framework and necessary operational capacity for addressing environmental protection and management challenges of the GMS Economic Cooperation Program						
Strategic Thrust II: Prevent and mitigate environmental hazards and threats from environmental degradation in the subregion						
Group 1: Projects that are ongoing or for immediate implementation and with identified financing						
	Strategic Thrust I					
1	GMS Core Environment Program (CEP), Phase I: Capacity Building and Financing for Environmental Management	2006-09	All GMS countries	7.7	7.7	Financed by ADB, Netherlands, Sweden, and GMS countries. Planning for Phase II of CEP taking place from Jan. to March 2010
2	Strategic Environment Assessments (SEAs) of Sector Strategies and Economic Corridors (CEP Component 1)	2006-09	Cambodia, PRC, Laos, Thailand and Vietnam	1.9	1.9	Inter-working group coordination will strengthen institutionalization of SEA in sector planning
3	Biodiversity Conservation Corridors Pilots for Biodiversity Conservation & Poverty Reduction (CEP Component 2)	2006-09	All GMS countries	13.6	13.6	Environment Operations Center (EOC) efforts underway to upscale BCI beyond pilots
4	Environment Performance Assessments for Monitoring Environmental Performance (CEP Component 3)	2006-09	All GMS countries	2.6	2.6	EPA framework (integrating BCI/ landscape, corridor, national/subregional performance indicators) is in place

Source: Asian Development Bank (ADB, 2010b).

Appendix 16: Plan of Action for GMS Development (Cont 1)

	Priority Projects/Activities	Indicative Timeline	Countries Involved	Estimated Total Cost ($M)	Financing ($M)	Remarks
5	GMS Core Environment Program (CEP) Phase I (Supplemental) for Enhancing Environmental Performance the GMS Economic Cooperation Program and Climate Proofing CEP	2008-11	All GMS countries	6.6	6.6	Financing includes ADB grant ($0.4 M); PRC ($0.5 M); Netherlands ($0.8 M) and Finland ($4.9 M). Supplemental activities encompass spatial planning decision tools, ecosystem valuation, material flow analysis and resource use efficiency. Need to elevate climate change agenda to highest policy making levels. EOC is strengthening SEA framework to integrate climate change in investments and development planning
	Strategic Thrust II					
6	GMS Flood and Drought Risk Management and Mitigation (Balanced Structural and Non-structural Measures)	2009-12	Cambodia, Laos and Vietnam	145.0	145.0	To be financed by ADB (loan of $30 M to Cambodia and Vietnam and grant of $20 M to Laos included in ADB indicative 2011 pipeline); Cambodian and Lao governments ($5 M each); Vietnam government ($20 M); co financing ($30 M)
7	Mekong Water Supply and Sanitation Project (integrated into the GMS Corridors Town Development Project)	2009-14	Cambodia, Laos and Vietnam	276.4	276.4	Loans to Cambodia and Vietnam ($26 M and $52 M respectively) and grant to Laos ($26 M); included in ADB indicative 2012 pipeline

Source: Asian Development Bank (ADB, 2010b).

Appendix 16: Plan of Action for GMS Development (Cont 2)

	Priority Projects/Activities	Indicative Timeline	Countries Involved	Estimated Total Cost ($M)	Financing ($M)	Remarks
Group 2: Projects for implementation later within the plan period and/or projects requiring financing						
	Strategic Thrust I					
8	Exploring Core Environment Program – Private Sector Partnership for Developing and Deploying Low Carbon Emitting and Polluting Freight Fleets in the GMS Transport Corridors	2008-11	All GMS countries	0.4	TBD	To build the foundation for a functioning public-private Partnership model to consolidate CEP-BCI's sustainable financing component
9	Scoping and Mapping of Climate Change Related Risks and Vulnerability of Core Environment Program/Biodiversity Corridor Initiative	2009-11	Laos/Vietnam	9.9	TBD	EOC undertaking climate change work under various cluster projects
10	Undertake Eco-efficiency Assessment of Key GMS Development Sectors Especially Agriculture and Natural Resources, and Energy	2009-12	All GMS countries	3.0	TBD	WGE assessing links between environment, energy and food and role of biofuels and between health and environment
11	Promotion of Rural Renewable Energy and Cleaner Production (renamed GMS Climate-Friendly Bioenergy Project)	2009-11	All GMS countries	1.0	TBD	TBD EOC to coordinate with Working Group on Agriculture (WGA) on the scope, activities and division of labor on the RRE action plan
12	Strengthening Water Resource Monitoring Capacity in the Lower Mekong Basin	2009-11	Cambodia and Vietnam	2.0	TBD	Need for EOC to establish closer working relationship with the Mekong River Commission (MRC) with respect to water quality monitoring

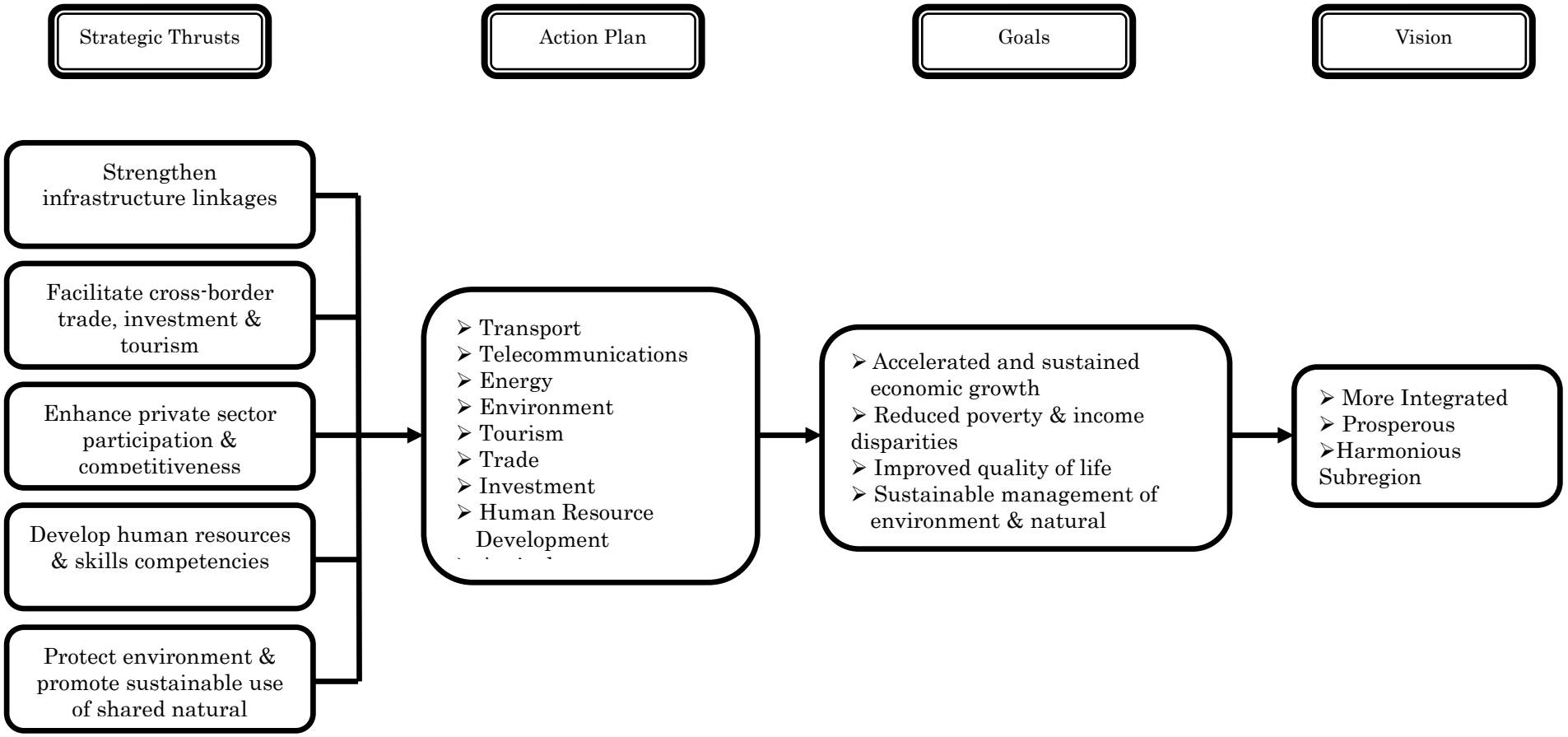
Source: Asian Development Bank (ADB, 2010b).

Appendix 16: Plan of Action for GMS Development (Cont 3)

	Priority Projects/Activities	Indicative Timeline	Countries Involved	Estimated Total Cost ($M)	Financing ($M)	Remarks
Group 2: Projects for implementation later within the plan period and/or projects requiring financing						
	Strategic Thrust I					
13	GMS Core Environment Program and Biodiversity Conservation Corridor Initiative in the GMS, Phase II	2012-15	Cambodia, Laos, Thailand and Vietnam	17.0	1.0	R-PATA included in ADB indicative 2011 pipeline. Cofinancing needed: $16 M
14	GMS Biodiversity Conservation Corridors for Poverty Reduction and Watershed Protection	2010-15	Cambodia, Laos and Vietnam	130.0	130.0	130.0 To be financed by ADB (loan of $30 M to Vietnam, grant of $15 M to Cambodia and $20 M to Laos) included in ADB indicative 2010 pipeline); Government financing ($15 M); and cofinancing needed ($50 M). R-PPTA of $1 M included in 2009 ADB pipeline
15	Promoting Low Carbon/ Climate Resilient Economies in the GMS	2012-14	Cambodia, Laos, Vietnam	1.0	1.0	R-PPTA included in ADB indicative 2012 pipeline

Source: Asian Development Bank (ADB, 2010b).

Appendix 17: Strategic Framework 2002 - 2012



Source: Goswami (2009).

Appendix 18: Financial Internal Rate of Return of Nam Leuk Hydropower Project

Unit: Million USD

Year	Total Cost	Total Generation (Gwh)	Export (Gwh)	Export Tariff	Export	Domestic Sales (kWh)	Domestic Tariff	Domestic Revenues	Total Revenues	Net Cash Flow
2000	19.645	286.600	276.300	0.029	7.988	0.000	0.021	0.000	7.988	11.657
2001	4.241	262.800	253.600	0.028	7.118	0.000	0.028	0.000	7.118	2.877
2002	0.994	243.800	238.600	0.030	7.045	0.000	0.032	0.000	7.045	6.051
2003	0.955	256.700	254.000	0.029	7.345	0.000	0.038	0.000	7.345	6.390
2004	0.959	245.000	242.500	0.030	7.385	0.000	0.051	0.000	7.385	6.426
2005	0.944	245.000	242.500	0.032	7.676	0.000	0.062	0.000	7.676	6.731
2006	2.208	245.000	130.900	0.033	4.308	94.241	0.062	5.860	10.168	7.960
2007	3.760	245.000	0.000	0.034	0.000	205.357	0.062	12.769	12.769	9.009
2008	3.808	245.000	0.000	0.035	0.000	205.842	0.062	12.799	12.799	8.991
2009	3.881	245.000	0.000	0.037	0.000	206.569	0.062	12.845	12.845	8.963
2010	3.889	245.000	0.000	0.040	0.000	207.054	0.060	12.317	12.317	8.428
2011	3.769	245.000	0.000	0.040	0.000	207.539	0.060	12.346	12.346	8.577
2012	3.779	245.000	0.000	0.040	0.000	208.266	0.060	12.389	12.389	8.610
2013	3.786	245.000	0.000	0.040	0.000	208.751	0.060	12.418	12.418	8.632
2014	3.705	245.000	0.000	0.040	0.000	202.932	0.060	12.072	12.072	8.367
2015	3.639	245.000	0.000	0.036	0.000	209.963	0.057	11.952	11.952	8.313
2016	3.648	245.000	0.000	0.036	0.000	210.691	0.057	11.993	11.993	8.345
2017	3.655	245.000	0.000	0.036	0.000	211.176	0.057	12.021	12.021	8.366
2018	3.664	245.000	0.000	0.036	0.000	211.903	0.057	12.062	12.062	8.398
2019	3.671	245.000	0.000	0.036	0.000	212.388	0.057	12.090	12.090	8.419
2020	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451

Source: Operations Evaluation Mission.

Appendix 18: Financial Internal Rate of Return of Nam Leuk Hydropower Project (Cont 1)

Unit: Million USD

Year	Total Cost	Total Generation (Gwh)	Export (Gwh)	Export Tariff	Export	Domestic Sales (kWh)	Domestic Tariff	Domestic Revenues	Total Revenues	Net Cash Flow
2021	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2022	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2023	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2024	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2025	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2026	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2027	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2028	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2029	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2030	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2031	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2032	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2033	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2034	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2035	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2036	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2037	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2038	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2039	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451
2040	3.680	245.000	0.000	0.036	0.000	213.115	0.057	12.131	12.131	8.451

Source: Operations Evaluation Mission.