The Nationwide Economic and Environmental Impacts of Tourism
A Computable General Equilibrium Approach for Thailand *

Anan Wattanakuljarus

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Comments should be sent to the author:
Anan Wattanakuljarus
Agricultural and Applied Economics Department
427 Lorch Street University of Wisconsin
Madison WI 53706

Email: awattanakulj@wisc.edu
ontanan@yahoo.com

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LIST OF ABBREVIATIONS

AMS	Agriculture, Manufacturing and Services
BASE	10% Inbound Tourism Expansion
CBA	Cost-Benefit Analyses
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CGE	Computable General Equilibrium
CPI	Consumer Price Index
cu.m.	Cubic Meters
DLD	Department of Livestock Development, Thailand
DOI	Domestic-Oriented Industries
DT	Direct Tourism
EOI	Export-Oriented Industries
GDP	Gross Domestic Product
GEMPACK	General Equilibrium Modeling Package
HighAg	High Income Households in Agriculture
HighNag	High Income Households in Non-Agriculture
IO	Input-Output
ISI	Import-Substituting Industries
IT	Indirect Tourism
LES	Linear Expenditure System
LowAg	Low Income Households in Agriculture
LowNag	Low Income Households in Non-Agriculture
MB	Million Baht
MOTS	Ministry of Tourism and Sports, Thailand
MPS	Marginal Propensity to Save
NESDB	National Economic and Social Development Board, Thailand
NESDP	National Economic and Social Development Plan, Thailand
NT	Non-Tourism
OAE	Office of Agricultural Economics, Thailand
PAD	Public, Administration and Defense
PWA	Piped Water Accessible Agriculture
RFD	Royal Forest Department, Thailand
RID	Royal Irrigation Department, Thailand
RTSD	Royal Thai Survey Department, Thailand
SAM	Social Accounting Matrix
TARGET	20% Inbound Tourism Expansion
TAT	Tourism Authority of Thailand
TDRI	Thailand Development Research Institute
TSA	Tourism Satellite Accounts
WIA	Water-Intensive Agriculture
WNA	Water Non-Intensive Agriculture
WNN	Water and Wastewater Non-Intensive Non-Agriculture
WORST	10% Inbound Tourism Reduction
WWN	Water and Wastewater-Intensive Non-Agriculture

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EXECUTIVE SUMMARY

Thai economic conditions considerably depend on the performance of tourism sectors. More than half of the Thai industries are directly and indirectly interdependent with tourism sectors. Given these large economic dependences upon tourism, any internal or external changes that affect Thai tourism could have substantial economy-wide impacts on resource allocation, sectoral outputs, income distribution, macroeconomic variables and the environment.

Using computable general equilibrium (CGE) models, the research finds that an inbound tourism expansion in Thailand can stimulate higher real GDP but with a deterioration in the trade balance due to an appreciation in the real exchange rate and an increase in imports of intermediate inputs for manufacturing. However, the current account deficit can decline owing to the extra foreign receipts from net inbound tourism that are large enough to pay off a reduction in the trade surplus.

An inbound tourism expansion benefits all household classes in terms of an increase in consumption, utility and income. Within the same income level, households in non-agriculture gain more than households in agriculture. Within the same sector, the benefits are concentrated in high income households rather than low income households. The results point out that an inbound tourism expansion is not a pro-poor or pro-agricultural household policy as long as the owners of primary factors in agriculture, especially low income agricultural households, do not participate in tourism activities.

The simulation predicts an increase in water demand by both agriculture and non-agriculture due to an inbound tourism expansion. With other things fixed, this implies an increase in wastewater discharge as well. The largest increases in piped water use are in manufacturing, indirect tourism, water and wastewater-intensive non-agriculture and domestic-oriented industries. If a major concern is to reduce water use and wastewater discharge, a decrease in piped water subsidy might be an appropriate policy option. Therefore, the effects of a reduction in piped water subsidy when there is an inbound tourism expansion should be further investigated in future research.

1. INTRODUCTION

1.1 Description of the problem: key economic and environmental concerns

With its well-known tourist destinations, and thanks to the variety and the abundance of its natural resources, distinctive and indigenous arts, unique culture and culinary delicacies,[1] Thailand is turning its tourism industry into a high-gear economic engine. Since an establishment of the Tourism Authority of Thailand (TAT) in 1976, the Thai government has incorporated tourism in each five-year National Economic and Social Development Plan (NESDP). Tourism has now become so large and important that in 2002 the government established the Ministry of Tourism and Sports (MOTS).

Like the country's trademark rice exports, tourism is now a major contributor to the Thai economy. Its importance could not be more obvious than in 1997 – the year of the Asian economic breakdown.[2] In an attempt to generate a quick recovery, the Thai government launched a series of tourism promotion campaigns, from "*Visit Thailand Year*" to "*Thailand: the Gateway to Indochina*" to a-talk-of-the-town "*Amazing Thailand*" and the ongoing "*Unseen Thailand*".[3] Generally, inbound tourist expenditure in Thailand has been on an upward trend, as shown in figure 1.

The importance of tourism to the Thai economy can be seen from national accounts data and Thailand's Tourism Satellite Accounts (TSA). On average during 1998-2005, Thai tourism directly and indirectly accounted for 13% of GDP (655 billion baht), 10% of employment (3 million jobs), 13% of exports (417 billion baht), 12% of investment (117 billion baht) and 3% of government budget (13 billion baht).

The importance of tourism to the Thai economy from the point of view of the Thai government can be seen in budget allocations and the corresponding predictions of tourism receipts. By spending 2,500 million baht to stimulate tourism industries in 2005, the Thai government expects to gain 13.38 million inbound tourists and 450,000 million baht tourism receipts.[4]

Indeed, tourism has been heavily promoted not only by the Thai government but also by the governments of many countries in Southeast Asia as a key component of development strategies for several decades.[5] This is because it is believed that tourism promotion will serve as a substantial source of employment, foreign exchange earnings and export receipts, thereby contribute to economic growth and improved income distribution.

By nature, however, tourism directly and indirectly interacts with numerous sectors and institutions. According to social accounting matrix in 2001 (TDRI, 2004), more than half of the sectors are interdependent with tourism. Given these intersectoral links, any internal or external changes that affect Thai tourism could have considerable economy-wide impacts on resource allocation, industry outputs, income distribution, key macroeconomic variables and the environment.

In Thailand and other developing countries, land, forests,[6] irrigation water and piped water are key natural resources for agriculture, forestry, manufacturing and services. To the extent that natural resources and the environment influence the production in developing countries, they can be thought of as factors of production. Importantly, the management and distribution of water resources inevitably has environmental connections with land use and forest benefits; thus, any changes that affect the allocation of water resources can also create conflicts of land use in agriculture and forestry as well.

Moreover, conflicts in water allocation are so serious that Thailand could face a water crisis in the near future unless water management and allocation are better managed. In Thailand, water is used for five major purposes: 1) irrigation, 2) household consumption, 3) industry and tourism, 4) electricity production and 5) ecological purposes. Table 1 reports estimated water demand by these five activities up to year 2016 (Kaosa-ard et al., 2001). On average, demand for surface water and underground water is expected to increase by 1.27% and 1.93% a year, respectively.

Among non-agricultural industries, tourism is relatively water-intensive sector. The estimated minimum water demand by a tourist is 300 liters/person/day (0.3 cu.m./person/day). The estimated maximum water demand may be up to 1,000 liters/person/day in luxury hotels. Using TAT data on foreign tourist numbers and average days per visit during 1990-2006, the minimum water demand by all foreign tourists can be calculated as depicted in figure 2. These numbers represent only direct water demand by foreign tourists, excluding domestic tourists and other direct and indirect tourism-related industries. If the economy-wide effects are taken into account, total water demands by tourism are anticipated.

Unfortunately, the perceived economic merits of tourism-based development and thus of tourism promotion policies might hinder policy makers and researchers from considering the economy-wide impacts, especially those on major macroeconomic indicators, other industries' performance, resource allocation, income distribution and the environment. Empirical evidence of the adverse economy-wide effects of an expansion of tourism can be found in multi-regional CGE models by Adams and Parmenter (1991, 1992, and 1995).

Up to now, there are no empirical studies in Thailand that consider the effects of tourism on the economy and the environment. Although the recently-adopted Tourism Satellite Accounts (TSA) framework[7] takes inter-industry and economy-wide effects into account, it does not consider adverse feedback effects of tourism. Inter-industry effects computed in TSA framework focus only on tourism-related industries; thus other industries not interacting with tourism are not taken into consideration.[8]

Besides the TSA framework, current economic impact analyses of tourism range from a simple comparison of data on tourism activities with key economic indicators to more complicated methods such as cost-benefit analyses (CBA), proportional multiplier methods, input-output (IO) models and computable general equilibrium (CGE) models.[9]

Among analyses of the economy-wide effects of tourism, IO models have been frequently used. These IO models tend to generate larger magnitudes of economic effects, especially on sectors most closely associated with tourism. This is because IO models cannot distinguish the gross effects of an activity on outputs, incomes and employment from the net effects after accounting for economy-wide linkages.

Adams and Parmenter (1991) and Dwyer et al. (2003) point out that IO models are not flexible enough to allow for general specifications of the behavior of consumers, producers, and investors. For example, IO models assume that fixed quantities of intermediate and primary inputs are required to produce a unit of output. This then rules out any possibility for industries to adjust their input structures in response to changes in relative prices.

CGE models are designed to overcome these problems. They incorporate factor market and other constraints allowing for potential crowding out of one activity by another as well as for input-output multiplier effects. The behavior of agents is modeled as sensitive to changes in relative prices as well as in quantity variables. CGE models can make explicit assumptions about government policy settings and can incorporate a more realistic set of economy-wide constraints on the supply side of the economy, phenomena not captured in either IO models or multiplier methods.

However, only a few empirical studies of tourism use these approaches,[10] for example, Adams and Parmenter (1991, 1992 and 1995), Zhou et al. (1997) and Mabugu (2002). Other general equilibrium works are theoretical studies, such as those by Copeland (1991), Nowak et al. (2004) and Palmer et al. (2004).

Depending on availability and accuracy of data, CGE models are capable of incorporating environmental concerns and being used to examine several economic issues at the same time. This research attempts to investigate the nationwide economic and environmental impacts of tourism in Thailand, using a CGE model. It is anticipated that this will highlight both positive and negative consequences of changes in tourism. A goal is to examine the underlying mechanisms of such consequences.

1.2 Research objectives

The general objective is to examine how tourism affects the economy and the environment of Thailand. The research specifically attempts to examine the impacts of changes in tourism on: macroeconomic variables, other industries, income distribution, factor market, land, forest, water resources and social welfare.

The remainder of this paper is structured as follows. Section 2 will describe research methodology: database, theoretical frameworks, macroeconomic closures, simulations and software program. Section 3 will examine the simulation results and their underlying mechanisms. Section 4 will conclude the research. The last section will recommend directions for further research in this area. All corresponding tables, figures and notes are appended at the end of the paper.

2. METHODOLOGY

2.1 Database

Necessary databases include base year social accounting matrix (SAM), natural resource data (land, forest and water resources), tourism data and parameters (shares and elasticities) associated with production and consumption functions.

2.1.1 Social accounting matrix (SAM) of Thailand[11]

The fundamental database for CGE models is a social accounting matrix (SAM). SAM (2001), the latest available database, used in this research was developed in TDRI (2004). The original SAM (2001) of TDRI, however, needs to be modified so that the new "Base SAM (2001)" is simple enough to achieve research objectives under time and resource constraints. There are five major modifications.

Firstly, the original SAM (2001) contains 1,007 accounts, more than 800 of which are intermediary and subsequently removed so that the new Base SAM (2001) contains only direct accounts like other standard SAMs. Secondly, an agricultural operating surplus is disaggregated into two separate primary factors, namely agricultural land and capital. Thirdly, labor factors are disaggregated into nine broad categories of occupations. Fourthly, forest and water accounts are incorporated into the Base SAM (2001) by using the results of Sussangkarn and Kumar (1997). Finally, tourism is disaggregated into five regions: Bangkok, Central and West, East and Northeast, North and South for further research in this area.

The finalized Base SAM (2001) contains 208 accounts. There are 80 activities, 80 commodities, three margin services, 18 types of occupations in agriculture and non-agriculture, land, two capitals in agriculture and non-agriculture, forest benefits, four classes of households, a corporation, the government, eight types of taxes and subsidies, a savings/investment, an aggregate tourism, five regional tourisms, rest of the world (ROW), and an inventory.

2.1.2 Land, forest and water data[12]

The research incorporates land, forest and water resources into SAM in monetary terms. This contrasts with alternative approaches that rely on modeling natural resources and the environment by means of physical satellite accounts, such as those recommended in the Integrated Environmental and Economic Accounting 2003 (SEEA 2003) of the United Nations. The physical satellite accounts of Thailand responsible by National Economic and Social Development Board (NESDB) are now under construction.

An alternative approach based on a study by Sussangkarn and Kumar (1997) is applied here. In their study, water behind dams or in reservoirs is defined as natural water. As depicted in figure 3, natural water is distributed to piped water systems and irrigation water systems by the Royal Irrigation Department (RID). Piped water is managed and distributed to non-agriculture and a few agriculture by piped water sectors. Irrigation water is managed and distributed to all agriculture by the RID.

Demands and supplies of piped water are already included in the Base SAM (2001), while those of irrigation water are not explicitly shown as a separate account. This is because they are implicitly embedded in the account of Public, Administration and Defense (PAD). Therefore, a task is to separate demands and supplies of the RID from those of PAD and then identify this new account as a natural water sector.

It is recognized that, in the conventional SAM, natural water is unpriced. Thus, there must be subsidies to cover the costs of management and distribution incurred by the RID. This requires entering the value of subsidized inputs as a negative item in the SAM. Other adjustments are also made for land areas used for water infrastructure, by calculating the equivalent net rent based on land rent in the agricultural sector and subtracting it from gross operating surplus. Forestry is incorporated in the model by calculating the net rent for land areas exploited for forestry which is then subtracted from the gross operating surplus of the forestry sector.

2.1.3 Tourism data

Fortunately, the original SAM (2001) of TDRI contains tourism expenditures and demands for tourism by residents and foreign tourists. It is useful to classify an aggregate tourism into regional tourism for future research on the impacts of environmental changes on tourism. The data of tourism receipts from residents and foreign tourists recorded in TDRI (2001) are used to disaggregate.

2.1.4 Production and consumption parameters

Several production and consumption parameters, such as constant elasticities of substitution (CES) within primary inputs and intermediate inputs, household expenditure elasticities, export demand elasticities and Armington elasticities for Thailand are gathered via literature search. Sources of this data include Sarntisart (1993), Warr et al. (1993), Sussangkarn and Kumar (1997) and Horridge (2005).

2.2 Theoretical frameworks[13]

The CGE model is adapted from Löfgren, Harris and Robinson (2001), A Standard Computable General Equilibrium (CGE) Model in GAMS, Trade and Macroeconomics Division, International Food Policy Research Institute (IFPRI). The programming for implementing the model is modified from:

i) GEMPACK codes of Horridge, Centre of Policy Studies and Impact Project, Monash University, Australia
ii) Harrison and Pearson, Computing Solutions for Large General Equilibrium Models Using GEMPACK, Computational Economics, vol. 9 (1996), pp. 83-127
iii) Horridge (2005). ORANI-G: A Generic Single-Country Computable General Equilibrium Model. Edition prepared for the Practical GE Modelling Course, February 7-11, 2005. Centre of Policy Studies and Impact Project, Monash University, Australia.

Basically, the CGE model explicitly specifies behaviors of producers, households, tourists, exporters, importers, investors and the government as well as market clearing

conditions and numerous macroeconomic variables and price indices. Behaviors of these agents are described as follows.

2.2.1 Producers

Producers maximize their profits or minimize their costs conditional on the nested constant elasticity of substitution technology (CES) as depicted in figure 4. Inputs to production are primary factors and intermediate inputs. Primary factors are a combination of labor, capital and natural resources (land and forest). Labor is a composite of various occupations as shown in the lowest nest. Intermediate inputs consist of several composite goods including irrigation water and piped water. The model also includes technical progress of each input representing required quantities of inputs per unit output.

A nested CES technology is used here to allow substitutability between inputs. If one type of inputs became more expensive, some other types could be used to substitute for that type according to the elasticity of substitution. If the elasticity of substitution is very high, a small change in relative prices between inputs will cause big changes in relative shares of these inputs. A CES technology can be switched to a fixed proportion or Leontief technology by setting the elasticity of substitution to zero.

2.2.2 Households

Each household spends its disposable incomes on composite goods and tourism. Disposable incomes are the net of direct income taxes, savings and transfers to and from other institutions. From figure 5, household expenditure on composite goods is divided into subsistence and luxury parts. Only the luxury parts enter into the household's Klein-Rubin utility function.

The Klein-Rubin utility function is a non-homothetic utility such that a rising income causes budget shares to change although the price ratios are fixed. This contrasts with the CES and Cobb-Douglas utility functions which are homothetic such that budget shares depend only on prices, not incomes. Hence, households in the model are able to adjust combinations of consumption as their incomes change.

Household demand derived from this utility maximization problem is in a form of linear expenditure system (LES) or the Stone-Geary demand system. In this system, subsistence demands for composite goods are fixed regardless of their prices. Rest of the total household spending after subsistence expenditures are deducted is considered as luxury expenditure. This luxury expenditure is allocated to each composite good according to constant marginal budget shares. The model also allows the effect of a switch in consumer spending induced by taste change parameters.

2.2.3 Tourists

Typically, tourism can be thought of as a bundle of goods and services combined together with a fixed proportion or Leontief technology as depicted in figure 6. This is because tourists, for instance, cannot substitute transportation for food, hotels or other services. This is the same assumption used by Blake and Gillham (2001). Outbound

tourism demanded by households is a function of disposable incomes. Inbound tourism demanded by foreigners is a function of tourism prices and exchange rates.

2.2.4 Exports

Final production outputs are allocated between exports and local markets according to a constant elasticity of transformation (CET) function. This assumption captures the possibility that goods sold in export markets are not exactly the same as those sold in local markets. If prices in export markets rise relative to domestic prices, local producers will tend to sell more in export markets for a given unit of outputs.

The elasticity of transformation in the CET function indicates a degree of conversion of an undifferentiated commodity into goods for both markets (Horridge, 2005). If the elasticity of transformation is very high, a small change in relative prices between exports and local markets will cause considerable changes in the relative market shares of both destinations. Foreign demand schedules for commodities are downward-sloping with respect to export prices in foreign currency.

2.2.5 Imports

Composite goods are actually formed from domestic products and imports. Domestic products and imports are combined together by local producers according to a CES function to reflect that domestic products and imports are not perfect substitutes as suggested in the Armington assumption.

Only local producers use imports directly. They particularly combine imports with their own outputs to make composite goods. These composite goods are then used as intermediate inputs for production and as final goods for consumption of households, tourists, investments and the government.

According to the Armington assumption, if prices of domestic products rise, local producers will tend to use more imports for a given unit of composite goods. The degree of responsiveness to price changes depends on the elasticity of substitution. For example, if the elasticity of substitution is very high, a small change in relative prices between domestic goods and imports will cause big changes in relative shares of domestic goods and imports for a given unit of composite goods.

2.2.6 Investment and the government

Investment and the government demand for fixed proportion of composite goods. Total investment and government consumption on composite goods are parts of the GDP. Government incomes consist of tax revenues and transfers from other institutions. Sources of tax revenues are direct and indirect taxes. Direct taxes include household income taxes and corporate taxes. Indirect taxes include excise taxes, value added and sales taxes (VAT), import tariffs, export taxes, forest taxes and subsidy of natural water. Government expenditures consist of consumption, transfers to other institutions and investments. Rest of the government incomes after all expenditures are deducted are government savings.

2.2.7 Savings pool

The savings pool of domestic institutions, which can be thought of as a leakage, is fixed. Hence, the model captures only the pure effects of tourism without the effects of a change in domestic savings (or leakages). This assumption shifts the burden of adjustment to a shock onto household expenditures, changes in which then approximate changes in a money-metric welfare measure. In this model, direct income tax rates on households are adjusted to keep government savings constant when there is a change in tourism.

2.2.8 Numeraire variable

In this model, a nominal exchange rate (a ratio of local prices to foreign prices) is a numeraire variable. This implies that:

i) Other prices are expressed as relative prices to the numeraire
ii) All real endogenous variables are homogenous of degree zero to the numeraire, i.e. a 1% change in the nominal exchange rate causes 0% change in all real endogenous variables
iii) All nominal prices and monetary values are homogenous of degree one to the numeraire, i.e. a 1% change in the nominal exchange rate causes 1% change in all nominal prices and monetary values

2.2.9 Consumer price index (CPI)

Nominal wages and unit prices of other factors such as rental prices of capital, land and forest are CPI-indexed. That is, if the CPI increases, the nominal wages and unit prices of other factors will increase proportionally. These CPI-indexed wages and prices are the perception of laborers.

2.3 Macroeconomic closures

Macroeconomic closures specify exogenous and endogenous variables to reflect the real world and are used as a guideline to determine the underlying macroeconomic mechanism. From figure 7, exogenous variables are depicted in rectangles and endogenous variables are depicted in ovals. The arrows indicate a plausible direction of causation between variables. The upper part of the figure is a supply side or income side of the GDP while the lower part is a demand side or expenditure side. For given values of exogenous variables set by a researcher, the model simultaneously determines all values of endogenous variables in the equilibrium.

On the supply side, technical change, employment and supplies of land, forests and capital are exogenous, while wages and rates of return on land, forests and capital are endogenous. The Thai labor market can be allocated across sectors. The average unemployment rate (3% of labor forces) is so low that the Thai labor market can be considered as being fully utilized. Technical change can be exogenously set according to the actual technical progress (or regress) in an economy at that time. In a short to medium run, land and forest uses are fixed but can be allocated for different crops and activities such as water systems. Thus, the model allows for a conflict of land use between crops, forestry and water systems.

On the demand side, household consumption is assumed to be endogenous so that the model can directly determine social welfare effects. Government consumption and investment are fixed. In the Base SAM (2001), investment already contains capital stocks. To capture the pure effects of tourism without the effects of a change in domestic savings, marginal propensity to save (MPS) of private institutions is adjusted so that their savings are fixed, while direct income tax rates on households are also adjusted to keep government savings constant.

Tourism consumption can be exogenously set according to a tourism boom or growth. Tourism consumption, however, can be switched to an endogenous variable if the effects on tourism are considered. The trade balance, the current account deficit (or foreign savings), terms of trade and real devaluation are endogenously determined by the model. The effects on these macroeconomic variables are main concerns of policy makers in Thailand.

The adjustment mechanism in an economy occurs in both supply and demand sides of GDP. If there is a change in any exogenous variables, the model will adjust all relative prices until new equilibrium prices equate the growth in real GDP from demand side to that from supply side. The actual direction and magnitude of the adjustment will be clear once simulation results are analyzed. The macroeconomic closure together with the theoretical framework and the underlying database will be used to interpret the simulation results.

2.4 Simulations and software program

According to tourism statistics of Tourism Authority of Thailand, the average annual growth rate of inbound tourism is around 10%. Thus, the model assumes a 10% inbound tourism expansion in the base simulation. The next model assumes a 20% inbound tourism expansion according to tourism strategy of the Ministry of Tourism and Sports. Both simulations suppose that tourism expands uniformly in all regions.[14]

However, several bad events such as Tsunami disaster, bird flu, SARS, the southern violence, wars and rising oil prices have caused inbound tourism to be volatile. The next simulation considers the effects of an inbound tourism recession. For the worst case, the simulation assumes a 10% inbound tourism reduction in all regions. The research, therefore, will implement three simulations with fixed supplies of all primary factors suggested by the neo-classical model closure. In sum,

BASE 10% inbound tourism expansion with fixed supplies of all primary factors
TARGET 20% inbound tourism expansion with fixed supplies of all primary factors
WORST 10% inbound tourism reduction with fixed supplies of all primary factors.

Simulation results will be analyzed in three groups: macroeconomic results, institutional results and sectoral results. For simplicity and concise discussion, this research will focus only on the BASE simulation results. The simulation results of TARGET and WORST will be compared with those of BASE.

The underlying theoretical framework, macroeconomic closure and database are written in a software program, GEMPACK (General Equilibrium Modeling Package), to simulate various scenarios. By default, the simulation results produced by GEMPACK are described in percentage changes or ordinary changes from the value that would otherwise have been.

3. SIMULATION RESULTS

To address research questions from large simulation results, it might be worthwhile (if applicable) to analyze sectoral results according to the following four sectoral aggregates. These sectoral aggregates are listed in table 2.

Agriculture, manufacturing and services sectors (AMS) [15]

- Agriculture (**A**) are those industries numbered (1) to (27) and (36)
- Manufacturing (**M**) are those industries numbered (28) to (35) and (37) to (59)
- Services (**S**) are those industries numbered (60) to (81).

Tourism-related sectors (DT, IT, NT)

- Direct tourism-related industries (**DT**) are those with tourism expenditure shares greater than 2%. 10 industries are in this group.
- Indirect tourism-related industries (**IT**) are those with tourism expenditure shares less than 2%. 34 industries are in this group.
- Non-tourism industries (**NT**) are those with zero tourism expenditure shares. 36 industries are in this group.

Water use and wastewater discharge sectors (WIA, WNA, PWA, WWN, WNN)

Most of agriculture has no access to piped water and requires irrigation water. Access to piped water and shares of irrigation water are used to classify agriculture into three groups:

- Water-intensive agriculture (**WIA**) is the group of sectors without access to piped water and which use more than 3% of the total irrigation water supply to agriculture. This group consists of paddy, fruit trees, tree crops, and vegetables.
- Water non-intensive agriculture (**WNA**) is those sectors without access to piped water and which uses irrigation water less than 3% of the total irrigation water supply to agriculture. This group consists of field crops and a few tree crops.
- Piped water accessible agriculture (**PWA**) is those sectors not in WIA and WNA. They have access both to piped water and irrigation water. This group consists of flowers, livestock, forestry, fisheries, and agricultural processing and services.[16]

Non-agriculture, i.e. manufacturing and services, is categorized into two groups according to the intensity of water use and wastewater discharge. Generally, manufacturing and mining industries are grouped using the results of other research, while service industries are grouped according to shares of piped water use. Service industries that use more than 6.0% of the total piped water supply to service industries are classified as water-intensive sectors. Wastewater discharges from service industries are approximately proportional to the piped water use, thus water-intensive service industries

can also be thought of as wastewater-intensive ones. In sum, non-agriculture is classified into: [17]

- Water and wastewater-intensive non-agriculture (**WWN**)
- Water and wastewater non-intensive non-agriculture (**WNN**).

Trade patterns (EOI, ISI, DOI)

- Export-oriented industries (**EOI**) are those with shares of export receipts in total sales greater than 30%.
- Import-substituting industries (**ISI**) are those with shares of imports in total domestic demands greater than 60%. In other words, shares of domestic products in total domestic demands are less than 40%.
- Domestic-oriented industries (**DOI**) are the rest and regarded as non-tradable sectors.

3.1 Macroeconomic results of the BASE simulation

Key macroeconomic results are shown in table 3, under the BASE column. Consider the expenditure side or demand side of GDP: a 10% growth in inbound tourism (line 5) induces 0.11% growth of real GDP (line 1). Given government consumption (line 3) and investment (line 4) constant, higher incomes enable households to consume 3.51% more (line 2).

Due to an increase in household and tourism consumption, total domestic absorption increases by 2.55% (line 6).[18] Since total domestic absorption grows at a higher rate than the real GDP does, the trade balance (exports – imports) has to fall in order to balance the real GDP growth rate. Thus, the trade surplus reduces by 36 billion baht (line 9). A 2.39% decrease in export volume (line 7) and a 1.73% increase in import volume (line 8) are responsible for this reduction.

A 3.53% rise in the GDP price index (line 11) causes an appreciation in the real exchange rate by 3.41% (line 19). This real exchange rate appreciation indicates a loss in international competitiveness for exports, as can be seen from a 1.91% increase in the terms of trade (line 20) or export price index (line 17). This means that exports are 1.91% more expensive than they would otherwise have been.

A growth in domestic demands over domestic supplies due to an inbound tourism expansion raises all price indices, as can be seen from a 2.53% increase in the consumer price index (CPI) (line 13), a 3.27% increase in the government price index (line 14), a 2.00% increase in the investment price index (line 15), and a 2.62% increase in the tourism price index (line 16). Therefore, the absorption price index increases by 2.48% (line 12).[19] A rise in domestic price indices gives an incentive for the allocation of resources from export-oriented industries (EOI) to domestic-oriented industries (DOI). This resource allocation will be explained later, in the institutional and sectoral results.

Although there is a deterioration of the trade balance, the current account deficit declines by 28 billion baht (line 10), mainly due to the receipt of an additional 24 billion baht from net inbound tourism (line 22 subtracted from line 21) and net transfers from rest of the world.

The savings pool of domestic institutions (line 23), which can be thought of as a leakage, is fixed. Specifically, to keep government savings constant when there is a 10% inbound tourism expansion, direct income tax rates on households are reduced by 0.27%. To keep household and corporate savings constant when there is a 10% inbound tourism expansion, their marginal propensity to save has to be varied.

Now, consider the income side or supply side of GDP with fixed primary factor supplies (line 32-39). The weighted-average real wage increases by 1.05% (line 24). However, only the real wage in non-agriculture increases (1.16%, line 26), while that in agriculture slightly decreases (0.0014%, line 25). Similarly, the weighted-average real rate of return on capital rises by 1.24% (line 29), but only real rate of return on non-agricultural capital rises (1.31%, line 31), while that on agricultural capital declines (0.04%, line 30). The real rates of return on land and forest increase by 0.25% (line 27) and 0.85% (line 28), respectively.

Thus, an inbound tourism expansion improves the productivity of factors used in non-agriculture rather than in agriculture, especially non-agricultural labor and capital. This widens the differential wage and the differential rate of return on capital between agriculture and non-agriculture. The next results will examine how the benefits and costs of an inbound tourism expansion are distributed across institutions and industries.

3.2 Institutional results of the BASE simulation

Key institutional results of the BASE simulation are presented in table 4, under the BASE column. From now on, the following abbreviations are used:

LowAg	the poorest 80% of households in agriculture or “low income in agriculture”
HighAg	the richest 20% of households in agriculture or “high income in agriculture”
LowNag	the poorest 80% of households in non-agriculture or “low income in non-agriculture”
HighNag	the richest 20% of households in non-agriculture or “high income in non-agriculture”.

3.2.1 Overview

From table 4, a 10% inbound tourism expansion benefits all household classes in terms of an increase in overall consumption, utility and income. An increase in income induces all household classes to consume more of many kinds of goods and services. This is because the non-homothetic Klein-Rubin utility function allows households to change consumption patterns as income changes.

However, within the same income level, households in non-agriculture gain more benefits than those in agriculture. Within the same sector, high income households gain more benefits than low income ones. As a result, low income agricultural households gain the smallest benefits, while high income non-agricultural households gain the largest

benefits. This implies that an inbound tourism expansion is not a pro-agricultural or pro-poor household policy.

3.2.2 Household consumption patterns

Changes in household consumption affect only luxury (or supernumerary) consumption since subsistence consumption is fixed according to the Klein-Rubin utility function. These patterns represent changes in real supernumerary consumption on each commodity.[20] Changes in household consumption patterns with respect to tourism aggregates and water use aggregates are depicted in figures 8 and 9, respectively. Changes in household expenditure reported in table 4 are also presented on the top of the bar chart. Thus, by looking across household classes, this chart also states a trend of consumption as household expenditure increases.

From figure 8, all household classes tend to spend more on indirect and direct tourism, rather than non-tourism. According to figure 9, all household classes increase consumption of water and wastewater-intensive non-agriculture (WWN), rather than non-intensive sectors (WNN). Within agricultural consumption, all household classes tend to spend more on water-intensive crops (WIA and PWA) than water non-intensive crops (WNA).

3.2.3 Factor income and distribution[21]

As inbound tourism expands, agricultural wage income rises by 2.53%, non-agricultural wage income rises by 3.72%, land income rises by 2.79%, agricultural capital income rises by 2.50%, non-agricultural capital income rises by 3.88%, and forest income rises by 3.40%. This implies that capital and labor in non-agriculture are the factors that gain the most.

The major owner of the factor that gains the most will get the most benefits from an inbound tourism expansion. Since corporations are the major owners of capital in non-agriculture, corporate incomes will rise most. Similarly, since high income non-agricultural households are the major owners of labor in non-agriculture, they are the next beneficiaries. As expected, corporations earn the highest extra income (68,491 MB), while HighNag earn the second highest extra income (59,946 MB) from an inbound tourism expansion.

In sum, capital and labor in non-agriculture are the first and second beneficiaries, while other factors gain only slightly. As a result, corporations and HighNag are the first and second winners, while other institutions get only a small extra income. This confirms that an inbound tourism expansion is not a pro-poor household policy.

3.3 Sectoral results of the BASE simulation

3.3.1 Sectoral outputs, resource allocation and imports

Figure 10 presents percentage changes in sectoral outputs due to a 10% inbound tourism expansion. Based on a 0.11% increase in real GDP, industries that grow by less than 0.11% are ‘not performing well’, while industries that grow by more than 0.11% are

'performing well'. Table 5 lists these industries according to this performance. Changes in sectoral outputs occur as a result of factor reallocation and changes in import volumes across sectors. The best way to understand a mechanism of changes in sectoral production is to simultaneously examine the following figures, particularly, with respect to tourism aggregates and water use aggregates, respectively:

- Changes in sectoral outputs, as shown in figures 11 – 12
- Changes in primary factor allocation, as shown in figures 13 – 14
- Changes in imports of intermediate inputs, as shown in figures 15 – 16.

3.3.2 Tourism aggregates

Consider figures 11, 13 and 15. A 0.49% expansion in direct tourism outputs (figure 11) is mainly due to a 0.14% increase in capital use and a 0.12% increase in labor employment (figure 13) and partly due to a 0.32% increase in imports (figure 15). As shown in figure 13, capital and labor are released from indirect tourism and non-tourism to direct tourism, while land is reallocated from non-tourism to indirect tourism. Generally, land is reallocated to domestic-oriented industries (DOI) especially those indirectly supply goods and services for tourism demands, such as (7) vegetable, (8) fruit, (10) coconut, (21) poultry products, and (27) fresh water fishery.

Although there is a 0.04% reduction in capital use and a 0.09% reduction in labor employment in indirect tourism (figure 13), outputs of indirect tourism increase by 0.40% (figure 11) due to a considerable increase in imports of intermediate inputs. As shown in figure 15, there is a 1.06% increase in imports in indirect tourism. Likewise, although there is a reduction in all factor uses in non-tourism (figure 13), non-tourism outputs slightly increase due to a 0.35% increase in their imports (figure 15).

3.3.3 Water use and wastewater discharge aggregates

Consider figures 12, 14 and 16. According to figure 12, piped water accessible agriculture (PWA) expands its outputs by an extra 0.07%; intensive irrigation water agriculture (WIA) expands with a small extra 0.01%; non-intensive irrigation water agriculture (WNA) expands by only 0.007%. This means that a 10% inbound tourism expansion stimulates agriculture to use relatively more piped water than irrigation water.

Next, consider water use and wastewater discharge in non-agriculture. From figure 12, a 10% inbound tourism expansion stimulates 0.67% extra outputs of non-agriculture that use piped water and emit wastewater intensively (WWN) and 0.32% extra outputs of non-agriculture that use piped water and emit wastewater non-intensively (WNN). Hence, an inbound tourism expansion stimulates non-agriculture to expand production toward higher use of piped water and higher discharge of wastewater. From figure 14, there is an incentive to allocate capital and labor from WNN to WWN, while the increase in imports of intermediate inputs in WWN and WNN is 0.96% and 0.67%, respectively (figure 16).

The above findings suggest that the economy-wide water use is in the direction of piped water rather than irrigation water. As indicated in the simulation results, the

economy-wide irrigation water supply declines by 0.11%, while the economy-wide piped water supply expands by 0.83% as a result of a 10% inbound tourism expansion.

In conclusion, a 10% inbound tourism expansion stimulates production toward: (i) direct and indirect tourism, and (ii) water and wastewater intensive non-agriculture (WWN). Primary factors are mainly allocated toward: (i) direct tourism and (ii) WWN. Finally, an increase in imports of intermediate inputs is mainly for: (i) indirect tourism and (iii) WWN and WNN.

3.4 TARGET and WORST simulations

Recall that TARGET simulates a 20% inbound tourism expansion while WORST simulates a 10% inbound tourism contraction. Key macroeconomic and institutional results of these two simulations are shown in table 3 and 4, under the TARGET and WORST columns, the respectively. In general, the TARGET simulation results are parallel to the BASE simulation results such that the impacts of an inbound tourism expansion are in the same direction but of different magnitude. Specifically, the TARGET simulation results are larger in magnitude than the BASE simulation results.

For instance, the TARGET winners will gain more than the corresponding BASE winners. On the other hand, the TARGET losers will be more adversely affected than the corresponding BASE losers. Similarly, any expansion that occurs in the BASE simulation will expand more in the TARGET simulation while any contraction that occurs in the BASE simulation will contract more in the TARGET simulation. Hence, the qualitative results, especially the direction of the impacts, predicted by the BASE simulation can also be applied to the TARGET simulation as well.

In contrast, the direction of the impacts predicted by the WORST simulation is opposite to the corresponding impacts predicted by the BASE simulation. For example, the BASE winners will become the losers in the WORST simulation while the BASE losers will become the winners in the WORST simulation. Similarly, any expansion that occurs in the BASE simulation will be a contraction in the WORST simulation whereas any contraction in the BASE simulation will be an expansion in the WORST simulation. However, the magnitude (in absolute value) of the impacts predicted by the BASE and the WORST simulation is not necessarily to be the same.

3.5 Environmental issues

The simulation predicts an increase in water demand by both agriculture and non-agriculture due to an inbound tourism expansion.[22] With other things fixed, this implies an increase in wastewater discharge as well. Without proper treatment and control, wastewater could contaminate clean water supply systems.[23] Likewise, with other things the same, an inbound tourism expansion can induce higher air pollution emissions from rising activities in transportation, manufacturing production and primary energy use.[24]

An increase in water use, wastewater discharge and air pollution emission generates higher environmental costs in an economy. Especially, the simulation predicts that the costs of production and distribution of natural water to irrigation agriculture and

piped water systems become higher. As shown in table 6, the highest increase in the costs of water subsidy is for piped water systems.

Table 7 lists all piped water users and their piped water expenditures according to the BASE simulation results. This table indicates that the major piped water users are manufacturing, services, and non-agricultural households. Consider percentage changes in piped water use by sectoral aggregates according to the BASE simulation in figures 17 – 20. From these figures, the largest increases in piped water use are: (i) manufacturing, (ii) indirect tourism, (iii) water and wastewater-intensive non-agriculture (WWN), and (iv) domestic-oriented industries (DOI).

There are many policy options for the government to cover the costs of water subsidy (or any other costs that might occur to an economy) due to an inbound tourism expansion. For example, the benefits of the sectors or institutions that considerably gain from an inbound tourism expansion might be used to support those costs in the forms of indirect taxes (e.g., sales taxes, excise taxes and VAT taxes) or direct taxes (e.g., income taxes and corporate taxes) or direct lump sum transfers between the winners and the losers. The effects of such policies are different and beyond the scope of this research. However, if a major concern is to reduce water use and wastewater discharge, a decrease in water subsidy might be an appropriate policy option. Therefore, the effects of a reduction in piped water subsidy when there is an inbound tourism expansion should be further investigated in the future research.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The economy-wide effects of an inbound tourism expansion on the economy and environment in Thailand include both benefits and costs. These are distributed unevenly across institutions and sectors. An inbound tourism expansion in Thailand can stimulate higher real GDP but with a deterioration in the trade balance due to an appreciation in the real exchange rate. An inbound tourism expansion causes a substantial increase in imports of intermediate inputs in manufacturing. Although the trade balance deteriorates, the current account deficit can decline owing to the extra foreign receipts from net inbound tourism and transfers that have to be large enough to pay off a reduction in the trade surplus.

An inbound tourism expansion benefits all household classes in terms of an increase in consumption, utility and income. An increase in income induces all household classes to consume more of a variety of goods and services. On average, households tend to spend more on manufacturing, especially indirect tourism, and water and wastewater intensive non-agriculture (WWN) products.

However, within the same income level, households in non-agriculture gain more than households in agriculture. Within the same sector, the benefits are concentrated in high income households rather than low income households. This is because an inbound

tourism expansion benefits the owners of capital and labor in non-agriculture rather than the owners of factors in agriculture. Since high income households in non-agriculture and corporations are the major owners of non-agricultural factors, these two institutions become the biggest gainers from an inbound tourism expansion. This substantial income allows high income households to increase supernumerary consumption and attain more utility than low income households. These results point out that an inbound tourism expansion is not a pro-poor or pro-agricultural household policy as long as the owners of primary factors in agriculture, especially low income agricultural households, do not participate in tourism-related activities.

Consider the effects on sectoral production. An inbound tourism expansion stimulates higher outputs in services. A reduction in competitiveness of manufacturing and agricultural products in export markets, due to an appreciation in the real exchange rate, causes a reduction in exports but an expansion in imports in manufacturing that directly and indirectly interacts with tourism activities.

Within agriculture, agriculture that uses both piped and irrigation water expands by more than agriculture that uses only irrigation water. Within non-agriculture, an inbound tourism expansion tends to stimulate manufacturing production that uses a lot of piped water and discharge large amounts of wastewater. Thus, the net use of piped water and the net discharge of wastewater are higher.

Piped water and irrigation water are supposed to be from the same sources of natural water, such as behind dams and reservoirs. Hence, the economy-wide natural water supply has to expand in order to meet higher water demand. In Thailand, the total costs of production and distribution of natural water are subsidized by the government through the Royal Irrigation Department (RID). Therefore, as long as the government still covers these costs, government expenditure on the subsidy must rise as tourism expands. This also affects government expenditure in other areas, such as transfers to households and corporations.

4.2 Recommendations for future research

There are several research extensions to address different research problems. Generally, the extension involves improvements in databases, modification of theoretical frameworks underlying the CGE models and simulation of various government policies on tourism industries. Additional databases, a revised model and new simulations are inevitable and interdependent tasks for further research. The following examples are possible research extensions.

Possible directions for further research include the impacts of tourism on the regional economy and the environment. This regional extension enables national quantity results to be broken down according to regions. This can be done by top-down or bottom-up approaches. In principle, in the top-down approach, the national results are obtained first and then are allocated to the regional results through several equations in such a way that the sum across regions is equal to that of the economy-wide all together. This approach requires less data and computing resources than the latter approach.

The bottom-up approach requires behavioral equations of agents in the regions with economy-wide variables defined as explicit aggregation of the corresponding regional variables. This approach requires more data on regional input-output tables, regional SAM and inter-regional trade flows.

The second extension involves environmental problems. For example, the research can incorporate other sources of water such as groundwater into the model. In addition, the model may include environmental feedback effects in the economic systems such as the effects of environmental quality on production function, the effects of pollution emission and abatement activities on utility function, the inclusion of pollution control costs in production and the inclusion of pollution abatement technologies in economic systems.

The current research examines the effects of exogenous changes in tourism consumption. Thus, the third extension of the research is to examine the impacts of various government policies or investments related to tourism on the economy and the environment, for example, the impacts of an increase in capital investments in direct tourism-related industries, the impacts of an increase in investments in specific tourism regions, the impacts of a change in sales taxes or excise taxes on tourism goods and services, the impacts of a change in water subsidy on tourism industries, etc. This type of experiment will analyze costs and benefits of various tourism policies.

Tables

Table 1 Forecast of water demand by major users in Thailand, million cu.m.

Year	1996	2001	2006	2016	Annual growth (%)
Surface water					
Irrigated agriculture and livestock	20,135	21,802	23,013	25,373	1.30
Household consumption	1,060	1,198	1,256	1,373	1.48
Industry and tourism	712	804	862	954	1.70
Other	2,253	2,584	2,584	2,584	0.74
Total surface water demand	24,160	26,389	27,715	30,284	1.27
Underground water					
Irrigated agriculture and livestock	40	40	40	40	-
Household consumption	316	358	388	457	2.22
Industry and tourism	447	510	550	616	1.89
Total underground water demand	803	908	978	1,113	1.93
Total water demand	24,964	27,297	28,692	31,397	1.29

Sources: Kaosa-ard et al. (2001).

Table 2 Industry classifications with respect to sectoral aggregates

Industry		A	M	S	DT	IT	NT	WIA	WNA	PWA	WWN	WNN	EOI	ISI	DOI
1	Paddy	•					•	•							•
2	Maize	•					•		•						•
3	Sorghum	•					•		•						•
4	Cassava	•					•		•						•
5	FlowerOth	•				•				•				•	
6	BeanNut	•				•			•					•	
7	Vegetable	•				•		•							•
8	Fruit	•				•		•							•
9	Sugarcane	•					•	•							•
10	Coconut	•				•			•						•
11	PalmBean	•					•		•						•
12	KenafJute	•					•		•						•
13	CottonKapok	•					•		•					•	
14	TobaccoLeaf	•					•		•					•	
15	CoffeeTea	•					•		•				•		
16	Rubber	•					•	•					•		
17	CattleBuff	•					•			•				•	
18	Swine	•					•			•					•
19	OthLiveStoc	•				•				•				•	
20	Poultry	•					•			•			•		
21	PoultryProd	•				•				•					•
22	SilkFarm	•					•			•					•
23	AgService	•					•			•					•
24	LogCoalWood	•				•				•				•	
25	OthForest	•				•				•					•
26	MarineFish	•				•				•			•		
27	FreshFish	•				•				•					•
28	Lignite		•				•				•				•
29	CrudeOilGas		•				•					•			•
30	IronOre		•				•				•			•	
31	TinMining		•				•				•			•	
32	Tungsten		•				•				•			•	
33	OthMining		•				•				•		•		
34	Fluorite		•				•				•				•
35	SaltMfg		•				•					•			•
36	AgProcess	•					•			•					•
37	RiceMilling		•			•					•		•		
38	TapiocaMfg		•				•				•		•		
39	SugarMfg		•			•					•		•		

Table 2 Industry classifications with respect to sectoral aggregates (continued)

Industry		A	M	S	DT	IT	NT	WIA	WNA	PWA	WWN	WNN	EOI	ISI	DOI
40	OthFoodMfg		•		•						•		•		
41	Beverage		•		•						•				•
42	TobaccoMfg		•			•						•			•
43	Textile		•		•						•		•		
44	Clothing		•		•							•	•		
45	LeatherShoe		•		•						•		•		
46	WoodProd		•			•						•		•	
47	Furniture		•				•					•	•		
48	PaperProd		•			•					•			•	
49	PrintPublsh		•		•							•			•
50	ChemProd		•			•					•			•	
51	PetroProd		•				•					•		•	
52	RubberPlast		•			•					•		•		
53	NonMetalPro		•			•					•			•	
54	BasicMetal		•				•				•		•		
55	FabMetalPro		•			•					•			•	
56	Machinery		•				•					•		•	
57	ElectricMac		•			•					•			•	
58	TransprtEqp		•			•						•	•		
59	OthMfg		•		•							•	•		
60	Electricity			•		•					•				•
61	GasMfgDist			•			•					•			•
62	PipeWater			•		•					•				•
63	Construct			•			•					•			•
64	Trade			•			•				•				•
65	Restaurant			•	•						•				•
66	Hotel			•	•						•				•
67	Transport			•	•						•				•
68	Communicate			•		•						•			•
69	BankFinance			•		•						•			•
70	Insurance			•		•						•			•
71	OwnDwelling			•		•					•				•
72	BusinessSrv			•			•					•			•
73	PubAdmDef			•		•						•			•
74	Education			•			•				•				•
75	MedHealth			•		•					•				•
76	NonProfit			•		•						•			•
77	RecEntertan			•		•						•			•
78	Repairs			•		•						•			•
79	PersnHouSrv			•		•						•			•
80	Water			•			•				•				•

Table 3 Key macroeconomic results: BASE, TARGET and WORST simulations

*Percentage changes (if not indicated as million baht changes, **MB**)*

Line	Macroeconomic Variables	BASE	TARGET	WORST
1	Real GDP	0.1149	0.2324	-0.1124
2	Real household consumption	3.5135	7.1438	-3.4065
3	Real government consumption	0	0	0
4	Real investment	0	0	0
5	Real tourism consumption	10	20	-10
6	Real domestic absorption	2.5504	5.1669	-2.4898
7	Real export volume	-2.3860	-4.8153	2.3459
8	Real import volume, CIF	1.7292	3.5816	-1.6189
9	Trade surplus (**MB**)	-36,213	-76,554	32,509
10	Current account deficit (**MB**)	-27,731	-57,404	25,999
11	GDP price index	3.5312	7.3403	-3.2844
12	Absorption price index	2.4762	5.1292	-2.3182
13	Consumer price index, CPI	2.5340	5.2437	-2.3771
14	Government price index	3.2721	6.7939	-3.0500
15	Investment price index	1.9964	4.1326	-1.8717
16	Tourism price index	2.6179	5.4212	-2.4526
17	Export price index	1.9069	3.9376	-1.7958
18	Import price index	0	0	0
19	Real devaluation	-3.4107	-6.8384	3.3959
20	Terms of trade	1.9069	3.9376	-1.7958
21	Inbound tourism (**MB**)	32,107	65,894	-30,584
22	Outbound tourism (**MB**)	8,335	17,333	-7,747
23	Domestic savings pool (**MB**)	0	0	0
24	Real wage, weighted average	1.0500	2.1525	-1.0019
25	Real wage, agriculture	-0.0014	0.0518	0.0515
26	Real wage, non-agriculture	1.1601	2.3726	-1.1123
27	Real rate of return on land	0.2459	0.5523	-0.1906
28	Real rate of return on forest benefits	0.8451	1.7647	-0.7775
29	Real rate of return on capital, weighted average	1.2391	2.5339	-1.1880
30	Real rate of return on capital, agriculture	-0.0379	-0.0188	0.0900
31	Real rate of return on capital, non-agriculture	1.3136	2.6829	-1.2626
32	Real employment, weighted average	0	0	0
33	Real employment, agriculture	0	0	0
34	Real employment, non-agriculture	0	0	0
35	Real land use	0	0	0
36	Real forest benefits use	0	0	0
37	Real capital use, weighted average	0	0	0
38	Real capital use, agriculture	0	0	0
39	Real capital use, non-agriculture	0	0	0

Table 4 Key institutional results: BASE, TARGET and WORST simulations

*Percentage changes (if not indicated as million baht changes, **MB**)*

Line	Institutional Variables	BASE	TARGET	WORST
1	Real household consumption			
	- LowAg	2.1992	4.4875	-2.1176
	- HighAg	4.1316	8.4166	-3.9918
	- LowNag	2.8949	5.8796	-2.8123
	- HighNag	4.4440	9.0307	-4.3134
2	Social welfare (utility)			
	- LowAg	3.1750	6.4776	-3.0581
	- HighAg	7.0617	14.3882	-6.8207
	- LowNag	4.4447	9.0251	-4.3201
	- HighNag	7.6019	15.4611	-7.3666
3	Household incomes			
	- LowAg	5.0893	10.5956	-4.7199
	- HighAg	5.1495	10.7188	-4.7775
	- LowNag	5.5691	11.5788	-5.1780
	- HighNag	5.7916	12.0409	-5.3850
4	Savings (**MB**)			
	- LowAg	0	0	0
	- HighAg	0	0	0
	- LowNag	0	0	0
	- HighNag	0	0	0
	- Corporation	0	0	0
	- Government	0	0	0

Table 5 Sectoral performance according to changes in sectoral outputs, the BASE simulation

'Not performing well': Industries grow by less than 0.11%	
'Losers' growth < 0	(4) Cassava, (9) Sugarane, (16) Rubber, (23) AgService, (28) Lignite, (30) IronOre, (31) TinMining, (32) Tungsten, (33) OthMining, (34) Fluorite, (35) SaltMfg, (38) TapiocaMfg, (54) BasicMetal, (69) BankFinance, (73) PubAdmDef, (76) NonProfit, (77) RecEntertan, (78) Repairs, (80) Water
0 < growth < 0.11	(12) KenafJute, (15) CoffeeTea, (53) NonMetalPro, (56) Machinery, (63) Construct
'Performing well': Industries grow by more than 0.11%	
0.11 < growth < 1.70	(1) Paddy, (2) Maize, (3) Sorghum, (6) BeanNut, (10) Coconut, (11) PalmBean, (13) CottonKapok, (17) CattleBuff, (18) Swine, (19) OthLiveStoc, (20) Poultry, (22) SilkFarm, (24) LogCoalWood, (25) OthForest, (26) MarineFish, (29) CrudeOilGas, (36) AgProcess, (37) RiceMilling, (39) SugarMfg, (40) OthFoodMfg, (43) Textile, (46) WoodProd, (48) PaperProd, (50) ChemProd, (51) PetroProd, (52) RubberPlast, (57) ElectricMac, (60) Electricity, (61) GasMfgDist, (62) PipeWater, (64) Trade, (70) Insurance, (72) BusinessSrv, (74) Education, (75) MedHealth, (79) PersnHouSrv
Winners growth > 1.70	(5) FlowerOth, (7) Vegetable, (8) Fruit, (14) TobaccoLeaf, (21) PoultryProd, (27) FreshFish, (41) Beverage, (42) TobaccoMfg, (44) Clothing, (45) LeatherShoe, (47) Furniture, (49) PrintPublsh, (55) FabMetalPro, (58) TransprtEqp, (59) OthMfg, (65) Restaurant, (66) Hotel, (67) Transport, (68) Communicate, (71) OwnDwelling

Table 6 An increase in water subsidy due to a 10% inbound tourism expansion, million baht (MB)

Rank*	**Industries**	**Old subsidy (MB)**	**New subsidy (MB)**	**Increase (MB)**
1	(62) PipeWater	41,828	43,525	1,697
2	(7) Vegetable	20,216	21,019	803
3	(36) AgProcess	19,938	20,696	757
4	(8) Fruit	16,825	17,504	679
5	(1) Paddy	12,409	12,724	314
6	(26) MarineFish	22,815	22,986	172
7	(18) Swine	4,030	4,163	134
8	(17) CattleBuff	3,500	3,613	113
9	(21) PoultryProd	2,491	2,602	111
10	(20) Poultry	7,724	7,820	96
	Others	32,708	33,110	402
	Total	184,485	189,764	5,279

* In rank of an increase in water subsidy

Table 7 Piped water expenditures as inbound tourism expands by 10%, the BASE simulation

	Piped water users	**Piped water expenditures W_i (MB)**	**Percentage $W_i / \sum_i W_i$ (%)**
1	Agriculture	1,376	3.83
2	Manufacturing	*10,543	*29.37
3	Services	*7,882	*21.96
4	Total piped water expenditures of production (1) + (2) + (3)	19,801	55.17
5	Low income households in agriculture	3,024	8.43
6	High income households in agriculture	610	1.70
7	Low income households in non-agriculture	*5,131	*14.29
8	High income households in non-agriculture	*5,834	*16.25
9	Total piped water expenditures of households (5) + (6) + (7) + (8)	14,599	40.67
10	Government	1,473	4.10
11	ROW	6	0.02
12	Inbound tourism	14	0.04
	Total piped water expenditures of all users (4) + (9) + (10) + (11) + (12)	35,893	100.00

* Indicate the major piped water users

Figures

Figure 1 Inbound tourist expenditure of Thailand, 1990-2005
Tourism Authority of Thailand (TAT)

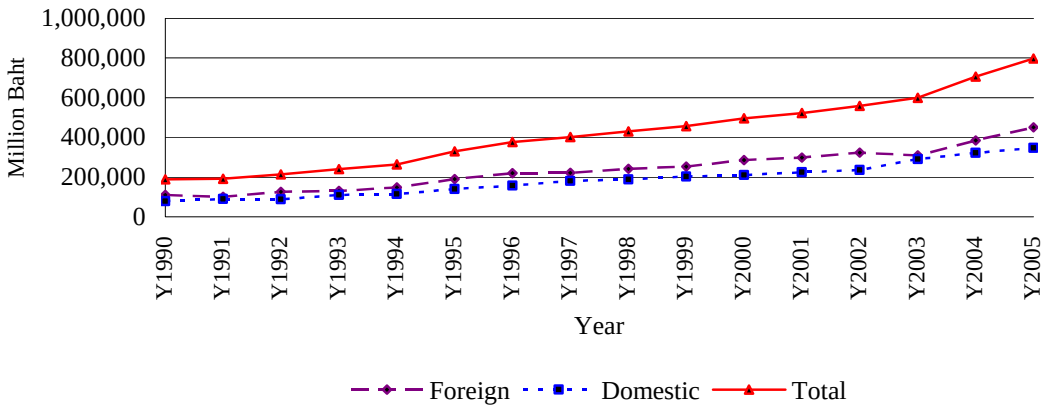


Figure 2 Minimum water demand by foreign tourists, 1990-2006
[Number of foreign tourists] x [Average days of stay] x [0.3 million cu.m.]

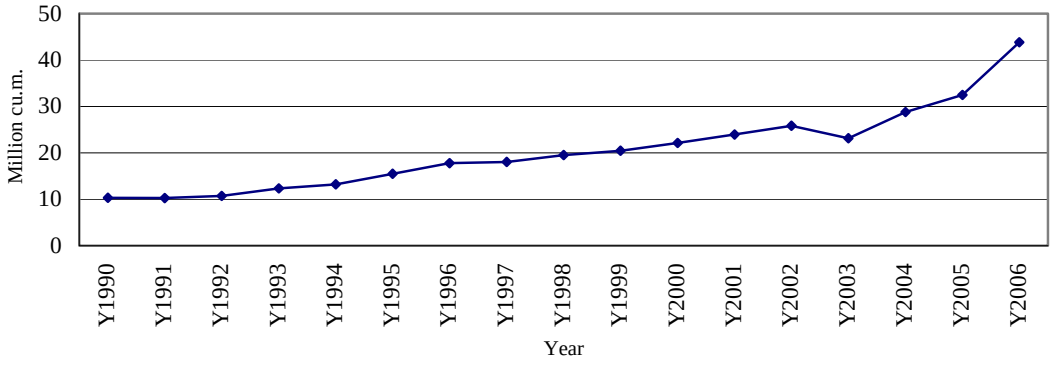


Figure 3 Distribution of natural water to agriculture and non-agriculture

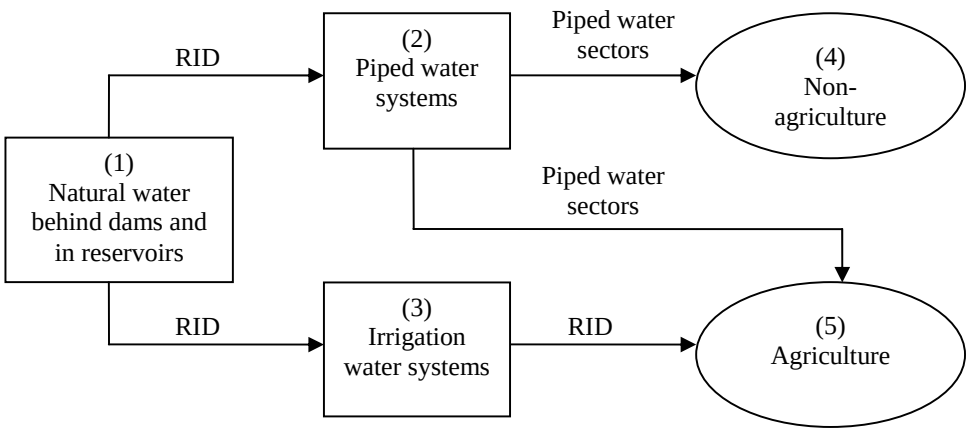


Figure 4 Nested constant elasticity of substitution (CES) production structure

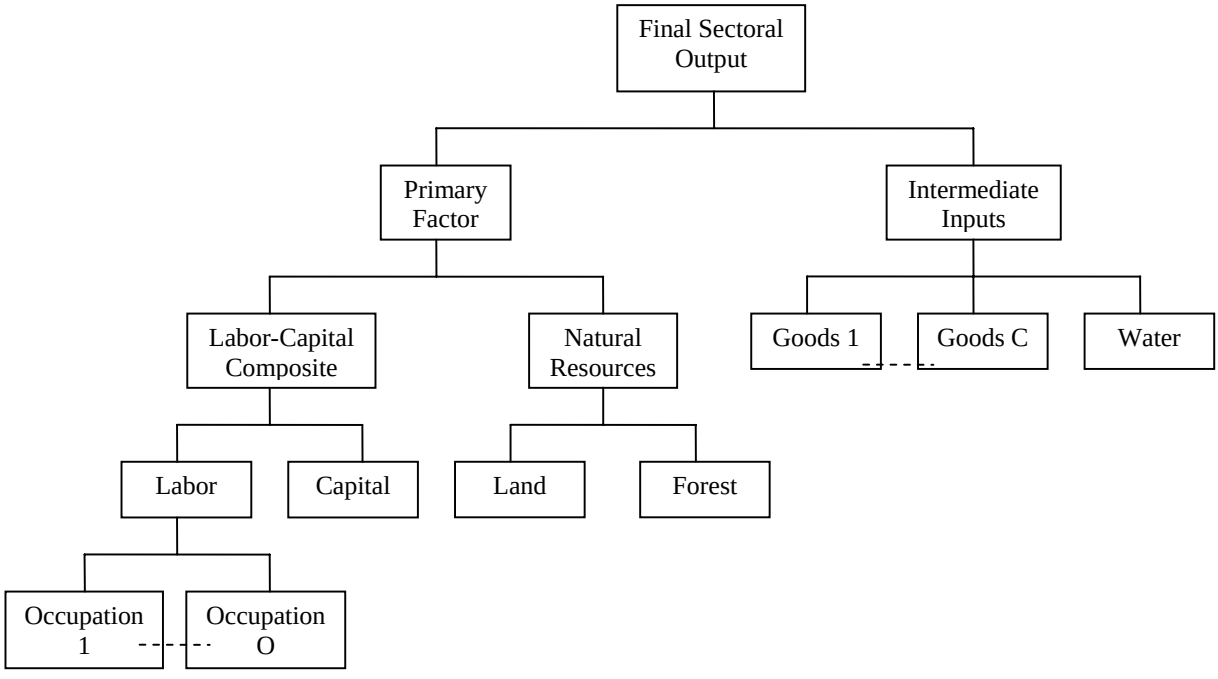


Figure 5 Household demand for composite goods

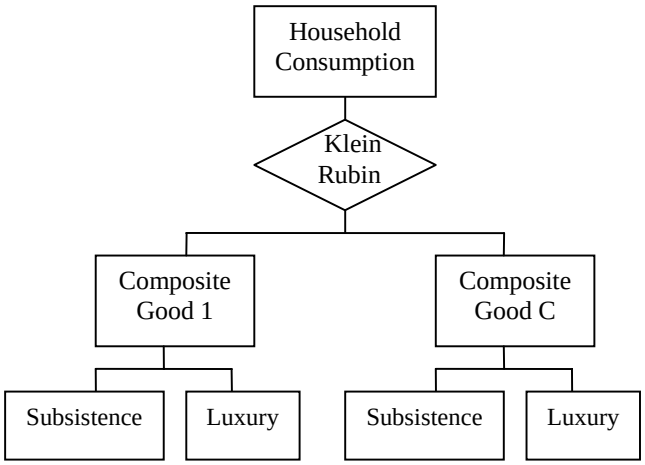


Figure 6 Tourism expenditures

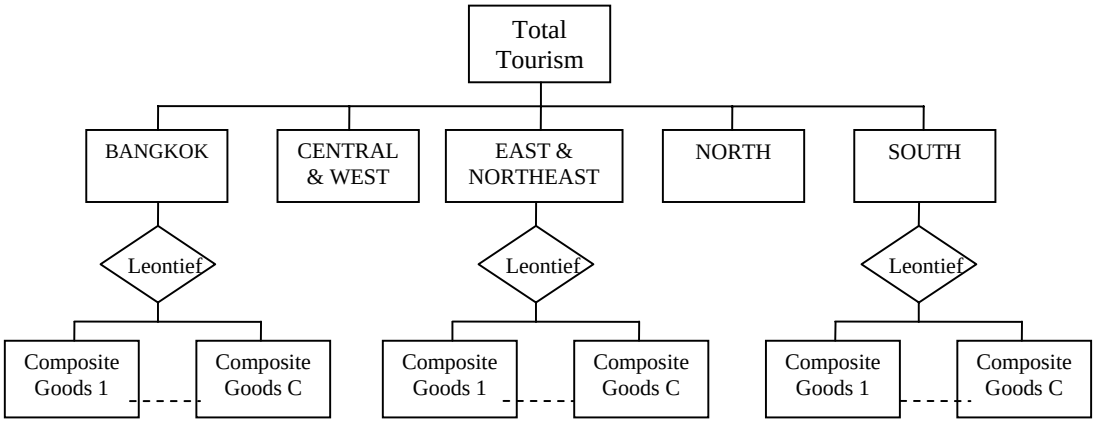


Figure 7 Macroeconomic closures

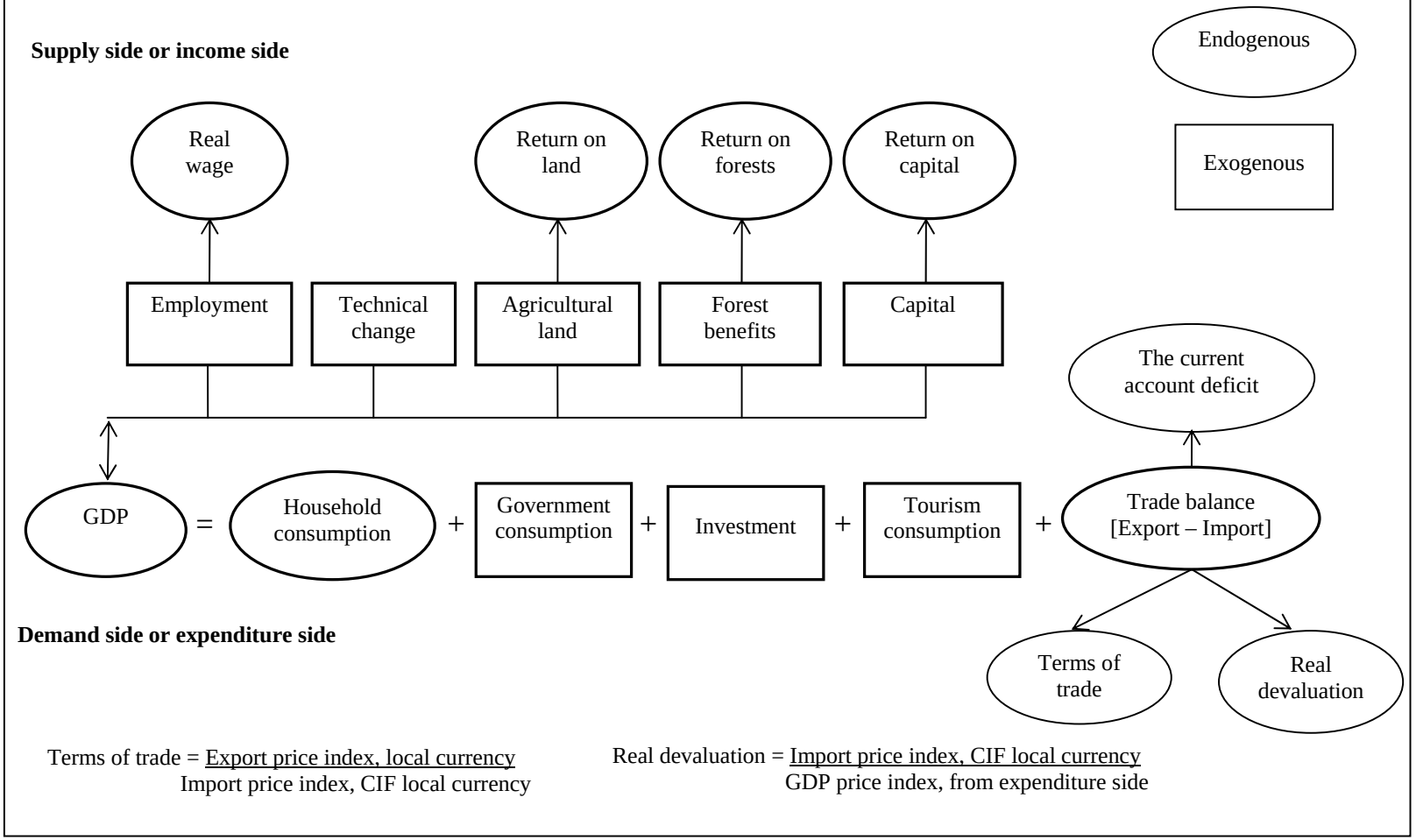
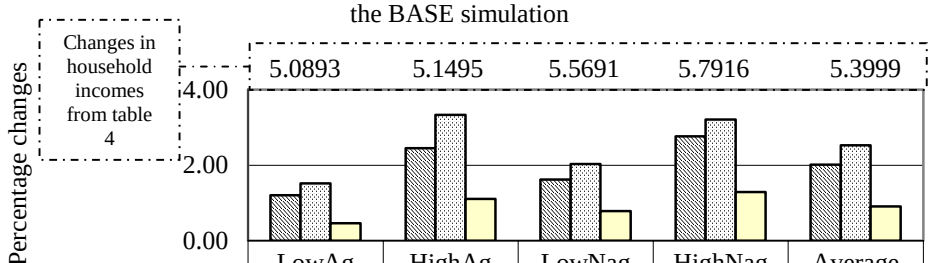
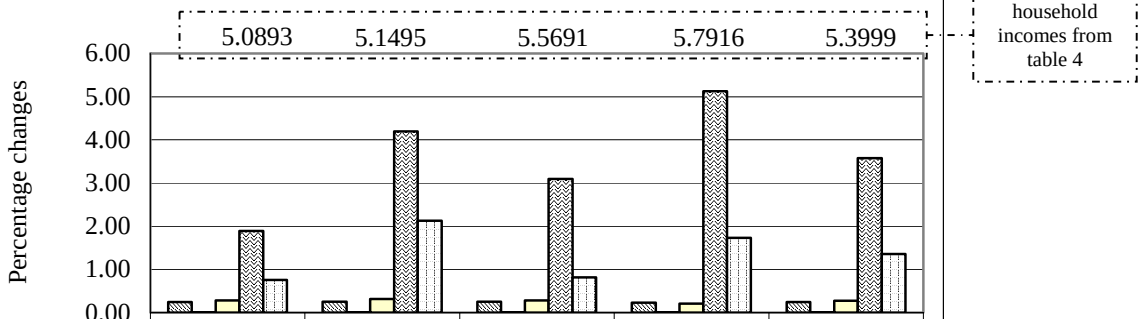


Figure 8 Patterns of consumption in terms of tourism aggregates the BASE simulation



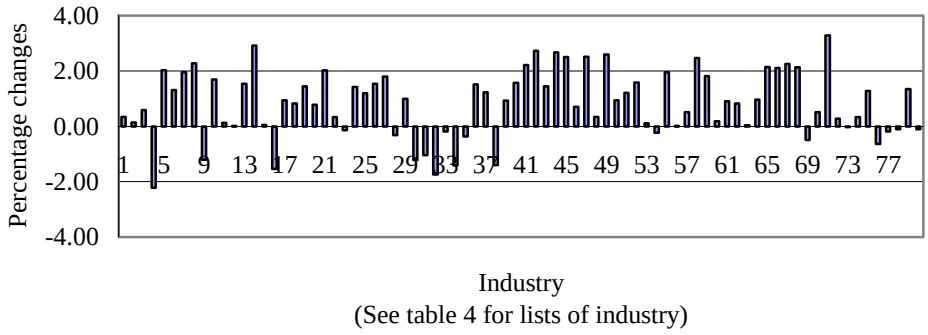
	LowAg	HighAg	LowNag	HighNag	Average
Direct tourism	1.2022	2.4501	1.6197	2.7645	2.0091
Indirect tourism	1.5137	3.3288	2.0328	3.2047	2.5200
Non-tourism	0.4585	1.1027	0.7815	1.2892	0.9080

Figure 9 Patterns of consumption in terms of water use aggregates the BASE simulation



	LowAg	HighAg	LowNag	HighNag	Average
WIA	0.2422	0.2559	0.2501	0.2301	0.2446
WNA	0.0095	0.0083	0.0101	0.0067	0.0087
PWA	0.2815	0.3171	0.2843	0.2108	0.2734
WWN	1.8890	4.1938	3.0922	5.1264	3.5754
WNN	0.7539	2.1252	0.8118	1.7308	1.3554

Figure 10 Changes in sectoral outputs
the BASE simulation



Industry
(See table 4 for lists of industry)

Figure 11 Changes in sectoral outputs in terms of tourism aggregates
the BASE simulation

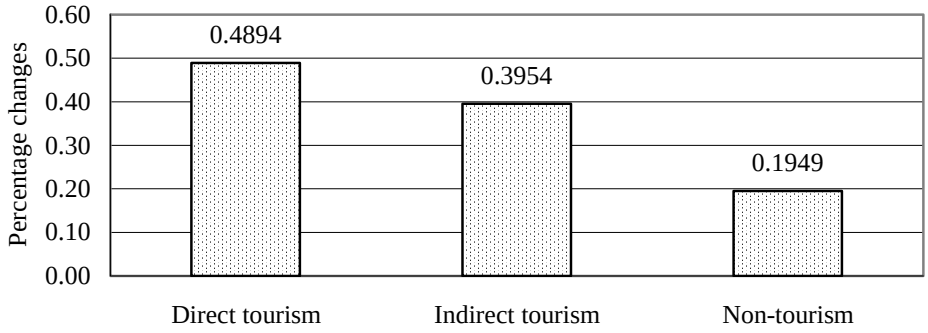


Figure 12 Changes in sectoral outputs in terms of water use
the BASE simulation

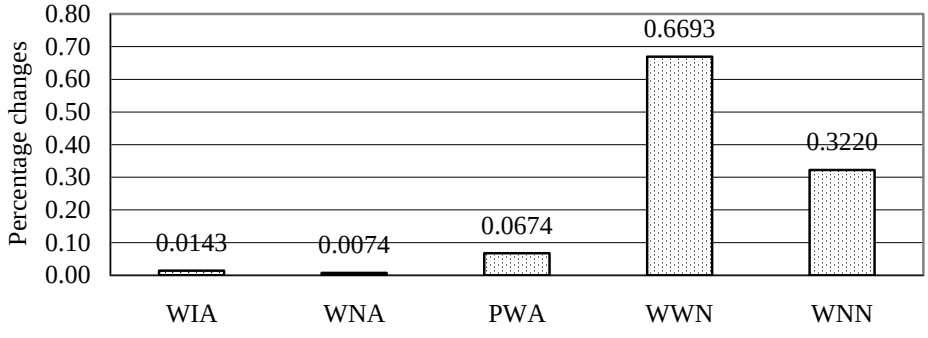
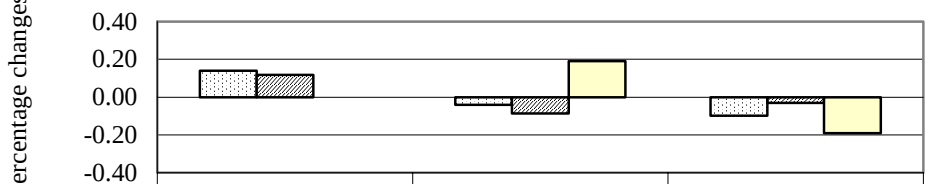
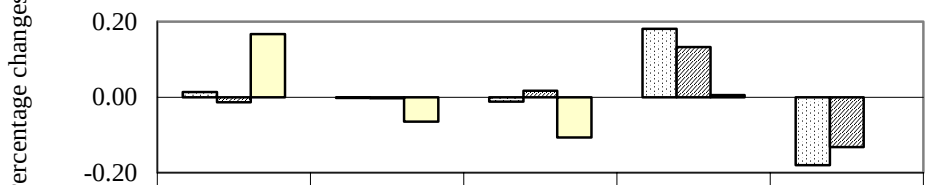


Figure 13 Changes in factor use in terms of tourism aggregates
the BASE simulation



	Direct tourism	Indirect tourism	Non-tourism
Capital	0.1399	-0.0412	-0.0986
Labor	0.1176	-0.0873	-0.0302
Land	0.0000	0.1911	-0.1907

Figure 14 Changes in factor use in terms of water use aggregates
the BASE simulation



	WIA	WNA	PWA	WWN	WNN
Capital	0.0136	-0.0018	-0.0118	0.1809	-0.1806
Labor	-0.0139	-0.0028	0.0167	0.1323	-0.1321
Land	0.1671	-0.0649	-0.1072	0.0053	0.0000

Figure 15 Changes in imports in terms of tourism aggregates
the BASE simulation

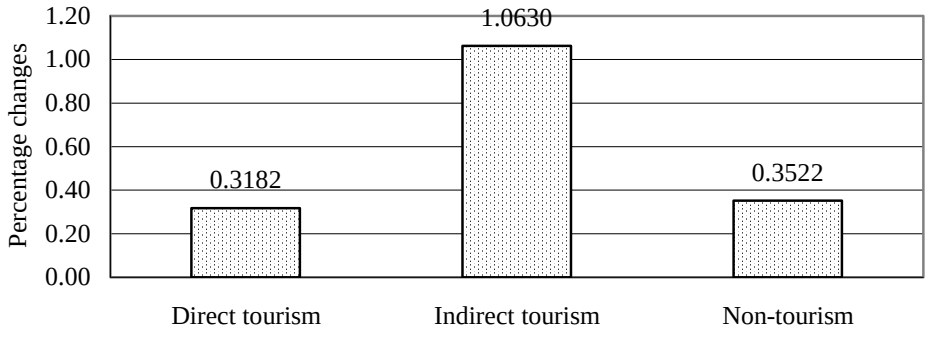


Figure 16 Changes in imports in terms of water use aggregates the BASE simulation

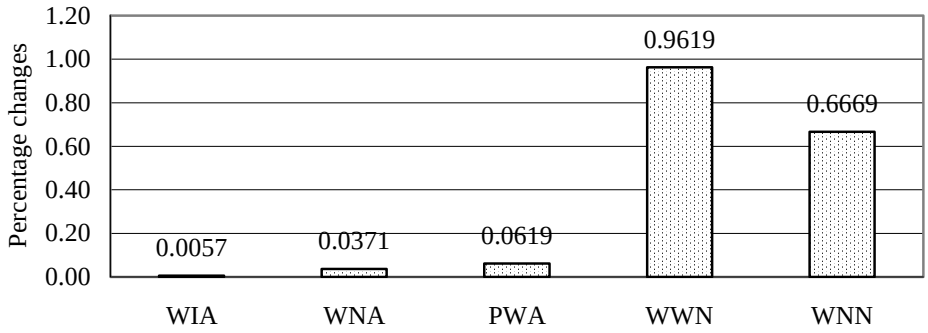


Figure 17 Changes in piped water use in terms of AMS aggregates the BASE simulation

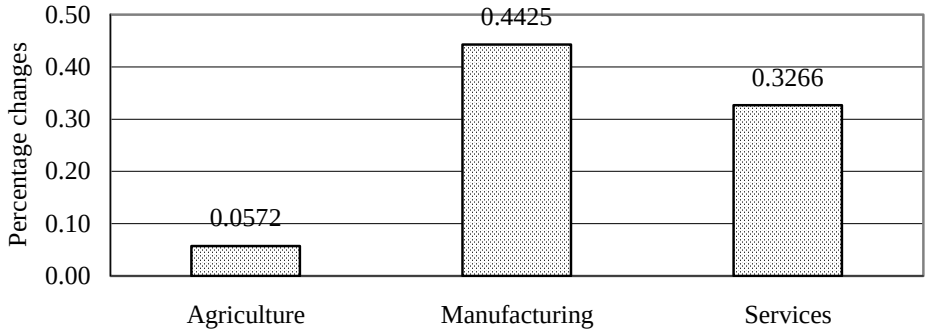


Figure 18 Changes in piped water use in terms of tourism aggregates the BASE simulation

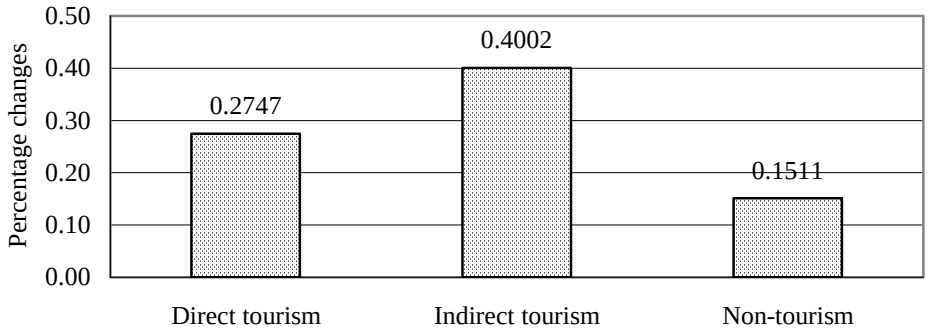


Figure 19 Changes in piped water use in terms of water aggregates the BASE simulation

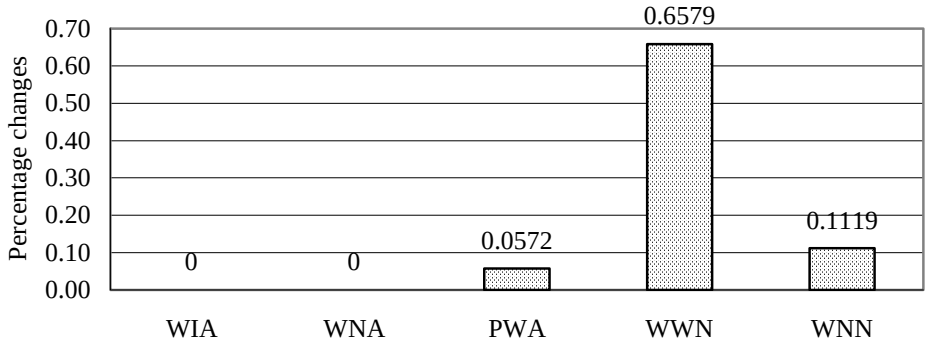
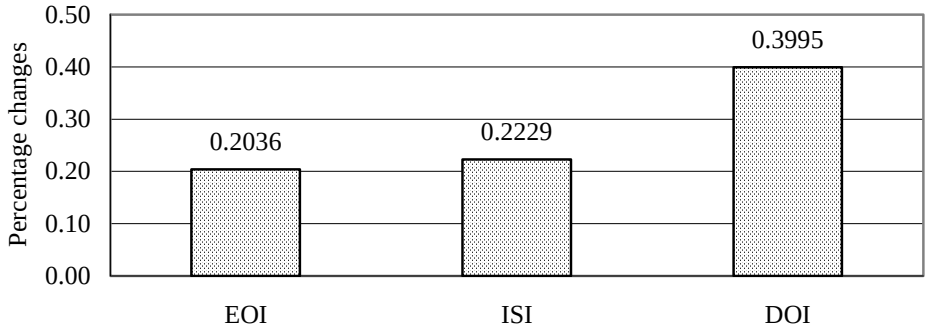


Figure 20 Changes in piped water use in terms of trade aggregates the BASE simulation



Notes

1. TDRI (2001), pp. 273, reports that there are totally 2,644 tourist destinations in Thailand. They are classified into 1,200 natural resource destinations, 1,039 historical and religious destinations and 405 cultural, traditional and social destinations.

2. Even now tourism is hopefully believed as a major source of foreign receipts that can improve the current account deficit and recover the Thai economic downturns although Thai tourism has been hit by SARS, bird flu, Tsunami disaster, oil price shocks and violence in the Southern borders of Thailand.

3. See TAT, TDRI (1993, 2001) for tourism structure, policies and promotion strategies in Thailand.

4. 2,500 million baht budget is allocated for the following four expenditures:
   (a) 600 million baht is used to subsidize: VISA fees for Chinese and Russian tourists, airport fees at Phuket and Krabi airports and diesel fuel for boats of diving agencies
   (b) 800 million baht is used for foreign marketing efforts in: China (285 MB), Japan (238 MB), Hong Kong, Singapore and Malaysia (108 MB), Korea (10 MB), Australia (39 MB) and Europe (120 MB)
   (c) 100 million baht is used for domestic marketing efforts such as public relation and advertisement
   (d) 1,000 million baht is used to improve tourism goods and services in: old tourist destinations (450 MB), new tourist destinations (300 MB), tourist villages in 12 provinces (100 MB), research and development in tourism (100 MB) and guides (50 MB).

   Sources: Thai local newspaper: Thairath (July 25, 2005) and Dailynews (August 18, 2005)

5. See TDRI (1993) for tourism development plans in Thailand (chapter 1), tourism strategies and promotion policies in Thailand (chapter 9), in Indonesia (chapter 2, pp. 25-30) and in Singapore (chapter 2, pp. 33-34). See also Chon (2000).

6. In 2001, 25% of total areas (128,976 sq.km.) are forests, while the rest (384,139 sq.km.) are non-forest. Within non-forest, 210,146 sq.km. (55% of non-forest) are agricultural farm holding lands and 173,993 sq.km. (45% of non-forest) are unclassified lands. [Sources: Royal Forest Department Thailand (RFD), Office of Agricultural Economics Thailand (OAE) and Royal Thai Survey Department (RTSD)].

7. See WTTC (2004) for TSA frameworks. See Wongnopadondecha and Roongruangchaiboon (2003) for a report of Thailand's TSA.

8. TSA framework is based on the demand side concept of economic activities. It determines consumption and demand for travel and tourism (T&T) in the economy and then uses input-output models to trace the supply side. The supply side is then quantified into two levels, industry and economy level. The basic industry level captures only direct impacts of T&T on the industry, while the broader economy level captures both direct and indirect impacts of T&T on the economy-wide.

9. See Frechtling (1987), Dwyer and Forsyth (1993a, 1993b), Clarke and Ng (1993) for a CBA method. See Archer (1982, 1989), Sinclair and Sutcliffe (1988), Slee et al. (1997) for proportional multiplier methods. See Diamond (1975), Fletcher (1989), Heng and Low (1990), West (1993), Tohamy and Swinscoe (2000), Hernández (2004) for IO models.

10. Some possible reasons are the lack of data on tourism expenditures and the difficulty of identification and inclusion of tourism-related sectors in the IO table and Social Accounting Matrix (SAM).

11. See a complete modification and discussion of the Base SAM (2001) in Wattanakuljarus (2004), the first progress report: "A 2001 Social Accounting Matrix (SAM) for the Analyses of Economic and Environmental Impacts of Tourism in Thailand". November 1, 2004.

12. See a complete incorporation of land, forests and water resources in Wattanakuljarus (2005), the second progress report: "A SAM Based GEMPACK AGE Model for the Analyses of Economic and Environmental Impacts of Tourism in Thailand". April 4, 2005.

13. See details of the model in the second progress report: "A SAM Based GEMPACK CGE Model for the Analyses of Economic and Environmental Impacts of Tourism in Thailand". April 4, 2005.

14. Thai government invests 2,500 million baht in a tourism sector in order to attain 450,000 million baht of foreign tourism receipts. These receipts are 180 times of the tourism budget. Hence, it is applicable to assume an exogenous shift in an inbound tourism demand here.

15. These AMS sectoral aggregates are from the original classification of TDRI SAM, see TDRI (2004).

16. From a report of the Department of Livestock Development, Thailand, cattle need water 40 liters/head/day, swine need 6 liters/head/day and poultries need 0.3 liters/head/day. In 2001, from a report of the Office of Agricultural Economics, Thailand, there were 1,452,465 cattle, 9,716,135 swine and 1,170,510,587 poultries. Hence, the total water demand by livestock in 2001 was about 170 million cu.m.

17. Several studies provide similar conclusions regarding water and wastewater intensive manufacturing. For example, Laplante and Meisner (2001) conclude that:

> "Our results clearly demonstrate that industrial BOD and TSS emissions are accounted for by a very limited number of industrial sectors. Across regions and provinces, typically 4 or 5 industrial sectors account for more than 80% of total releases of industrial BOD and TSS emissions. These sectors typically include the following ones: iron and steel, pulp, paper and paperboard, distilled spirits, dairy products, sugar factories and refineries, fish products, industrial chemicals except fertilizer and nonferrous metals."

    Their conclusions are similar to various research cited in Kaosa-ard, et al., (2001), such as Jyothsna Mody (1997), and CMS Engineering and Management Co., Ltd. (1998). Also, see Thailand Environment Monitor 2000 of the World Bank.

18. From Base SAM, the total domestic absorption consists of household consumption shares (54.84%), government consumption shares (11.39%), investment shares (27.55%), and tourism consumption shares (6.23%). Therefore, the total domestic absorption increases approximately by: (0.5484) x (3.5135%) + (0.1139) x (0%) + (0.2755) x (0%) + (0.0623) x (10%) = 2.5498%.

19. Similarly, the absorption price index increases approximately by: (0.5484) x (2.5340%) + (0.1139) x (3.2721%) + (0.2755) x (1.9964%) + (0.0623) x (2.6179%) = 2.4754%.

20. To be precise, it is a change in real supernumerary consumption multiplied by a supernumerary consumption share in total expenditures.

21. From Base SAM, factor income is the largest source of household income, as shown below:

Sources of income	LowAg	HighAg	LowNag	HighNag	Overall
Factor income	85.07	80.26	91.47	91.63	89.80
Transfer from corporation	7.40	7.40	7.40	7.40	7.40
Transfer from government	4.41	7.23	0.66	0.57	1.64
Transfer from ROW	3.12	5.11	0.47	0.40	1.16
Total	100	100	100	100	100

22. Water demands in the current research are considered as the lower bound since other sources of water, such as groundwater and surface water not responsible by the RID are not included in the model.

23. Approximately, 60% of water for services and domestic use, such as drinking, food preparation, sanitation, washing, cleaning, watering gardens, laundries, swimming pools, restaurants and medical services ends up as wastewater discharge. About 85% of water for manufacturing use, such as cooling, processing, cleaning and waste removal becomes highly polluted wastewater. Finally, around 25% of water for agriculture use, such as irrigation of rice paddies, fish and prawn farms, cash crops and stock breeding is returned to the water systems with contaminations of pesticides and fertilizers which can have a profound effect on the aquatic environment. [Sethaputra et. al. 1990]

24. Air pollution emission rates from transportation, manufacturing and energy use in Thailand can be found in a study of Chongpeerapien et. al. 1990.

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