PROJECTION OF THE ECONOMIC IMPACTS OF CHANGES IN THAILAND'S TRANSPARENCY AND ASSOCIATED CHANGES IN CO_2 EMISSIONS

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A Dissertation Submitted in Partial
Fulfillment of the Requirements for the Degree of
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ABSTRACT

Title of Dissertation	Projection of the Economic Impacts of Changes in Thailand's Transparency and Associated Changes in CO_2 Emissions
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Economic growth is driven by the growth of capital in the neoclassical tradition. Likewise, economic growth is compromised by the leakage of potential capital growth. The factors in economic growth are the accumulation of 4 types of capital, comprising physical capital, human capital, natural capital, and social capital. They are complementary. The deficiency of any one can compromise economic growth and erode the supply of other types of capital. The deterioration of the social capital that brings corruption is an underlying factor for the drag on economic growth, loss of social welfare, underdeveloped political practice, and rapid depreciation of natural capital. In contrast, healthy economic growth is achieved by an increase in the supply of social capital, which uses transparency as a representation of social capital, adopting Thailand's corruption perceptions index (CPI). This study employs the computable general equilibrium (CGE) models in ORANI (Dixon et al., 1982). The 2010 edition of the 180 sectors of Thailand's input-output table by the Office of National Economic and Social Development Council (NESDC) was used as the CGE model database. The CGE system consists of 135,202 variables and 133,940 equations, which offer 1,262 structural exogenous variables.

The growth of the investment ratio is represented by the CPI growth rate that is applied to the CGE system for the projection of economic impacts, structural change, and associated changes in CO_2 emissions. Economic impact is measured by the growth of real GDP. Structural change is measured by the output growth of sectors that received

high and low benefits, and environmental change is measured by petroleum consumption, efficiency of petroleum usage, and carbon emissions.

In this study, the projection has two cases. Case 1 (base case) did not apply the growth of the CPI score that fixed an 8 percent investment rate. Case 2 applied investment ratio growth with the growth of the CPI score to compare two test scenarios. Scenario 1 for case 2 was given an 8 percent investment rate and a 0.94 percent per year investment ratio growth for all sectors. In scenario 2 for case 2, the scenario of the increased transparency in the petroleum sector was given an 8 percent investment rate, a 0.97 percent per year investment ratio growth for the petroleum sector, and a 0.94 percent per year investment ratio growth for the rest of the sectors.

The 30-year CGE model projection results demonstrate that transparency affects efficient investment, which leads to a prosperous economy. According to the comparison between Case 1 and 2, the application of the investment ratio growth with the growth of the CPI score produced a real GDP growth index that exceeded the base case from 239 to 308. This real GDP growth index has been apparently different over 20 years. The higher CPI score leads to expanding the investment due to rich social capital or transparency and trust. This trust creates investment to replace the depreciation of capital and new investment of capital stock by investment ratio growth. In addition, in scenario 2 for case 2, the Integrity Pact, a tool for increasing the CPI score, results that changes in the petroleum sector, such as increased capital, a decline in the price of petroleum, and it has positively affected the real GDP growth index. In the 30-year prediction, a strong effect was found in the transport and petroleum sectors. In terms of the resulting consequences, policymakers should have a policy not only to audit and monitor the government's administration for increased transparency and trust, but also the energy and environment conservation policies to support economic growth.

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Rapee Pholpanich

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ABBREVIATIONS

Abbreviations	Equivalence
CGE Model	Computable General Equilibrium Model
CPI	Corruption Perception Index
GDP	Gross Domestic Products
IP	Integrity Pact

CHAPTER 1

INTRODUCTION

1.1 Background

The traditional economic model explains economic growth in terms of the contribution of factors, including capital, labor, and raw materials, to output. In the tradition of Solow's (1956) and Swan's (1956) economic growth theory, economic growth is contributed to by the amount of capital per labor and technological progress. In the tradition of new growth theory (Romer, 1989), the quality attribute of labor is fundamental to technological progress and economic growth. The quality attribute of labor is termed human capital. Education and training are fundamental to the building of human capital. The development of East Asian economies is a famous case study for successful human capital accumulation. The Four Asian Tigers: Hong Kong, Singapore, South Korea, and Taiwan, have developed specialization and a competitive advantage that involve two aspects: physical capital and human capital. These countries have progressed in the implementation of educational policy (Page, 1994).

Capital can be broken down into four types: physical capital, human capital, social capital, and natural capital (Hawken, Lovins, & Lovins, 1999; Thomas et al., 2000; Santelmann, McDonnell, Bolte, & Chan, 2012; Beretti, Figuieres, & Grolleau, 2013). Physical capital includes buildings, machines, tools, and equipment. The evolution of these capitals through time is driven by experience, learning, knowledge, scientific discovery, invention, innovation, and inspiration to improve human living conditions. The contribution of physical capital to economic growth is expressed in terms of quantity, which is measured by efficiency. Newly-developed and improved machinery and equipment are more efficient and productive.

Human capital is the quality of labor to produce goods and services of improved quality and quantity. Similarly, the evolution of human capital through time has been

driven by education, improved knowledge, scientific discovery, experience, and learning. Human capital is the underlying factor for the improvement of physical capital.

Social capital is the quality of the whole society. It involves a peaceful living, absence of conflict, division of labor, and fair distribution of wealth. These characteristics involve trust, law-abiding behavior, rule-respecting culture, giving tradition, and responsible practice. Anti-corruption is the underlying factor for rich social capital.

Natural capital is the endowment of natural resources. This includes clean nature, clean air, clean water, rich soil, forest stock, biodiversity, bio-resources, energy reserves, mineral reserves, and fresh water reserves. These contribute to economic growth in terms of input materials and emission assimilative capacity. The depletion of these capitals is caused by human use. The rate of natural capital depreciation is determined by the wisdom of human use. The underlying problem of the high rate of the natural capital depreciation is their open-access nature. The absence of common rules governing the exploitation of natural capital is termed the tragedy of the commons (Hardin, 1968).

The contribution of social capital is expressed in terms of favorable transaction costs and deterioration. Rich social capital contributes to lower transaction costs. Social capital is characterized by the trust of consumers and the responsibility of entrepreneurs, which represent the social quality of the whole nation.

Natural capital contributes to economic growth in terms of the stock of raw material and the exploitation of environmental assimilative capacity. The depreciation of natural capital is caused by the exploitation of natural resources and the environment. Natural capitalism acknowledges “the critical interdependency between the production and the use of human-made capital and the maintenance and supply of natural capital,” which natural capital was accumulated prosperity in the form of made up of resources, living system and ecosystem services (Hawken et al., 1999, pp. 3-4). Furthermore, it has been observed that there is an association between a high ratio of natural resources in exports and low economic growth rates (Sachs & Warner, 1995, p. 1).

The efficient use of natural capital sustains economic growth. The efficiency of the use of natural resources can be jeopardized by corruption. Poor efficiency can be

measured in terms of the depreciation of natural capital. Depreciation is more accelerated by more severe corruption. Pendergast, Clarke, and van Kooten (2008) found that resource abundance is not a sufficient condition for progress in economic development.

Abundant natural resources are associated with rent-seeking behavior, which negatively affects economic welfare. Rent-seeking culture is characterized by corruption and unlawful practice. The practice of corruption deteriorates social capital, increases transaction costs, and undermines the competitiveness of an economy.

The deterioration of social capital is an underlying factor for the drag on economic growth, the loss of social welfare, underdeveloped political practices, and rapid depreciation of natural capital. In particular, the corruption issue is an obstacle to economic growth (Bose, Capasso, & Murshid, 2008, p. 1).

Thailand's National and Social Development Plan has documented the rapid depreciation of natural resources and the deterioration of clean environment since the Forth plan (B.E. 2520-2524) (NESDB, 1977). Economic growth at the end of the Second plan slowed down as import substitution reached saturation. The Third plan redirected the Thai economy to exploit its export capacity to drive economic growth. The exploitation involved giving privileges, income tax exemptions, import duty exemptions, and other investment incentives schemes to attract foreign investment to speed up exports.

Thailand's exports during the early stage consisted primarily of natural resource commodities which exploited abundant endowments, including, rice, maize, tapioca, sugar, rubber, timber, fruits, vegetables, fish and marine commodities, livestock, poultry, and minerals. Forest areas have rapidly decreased to 38 percent of total forest areas because of deforestation in the exploitation of wood, and there is congestion in Bangkok since there is no decentralization to provincial towns. This has been causing problems with environmental degradation and pollution in urban areas (NESDB, 1977). As these capacities have been exhausting the Fifth plan, they were adapted to provide an investment climate for the export of simple labor-intensive industrial products. The decentralization of industries was introduced to reduce congestion in the capital city. Industries were given privileges to relocate outside Bangkok and vicinity.

Industrial estates were built on the eastern seaboard to exploit the endowment of natural gas found in the Gulf of Thailand (NESDB, 1981). Natural gas was input to the petrochemical industries complex in Maptaphut district. Other industries were attracted to locate on the eastern seaboard in industrial estates. Industries have occupied the territory around the Gulf of Thailand to exploit easy access to sea transportation, the supply of cheap energy, and the dumping of waste into the open environment. The trade-off between economic growth and the environment has always favored economic growth in the name of employment and income creation and poverty fighting.

The progress of development in Thailand has been slow compared to the Four Asian Tiger NICs (newly-industrialized countries). Thailand has mistakenly used its open natural endowment for exports, which have returned small economic development benefits. For more than 50 years since 1961, Thailand has not transcended low-middle income countries and developing countries.

Deteriorating social capital has fueled political conflicts and social unrest from time to time. Discontent regarding the exploitation of natural endowments, corruption, and unlawful practices has been the excuse for the 13 coups in Thai history (KPI, 2014; Bunyong Pongpanich, 2014). Elections have become an opportunity for entrepreneurs to enter the political arena to exploit superior business returns. Small investment to win election pays back high profitable amounts (Satinee Wisutthatham, 2011). The last coup in 2014 was welcomed by Thais to resolve the political conflicts fueled by corruption.

The underlying cause of political conflicts and civil unrest was unethical practices by elected governments, supported by participating bureaucrats, capitalist media, and beneficial enterprises. Elections are favored by the Thais that benefit from selective policies. A patronage culture has divided Thais to blame the opposite side for economic and political damage. The root cause is widespread corruption by elected governments, which win elections by popular schemes (NACC, 2008, 2014).

Deterioration of social capital creates corruption. Thais has been brought up in the deteriorating social environment of a patronage culture. Common practices are governed by self-interest and reciprocation. Laws and regulations have been used as tools to acquire rent-seeking opportunity. In order to gain from this system, peer cooperation and reciprocation are employed. Corruption cases are never prosecuted.

Cases can be dropped at the investigation level or the Attorney General's office level. Successful corruption and the lack of successful prosecution set examples for many to follow. Common interests are traded off by personal interests.

The cost of the trade-off between self-interests and common interests is transaction costs. The deterioration of social capital is associated with high transaction costs for businesses undertaking. Business expenses are increasingly deducted for bribery to government officials to get projects or contracts with the state up to as much as 30 percent (UTCC, 2014). Over-budgeting is a common practice in the bureaucratic system. In this context, entrepreneurs face two side constraints. One is competition in the world market. The other is the corruption cost of business undertaking. Competiveness in the world market costs the poor in terms of low wages and under-standard welfare. Likewise, competiveness in world market costs the nation in terms of unlawful environmental exploitation and depreciation of natural capital.

An important instance of an unethical practice concerns the energy system. Energy privatization in 2001 has turned energy state enterprises to 49 percent private ownership (Puree Sirasoontorn, 2007, p. 9). The monopoly nature of the energy industry has cost the Thai public with high energy prices to guarantee high profit for private shareholders. Energy costs are heightened by the monopoly structure and backed by corruptive policy. As Nikomborirak has stated (Deunden Nikomborirak, 2012), "the issue is the question of the public, is the real cost of gas, NGV and LPG. It seems pin people down as the retail price, that referred by the ministry are priced at 'cost plus' of the entrepreneurs. It is not the market price since the power markets is monopoly by PTT from upstream to downstream. Price is not market price for reference". It is accused that energy resources are robbed to strengthen political power.

In this study, economic growth is driven by the growth of capital as in the neoclassical tradition. Likewise, economic growth is compromised by the leakage of potential capital growth. The economic cost of the leakage of potential capital growth is measured by the difference between economic growth with potential capital growth and economic growth with the leakage of potential capital growth.

Technically, an entrepreneur owns and employs physical capital to produce goods and services. The return to the entrepreneur is the difference between the price of physical capital and the cost of capital. The price of physical capital is termed rent.

The demand for and supply of physical capital determine the price of capital. Increased goods and service demands involve increased working hours for physical capital (machines), which drive increased prices of physical capital, thereby increasing return to the entrepreneur. On the one hand, the increased prices of physical capital drive increases in the price of goods and services across the economic system. On the other hand, the increased supply of physical capital decreases the rent of physical capital. The decreased price of physical capital drives decreases in the price of goods and services across the economic system.

Physical capital has depreciated over time at different rates depending on the types of capital. The depreciation of physical capital is caused by "wear and tear" from working. The depreciation rate is calculated by capital costs divided by years of working life. The entrepreneur saves annual enterprise profits equal to the depreciation of physical capital to install new capital (new machines) at the end of the existing capital life time.

Social capital is the ethical and responsible quality of the entrepreneur. Trust and loyalty are earned over the life of the enterprise. Physical capital is augmented by social capital. The increased supply of social capital decreases the price of social capital, referred to as transaction costs. Low transaction costs increase the competitiveness of goods and services. Likewise, high transaction costs weaken the competitiveness of goods and services. Healthy economic growth is achieved by an increase in the supply of social capital. The deterioration of social capital compromises economic growth.

Over-budgeting is used by the corruptor. In this case tax revenue becomes less productive the more corruption there is. Increased private profits are leaked to the corruptor.

Natural capital is the endowment of the abundance of nature, for example, rich soil, fresh water reserves, forest stock, mineral reserves, a clean atmosphere, a clean ocean, productive temperatures, and environmental spaces (include both stocks and sinks). These are depleted and degraded by human use. Human wisdom can sustain the use of these resources. Unwise use results in rapid depletion and degradation. Central to unwise use is the problem called the tragedy of the commons (Hardin, 1968), where rules and laws are absent.

Conflict exists between private and common interests. Rational behavior results in favoring private over common interests. In order to resolve the tragedy of the commons, humans accept common rules as the laws governing the use of nature. However, private interest drives individuals to seek opportunity to violate the laws to exploit nature. Law enforcement is central to preventing the tragedy of the commons.

The depletion and degradation of natural capital are termed depreciation. The contribution of natural capital to economic growth is weakened by the depreciation of natural capital. This depreciation is reflected in the capacity of production through the total supply of capital. Depleted natural capital reduces the total potential of capital. The total amount of capital is the composite amount of four types of capital. Likewise, the price of total capital is the composite price of three types of capital. The depreciation of natural capital and the deterioration of social capital reduce the amount of total capital, which raises the price of total capital. The competitiveness of goods and services across the economy is weakened by the increased price of capital. Economic growth potential is compromised by deteriorated competitiveness.

In this study, the deficiency of any one of four types of capital can compromise economic growth. The abundance of human capital explains the abundance of physical capital. The abundance of social capital explains the abundance of the three other capitals, as shown in Figure 1.1.

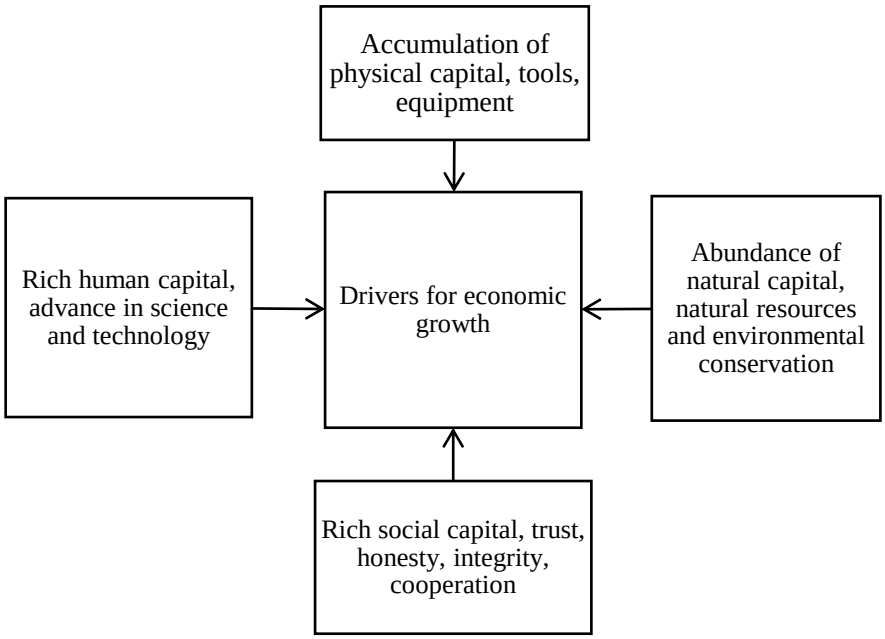

Figure 1.1 Concept of 4 Types of Capital and Abundance of Economic

The study of capital and capital driving economic growth focuses on qualitative analysis using international countries' data to describe their relationships. It discloses the mechanisms of capital, especially social capital, that affect economic changes. Additionally, this study uses transparency as a representation of social capital, adopting Thailand's corruption perceptions index (CPI) published by Transparency International and applying the CGE model to forecast and test its influential magnitude for long-term economic growth.

Weakened economic performance caused by corruption causes that increases transaction cost of business and reduces investment efficiency. CPI reflects the level of corruption. In addition, empirical study has found that corruption scores can be correlated with investment and economic growth rate (Mo, 2001; Podobnik, Shao, Njavro, Ivanov, & Stanley, 2008). An anti-corruption tool, the Integrity Pact (IP), enhances transparency in public procurement. The use of the IP in the petroleum refinery sector will change the efficiency of petroleum utilization. The growth of the economy is accompanied by the use of oil, which affects CO_2 emissions, as shown in Figure 1.2.

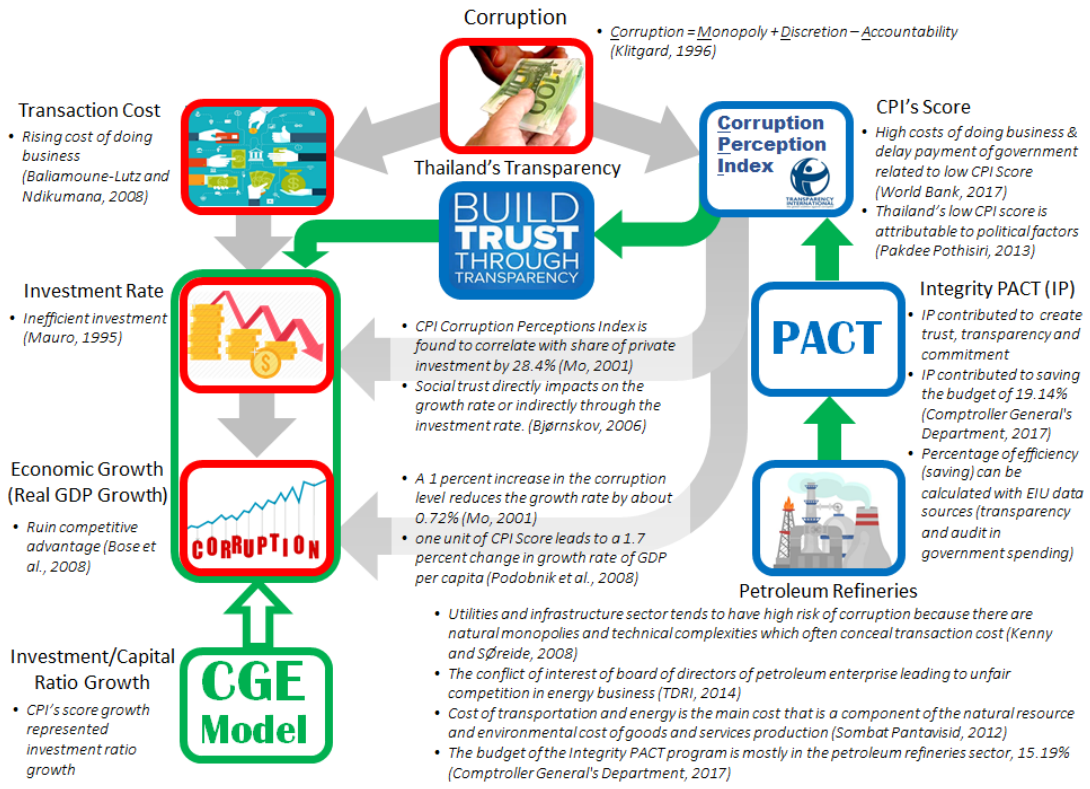

Figure 1.2 Weakened Economic Performance Caused by Corruption

1.2 Objectives of the Study

1.2.1 To project the economic impacts of changes in social capital quantified in terms of Thailand's transparency indices.

1.2.2 To project changes in CO_2 emissions associated with changes in Thailand's economic structure.

1.2.3 To study a channel to curb CO_2 emissions based on knowledge about changes in Thailand's economic structure.

1.3 Scope and Limitations of the Study

1.3.1 The CGE model is used to project changes in real GDP over 30 years to test the impact of changes in social capital on Thailand's economy.

1.3.2 The change in real GDP is the net of changes in Thailand's economic structure.

1.3.3 The change in CO_2 is net of changes in the structure of Thailand's oil consumption associated with changes in Thailand's economic structure.

1.3.4 The changes in the structure of Thailand's oil consumption associated with changes in Thailand's economic structure provide clues to curbing the release of CO_2.

1.3.5 The limitations of this study stem from a number of economic assumptions used in the CGE model, including the elasticities of the factor substitution of goods production and capital goods production, the elasticities of the substitution of goods consumption, the elasticities of exports, and the rate of capital accumulation. The data limitations stem from outdated input-output tables, the aggregation of commodities and industries of the input-output tables, and the reconstruction of the matrices of investment spending. Other limitations include simulation closures that assume fixed real wages, the fixed ratio of trade balance and nominal GDP, and a perfectly flexible exchange rate.

1.4 Expected Benefits of the Study

The expected benefits from this study consist of 3 levels of impact, and the results will yield the following:

Table 1.1 Expected Benefits of the Study

	Expected Benefits of the Study	Impact Pathway
1.4.1	Thailand will be informed about the economic potential of building an increasingly-transparent society as well as the opposite.	Output
1.4.2	Thailand will be informed about CO_2 emissions as the consequence of economic changes.	
1.4.3	Thailand will be made aware of the consequences of building an increasingly-transparent society as well as the opposite.	Outcome
1.4.4	Thailand will be aware of the trajectory of CO_2 emissions.	
1.4.5	Thailand will be able to create a culture to promote an increasingly-transparent society with confidence where the country as a whole will be rewarded with economic prosperity.	Impact
1.4.6	Thailand will be able to find a channel to curb CO_2 emissions through knowledge about pollution sources.	

CHAPTER 2

THEORY AND LITERATURE REVIEW

2.1 Economic Growth

Development is usually attached to economic growth, which provides greater consumption and production per capita. Maslow's (1943) hierarchy is usually used in describing the elevation of human wants further up from the survival level. Economic growth, which helps to satisfy human needs, however, is not a sufficient condition for development. A number of factors may prevent a society from addressing development issues despite economic growth. These include chronic poverty, lack of education, shortage of health care, spread of crime, the absence of social safety, the growth of corruption, increased urban congestion, the expansion of slums, the depletion of natural resources, and deteriorating environmental quality. These issues can be attributable to the absence of mechanisms for the distribution of income and economic growth.

In this study, the approach to addressing development issues is thought to involve basic tools encompassing the accumulation of four types of capital: physical capital, human capital, social capital, and natural capital, as shown in Figure 2.1 (Rapee Pholpanich & Sompote Kunnoot, 2018, pp. 154-168). Physical capital refers to the machines, tools, and equipment necessary for greater economic output, which play a role in material growth (Solow, 1956; Swan, 1956). Human capital refers to the capability to improve the work of physical capital, including machines, tools, equipment, and other things in human society (Romer, 1989). Social capital refers to the capability of a whole society to organize collaboration to enable individuals to play different roles in concert with the accomplishment of certain goals (Putnam, 1993). Natural capital refers to the endowment of nature, including land fertility, water, forests, minerals, energy, and other natural resources and environmental quality that support the capability to improve material availability and human learning ability, and that

enable useful collaboration (Hawken et al., 1999). A shortage in any of these capitals is likely to compromise the effort to address development issues.

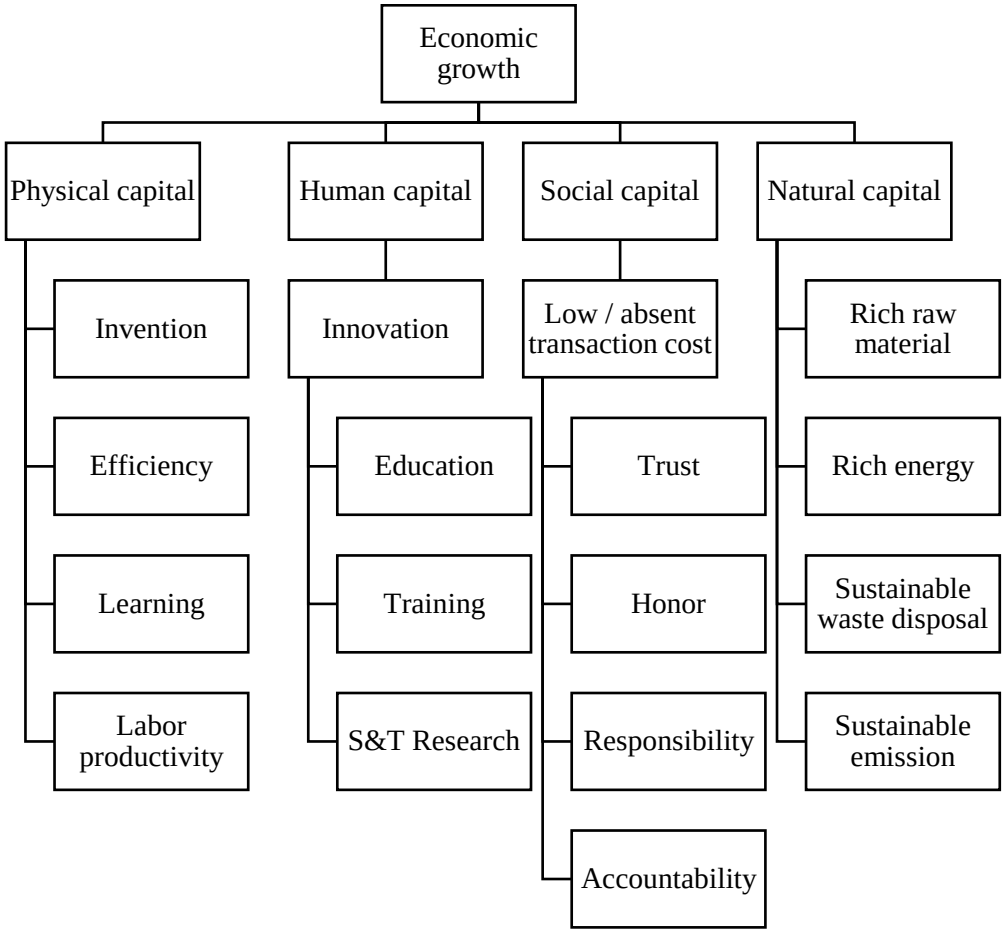

Figure 2.1 Connection between Economic Growth and Four Types of Capital
Source: Rapee Pholpanich & Sompote Kunnoot, 2018.

The accumulation of human capital involves education, training, science and technology research, experience sharing, and learning culture. Social capital is characterized by goodwill, honor, trust, cooperation, and responsibility and accountability. Natural capital is characterized by sustainable uses of natural resources, raw materials, minerals, energy, and plants and animal, and sustainable uses of the environment for waste disposal and the absorption of emissions. The Gaia hypothesis posits that ecosystem security and stability are regulated and controlled by the diversity of living organisms (Lovelock, 1988).

The four types of capital cited are mutually complementary. The creation of physical capital, which increases efficiency and labor productivity, is a product of invention driven by human capital through learning, innovation, education, training, and science and technology research. Invention and innovation are enriched by social capital through social collaboration, the division of labor, and harmony. A law abiding and strongly disciplined culture is characterized as responsibility and accountability, which are a source of trust and honor and low or the absence of transaction costs. Competitiveness is strengthened not only by efficiency and innovation but also by favorable transaction costs. Likewise, natural capital is enriched through a law abiding and strongly disciplined culture.

2.2 Development Literature

For demonstration purposes, economic growth is traditionally described as driven by an increase in capital (K) per unit of labor (L). In the real world, a number of factors contribute to economic growth, including land, natural resources, and energy. In the neoclassical tradition (Solow 1956; and Swan 1956), economic growth is explained by the amount of capital per labor while technological progress is held responsible for residuals. Accounting for the rest of the growth factors is called total factor productivity (TFP), usually expressed in functional form as Q= F (K,L;t), where Q denotes output, K denotes capital, L denotes labor, and t denotes technological change over time. This means that output increases more than the contribution of labor and capital.

Subsequent observations led Romer (1989) to add the quality attribute of labor to economic growth accounting, which has been labeled the new growth theory. The quality attribute of labor is synonymous with human capital, which is the force behind technological progress. Human capital is a product of education, training, learning, and experience. Technological progress, thus, has become an endogenous factor.

Physical capital includes buildings, machines, tools, and equipment. The evolution of these capitals through time is driven by experience, learning, knowledge, scientific discovery, invention, innovation, and inspiration to improve human living conditions, all of which are human capital. These quality attributes explain the

distribution aspect of economic development. Labor is paid in terms of productivity, the increase in output per labor, which can be gained through substitution to increase the ratio between capital and labor. On the other hand, the return to the capital owner can be improved through increased quality of capital. The growth of the output in excess of the growth of total factors, known as total factor productivity, is thus explained endogenously in terms of the quality attribute of both labor and capital. The quality attribute can be regarded as internal to the firm.

Social capital enters into economic development as a factor inside and outside the firm. Social capital involves trust between master and agent, which derives from the responsibility of the two sides. The abundance of social capital minimizes labor turnover, transaction costs, and petition and policing costs, while collaboration and royalty are maximized. With these favorable inside conditions, production costs are minimized while competitiveness improves.

Trust between the customer and the supplier of goods and services is analogous to the relationship between master and agent. Again, this aspect of social capital involves trust between the customer and supplier, which derives from the responsibility of the two sides. More improved services can be provided in a society in which the customer is honored. Similarly, customer transaction costs can be minimized or absent as the supplier is trusted for his or her responsibility. With these favorable conditions outside the firm, trade and exchange grow while competitiveness is gained.

The course of the development of the East Asian economies which began in the decade of the 70s is known for success in the accumulation of physical, human, and social capitals. The Four Tigers, including Hong Kong, Singapore, South Korea and Taiwan, sustained a high growth rate (around 7 percent per year) in the period 1965-1990 and achieved rapid industrialization (Romer, 1989; Page, 1994, pp. 219-220, 247). On the other hand, corrupt policy and misgovernance are sources of poor productivity, underinvestment, and weak growth (Thomas et al., 2000).

Human capital is the quality of labor. The Buddhist tradition has four mental qualities or bases for success (the four Iddhipada), consisting of aspiration (Chanda), effort (Viriya), thoughtfulness (Citta), and investigation (Vimamsa). The source of human capital is the accumulation of thought, discovery, experimentation, detection, monitoring, planning, evaluation, and improvement. Human capital is comprised of

knowledge, skill, and wisdom. The accumulation of knowledge involves education, advancement in science, experience, and learning. Human capital is vital for the accumulation of physical capital. Human innovation has produced infrastructure, technologies, and processes for manufactured capital (Porritt, 2007).

Social capital is built from networks that are a product of trust among people that are willing to abide by society's law and social rules. The source of social capital is the abundance of trust, civil engagement, and civil society (Coleman, 1988; Putnam, 1993). A society is rich in social capital as society's interests become more important than individual interests.

From the development perspective, trust and accountability are the qualities of people that are beneficial for trade and economic growth (Sabatini, 2006, pp. 6-7, 19-20). On a broader spectrum, competitive advantage is made more powerful by the smooth flow of business transactions facilitated by low transaction costs, search costs, the absence of prepayments or guarantees or and monitoring costs (Fukuyama, 1999; Pretty & Ward, 2001, p. 211). Social capital can be measured by voluntary work or association, and informal networks and trust, which are outputs that includes bonding, coordination, and cooperation. According to Tsujinaka, "capital can be accumulated and invested by the people" (Tsujinaka, 2017, p. 9). At the micro scale, an obvious example of social capital that creates physical capital is the chit fund and microcredit (Anderson, Locker, & Nugent, 2002).

From the human capital perspective, education, learning, and technology transfer are facilitated by social capital (Romer, 1989; Sabatini, 2006, p. 5; Santelmann, McDonnell, Bolte, & Chan, 2012, pp. 581-583).

From the natural capital perspective, sustainable use of natural resources and effective protection of the environment are facilitated by social capital. The opposite case is described as the tragedy of the commons (Hardin, 1968).

From an empirical study perspective, Hanousek and Kochanova (2015) found that low labor productivity is associated with low real sales and high bribery.

The deficiency of social capital is described in terms of high transaction costs, involving search and information costs, bargaining and decision costs, and policing and enforcement costs (Akibari, 2005). Additionally, social capital deteriorates as corruption grows (Bjørnskov, 2003, p. 22-23).

Both corruption and transaction costs are externalities that damage a society (Johnson, 2005). In contrast, social capital is a public good that is indivisible and under-supplied (Fukuyama, 1995, 1999; Pretty & Ward, 2001, p. 212; Ostrom, 2012).

From the organization perspective, agent-principal adverse selection and moral hazards are sources of inefficiency and costs to enterprises (McColgan, 2001). Competitive advantage and enterprise growth are produced by the opposite.

The relationships and interactions among physical capital, human capital, natural capital, and social capital are conceptualized in Figure 2.2.

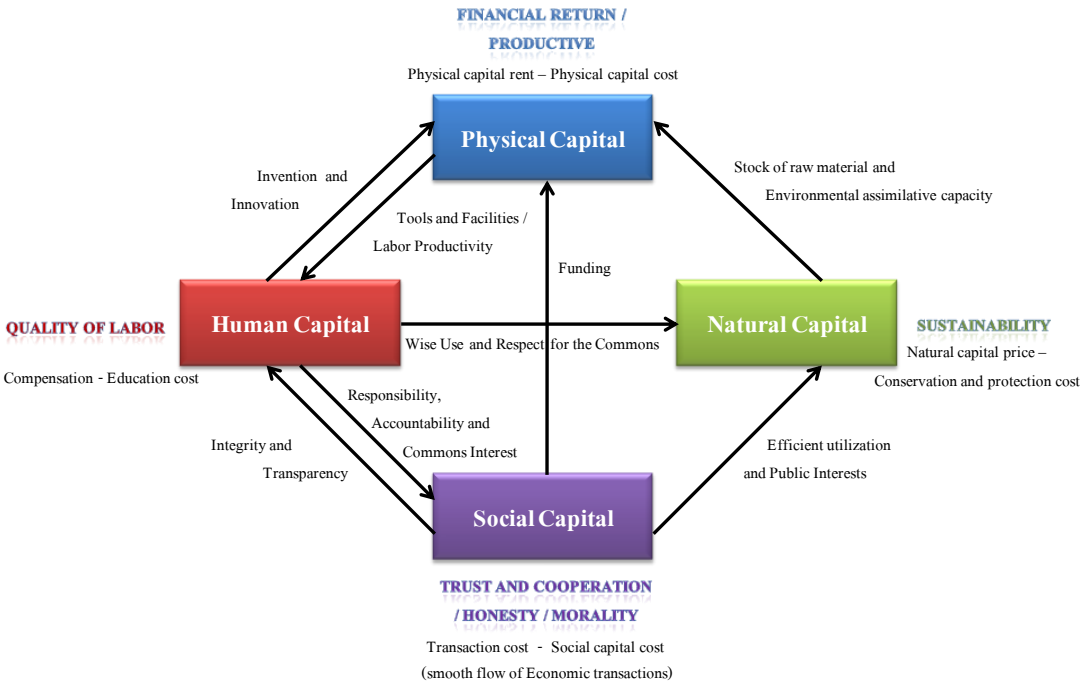

Figure 2.2 Relation of 4 Types of Capital

Source: Rapee Pholpanich & Sompote Kunnoot, 2018, p. 160.

2.3 Mechanism of Capital Accumulation

The capital accumulation function (Dixon, Parmenter, Sutton, & Vincent, 1982, pp. 118-122) is graphed in Figure 2.3. The horizontal axis measures the ratio K_1/K_0, whereas the vertical axis measures the ratio R_1/R_0.

R_0 = Current return of capital is difference between capital rent and capital cost:

$R_0 = P_K - C_K$

K_1 = Future capital stock is net current capital stock plus investment:

$K_1 = (K_0 - D) + I$

K_0 = Current capital stock

R_1 = Future return of capital

D = Depreciation of capital

I = Investment

P_k = Capital price

C_k = Capital cost

Assuming a certain value for R_1, which is the future unknown value, the ratio R_1/R_0 depends on R_0, which depends on the difference between capital rent and capital costs. Capital rent (P_K) can be increased by demand expansion from a prosperous economy. Capital costs (C_K) can be decreased by the lower price of goods and materials from the innovation of technology. If capital costs can be lowered, the R_0 value will be raised, which lowers the R_1/ R_0 value and drives the increase in K_1/K_0. The increase in K_1/K_0 is the driver of economic growth.

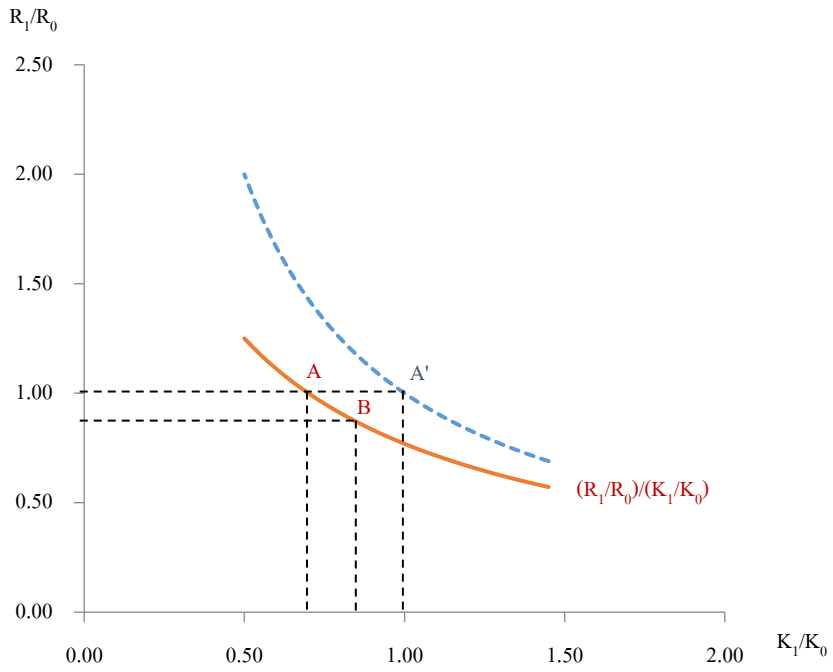

Figure 2.3 Capital Accumulation Function

Each of the four types of capital accumulation can be analyzed in a similar manner. However, they differ in how capital rent and capital costs are measured. The current return of human capital (R_0h) is the difference between labor income and education costs, and the current return of physical capital (R_0p) is the difference between physical capital rent and physical capital costs. The current return of social capital (R_0s) is the difference between the price of goods and transaction costs. Transaction costs arise from the short supply of social capital. The current return of natural capital (R_0n) is the difference between the prices of natural resources and services and the cost of extraction.

Physical capital accumulation (I) is measured in terms of an increase in K_1/K_0, for the same R_0. Similarly, a decrease in K_1/K_0, for the same R_0 is an instance for situation such as a change in government policy, a natural disaster, or political turmoil.

Human capital accumulation (I) is measured in terms of an increase in K_1/K_0, for the same R_0. A decrease in K_1/K_0, for the same R_0 is an instance of change in government policy, a natural disaster, or political turmoil.

Social capital accumulation (I) is measured in terms of an increase in K_1/K_0, for the same R_0 which is an instance of the evolution of culture, social change, or government policy change. A decrease in K_1/K_0, for the same R_0 is an instance of negative social change, deteriorating cultural norms, changes in government policy, political misgovernance, the growth of patronages culture, or corruption.

Natural capital accumulation (I) is measured in terms of an increase in K_1/K_0, for the same R_0 , and is an instance of social wisdom in creating the value of natural capital. A decrease in K_1/K_0, for the same R_0 is an instance of a decrease in the quantity and quality of natural resources.

A natural master-agent relationship can be stipulated between four groups in a society, consisting of labor, politicians, bureaucrats, and entrepreneurs as shown in Figure 2.4. Labor is a master that chooses a politician as an agent. Similarly, a politician is a master that uses his or her power over a bureaucrat, who serves as the agent. Likewise, a bureaucrat is a master that administers day-to-day business over agents encompassing all entrepreneurs. Lastly, an entrepreneur is a master that employs labor as its agent.

A typical master-agent relationship is adverse selection and a moral hazard. Adverse selection is difficulty encountered by a master to choose an honest agent to work with, while an agent hides as much as possible his or her true nature. A moral hazard is difficulty for a master to access true information from employed agents. These difficulties become costs for an enterprise. On the opposite end, the competitive advantage of an enterprise is elevated if these difficulties are eliminated or minimized.

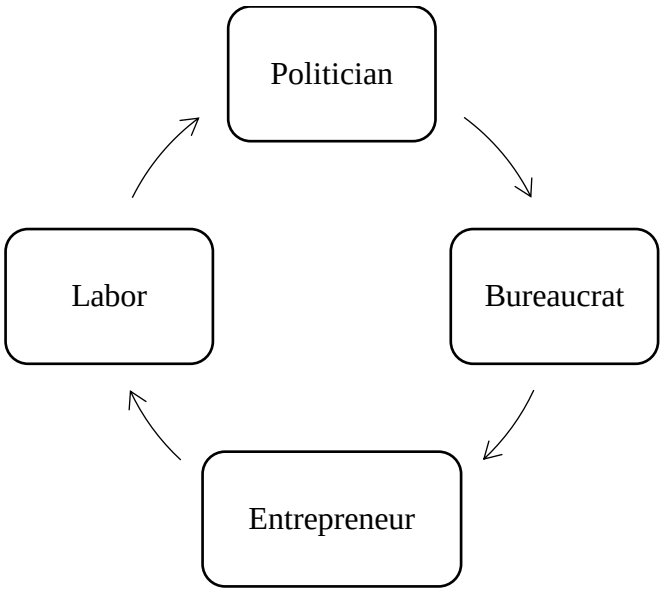

Figure 2.4 A Natural Master-Agent Relationship among Four Groups

2.4 Weakened Economic Performance Caused by Corruption

Corruption is motivated by a number of factors. It is a product of inefficiency in public services (Hanousek & Kochanova, 2015). A small bribery is selectively used to speed up public processes (Leff, 1964, and Huntington, 1968 as cited in Mauro, 1995, p. 681). As bribery becomes a common practice, intentional delay can become common as well. As the practice becomes common, a permanent cost to enterprises becomes established. In this way, competitive advantage is ruined (Bose et al., 2008, p. 1). Corruption has a negative effect on private investment by raising the costs of doing business over the return of capital (Baliamoune-Lutz & Ndikumana, 2008). Moreover, the Doing Business report has shown a negative association between firms that pay bribes to do trading across borders (high costs of doing business) and the corruption perceptions index (average CPI score is lower), and a positive correlation between payment delays when private selling to the government (shorter payment time periods) and the corruption perceptions index (average CPI score is higher) (World Bank, 2017, pp. 84, 99). Improved public process efficiency at the same time as compensation for improved public productivity can benefit both competitive advantage and the modernization of public services.

At the middle level, law and regulations become ineffective as authority becomes the public administration for exercising rent seeking. As laws and regulations are unable to protect the public, damage can expand to the level that undoes economic development or even causes net negative results.

At the policy level, corruption weakens economic growth by leading to inefficient investment choices (Mauro, 1995, pp. 700-705).

From the empirical study perspective, a study by Hong Kong Baptist University founded that a 1 percent increase in the corruption level reduces the growth rate by about 0.72%. The corruption perceptions index was found to correlate with the share of private investment at 28.4% and human capital at 9.7% (Mo, 2001, pp. 73-76). In addition, study of the impact of corruption on the economic growth rate has shown that an increase in the corruption perceptions index's score by one unit leads to a 1.7 percent change in the growth rate of GDP per capita (Podobnik et al., 2008, pp. 549-550), as shown in Figure 2.5. In other studies, corruption was found to produce a negative impact on economic growth through weakening human capital and political instability (Dridi, 2013, p. 121). Further, articles on social trust contributing to economic growth have shown that social trust is strongly associated with corruption and violent crime, indicating that social trust affects investment rate and economic growth. It directly impacts the growth rate or indirectly the investment rate (Bjørnskov, 2006, pp. 15-22).

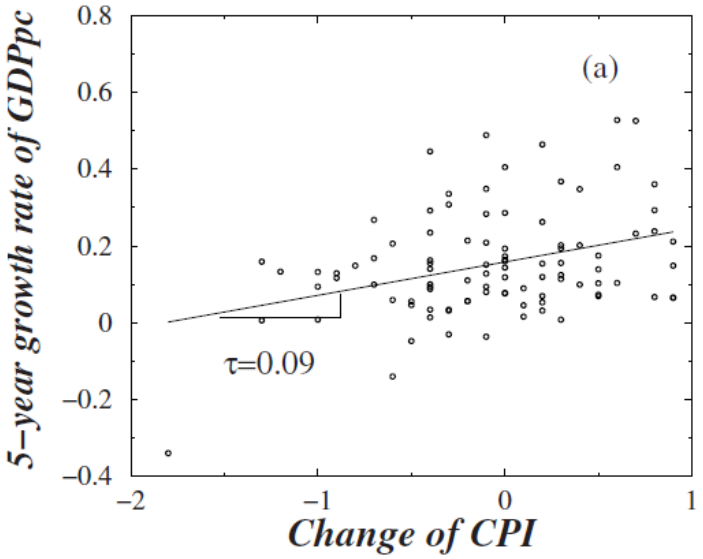

Figure 2.5 Countries Improving Their Corruption Level Generate Larger GDP per Capita Growth Rate

Source: Podobnik et al., 2008, p. 549.

2.5 Corruption Perception Index

The long-term trend regarding the corruption problem in Thailand shows improvement despite falling international rankings. Thailand's corruption perceptions index for the period from 1995 to 2016, with a base of 100 points, compiled and released by Transparency International (TI), is shown in Table 2.1 and Figures 2.6 to 2.7. A trend line constructed by the author shows an improvement rate of 0.94 percent per year. The long-term improvement, however, is characterized by a large band of short-term fluctuations. In terms of international standards, Thailand's ranking is continuing on a worsening path. This ranking is way down from 43 to 96 in 1995 and 2016.

Thailand's low score is attributable to political factors (Pakdee Pothisiri, 2013). The most acute complication is known as corruption by policy. Corruption is seen as hidden under policies announced by political parties during an election. In this case, unsuccessful corruption policing is characterized by opposition voting against outnumbered ruling parties. The master-agent relationship between politicians and bureaucrats makes it difficult for independent anti-corruption bureaus to find evidence, to conduct investigations, and to file cases to courts. As corruption becomes a mutual

benefit for politicians, bureaucrats, and media, policing by citizens seems to be less possible. It has been a long tradition in Thailand that voters accept politicians' bribery in exchange for votes. This makes political influence stronger as corruption policing becomes increasingly difficult (NACC, 2014).

Table 2.1 Thailand's Corruption Perceptions Index (CPI) Score, Trend Value of CPI Score, CPI Ranking, and Trend Value of the CPI Ranking

Year	CPI Score	Trend Value of CPI Score	CPI Ranking	Trend Value of CPI Ranking
1995	27.9	30.63	32	43.29
1996	33.3	30.95	37	45.82
1997	30.9	31.27	39	48.35
1998	30	31.58	61	50.87
1999	32	31.90	68	53.40
2000	32	32.22	60	55.92
2001	32	32.53	61	58.45
2002	32	32.85	64	60.98
2003	33	33.17	70	63.50
2004	36	33.48	64	66.03
2005	38	33.80	59	68.56
2006	36	34.12	63	71.08
2007	33	34.43	84	73.61
2008	35	34.75	80	76.13
2009	34	35.07	84	78.66
2010	35	35.38	78	81.19
2011	34	35.70	80	83.71
2012	37	36.02	88	86.24
2013	35	36.34	102	88.77
2014	38	36.65	85	91.29
2015	38	36.97	76	93.82
2016	35	37.29	101	96.34

Remark: The CPI score has been changed from base 10 to 100 in 2012

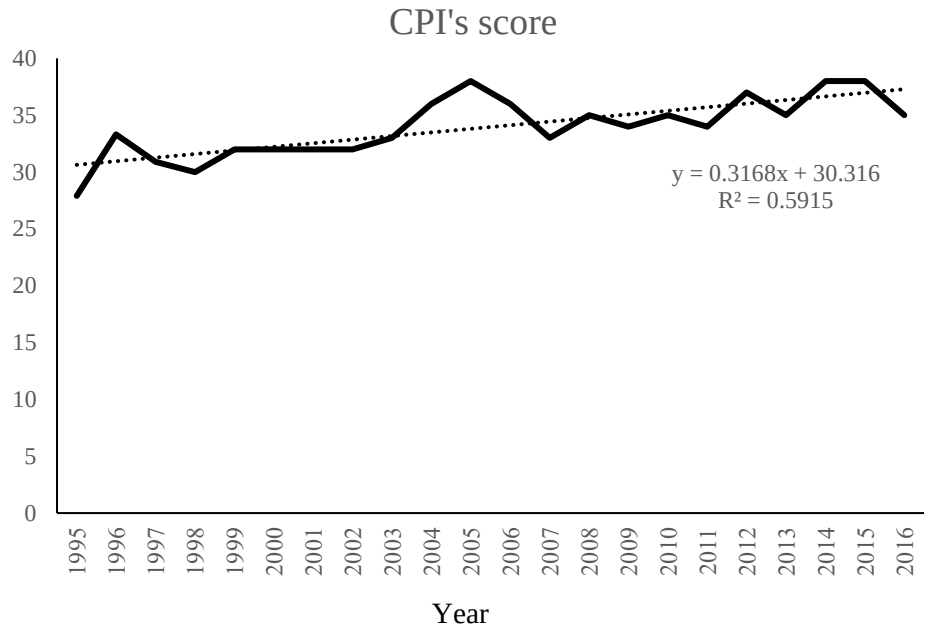

Figure 2.6 Corruption Perceptions Index of Thailand

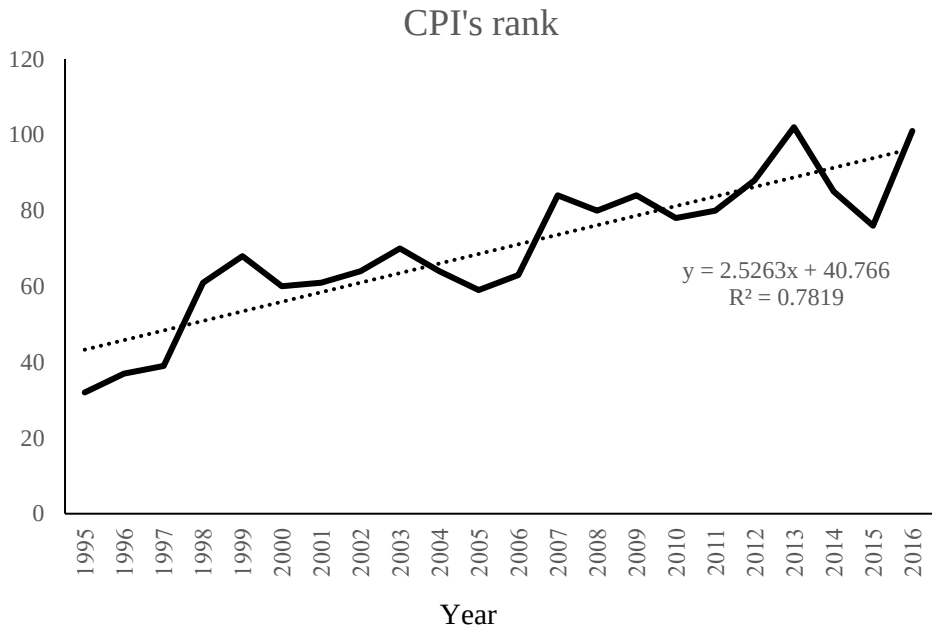

Figure 2.7 Corruption Perceptions Index Ranking of Thailand

In fact, the CPI index of Thailand has been compiled from available sources by 6 to 9 organizations, as seen in Tables 2.2 to 2.3. Specifically, the source of the WEF and GI significantly influences the CPI score, as shown in Table 2.4, especially by bureaucrats receiving bribes from entrepreneurs that are barriers to business creation. Additionally, the source of EIU is significantly related to the CPI. It involves transparency and audit in government spending.

The relationship of corruption and transaction costs affects investment. On the one hand, bribery is an economic rent that causes higher production costs of goods and services. It is also social capital rent that increases transaction costs of doing business. On the other hand, countries with high CPI scores are very transparent and rich in social capital. These countries have low transaction costs and high current returns on social capital. Future social capital increases by expanding investment in social capital. Transparency produces positive impacts on economic growth through strengthening social capital, eliminating bribes between entrepreneurs and bureaucrats by the Integrity Pact and strict audits of government spending.

Table 2.2 Content of the Survey of Each Data Source Related to Thailand's Corruption Perceptions Index

	Data Sources	Related Content of the Survey
1)	Bertelsmann Foundation Transformation Index (BF-BTI)	Effective anti-corruption and Law Enforcement: • Prosecution of or penalty for government officials that abuse their position • Success in combating government corruption.
2)	Economist Intelligence Unit Country Risk Ratings (EIU)	Transparency and audit in government spending: • Clear procedures and accountability governing, and proper purposes of using, public funds • Abuses of public resources • Professional civil services were appointed directly from the government • Audit system by independent auditing body • A tradition of payment of bribes to secure contracts and gain favors
3)	Global Insight Country Risk Ratings (GI)	Doing business with corruption: • Payment of bribery to obtain business permits, favorable policy, and everyday paperwork
4)	IMD World Competitiveness Yearbook (IMD)	Competitiveness of nations: • Bribery and corruption exist or do not exist
5)	Political and Economic Risk Consultancy Asian Intelligence (PERC)	Corruption affects business operations: • The perception and grading of the corruption problem that affects positions and institutions in which work is carried out
6)	Political Risk Services International Country Risk Guide (ICRG)	Corruption in the political system: • Authorities or politicians are corrupt, using patronage and nepotism systems • Reciprocal relationships between politics and business
7)	World Economic Forum Executive Opinion Survey (WEF)	Barriers to doing business: • Business must pay bribes or extra payments in the process; i.e. imports and exports, public utilities, annual tax payments, awarding of public contracts and licenses, obtaining favorable judicial decisions
8)	World Justice Project Rule of Law Index (WJP)	Government officials abuse their positions: • Government officials in the executive branch, judicial branch, judicial branch, and legislature do not use public office for private gain
9)	Varieties of Democracy Project (VDEM)	Pervasive political corruption: • The pervasive political corruption that cover different areas, levels, and types of corruption in four different government spheres, consisting of the public sector, the executive, legislative, and the judicial

Source: Transparency International, 2016.

Table 2.3 CPI Score and Data Sources Score

	CPI Score	Data Sources								
		BF-BTI	EIU	GI	IMD	PERC	ICRG	WEF	WJP	VDEM
2010	35	39	33	34	44	28	-	34	-	-
2011	34	39	32	33	40	29	26	33	38	-
2012	37	45	38	42	38	35	31	35	-	-
2013	35	40	38	32	36	39	31	35	33	-
2014	38	40	38	42	32	35	31	38	44	-
2015	38	40	38	42	38	42	31	43	26	-
2016	35	40	37	22	44	-	32	37	37	24

Source: Transparency International, 2011-2017.

Table 2.4 Correlation between CPI Score and Data Sources Score

		CPI Score	BF-BTI	EIU	GI	IMD	PERC	ICRG	WEF	WJP
CPI Score	Sig. (2-tailed)	1	.470	.679	.773*	-.621	.602	.535	.794*	-.143
	Pearson Correlation		.288	.093	.042	.137	.206	.274	.033	.819
	N	7	7	7	7	7	6	6	7	5
BF-BTI	Sig. (2-tailed)		1	.574	.432	-.267	.269	.421	.024	-.032
	Pearson Correlation			.178	.333	.562	.606	.405	.960	.959
	N		7	7	7	7	6	6	7	5
EIU	Sig. (2-tailed)			1	.267	-.538	.862*	.946**	.612	-.298
	Pearson Correlation				.563	.213	.027	.004	.144	.626
	N			7	7	7	6	6	7	5
GI	Sig. (2-tailed)				1	-.663	.434	.008	.387	-.119
	Pearson Correlation					.104	.390	.988	.391	.848
	N				7	7	6	6	7	5
IMD	Sig. (2-tailed)					1	-.589	-.132	-.351	-.219
	Pearson Correlation						.219	.804	.441	.723
	N					7	6	6	7	5
PERC	Sig. (2-tailed)						1	.772	.742	-.745
	Pearson Correlation							.126	.091	.255
	N						6	5	6	4
ICRG	Sig. (2-tailed)							1	.523	-.172
	Pearson Correlation								.287	.782
	N							6	6	5
WEF	Sig. (2-tailed)								1	-.469
	Pearson Correlation									.425
	N								7	5
WJP	Sig. (2-tailed)									1
	Pearson Correlation									
	N									5

Source: Calculated.

2.6 Mechanisms to Enhance Transparency

Transparency is covered by the principle of good governance that is associated with corruption prevention. Corruption is defined differently depending on the cause of the corruption and the ill effect of corruption, such as abusing one's power to ask for bribes. A tool and mechanism can enhance the efficiency of government spending and the transparency of government procurement, the Integrity Pact, as mentioned earlier, which can increase the CPI score. Figure 2.8 shows tools and mechanisms to curb corruption that are related to increasing the CPI's score in each data source. The data source of the Economist Intelligence Unit Country Risk Ratings (EIU) has content regarding transparency and audits regarding government spending. In order to curb corruption in government procurement, the Integrity Pact has been used to create trust, transparency, and commitment; likewise, e-Bidding creates transparency. Additionally, other tools and mechanisms to curb corruption can be applied to this study but it depends on the availability of the data. Therefore, this study will use the Integrity Pact as a tool.

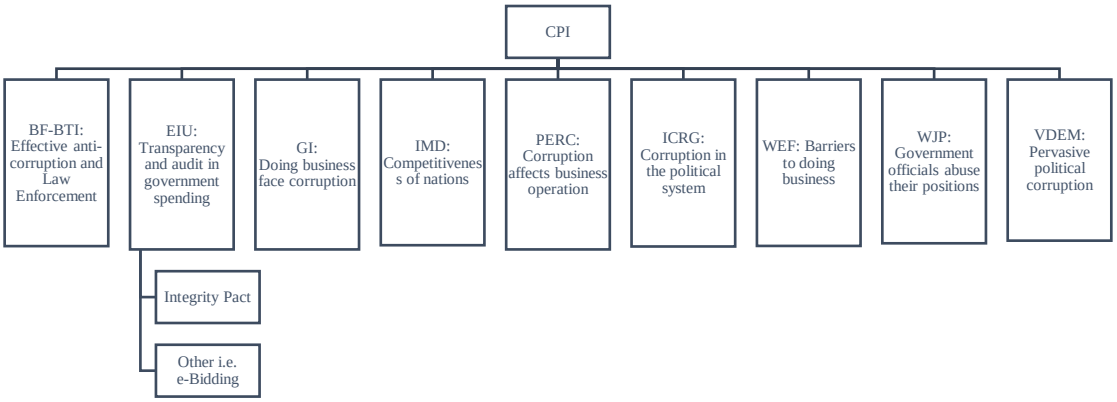

Figure 2.8 Tools and Mechanisms to Curb Corruption That Are Related to Increasing the Score of the Data Sources Corruption Perceptions Index

The Integrity Pact Program is a procurement contract that must have transparency, integrity, morality, and no fraud or misconduct corruption such as no bribery and no abuse of official positions. The three parties that work on the Integrity Pact process consist of government agencies, and private (supplier) and independent observers. The key success factors of procurement projects come not only from independent observers that work from the beginning, writing terms of reference, until the end of project, but also from leadership commitment, such as the Prime Minister, Minister of Finance, the Comptroller General's Department, the State Enterprise Policy Office, and head of the agency and staff involved in procurement agencies. Consequently, the use of the Integrity Pact is to cut the cycle of the master-agent relationship.

Since 2015, the projects that have participated in the Integrity Pact have consisted of 12 sectors, as shown in Table 2.5. However, PPT Public Company Limited (petroleum refineries sector) has recently participated in 3 projects, which are worth 56,300 million baht and account for 15.19% of a total of 370,617 million baht worth of IP projects (updated as of April 26, 2017) (Comptroller General's Department, 2017; Anti-corruption Organization of Thailand, 2018). As a result, the share of the petroleum refineries sector has increased. Further, the cost of transportation and energy is the main cost that is a component of the natural resource and environmental cost of goods and services production (Sombat Pantavisid, 2012, p. 131). Consequently, the energy projects under the petroleum refineries sector that participate in the Integrity Pact can create more transparency and flow of business transactions.

Table 2.5 Budget of Projects Participating in the Integrity Pact Program by Sector

Sectors	Budget (Million Baths)
066 Tobacco products	7,150
093 Petroleum refineries	4,800
135 Electricity	4,014
139 Non-residential building construction	10,564
140 Public works for agriculture and forestry	3,477
141 Non-agriculture public works	3,511
143 Construction of communication facilities	13,000
149 Railways	73,204
150 Road passenger transport	4,053
156 Air transport	100
165 Public administration	9,122
167 Education	600
174 Radio, television, and related services	1,703.9
Total	**135,299**

Remark: Information as of February 15, 2017.

The use of the Integrity Pact creates benefits and increases procurement efficiency consisting of budget savings and procurement process development. Regarding the implementation of the Integrity Pact in the procurement process from February 2015 to April 2017, 23 contracts out of 44 projects were signed. These contracts are worth 32,201.43 million baht, saving a budget of 6,126.28 million baht or 19.14 percent (Comptroller General's Department, 2017). Therefore, procurement efficiency that is saving a budget of 19.14 percent can calculated to EIU score, and increases CPI score as shown in Table 2.6. The data of the EIU describes transparency and the audit of government spending consistent with the procurement process issued by the Integrity Pact.

Table 2.6 Integrity Pact Efficiency Increases the CPI score

	CPI Score	Data Sources Score								
		BF-BTI	EIU	GI	IMD	PERC	ICRG	WEF	WJP	VDEM
2010	35	39	33	34	44	28	-	34	-	-
2011	34	39	32	33	40	29	26	33	38	-
2012	37	45	38	42	38	35	31	35	-	-
2013	35	40	38	32	36	39	31	35	33	-
2014	38	40	38	42	32	35	31	38	44	-
2015	38.4	40	45.3	42	38	42	31	43	26	-
2016	35.4	40	44.6	22	44	-	32	37	37	24

Source: Calculated.

2.7 Corruption in Natural Resources: The Petroleum Sector

The public sector is responsible for the economics and social benefit of all people through government management. Government management has public sector principles consisting of democratic standards, including accountability, transparency, fairness, and public integrity (Amundsen & Andrade, 2009, pp. 18-24). Public services, such as utilities and the infrastructure sector, tend to have high risks of corruption because there are natural monopolies and technical complexities that often conceal transaction costs (Kenny & Søreide, 2008, p. 6), for example surveys, construction, and operations with sophisticated financial contracting. Public procurement is related to the activities that have high risks of corruption. The tools and strategies for corruption prevention in the petroleum sector (Amundsen, 2011) show that corruption risks in the value chain of this sector consist of preparation, exploration, development, production, rehabilitation, and decommissioning, and each chain includes main activities, main actors, governance challenges, and corruption challenges, especially corruption challenges: clear contractual frameworks; transparent bidding and award procedures; access to and handling of concessions for production; and lack of checks and balances. From the macro view, the problem of corruption has three consequences: resources, economics, and political. A resources consequence of corruption, countries with abundant resources often have poor economic development and have problems in managing and utilizing their natural resources, for example regarding valid and

transparent data handling, clear contract designs, and transparent bidding. An economics consequence of corruption, countries have problems regarding relative price effects, volatility from over-investment, crowding out of productive sectors, weak redistribution, and squandering out such as capital flight. A political consequence of corruption, the state has increased benefits that creates a greater burden of anti-corruption, such as checks and balances; more unearned income from natural resources (depleted natural resources); and more conflicts caused by inequality. From the micro view, bribe payments and fraud in weak procurement bidding processes, such as bid/concession solicitations, vendor/concessionaire selection, and vendor/concessionaire contracting, leading to unfair competition and price distortions that are obstacles to doing business. Examples are the following: the conflict of interest of the board of directors of PTT leading to unfair competition in the energy business because many members of the board of directors of PTT are executives of the Energy Ministry and the Ministry of Energy, who are responsible for selecting the concessionaire (TDRI, 2014, p. 64-67).

2.8 Related Research

In a report by the Economic Development Institute of the World Bank, entitled "Social Marketing Strategies to Fight Corruption", Kindra and Stapenhurst (1998) discussed extensively the possibility of adopting a "social marketing" tool to fight corruption. This approach to curbing corruption is to promote awareness and attitudinal changes. It is anti-corruption attitudes that transcend into a variety of mechanisms that reward uncorrupt or punish corrupt behavior. Social marketing for anti-corruption campaigns reduces the level of the social acceptance of corruption practices.

Klitgaard (1998) describes a circumstance in which corruption flourishes with the following simple equation: C (Corruption) = M (Monopoly) + D (Discretion) – A (Accountability). Corruption is caused by a monopoly of power in economic governance. Discretionary power, especially in developing countries and countries transitioning from developing to developed countries where the administration rules and regulations are weak. Accountability deficiencies, especially ethics and audit management systems, and financials, which are less efficient.

To interpret Klitgaard's (1998) notion, it can be noted that these conditions can prevail in all societies regardless the level of development or form of ruling power. Historically, in Thailand, as in many countries, corruption is highly rampant during the rule of the elected government. The negative side of social marketing is evidenced by twisted public perceptions about policies released by political parties. Policies can be made popular as they target the majority of people. Winning political parties can hold their rights against the opposition as they are legitimately elected to be a government. Behind the legitimacy of the elected government, a range of fraud and corruption is carried out. A society is divided by policies that favor certain groups and that invoke opposition by other groups. As policies favor the majority of people, a political party becomes a monopoly. Discretion is a result of unplanned.

An environment that encourages corruption is one that is dominated by monopoly power (M), discretion (D), and accountability (A) (Kindra & Stapenhurst, 1998). Klitgaard (1998) offered an explanation that Corruption = Monopoly + Discretion – Accountability. In terms of opportunity and motivation, persons involved in corruption may be classified into three types. Petty corruption involves low-paid civil servants that are motivated to depend on small bribes to meet their needs. Mid-level corruption involves agencies that are lawfully given opportunity for rent-seeking practices. Grand corruption involves high authority that is able to grant sizable awards in exchange for bribery, kickbacks, and other benefits given by persons or enterprises seeking government tenders and sales (Kindra & Stapenhurst, 1998, p. 8-9; USAID, 2002, p. 11).

In Thailand, a number of agencies are joining hands in an effort to stem corruption. One important area is natural resources and environment-related corruption. Diminishing natural resources and degrading the environment represent damage that affects a large number of people in rural areas. This type of corruption has become increasingly organized, involving collaboration between capitalists, government officials, and transnational corruption networks. A war against corruption has been organized to mobilize cooperation between the Public Sector Anti-Corruption Commission (PACC), the Department of Special Investigation (DSI), the Ministry of Natural Resources and Environment, the Ministry of Interior, and the Agricultural Land Reform Office to move against natural resource and environment-related corruption.

The scope of cooperation includes the sharing of information personnel, evidence, training, knowledge management, and public participation (Ministry of Justice, 2013).

A report of survey research on corruption in Thailand was released by the Center for Economics and Business Forecasting of University of the Thai Chamber of Commerce (University of the Thai Chamber of Commerce, 2014). This study found that 75 percent of business owners are obliged to pay bribes to bureaucrats and politicians, ranging from 25 to 35 percent of project costs, to obtain a contract.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Mission Design

In this research, the variation of capital stock overtime, which is influenced by changes in Thailand's corruption perceptions index (CPI) published by Transparency International, is applied to a forecasting the computable general equilibrium (CGE) model in order to test its influential magnitude for long-term economic growth, as show in Figure 3.1. Two comparing scenarios will be produced, including one without the CPI and the other with the CPI. The results are subject to further investigation concerning entailed energy intensity, which will be represented by the use of petroleum fuel, coupled with CO_2 emissions. It is expected that changes in capital intensity across economic sectors may influence different levels of growth at the sector level. Overall energy intensity is expected to be influenced by different levels of growth at the sector level. The interplay of the complex structure of the economy is expected to produce results that are inclusive of a large number of economic factors. Prejudgment could be confirmed or revised upward or revised downward by the test. Policy review can be proposed using the test results.

The CPI is historical. This makes the nature of investigation historical. However, given such a historical perspective, it is possible to project into the future using the same parameter and its sensitivity. Policy review can be proposed in certain areas with the purpose of economic development and environmental issues in mind.

The growth process adopted in the forecasting CGE model is neoclassical economic approach. Capital stock in respective economic sectors depreciates annually for a given percentage. The depreciated portion is annually renewed by new investment. If the depreciated portion and the renewed portion are the same, the capital stock remains the same. If, on the other hand, new investment exceeds depreciation, the

capital stock increases and economic growth is produced. However, if new investment is short of depreciation, capital stock decreases and negative economic growth is produced.

In this study, the CPI is considered as an indicator of social capital, which augments physical capital with the ability to produce more goods and services. Social capital is valued in a number of ways, including goodwill in corporate financial ledgers, trust, the absence of transaction costs, low financial costs, the absence of corruption, and more. A higher value of the CPI is taken as improvement in social capital. With the presence of change in the CPI, the study of social capital is possible.

In order to apply the CPI with the forecasting CGE model, the CPI is multiplied into a new investment parameter so that the capital stock is renewed with new physical stock and social capital. As change in the CPI fluctuates over time, the CGE projection is divided into several unequal periods to suit the CPI pattern. With a historical CPI parameter and its sensitivity, economic growth is projected into the future with alternative scenarios and their coupling CO_2 trail.

The CGE forecasting projection enables the reading of changes of a number of macroeconomic variables and sector levels.

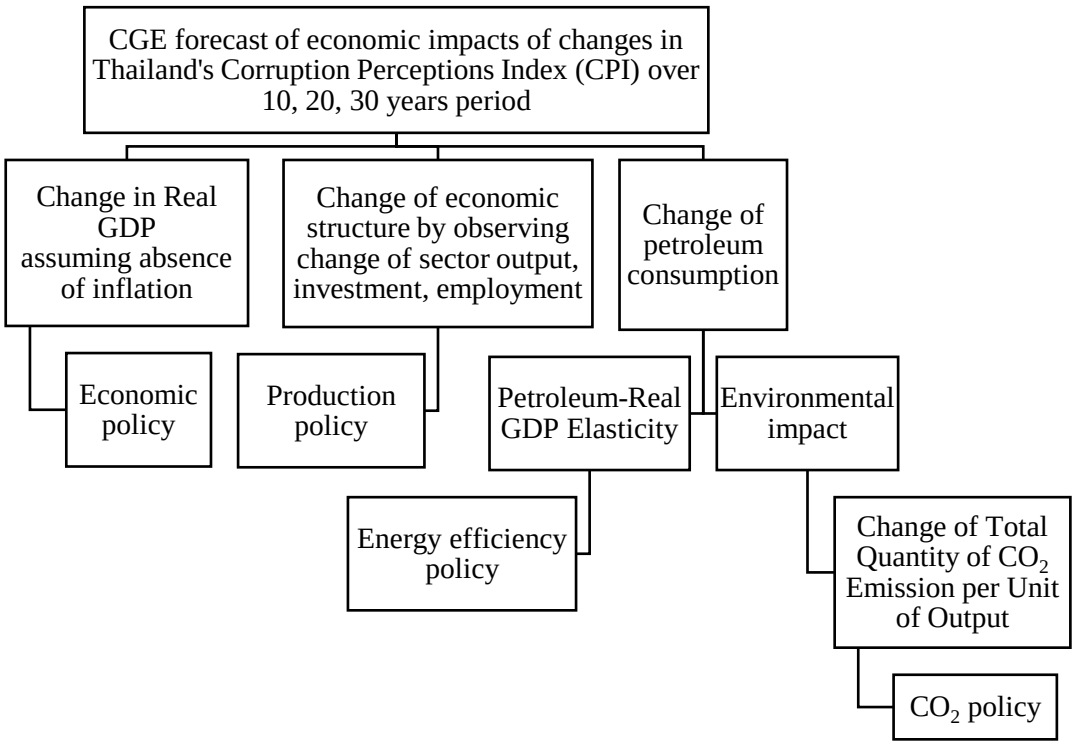

Figure 3.1 Study Contribution

3.2 Arrangement of an Input-Output Table for the CGE Model

The present design of a forecasting CGE model is based on Thailand's input-output table. In order to enable a design of a forecasting CGE model, Thailand's input-output table is rearranged to extend single column investment data into a square investment matrix. A single investment column informs only expenditure on respective goods and services for investment purposes. A square investment matrix is arranged to inform how much investment occurs for respective production, which explains the expenditure for respective goods and services. The distribution of investment for respective production is computed based on the distribution of the depreciation information available in the input-output table. The total investment of all production must equal the total investment of single-column investment expenditure. The equality of the demand and supply of the input-output table is unaltered. The investment matrix arrangement is shown in Figure 3.2.

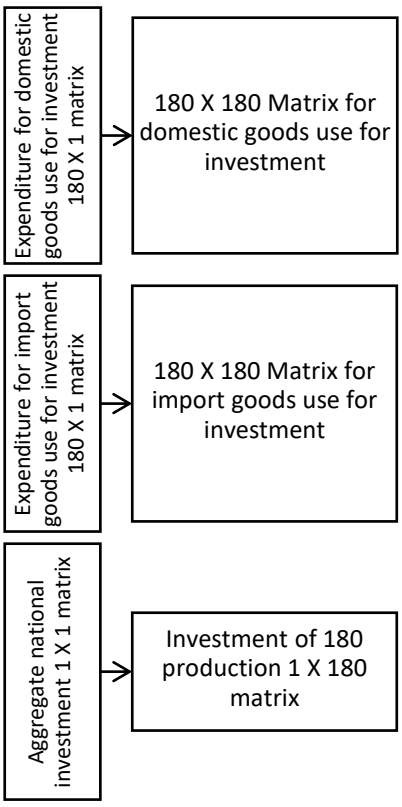

Figure 3.2 Investment Data Rearrangement

A second rearrangement is to collapse the depreciation data (Row 203) with the profit data. The profit data are used to represent capital stock. A parameter is applied to depreciate the capital stock over time. Investment renews the depreciated capital stock.

The reconfiguration of Thailand's input-output table is shown in Figure 3.3. The 2010 edition of Thailand's input-output table is available on the website of Office of National Economic and Social Development Council (NESDC). The sector classification of Thailand's input-output table is shown in Appendix A.

Figure 3.3 displays matrix configuration of variables named for the CGE model. Domestic intermediate input is denoted by $x0_{i,j,1}$ whereas import intermediate input is denoted by $x0_{i,j,2}$. Labor input, capital input, and indirect taxes are denoted by $x01_j$, $x02_j$, and $x03_j$ respectively. Investment expenditure for domestic goods and import goods is denoted by 180 X 180 matrix $x1_{i,j,1}$ and $x1_{i,j,2}$ respectively. Household consumption for domestic goods and import goods is denoted by 180 X 1 matrix $x2_{i,1}$ and $x2_{i,2}$ respectively. Government consumption for domestic goods and import goods is denoted by 180 X 1 matrix $x3_{i,1}$ and $x3_{i,2}$ respectively. Export of 180 goods is denoted by matrix $x4_i$. Inventory of 180 goods and services is denoted by 180 X 1 matrix $x5_{i,1}$ and $x5_{i,2}$ respectively. Special export of 180 goods is denoted by matrix $x6_i$.

Value added originating from wages, profits, and indirect taxes sum to $va1$, $va2$, $va3$, which sums to $gdpi$, representing gross domestic products computed from income.

$x0_{i,j,1}$	$x1_{i,j,1}$	$x2_{i,1}$	$x3_{i,1}$	$x4_i$	$x5_{i,1}$	$x6_i$		$z01_i$
$x0_{i,j,2}$	$x1_{i,j,2}$	$x2_{i,2}$	$x3_{i,2}$		$x5_{i,2}$		$z02_i$	
$x01_j$								$va1$
$x02_j$								$va2$
$x03_j$								$va3$
$z01_j$								$gdpi$

Figure 3.3 Arrangement of Input-Output Table of Thailand's Economic System
Note: *i=180; j=180*

3.3 Methodology

A forecasting CGE model is devised to use GEMPACK for computation and to be compatible with the rearranged 180 sectors of Thailand's input-output table. The components of the model are adapted from ORANI (Dixon et al., 1982; Horridge, Parmenter, & Pearson, 1993).

The CGE system consists of 135,202 variables and 133,940 equations, which offer 1,262 structural exogenous variables, as displayed in Table 3.2 to Table 3.5. The aggregate production function is specified in Leontief form, which branches into CES (constant elasticity of substitution) form to cover the substitution between domestic and imported intermediate factors and for the primary factors between labor and capital. Indirect taxes are branched under the Leontief form. These configurations are shown in Figure 3.4.

Investment output is specified in CES form of production function for substitution between domestic and import goods. Household consumption and government consumption are specified in the Cobb-Douglas utility maximizing form. The export demand is specified to inversely respond to the world price of exports. Exogenous shifts of foreign demand are also provided.

Nominal GDP is computed from two sources. One is the sum of the value added denoted by *gdpi*. The other is the macro identity denoted by *gdpe*, which is the sum of aggregate household consumption, investment consumption, government consumption, and net exports (aggregate export less aggregate import). The model accuracy (or error) can be inspected by the equality (or lack of it) of *gdpi* and *gdpe*.

Change in real terms is denoted by real variables, which are common indicators, including real GDP, real aggregate investment consumption, real aggregate household consumption, real aggregate government consumption, real wages, and the real price of capital. These real variables are evaluated according to the difference between the nominal variables and GDP deflator for real GDP and the relevant price index for other indicators.

The required core structure of a CGE model includes 5 components: (1) the supply equation, which specifies the production function covering intermediate and primary inputs; (2) the final demand equation, which specifies investment demand,

household and government consumption, export demand, and other final demands; (3) the price equation, which specifies how the price of goods and services is determined; (4) the equilibrium equation, which specifies the condition for the equality of demand and supply; and (5) the numeraire equation, which specifies the reference point for the variables to depart from.

Other equations are used for reading changes in the economy, to establish connections, and to convey useful information.

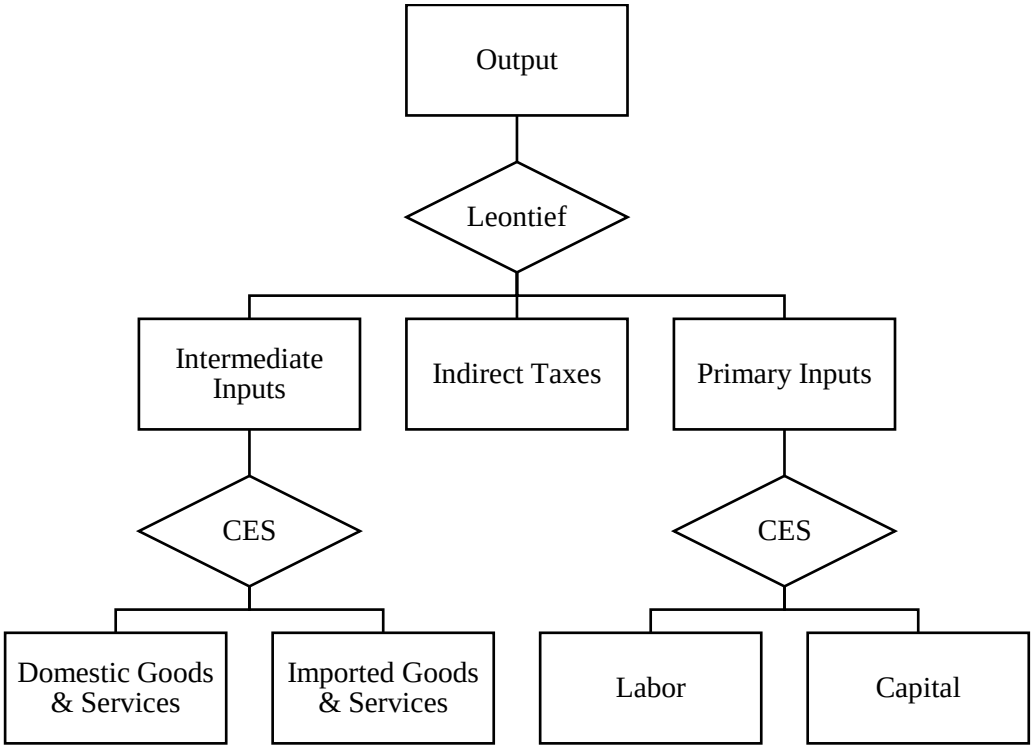

Figure 3.4 Specification of Production Function

Table 3.1 Variables of CGE Model

	Variable	Description	Range
1	$p0_{i,s}$	Price of domestically produced goods and imported goods	360
2	$p01_j$	Labor price	180
3	$p02_j$	Capital rental price	180
4	$p03_j$	Indirect tax rate	180
5	$pz1_j$	Investment cost	180
6	$cpi1$	Investment price index	1
7	$cpi2$	Consumer price index	1
8	$cpi3$	Government consumption price index	1
9	$rp01_j$	Real price of labor	180
10	$rp02_j$	Real capital rental price	180
11	xr	Exchange rate	1
12	$pw1_i$	Export world price	180
13	$pw2_i$	Import world price	180
14	$v1_i$	Export tax (subsidy)	180
15	$v2_i$	Import tax	180
16	$fx4_i$	Foreign demand independent shift (Shift of export demand)	180
17	$x0_{i,j,s}$	Produced input used by commodity production	64,800
18	$x01_j$	Labor input	180
19	$x02_j$	Capital input	180
20	$x03_j$	Indirect taxes	180
21	$z01_j$	Commodity supply and demand	180
22	$z02_i$	Total Imports of Commodity i	180
23	$z1_j$	Capital output (Investment by sector)	180

Table 3.1 (Continued)

	Variable	Description	Range
24	$cx1_{i,s}$	Total investment demand (Investment by column)	360
25	$gdpi$	Nominal gross domestic products computed from value added (Income side GDP)	1
26	va_1	Total value of labor input	1
27	va_2	Total value of capital input	1
28	va_3	Total value of indirect taxes	1
29	$gdpe$	Nominal gross domestic products computed from final demand (Expenditure side GDP)	1
30	$gdpr$	Real GDP	1
31	$gdpdf$	GDP deflator	1
32	$c1$	Total investment consumption	1
33	$c1r$	Real total investment consumption	1
34	$c2$	Total household consumption	1
35	$c2r$	Real total household consumption	1
36	$c3$	Total government consumption	1
37	$c3r$	Real total government consumption	1
38	$r0_j$	Current rate of return	180
39	$r1$	Average rate of return	1
40	$k1$	Average capital stock	1
41	$k0_j$	Current capital stock	180
42	e	Total value of exports	1
43	m	Total value of imports	1
44	ΔBT	Change in trade balance	1
45	ΔDT	Change in trade balance-GDP ratio	1
46	$x1_{i,j,s}$	Investment consumption of commodity i	64,800
47	$x2_{i,s}$	Household consumption of commodity i	360
48	$x3_{i,s}$	Government consumption of commodity i	360

Table 3.1 (Continued)

	Variable	Description	Range
49	$x4_i$	Exports of commodity i	180
50	$x5_{i,s}$	Inventory commodity i	360
51	$x6_i$	Special exports commodity i	180
52	$delFudge$	Forecast Variable	1
53	f_accum_j	Capital Shift	180
54	oil	Oil consumption (Quantity)	1
55	oil_v	Oil consumption (Value)	1
56	oil_fd	Oil consumption in final demand (Quantity)	1
57	oil_fdv	Oil consumption in final demand (Value)	1
58	oil_int	Oil consumption in intermediate (Quantity)	1
59	oil_intv	Oil consumption in intermediate (Value)	1
60	oil_nx	Oil consumption excluding export and special export (Quantity)	1
61	oil_v_nx	Oil consumption excluding export and special export (Value)	1
62	oil_fd_nx	Oil consumption in final demand excluding export and special export (Quantity)	1
63	oil_fdv_nx	Oil consumption in final demand excluding export and special export (Value)	1
	Total		**135,394**

Table 3.2 Equations in Linear Percentage Change Form and Range; Variables are in Lower Case, and Shares are in Upper Case

No.	Equation	Range
1	Total demand for domestic goods	
	$z01_i = \sum_{j=1}^{180} RX0_{i,j,1} \cdot x0_{i,j,1} + \sum_{j=1}^{180} RX1_{i,j,1} \cdot x1_{i,j,1} + RX2_{i,1} \cdot x2_{i,1} + RX3_{i,1} \cdot x3_{i,1} + RX4_i \cdot x4_i + RX5_{i,1} \cdot x5_{i,1} + RX6_i \cdot x6_i$	180
2	Total demand for imported goods	
	$z02_i = \sum_{j=1}^{180} RX0_{i,j,2} \cdot x0_{i,j,2} + \sum_{j=1}^{180} RX1_{i,j,2} \cdot x1_{i,j,2} + RX2_{i,2} \cdot x2_{i,2} + RX3_{i,2} \cdot x3_{i,2} + RX5_{i,2} \cdot x5_{i,2}$	180
3	Production function	
	$x0_{i,j,s} = z01_j - 1 \cdot \left(p0_{i,s} - \sum_{r=1}^{2} SZX0_{i,j,r} \cdot p0_{i,r}\right)$	64,800
4	Labor Demand	
	$x01_j = z01_j - 1 \cdot \left(p01_j - [(SFAC1_j \cdot p01_j) + (SFAC2_j \cdot p02_j)]\right)$	180
5	Capital Demand	
	$x02_j = z01_j - 1 \cdot \left(p02_j - [(SFAC1_j \cdot p01_j) + (SFAC2_j \cdot p02_j)]\right)$	180
6	Indirect taxes	
	$x03_j = p03_j + p0_{j,1} + z01_j$	180
7	Total Labor Demand (employment)	
	$va_1 = \sum_{j=1}^{180} S01_j \cdot (p01_j + x01_j)$	1
8	Total capital stock	
	$va_2 = \sum_{j=1}^{180} S02_j \cdot (p02_j + x02_j)$	1

Table 3.2 (Continued)

No.	Equation	Range
9	Total indirect taxes collection	
	$va_3 = \sum_{j=1}^{180} S03_j \cdot (p03_j + x03_j)$	1
10	Gross domestic products computed from income	
	$gdpi = (H01 \cdot va_1) + (H02 \cdot va_2) + (H03 \cdot va_3)$	1
11	Substitution of Investment (Investment spending)	
	$x1_{i,j,s} = z1_j - 1 \cdot \left(p0_{i,s} - \sum_{r=1}^{2} SZX1_{i,j,r} \cdot p0_{i,r}\right)$	64,800
12	Substitution of Domestic Household consumption	
	$x2_{i,s} = c2 - p0_{i,s}$	360
13	Substitution of Government expenditure	
	$x3_{i,s} = c3 - p0_{i,s}$	360
14	Export demand	
	$pw1_i = -GAM_i \cdot x4_i + fx4_i$	180
15	Inventory demand	
	$x5_{i,s} = c2r$	360
16	Special export	
	$x6_i = c2r$	180
17	Investment/capital accumulation	
	$k0_j = \left(K\_TERM_j \cdot delFudge\right) + \left(M\_TERM_j \cdot R\_T_j \cdot z1_j\right) + f\_accum_j$	180
18	Capital utilization	
	$x02_j = k0_j$	180
19	Current rate of return of capital	
	$r0_j = 1.3 \cdot (p02_j - pz1_j)$	180
20	Total return	
	$r1 = \sum_{j=1}^{180} S02_j \cdot r0_j$	1

Table 3.2 (Continued)

No.	Equation	Range
21	Total capital	
	$k1 = \sum_{j=1}^{180} S02_j \cdot k0_j$	1
22	Price of domestic goods	
	$p0_{j,1} + z01_j = \sum_{i=1}^{180} HX0_{i,j,1} \cdot (p0_{i,1} + x0_{i,j,1})$	180
	$+ \sum_{i=1}^{180} HX0_{i,j,2} \cdot (p0_{i,2} + x0_{i,j,2})$	
	$+HX01_j \cdot (p01_j + x01_j) + HX02_j \cdot (p02_j + x02_j)$	
	$+HX03_j \cdot (p03_j + p0_{j,1} + z01_j)$	
23	Export price	
	$p0_{i,1} = pw1_i + v1_i + xr$	180
24	Import price	
	$p0_{i,2} = pw2_i + v2_i + xr$	180
25	Capital cost (Investment by sector)	
	$pz1_j + z1_j = \sum_{i=1}^{180} HZ1_{i,j,1} \cdot (p0_{i,1} + x1_{i,j,1})$	180
	$+ \sum_{i=1}^{180} HZ1_{i,j,2} \cdot (p0_{i,2} + x1_{i,j,2})$	
26	Capital output	
	$z1_j = c1 + r0_j$	180
27	Investment price index	
	$cpi1 = \sum_{j=1}^{180} SZ1_j \cdot pz1_j$	1

Table 3.2 (Continued)

No.	Equation	Range
28	Consumer price index	
	$\text{cpi2} = \sum_{i=1}^{180} \text{SX2}_{i,1} \cdot \text{p0}_{i,1} + \sum_{i=1}^{180} \text{SX2}_{i,2} \cdot \text{p0}_{i,2}$	1
29	Government price index	
	$\text{cpi3} = \sum_{i=1}^{180} \text{SX3}_{i,1} \cdot \text{p0}_{i,1} + \sum_{i=1}^{180} \text{SX3}_{i,2} \cdot \text{p0}_{i,2}$	1
30	Real investment	
	$\text{c1r} = \text{c1} - \text{cpi1}$	1
31	Real household consumption	
	$\text{c2r} = \text{c2} - \text{cpi2}$	1
32	Real government consumption	
	$\text{c3r} = \text{c3} - \text{cpi3}$	1
33	Total investment consumption (spending)	
	$\text{c1} = \text{gdpe}$	1
34	Total (Nominal) household consumption	
	$\text{c2} = \text{gdpe}$	1
35	Total (Nominal) government consumption	
	$\text{c3} = \text{gdpe}$	1
36	Total exports	
	$\text{e} = \sum_{i=1}^{180} \text{HX4}_i \cdot (\text{pw1}_i + \text{x4}_i)$	1
37	Total imports	
	$\text{m} = \sum_{i=1}^{180} \text{HM}_i \cdot (\text{pw2}_i + \text{z02}_i)$	1
38	Ordinary change in the balance of trade	
	$100 \cdot \Delta\text{BT} = (\text{VE} \cdot \text{e}) - (\text{VM} \cdot \text{m})$	1

Table 3.2 (Continued)

No.	Equation	Range
39	Ordinary change in balance of trade – GDP ratio (Debt-GDP)	
	$100 \cdot \mathrm{VGDPE} \cdot \Delta\mathrm{DT} = (\mathrm{VE} \cdot \mathrm{e}) - (\mathrm{VM} \cdot \mathrm{m}) - [(\mathrm{VE} - \mathrm{VM}) \cdot \mathrm{gdpe}]$	1
40	Real wage	
	$\mathrm{rp01_j} = \mathrm{p01_j} - \mathrm{cpi2}$	180
41	Real price of capital (capital rent)	
	$\mathrm{rp02_j} = \mathrm{p02_j} - \mathrm{cpi2}$	180
42	Total domestic investment by column	
	$\mathrm{cx1_{i,1}} = \sum_{\mathrm{j=1}}^{180} \mathrm{RCX1_{i,j,1}} \cdot \mathrm{x1_{i,j,1}}$	180
43	Total import investment by column	
	$\mathrm{cx1_{i,2}} = \sum_{\mathrm{j=1}}^{180} \mathrm{RCX1_{i,j,2}} \cdot \mathrm{x1_{i,j,2}}$	180
44	Demand-side GDP	
	$\mathrm{gdpe} = \sum_{\mathrm{i=1}}^{180} \mathrm{SHZCX1_{i,1}} \cdot (\mathrm{p0_{i,1}} + \mathrm{cx1_{i,1}}) + \sum_{\mathrm{i=1}}^{180} \mathrm{SHZCX1_{i,2}} \cdot (\mathrm{p0_{i,2}} + \mathrm{cx1_{i,2}}) + \sum_{\mathrm{i=1}}^{180} \mathrm{SHX2_{i,1}} \cdot (\mathrm{p0_{i,1}} + \mathrm{x2_{i,1}}) + \sum_{\mathrm{i=1}}^{180} \mathrm{SHX2_{i,2}} \cdot (\mathrm{p0_{i,2}} + \mathrm{x2_{i,2}}) + \sum_{\mathrm{i=1}}^{180} \mathrm{SHX3_{i,1}} \cdot (\mathrm{p0_{i,1}} + \mathrm{x3_{i,1}}) + \sum_{\mathrm{i=1}}^{180} \mathrm{SHX3_{i,2}} \cdot (\mathrm{p0_{i,2}} + \mathrm{x3_{i,2}}) + \sum_{\mathrm{i=1}}^{180} \mathrm{SHX4_i} \cdot (\mathrm{p0_{i,1}} + \mathrm{x4_i}) + \sum_{\mathrm{i=1}}^{180} \mathrm{SHX5_{i,1}} \cdot (\mathrm{p0_{i,1}} + \mathrm{x5_{i,1}}) + \sum_{\mathrm{i=1}}^{180} \mathrm{SHX5_{i,2}} \cdot (\mathrm{p0_{i,2}} + \mathrm{x5_{i,2}}) + \sum_{\mathrm{i=1}}^{180} \mathrm{SHX6_i} \cdot (\mathrm{p0_{i,1}} + \mathrm{x6_i}) - \sum_{\mathrm{i=1}}^{180} \mathrm{SHZ02_i} \cdot (\mathrm{p0_{i,2}} + \mathrm{z02_i})$	1

Table 3.2 (Continued)

No.	Equation	Range
45	GDP deflator	
	$\text{gdpdf} = \sum_{i=1}^{180} \text{SHZCX1}_{i,1} \cdot \text{p0}_{i,1} + \sum_{i=1}^{180} \text{SHZCX1}_{i,2} \cdot \text{p0}_{i,2}$ $+ \sum_{i=1}^{180} \text{SHX2}_{i,1} \cdot \text{p0}_{i,1} + \sum_{i=1}^{180} \text{SHX2}_{i,2} \cdot \text{p0}_{i,2}$ $+ \sum_{i=1}^{180} \text{SHX3}_{i,1} \cdot \text{p0}_{i,1} + \sum_{i=1}^{180} \text{SHX3}_{i,2} \cdot \text{p0}_{i,2}$ $+ \sum_{i=1}^{180} \text{SHX4}_{i} \cdot \text{p0}_{i,1}$ $+ \sum_{i=1}^{180} \text{SHX5}_{i,1} \cdot \text{p0}_{i,1} + \sum_{i=1}^{180} \text{SHX5}_{i,2} \cdot \text{p0}_{i,2}$ $+ \sum_{i=1}^{180} \text{SHX6}_{i} \cdot \text{p0}_{i,1} - \sum_{i=1}^{180} \text{SHZ02}_{i} \cdot \text{p0}_{i,2}$	1
46	Real GDP	
	$\text{gdpr} = \text{gdpe} - \text{gdpdf}$	1
47	Oil consumption (Quantity)	
	$\text{oil} = \sum_{j=1}^{180} \text{SCX0}_{93,j,1} \cdot \text{x0}_{93,j,1} + \sum_{i=1}^{180} \text{SCX0}_{93,j,2} \cdot \text{x0}_{93,j,2}$ $\sum_{j=1}^{180} \text{SCX1}_{93,j,1} \cdot \text{x1}_{93,j,1} + \sum_{i=1}^{180} \text{SCX1}_{93,j,2} \cdot \text{x1}_{93,j,2}$ $+ \text{SCX2}_{93,1} \cdot \text{x2}_{93,1} + \text{SCX2}_{93,2} \cdot \text{x2}_{93,2}$ $+ \text{SCX3}_{93,1} \cdot \text{x3}_{93,1} + \text{SCX3}_{93,2} \cdot \text{x3}_{93,2}$ $+ \text{SCX4}_{93} \cdot \text{x4}_{93}$ $+ \text{SCX5}_{93,1} \cdot \text{x5}_{93,1} + \text{SCX5}_{93,2} \cdot \text{x5}_{93,2}$ $+ \text{SCX6}_{93} \cdot \text{x6}_{93}$	1

Table 3.2 (Continued)

No.	Equation	Range
48	Oil consumption (Value)	
	$\text{oil\_v} = \sum_{j=1}^{180} \text{SCX0}_{93,j,1} \cdot (\text{p0}_{93,1} + \text{x0}_{93,j,1})$	1
	$+ \sum_{i=1}^{180} \text{SCX0}_{93,j,2} \cdot (\text{p0}_{93,2} + \text{x0}_{93,j,2})$	
	$+ \sum_{i=1}^{180} \text{SCX1}_{93,j,1} \cdot (\text{p0}_{93,1} + \text{x1}_{93,j,1})$	
	$+ \sum_{i=1}^{180} \text{SCX1}_{93,j,2} \cdot (\text{p0}_{93,2} + \text{x1}_{93,j,2})$	
	$+ \text{SCX2}_{93,1} \cdot (\text{p0}_{93,1} + \text{x2}_{93,1}) + \text{SCX2}_{93,2} \cdot (\text{p0}_{93,2} + \text{x2}_{93,2})$	
	$+ \text{SCX3}_{93,1} \cdot (\text{p0}_{93,1} + \text{x3}_{93,1}) + \text{SCX3}_{93,2} \cdot (\text{p0}_{93,2} + \text{x3}_{93,2})$	
	$+ \text{SCX4}_{93} \cdot (\text{p0}_{93,1} + \text{x4}_{93})$	
	$+ \text{SCX5}_{93,1} \cdot (\text{p0}_{93,1} + \text{x5}_{93,1}) + \text{SCX5}_{93,2} \cdot (\text{p0}_{93,2} + \text{x5}_{93,2})$	
	$+ \text{SCX6}_{93} \cdot (\text{p0}_{93,1} + \text{x6}_{93})$	
49	Oil consumption in final demand (Quantity)	
	$\text{oil\_fd} = \sum_{j=1}^{180} \text{SFDX1}_{93,j,1} \cdot \text{x1}_{93,j,1} + \sum_{i=1}^{180} \text{SFDX1}_{93,j,2} \cdot \text{x1}_{93,j,2}$	1
	$+ \text{SFDX2}_{93,1} \cdot \text{x2}_{93,1} + \text{SFDX2}_{93,2} \cdot \text{x2}_{93,2}$	
	$+ \text{SFDX3}_{93,1} \cdot \text{x3}_{93,1} + \text{SFDX3}_{93,2} \cdot \text{x3}_{93,2}$	
	$+ \text{SFDX4}_{93} \cdot \text{x4}_{93}$	
	$+ \text{SFDX5}_{93,1} \cdot \text{x5}_{93,1} + \text{SFDX5}_{93,2} \cdot \text{x5}_{93,2}$	
	$+ \text{SFDX6}_{93} \cdot \text{x6}_{93}$	

Table 3.2 (Continued)

No.	Equation	Range
50	Oil consumption in final demand (Value)	
	$\text{oil\_fdv} = \sum_{j=1}^{180} \text{SFDX1}_{93,j,1} \cdot (\text{p0}_{93,1} + \text{x1}_{93,j,1}) + \sum_{i=1}^{180} \text{SFDX1}_{93,j,2} \cdot (\text{p0}_{93,2} + \text{x1}_{93,j,2}) + \text{SFDX2}_{93,1} \cdot (\text{p0}_{93,1} + \text{x2}_{93,1}) + \text{SFDX2}_{93,2} \cdot (\text{p0}_{93,2} + \text{x2}_{93,2}) + \text{SFDX3}_{93,1} \cdot (\text{p0}_{93,1} + \text{x3}_{93,1}) + \text{SFDX3}_{93,2} \cdot (\text{p0}_{93,2} + \text{x3}_{93,2}) + \text{SFDX4}_{93} \cdot (\text{p0}_{93,1} + \text{x4}_{93}) + \text{SFDX5}_{93,1} \cdot (\text{p0}_{93,1} + \text{x5}_{93,1}) + \text{SFDX5}_{93,2} \cdot (\text{p0}_{93,2} + \text{x5}_{93,2}) + \text{SFDX6}_{93} \cdot (\text{p0}_{93,1} + \text{x6}_{93})$	1
51	Oil consumption in intermediate (Quantity)	
	$\text{oil\_int} = \sum_{j=1}^{180} \text{SINX0}_{93,j,1} \cdot \text{x0}_{93,j,1} + \sum_{i=1}^{180} \text{SINX0}_{93,j,2} \cdot \text{x0}_{93,j,2}$	1
52	Oil consumption in intermediate (Value)	
	$\text{oil\_intv} = \sum_{j=1}^{180} \text{SINX0}_{93,j,1} \cdot (\text{p0}_{93,1} + \text{x0}_{93,j,1}) + \sum_{i=1}^{180} \text{SINX0}_{93,j,2} \cdot (\text{p0}_{93,2} + \text{x0}_{93,j,2})$	1
53	Oil consumption excluding export and special export (Quantity)	
	$\text{oil\_nx} = \sum_{j=1}^{180} \text{SCX0\_nx}_{93,j,1} \cdot \text{x0}_{93,j,1} + \sum_{i=1}^{180} \text{SCX0\_nx}_{93,j,2} \cdot \text{x0}_{93,j,2} \sum_{j=1}^{180} \text{SCX1\_nx}_{93,j,1} \cdot \text{x1}_{93,j,1} + \sum_{i=1}^{180} \text{SCX1\_nx}_{93,j,2} \cdot \text{x1}_{93,j,2} + \text{SCX2\_nx}_{93,1} \cdot \text{x2}_{93,1} + \text{SCX2\_nx}_{93,2} \cdot \text{x2}_{93,2} + \text{SCX3\_nx}_{93,1} \cdot \text{x3}_{93,1} + \text{SCX3\_nx}_{93,2} \cdot \text{x3}_{93,2} + \text{SCX5\_nx}_{93,1} \cdot \text{x5}_{93,1} + \text{SCX5\_nx}_{93,2} \cdot \text{x5}_{93,2}$	1

Table 3.2 (Continued)

No.	Equation	Range
54	Oil consumption excluding export and special export (Value)	
	$\text{oil\_v\_nx} = \sum_{j=1}^{180} \text{SCX0\_nx}_{93,j,1} \cdot (\text{p0}_{93,1} + \text{x0}_{93,j,1})$	1
	$+ \sum_{i=1}^{180} \text{SCX0\_nx}_{93,j,2} \cdot (\text{p0}_{93,2} + \text{x0}_{93,j,2})$	
	$+ \sum_{i=1}^{180} \text{SCX1\_nx}_{93,j,1} \cdot (\text{p0}_{93,1} + \text{x1}_{93,j,1})$	
	$+ \sum_{i=1}^{180} \text{SCX1\_nx}_{93,j,2} \cdot (\text{p0}_{93,2} + \text{x1}_{93,j,2})$	
	$+ \text{SCX2\_nx}_{93,1} \cdot (\text{p0}_{93,1} + \text{x2}_{93,1}) + \text{SCX2\_nx}_{93,2} \cdot (\text{p0}_{93,2} + \text{x2}_{93,2})$	
	$+ \text{SCX3\_nx}_{93,1} \cdot (\text{p0}_{93,1} + \text{x3}_{93,1}) + \text{SCX3\_nx}_{93,2} \cdot (\text{p0}_{93,2} + \text{x3}_{93,2})$	
	$+ \text{SCX5\_nx}_{93,1} \cdot (\text{p0}_{93,1} + \text{x5}_{93,1}) + \text{SCX5\_nx}_{93,2} \cdot (\text{p0}_{93,2} + \text{x5}_{93,2})$	
55	Oil consumption in final demand excluding export and special export (Quantity)	
	$\text{oil\_fd\_nx} = \sum_{j=1}^{180} \text{SFDX1\_nx}_{93,j,1} \cdot \text{x1}_{93,j,1}$	1
	$+ \sum_{i=1}^{180} \text{SFDX1\_nx}_{93,j,2} \cdot \text{x1}_{93,j,2}$	
	$+ \text{SFDX2\_nx}_{93,1} \cdot \text{x2}_{93,1} + \text{SFDX2\_nx}_{93,2} \cdot \text{x2}_{93,2}$	
	$+ \text{SFDX3\_nx}_{93,1} \cdot \text{x3}_{93,1} + \text{SFDX3\_nx}_{93,2} \cdot \text{x3}_{93,2}$	
	$+ \text{SFDX5\_nx}_{93,1} \cdot \text{x5}_{93,1} + \text{SFDX5\_nx}_{93,2} \cdot \text{x5}_{93,2}$	

Table 3.2 (Continued)

No.	Equation	Range
56	Oil consumption in final demand excluding export and special export (Value)	
	$\text{oil\_fdv\_nx} = \sum_{j=1}^{180} \text{SFDX1\_nx}_{93,j,1} \cdot (\text{p0}_{93,1} + \text{x1}_{93,j,1})$	1
	$+ \sum_{i=1}^{180} \text{SFDX1\_nx}_{93,j,2} \cdot (\text{p0}_{93,2} + \text{x1}_{93,j,2})$	
	$+ \text{SFDX2\_nx}_{93,1} \cdot (\text{p0}_{93,1} + \text{x2}_{93,1}) + \text{SFDX2\_nx}_{93,2} \cdot (\text{p0}_{93,2} + \text{x2}_{93,2})$	
	$+ \text{SFDX3\_nx}_{93,1} \cdot (\text{p0}_{93,1} + \text{x3}_{93,1}) + \text{SFDX3\_nx}_{93,2} \cdot (\text{p0}_{93,2} + \text{x3}_{93,2})$	
	$+ \text{SFDX5\_nx}_{93,1} \cdot (\text{p0}_{93,1} + \text{x5}_{93,1}) + \text{SFDX5\_nx}_{93,2} \cdot (\text{p0}_{93,2} + \text{x5}_{93,2})$	
	Total	**134,132**

Table 3.3 Exogenous Variables and Range

	Variable	Comment	Range
1	rp01_j	Real price of labor	180
2	p03_i	Indirect tax rate	180
3	v1_i	Export subsidy	180
4	v2_i	Import tax	180
5	fx4_i	Foreign demand independent shift	180
6	pw2_i	Import price	180
7	delFudge	Forecast Variable	1
8	f_accum_j	Capital Shift	180
9	delBT	Change in trade balance	1
	Total		**1,262**

Table 3.4 Computation of Coefficients, Shares and Parameters

No.	Coefficients	Description	Formula
1	$VDINPUT_{i,j}$	Value domestic intermediate	$VDINPUT_{i,j} = p0_{i,1} \cdot X0_{i,j,1}$
2	$VMINPUT_{i,j}$	Value import intermediate	$VMINPUT_{i,j} = p0_{i,2} \cdot X0_{i,j,2}$
3	$VX01_j$	Value labor inputs	$VX01_j = p01_j \cdot X01_j$
4	$VX02_j$	Value capital inputs	$VX02_j = p02_j \cdot X02_j$
5	$VX03_j$	Value indirect taxes	$VX03_j = X03_j$
6	$VDX1_{i,j}$	Value domestic investment	$VDX1_{i,j} = p0_{i,1} \cdot X1_{i,j,1}$
7	$VMX1_{i,j}$	Value import investment	$VMX1_{i,j} = p0_{i,2} \cdot X1_{i,j,2}$
8	$VDX2_i$	Value domestic household consumption	$VDX2_i = p0_{i,1} \cdot X2_{i,1}$
9	$VMX2_i$	Value import household consumption	$VMX2_i = p0_{i,2} \cdot X2_{i,2}$
10	$VDX3_i$	Value domestic government consumption	$VDX3_i = p0_{i,1} \cdot X3_{i,1}$
11	$VMX3_i$	Value import government consumption	$VMX3_i = p0_{i,2} \cdot X3_{i,2}$
12	$VX4_i$	Value export	$VX4_i = p0_{i,1} \cdot X4_i$
13	$VDX5_i$	Value domestic inventory	$VDX5_i = p0_{i,1} \cdot X5_{i,1}$
14	$VMX5_i$	Value import inventory	$VMX5_i = p0_{i,2} \cdot X5_{i,2}$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
15	$VX6_i$	Value special export	$VX6_i = p0_{i,1} \cdot X6_i$
16	GAM_i	Export elasticity	GAM_i Computed export price elasticity
17	$VZ01_i$	Total domestic demand	$VZ01_i = \sum_{j=1}^{180} VDINPUT_{i,j} + \sum_{j=1}^{180} VDX1_{i,j} + VDX2_i + VDX3_i + VX4_i + VDX5_i + VX6_i$
18	$VZ02_i$	Total demand import goods	$VZ02_i = \sum_{j=1}^{180} VMINPUT_{i,j} + \sum_{j=1}^{180} VMX1_{i,j} + VMX2_i + VMX3_i + VMX5_i$
19	$VSPLY_j$	Total supply	$VSPLY_j = \sum_{i=1}^{180} VDINPUT_{i,j} + \sum_{i=1}^{180} VMINPUT_{i,j} + VX01_j + VX02_j + VX03_j$
20	$HX0_{i,j,1}$	Share of intermediate demand in total supply for domestic goods	$HX0_{i,j,1} = VDINPUT_{i,j}/VSPLY_j$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
21	$HX0_{i,j,2}$	Share of intermediate demand in total supply for import goods	$HX0_{i,j,2} = VMINPUT_{i,j}/VSPLY_j$
22	$HX01_j$	Share of labor demand in total supply	$HX01_j = VX01_j/VSPLY_j$
23	$HX02_j$	Share of capital demand in total supply	$HX02_j = VX02_j/VSPLY_j$
24	$HX03_j$	Share of indirect taxes in total supply	$HX03_j = VX03_j/VSPLY_j$
25	$VFAC_j$	Total primary factor	$VFAC_j = VX01_j + VX02_j$
26	$SFAC1_j$	Share of labor in primary factor	$SFAC1_j = VX01_j/VFAC_j$
27	$SFAC2_j$	Share of capital in primary factor	$SFAC2_j = VX02_j/VFAC_j$
28	VA_1	Total labor	$VA\_1 = \sum_{j=1}^{180} VX01_j$
29	VA_2	Total capital	$VA\_2 = \sum_{j=1}^{180} VX02_j$
30	VA_3	Total indirect tax	$VA\_3 = \sum_{j=1}^{180} VX03_j$
31	$S01_j$	Sector share of labor in total labor demand	$S01_j = VX01_j/VA\_1$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
32	$S02_j$	Sector share of capital in total capital demand	$S02_j = VX02_j / VA\_2$
33	$S03_j$	Sector share of indirect tax in total indirect tax	$S03_j = VX03_j / VA\_3$
34	VGDPI	Income GDP	$VGDPI = VA\_1 + VA\_2 + VA\_3$
35	H01	Total labor share in income-side GDP	$H01 = \frac{VA\_1}{VGDPI}$
36	H02	Total capital share in income-side GDP	$H02 = \frac{VA\_2}{VGDPI}$
37	H03	Total indirect tax share in income-side GDP	$H03 = \frac{VA\_3}{VGDPI}$
38	$VZX0_{i,j}$	Total Intermediate material demand by sector	$VZX0_{i,j} = VDINPUT_{i,j} + VMINPUT_{i,j}$
39	$SZX0_{i,j,1}$	Domestic share in combined total domestic-import intermediate demand	$SZX0_{i,j,1} = \frac{VDINPUT_{i,j}}{VZX0_{i,j}}$
40	$SZX0_{i,j,2}$	Import share in combined total domestic-import intermediate demand	$SZX0_{i,j,2} = \frac{VMINPUT_{i,j}}{VZX0_{i,j}}$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
41	$VZX1_{i,j}$	Total Investment demand by sector	$VZX1_{i,j} = VDX1_{i,j} + VMX1_{i,j}$
42	$SZX1_{i,j,1}$	Domestic share in combined Total Investment demand	$SZX1_{i,j,1} = \frac{VDX1_{i,j}}{VZX1_{i,j}}$
43	$SZX1_{i,j,2}$	Import share in combined Total Investment demand	$SZX1_{i,j,2} = \frac{VMX1_{i,j}}{VZX1_{i,j}}$
44	$COLX1_{i,1}$	Domestic investment by column	$COLX1_{i,1} = \sum_{j=1}^{180} VDX1_{i,j}$
45	$COLX1_{i,2}$	Import investment by column	$COLX1_{i,2} = \sum_{j=1}^{180} VMX1_{i,j}$
46	$RCX1_{i,j,1}$	Domestic share in combined total Investment by column	$RCX1_{i,j,1} = \frac{VDX1_{i,j}}{COLX1_{i,1}}$
47	$RCX1_{i,j,2}$	Import share in combined total Investment by column	$RCX1_{i,j,2} = \frac{VMX1_{i,j}}{COLX1_{i,2}}$
48	$VZ1_j$	Total investment by sector	$VZ1_j = \sum_{i=1}^{180} VDX1_{i,j} + \sum_{i=1}^{180} VMX1_{i,j}$
49	G_j	Depreciation of capital	$G_j = \frac{VZ1_j}{(VX02_j + VZ1_j)}$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
50	$VC1$	Total investment	$VC1 = \sum_{j=1}^{180} VZ1_j$
51	$SZ1_j$	Share in total investment	$SZ1_j = \frac{VZ1_j}{VC1}$
52	$HZ1_{i,j,1}$	Domestic share in total investment by sector	$HZ1_{i,j,1} = \frac{VDX1_{i,j}}{VZ1_j}$
53	$HZ1_{i,j,2}$	Import share in total investment by sector	$HZ1_{i,j,2} = \frac{VMX1_{i,j}}{VZ1_j}$
54	$VC2$	Total household consumption	$VC2 = \sum_{i=1}^{180} VDX2_i + \sum_{i=1}^{180} VMX2_i$
55	$SX2_{i,1}$	Domestic demand share in total household consumption	$SX2_{i,1} = \frac{VDX2_i}{VC2}$
56	$SX2_{i,2}$	Import demand share in total household consumption	$SX2_{i,2} = \frac{VMX2_i}{VC2}$
57	$VC3$	Total government consumption	$VC3 = \sum_{i=1}^{180} VDX3_i + \sum_{i=1}^{180} VMX3_i$
58	$SX3_{i,1}$	Domestic demand share in total government consumption	$SX3_{i,1} = \frac{VDX3_i}{VC3}$
59	$SX3_{i,2}$	Import demand share in total government consumption	$SX3_{i,2} = \frac{VMX3_i}{VC3}$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
60	VC5	Total inventory	$\mathrm{VC5} = \sum_{i=1}^{180} \mathrm{VDX5_i} + \sum_{i=1}^{180} \mathrm{VMX5_i}$
61	VC6	Total special export	$\mathrm{VC6} = \sum_{i=1}^{180} \mathrm{VX6_i}$
62	VE	Total export	$\mathrm{VE} = \sum_{i=1}^{180} \mathrm{VX4_i}$
63	VM	Total import	$\mathrm{VM} = \sum_{i=1}^{180} \mathrm{VZ02_i}$
64	GDPE	Expenditure GDP (Demand-side GDP)	GDPE = VC1+VC2+VC3+VC5+VC6+VE-VM
65	$\mathrm{HX4_i}$	Share in total exports	$\mathrm{HX4_i} = \frac{\mathrm{VX4_i}}{\mathrm{VE}}$
66	$\mathrm{HM_i}$	Share in total imports	$\mathrm{HM_i} = \frac{\mathrm{VZ02_i}}{\mathrm{VM}}$
67	$\mathrm{RX0_{i,j,1}}$	Share of intermediate demand in total demand for domestic goods	$\mathrm{RX0_{i,j,1}} = \mathrm{VDINPUT_{i,j}}/\mathrm{VZ01_i}$
68	$\mathrm{RX0_{i,j,2}}$	Share of intermediate demand in total demand for imported goods	$\mathrm{RX0_{i,j,2}} = \mathrm{VMINPUT_{i,j}}/\mathrm{VZ02_i}$
69	$\mathrm{RX1_{i,j,1}}$	Share of investment demand in total demand for domestic goods	$\mathrm{RX1_{i,j,1}} = \mathrm{VDX1_{i,j}}/\mathrm{VZ01_i}$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
70	$RX1_{i,j,2}$	Share of investment demand in total demand for imported goods	$RX1_{i,j,2} = VMX1_{i,j}/VZ02_i$
71	$RX2_{i,1}$	Share of household demand in total demand for domestic goods	$RX2_{i,1} = VDX2_i/VZ01_i$
72	$RX2_{i,2}$	Share of household demand in total demand for imported goods	$RX2_{i,2} = VMX2_i/VZ02_i$
73	$RX3_{i,1}$	Share of government demand in total demand for domestic goods	$RX3_{i,1} = VDX3_i/VZ01_i$
74	$RX3_{i,2}$	Share of government demand in total demand for imported goods	$RX3_{i,2} = VMX3_i/VZ02_i$
75	$RX4_i$	Share of export demand in total demand	$RX4_i = VX4_i/VZ01_i$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
76	$RX5_{i,1}$	Share of inventory demand in total demand for domestic goods	$RX5_{i,1} = VDX5_i/VZ01_i$
77	$RX5_{i,2}$	Share of inventory demand in total demand for imported goods	$RX5_{i,2} = VMX5_i/VZ02_i$
78	$RX6_i$	Share of special export demand in total demand for domestic goods	$RX6_i = VX6_i/VZ01_i$
79	$SHZCX1_{i,1}$	Domestic share of investment consumption in demand-side GDP	$SHZCX1_{i,1} = COLX1_{i,1}/VGDPE$
80	$SHZCX1_{i,2}$	Import share of investment consumption in demand-side GDP	$SHZCX1_{i,2} = COLX1_{i,2}/VGDPE$
81	$SHX2_{i,1}$	Domestic share of household consumption in demand-side GDP	$SHX2_{i,1} = VDX2_i/VGDPE$
82	$SHX2_{i,2}$	Import share of household consumption in demand-side GDP	$SHX2_{i,2} = VMX2_i/VGDPE$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
83	$SHX3_{i,1}$	Domestic share of government consumption in demand-side GDP	$SHX3_{i,1} = VDX3_i/VGDPE$
84	$SHX3_{i,2}$	Import share of government consumption in demand-side GDP	$SHX3_{i,2} = VMX3_i/VGDPE$
85	$SHX4_i$	Share of export in demand-side GDP	$SHX4_i = VX4_i/VGDPE$
86	$SHX5_{i,1}$	Domestic share of inventory in demand-side GDP	$SHX5_{i,1} = VDX5_i/VGDPE$
87	$SHX5_{i,2}$	Import share of inventory in demand-side GDP	$SHX5_{i,2} = VMX5_i/VGDPE$
88	$SHX6_i$	Share of special export in demand-side GDP	$SHX6_i = VX6_i/VGDPE$
89	$SHZ02_i$	Share of import in demand-side GDP	$SHZ02_i = VZ02_i/VGDPE$
90	T	Number of years covered by stimulation	$T = 10$ (10 years)
91	ORD_y	Years for y	$ORD_y = 1$ To T
92	DEP_j	Depreciation factors	$DEP_j = 0.95$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
93	R_T_j	Investment/Capital ratio	$R\_T_j = 0.08$ (Initial) $R\_T_j = R\_T_j \cdot (z1_j - k0_j)/100$ (Update) for Case 1 $R\_T_j = R\_T_j \cdot ([1 + IRG_j]\text{^}T \cdot z1_j - k0_j)/100$ (Update) for Case 2
94	IRG_j	Investment/capital ratio Growth	$IRG_j = 0$ (case 1) $IRG_j = 0.0094$ (scenario 1 for case 2) $IRG_{93} = 0.0097$, $IRG_{\text{rest sectors}} = 0.0094$ (scenario 2 for case 2)
95	Z_j	Capital stock ratio or K(T)/K(0) ratio	$Z_j = 1$ (Initial) $Z_j = k0_j$ (Update)
96	R_0_j	Y(0)/K(0) ratio	$R\_0_j = R\_T_j$
97	DEP_T_j	Depreciation factors (DEP) to the power of T	$DEP\_T_j = DEP_j\text{^}T$
98	N_term_j	Useful constant	$N\_term_j = \sum_{y=1}^{10} DEP_j\text{^}(T - ORD_y)$
99	M_term_j	Useful constant	$M\_term_j = \sum_{y=1}^{10} \left(\frac{ORD_y - 1}{T}\right) \cdot DEP_j\text{^}(T - ORD_y)$
100	K_term_j	delFudge coefficient	$K\_term_j = 100 \cdot \left(\frac{DEP\_T_j - 1 + R\_0_j \cdot N\_term_j}{Z_j}\right)$
101	$VCOM_i$	Total commodity demand	$VCOM_i = VZ01_i + VZ02_i$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
102	$SCX0_{i,j,1}$	Share of intermediate input in total demand for domestic goods	$\mathrm{SCX0_{i,j,1}} = \mathrm{VDINPUT_{i,j}}/\mathrm{VCOM}_i$
103	$SCX0_{i,j,2}$	Share of intermediate input in total demand for imported goods	$\mathrm{SCX0_{i,j,2}} = \mathrm{VMINPUT_{i,j}}/\mathrm{VCOM}_i$
104	$SCX1_{i,j,1}$	Share of investment consumption in total demand for domestic goods	$\mathrm{SCX1_{i,j,1}} = \mathrm{VDX1_{i,j}}/\mathrm{VCOM}_i$
105	$SCX1_{i,j,2}$	Share of investment consumption in total demand for imported goods	$\mathrm{SCX1_{i,j,2}} = \mathrm{VMX1_{i,j}}/\mathrm{VCOM}_i$
106	$SCX2_{i,1}$	Share of household consumption in total demand for domestic goods	$\mathrm{SCX2_{i,1}} = \mathrm{VDX2_i}/\mathrm{VCOM}_i$
107	$SCX2_{i,2}$	Share of household consumption in total demand for imported goods	$\mathrm{SCX2_{i,2}} = \mathrm{VMX2_i}/\mathrm{VCOM}_i$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
108	$SCX3_{i,1}$	Share of government consumption in total demand for domestic goods	$\mathrm{SCX3_{i,1}} = \mathrm{VDX3_i}/\mathrm{VCOM}_i$
109	$SCX3_{i,2}$	Share of government consumption in total demand for imported goods	$\mathrm{SCX3_{i,2}} = \mathrm{VMX3_i}/\mathrm{VCOM}_i$
110	$SCX4_i$	Share of export in total demand	$\mathrm{SCX4_i} = \mathrm{VX4_i}/\mathrm{VCOM}_i$
111	$SCX5_{i,1}$	Share of inventory in total demand for domestic goods	$\mathrm{SCX5_{i,1}} = \mathrm{VDX5_i}/\mathrm{VCOM}_i$
112	$SCX5_{i,2}$	Share of inventory in total demand for imported goods	$\mathrm{SCX5_{i,2}} = \mathrm{VMX5_i}/\mathrm{VCOM}_i$
113	$SCX6_i$	Share of special export in total demand	$\mathrm{SCX6_i} = \mathrm{VX6_i}/\mathrm{VCOM}_i$
114	$VFDD_i$	Final demand (domestic)	$\mathrm{VFDD_i} = \sum_{j=1}^{180} \mathrm{VDX1}_{i,j} + VDX2_i + VDX3_i + VX4_i + VDX5_i + VX6_i$
115	$VFDM_i$	Final demand (import)	$\mathrm{VFDM_i} = \sum_{j=1}^{180} \mathrm{VMX1}_{i,j} + VMX2_i + VMX3_i + VMX5_i$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
116	VFDT_i	Total oil final demand	$\mathrm{VFDT}_i = VFDD_i + VFDM_i$
117	$SFDX1_{i,j,1}$	Share of investment consumption in final demand for domestic goods	$\mathrm{SFDX1}_{\mathrm{i,j,1}} = \mathrm{VDX1}_{\mathrm{i,j}}/\mathrm{VFDT}_i$
118	$SFDX1_{i,j,2}$	Share of investment consumption in final demand for imported goods	$\mathrm{SFDX1}_{\mathrm{i,j,2}} = \mathrm{VMX1}_{\mathrm{i,j}}/\mathrm{VFDT}_i$
119	$SFDX2_{i,1}$	Share of household consumption in final demand for domestic goods	$\mathrm{SFDX2}_{\mathrm{i,1}} = \mathrm{VDX2}_{\mathrm{i}}/\mathrm{VFDT}_i$
120	$SFDX2_{i,2}$	Share of household consumption in final demand for imported goods	$\mathrm{SFDX2}_{\mathrm{i,2}} = \mathrm{VMX2}_{\mathrm{i}}/\mathrm{VFDT}_i$
121	$SFDX3_{i,1}$	Share of government consumption in final demand for domestic goods	$\mathrm{SFDX3}_{\mathrm{i,1}} = \mathrm{VDX3}_{\mathrm{i}}/\mathrm{VFDT}_i$
122	$SFDX3_{i,2}$	Share of government consumption in final demand for imported goods	$\mathrm{SFDX3}_{\mathrm{i,2}} = \mathrm{VMX3}_{\mathrm{i}}/\mathrm{VFDT}_i$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
123	$SFDX4_i$	Share of export in final demand for domestic goods	$\mathrm{SFDX4_i} = \mathrm{VX4_i}/\mathrm{VFDT}_i$
124	$SFDX5_{i,1}$	Share of inventory in final demand for domestic goods	$\mathrm{SFDX5_{i,1}} = \mathrm{VDX5_i}/\mathrm{VFDT}_i$
125	$SFDX5_{i,2}$	Share of inventory consumption in final demand for imported goods	$\mathrm{SFDX5_{i,2}} = \mathrm{VMX5_i}/\mathrm{VFDT}_i$
126	$SFDX6_i$	Share of special export in final demand for domestic goods	$\mathrm{SFDX6_i} = \mathrm{VX6_i}/\mathrm{VFDT}_i$
127	VIND_i	Domestic intermediate demand	$\mathrm{VIND}_i = VZ01_i - VFDD_i$
128	VINM_i	Import intermediate demand	$\mathrm{VINM}_i = VZ02_i - VFDM_i$
129	VINT_i	Total intermediate demand	$\mathrm{VINT}_i = \mathrm{VIND}_i + \mathrm{VINM}_i$
130	$SINX0_{i,j,1}$	Share of intermediate input in total intermediate demand for domestic goods	$\mathrm{SINX0_{i,j,1}} = \mathrm{VDINPUT_{i,j}}/\mathrm{VINT}_i$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
131	$SINX0_{i,j,2}$	Share of intermediate input in total intermediate demand for imported goods	$\mathrm{SINX0_{i,j,2}} = \mathrm{VMINPUT_{i,j}}/\mathrm{VINT}_i$
132	$\mathrm{VCOM\_nx}_i$	Total commodity demand excluding export and special export	$\mathrm{VCOM\_nx}_i = VZ01_i + VZ02_i - VX4_i - VX6_i$
133	$SCX0\_nx_{i,j,1}$	Share of intermediate input in total demand for domestic goods excluding export and special export	$\mathrm{SCX0\_nx_{i,j,1}} = \mathrm{VDINPUT_{i,j}}/\mathrm{VCOM\_nx}_i$
134	$SCX0\_nx_{i,j,2}$	Share of intermediate input in total demand for imported goods excluding export and special export	$\mathrm{SCX0\_nx_{i,j,2}} = \mathrm{VMINPUT_{i,j}}/\mathrm{VCOM\_nx}_i$
135	$SCX1\_nx_{i,j,1}$	Share of investment consumption in total demand for domestic goods excluding export and special export	$\mathrm{SCX1\_nx_{i,j,1}} = \mathrm{VDX1_{i,j}}/\mathrm{VCOM\_nx}_i$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
136	$SCX1\_nx_{i,j,2}$	Share of investment consumption in total demand for imported goods excluding export and special export	$\mathrm{SCX1\_nx_{i,j,2}} = \mathrm{VMX1_{i,j}/VCOM\_nx_i}$
137	$SCX2\_nx_{i,1}$	Share of household consumption in total demand for domestic goods excluding export and special export	$\mathrm{SCX2\_nx_{i,1}} = \mathrm{VDX2_i/VCOM\_nx_i}$
138	$SCX2\_nx_{i,2}$	Share of household consumption in total demand for imported goods excluding export and special export	$\mathrm{SCX2\_nx_{i,2}} = \mathrm{VMX2_i/VCOM\_nx_i}$
139	$SCX3\_nx_{i,1}$	Share of government consumption in total demand for domestic goods excluding export and special export	$\mathrm{SCX3\_nx_{i,1}} = \mathrm{VDX3_i/VCOM\_nx_i}$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
140	$SCX3_{i,2}$	Share of government consumption in total demand for imported goods excluding export and special export	$\text{SCX3\_nx}_{i,2} = \text{VMX3}_i/\text{VCOM\_nx}_i$
141	$SCX5\_nx_{i,1}$	Share of inventory in total demand for domestic goods excluding export and special export	$\text{SCX5\_nx}_{i,1} = \text{VDX5}_i/\text{VCOM\_nx}_i$
142	$SCX5\_nx_{i,2}$	Share of inventory in total demand for imported goods excluding export and special export	$\text{SCX5\_nx}_{i,2} = \text{VMX5}_i/\text{VCOM\_nx}_i$
143	$VFDD\_nx_i$	Final demand (domestic) excluding export and special export	$\text{VFDD\_nx}_i = \sum_{j=1}^{180} \text{VDX1}_{i,j} + VDX2_i + VDX3_i + VDX5_i$
144	$VFDM\_nx_i$	Final demand (import) excluding export and special export	$\text{VFDM\_nx}_i = \sum_{j=1}^{180} \text{VMX1}_{i,j} + VMX2_i + VMX3_i + VMX5_i$
145	VFDT_nx_i	Total oil final demand excluding export and special export	$\text{VFDT\_nx}_i = VFDD\_nx_i + VFDM\_nx_i$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
146	$SFDX1\_nx_{i,j,1}$	Share of investment consumption in final demand for domestic goods excluding export and special export	$\mathrm{SFDX1\_nx_{i,j,1}} = \mathrm{VDX1_{i,j}/VFDT\_nx_i}$
147	$SFDX1\_nx_{i,j,2}$	Share of investment consumption in final demand for imported goods excluding export and special export	$\mathrm{SFDX1\_nx_{i,j,2}} = \mathrm{VMX1_{i,j}/VFDT\_nx_i}$
148	$SFDX2\_nx_{i,1}$	Share of household consumption in final demand for domestic goods excluding export and special export	$\mathrm{SFDX2\_nx_{i,1}} = \mathrm{VDX2_i/VFDT\_nx_i}$
149	$SFDX2\_nx_{i,2}$	Share of household consumption in final demand for imported goods excluding export and special export	$\mathrm{SFDX2\_nx_{i,2}} = \mathrm{VMX2_i/VFDT\_nx_i}$

Table 3.4 (Continued)

No.	Coefficients	Description	Formula
150	$SFDX3\_nx_{i,1}$	Share of government consumption in final demand for domestic goods excluding export and special export	$\mathrm{SFDX3\_nx_{i,1}} = \mathrm{VDX3_i/VFDT\_nx_i}$
151	$SFDX3\_nx_{i,2}$	Share of government consumption in final demand for imported goods excluding export and special export	$\mathrm{SFDX3\_nx_{i,2}} = \mathrm{VMX3_i/VFDT\_nx_i}$
152	$SFDX5\_nx_{i,1}$	Share of inventory in final demand for domestic goods excluding export and special export	$\mathrm{SFDX5\_nx_{i,1}} = \mathrm{VDX5_i/VFDT\_nx_i}$
153	$SFDX5\_nx_{i,2}$	Share of inventory consumption in final demand for imported goods excluding export and special export	$\mathrm{SFDX5\_nx_{i,2}} = \mathrm{VMX5_i/VFDT\_nx_i}$

3.4 CGE Model Implementation

The forecasting CGE model was executed by GEMPACK (Harrison et al., 2011). The theory for the forecasting CGE model was transformed into programming instruction in GEMPACK "Tablo" format for completing checking for errors. Instructions were organized in sequence, including the specification of sets and subsets, variable names with a counting index, data reading and computation, the calculation of parameters, coefficients, shares, and the specification of equations. The model was compiled and linked by "Fortran" and transformed into executable form. Simulation of the model was carried out using an executable image by a GEMPACK command instruction file, which specified the set of exogenous variables and execution shock value.

The simulation of economic changes is illustrated in the figure below. Capital accumulation was determined by the assumption for the value of investment-capital ratio (R_Ti). The simulation starts with a shock value of 1 for the variable delFudge. The increase in the capital supply (x02j) drives economic change across the economy. The change in oil consumption is the result of economic change.

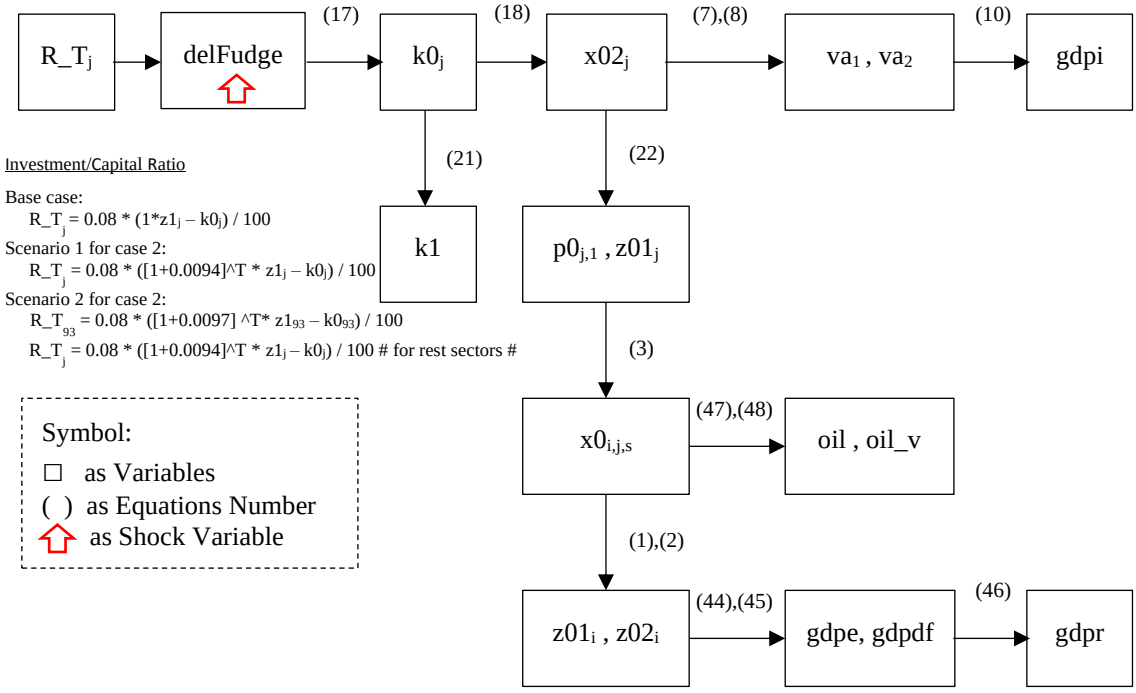

Figure 3.5 Relationship of Variables for the Model Simulation

CHAPTER 4

RESULTS

4.1 The Rationale for Transparency and Economic Growth

Transparency is related to investment through the capital accumulation that affects the growth of the economy. Capital accumulation has human capital and social capital as a supporting factor that the relationship between both capitals, as shown in Figure 4.1. The definitions of the terms are as follows. Wages or income from labor is the compensation for the worker. Profits or the income of capital is the return to the entrepreneur that requires a new investment. Human capital or quality of labor is the competency that consists of knowledge, skill, and integrity (attribute or "Punya" in the Sanskrit language). However, the elevating competence of labor results in wages being increased accordingly. Social capital or the quality of the collective group is trust and honesty, comprising trustworthiness and integrity, governance and transparency and cooperation. Consequently, increasing trust and honesty result in the transaction costs being reduced, and profits or savings being increased accordingly. Savings are the return to the entrepreneur that chooses to collect an additional investment/capital ratio.

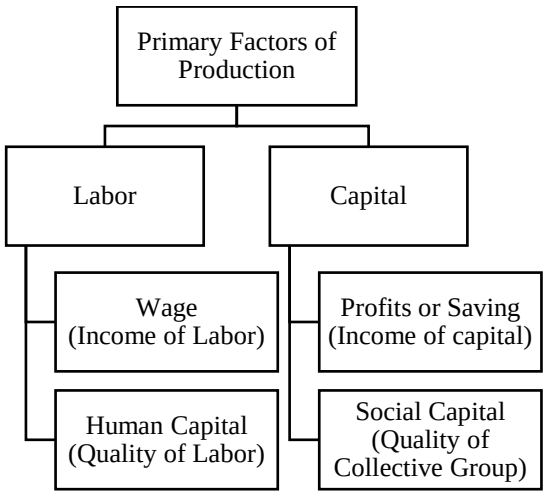

Figure 4.1 Relation between Both Human Capital and Social Capital

Social capital is comprised of trust and transparency. For countries that are rich in social capital, their price of social capital and transaction costs will be low. On the other hand, for countries that are poor in social capital, their price of social capital will be high. Individuals create the cost of social capital, which is the cost of tolerance of corruption. The countries that are very corrupt will result in the cost of tolerance of corruption being high, and therefore the price of social capital in that society and the transaction costs will be high accordingly. On the other hand, the transparent countries and low transaction costs will create a high return for social capital. Moreover, getting a return also encourages the entrepreneur to invest in social capital increasingly. The return sometimes may be not monetary but it will be a reward or an honor instead. On the other hand, using trust between together to fraud will be dangerous to gullible society that causes more deterioration of social capital. Investment builds trust to indemnify the deterioration of social capital takes a long time but trust destroying takes only a short time.

Natural capital is the natural resources and environmental quality that are not man-made capital. As with other capitals, for the countries with abundant natural resources and environmental quality, their price of natural capital and inexpensive inputs will be low. The cost of natural capital is a natural base asset of each country (they have no market price but have a shadow price). The countries that pollute a lot will have a greater impact on the conservation costs, and therefore the price of natural capital will rise in order to exploit the return on natural capital. The exploitation from natural resources causes natural capital to deteriorate. The investment for conserving natural resources, which are a common good, is not the state's responsibility but is the responsibility of all parties. If there is no cooperation, it is likely that the future price of natural capital will increase due to the limited resources and the occurrence of the tragedy of the commons.

The countries that are rich in social capital, transparent, and that have low transaction costs are the channel to social capital, which enable economic growth to occur. Social capital explicitly supports all stock of capitals beyond the contribution of physical capital, human capital, and natural capital. Furthermore, social capital accelerates all types of capital accumulation, and creates tolerance, immunity, and morality as per the cultural and social context, such as the merit system, and law and

administration of justice system, which produce honesty and trust. The transparency index is a proxy of social capital for measuring social capital. The Corruption Perceptions Index (CPI) represents the transparency index pertaining to fraud regarding procurement and bribery. For the countries that are very transparent, their transaction costs are more reduced. Almost zero transaction costs will generate further business savings and investment. Additionally, the enhancement of the procurement process such as the Integrity Pact can also increase the efficiency of procurement, including the CPI score as well.

Empirical evidence on the correlation between investment and the CPI reveals that investment creates a downward trend in corruption. The investment data use the Gross Fixed Capital Formation (GFCF) and a percentage of the gross domestic product (GDP) for the Private Sector published by World Development. The corruption data used the CPI score and the CPI rank published by Transparency International in 2007 to 2015. The analysis results show that investment is significantly correlated with the CPI score. Furthermore, investment is also highly correlated with corruption, especially in countries having less score than a 40-point average score, as shown in Table 4.1 to 4.2. In conclusion, a very transparent country will have high investment.

Table 4.1 Correlations among GFCF, the CPI Score, and the CPI Rank (all countries)

		GFCF	CPI's Score	CPI's Rank
GFCF	Sig. (2-tailed)	1	.190**	-.233**
	Pearson Correlation		.000	.000
	N	867	787	787
CPI's Score	Sig. (2-tailed)		1	-.941**
	Pearson Correlation			.000
	N		1562	1562
CPI's Rank	Sig. (2-tailed)			1
	Pearson Correlation			
	N			1562

Remark: ** Correlation is significant at the 0.01 level (2-tailed).

Notes: The Gross fixed capital formation, private sector (% of GDP) and CPI score and rank ranged from 2007 to 2015 and included 217 observations.

Source: Calculated from World Development Indicators, 2017; Transparency International, 2017.

Table 4.2 Correlation among GFCF, the CPI Score, and the CPI Rank (Especially Countries with Less Than Average Score (40 Points))

		GFCF	CPI's Score	CPI's Rank
GFCF	Sig. (2-tailed)	1	.249**	-.241**
	Pearson Correlation		.000	.000
	N	611	611	611
CPI's Score	Sig. (2-tailed)		1	-.953**
	Pearson Correlation			.000
	N		958	958
CPI's Rank	Sig. (2-tailed)			1
	Pearson Correlation			
	N			958

Remark: ** Correlation is significant at the 0.01 level (2-tailed).

Notes: The Gross fixed capital formation, private sector (% of GDP) and CPI's score and rank ranged from 2007 to 2015 and includes 217 observations.

Source: Calculated from World Development Indicators, 2017; Transparency International, 2017.

Furthermore, the correlation between the Private Investment Index and Thailand's CPI score, and the correlation of the Gross Domestic Product (GDP) and the Private Investment Index, have changed in the same direction, as shown in Table 4.3 and Figures 4.2 to 4.3. The mentioned relationships indicated that the CPI score and the GDP are significantly correlated with the Private Investment Index, as shown in Table 4.4.

Table 4.3 Thailand's CPI Score, the Private Investment Index, and GDP

Year	CPI Score/1	Private Investment Index/2	GDP/3
1995	28	-	4,217,612
1996	34	-	4,638,607
1997	31	-	4,710,309
1998	30	-	4,701,553
1999	32	-	4,789,827
2000	32	100.00	5,069,821
2001	32	108.26	5,345,004
2002	32	118.79	5,769,577
2003	33	133.17	6,317,303
2004	36	155.86	6,954,281
2005	38	172.22	7,614,413
2006	36	175.11	8,400,647
2007	33	175.59	9,076,303
2008	35	183.75	9,706,929
2009	34	161.10	9,658,664
2010	35	193.36	10,808,142
2011	34	208.92	11,306,907
2012	37	240.55	12,357,403
2013	35	239.62	12,921,155
2014	38	230.43	13,203,737
2015	38	-	13,672,851
2016	35	-	-

Remark: CPI's score has been changed from base 10 to 100 in 2012

Source: /1 CPI 1995 - 2016 adapted from Transparency International, 2017.

/2 Private Investment Index calculated from Private Investment Index and Elements seasonally adjusted, 3 month moving average (base year 2000) to year average, Bank of Thailand, 2017.

/3 GDP 2016 (at current price) (unit: million bath), NESDC, 2019.

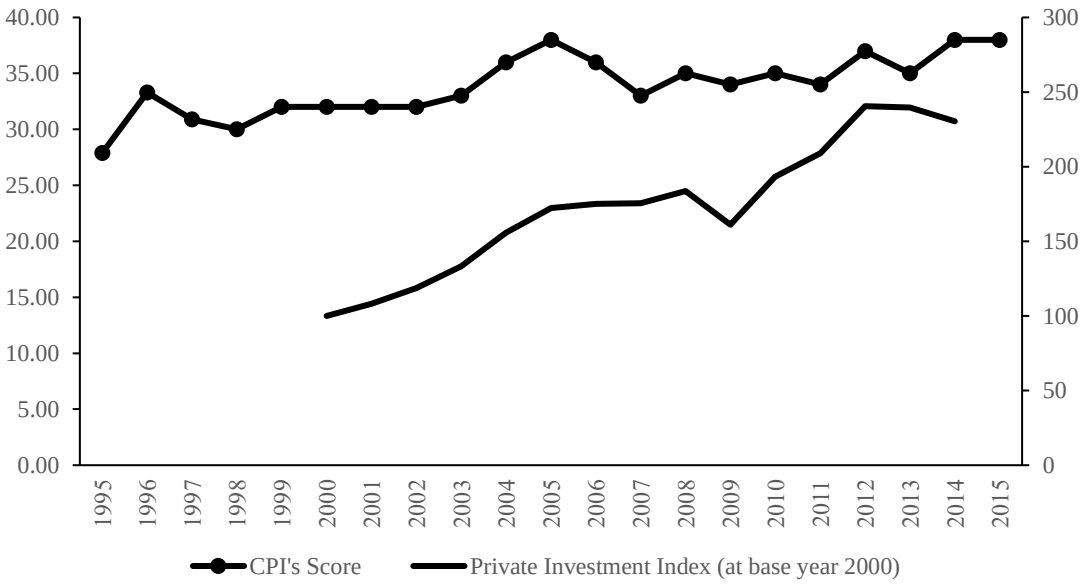

Figure 4.2 Trend Line of Private Investment Index and Corruption Perceptions Index (CPI)

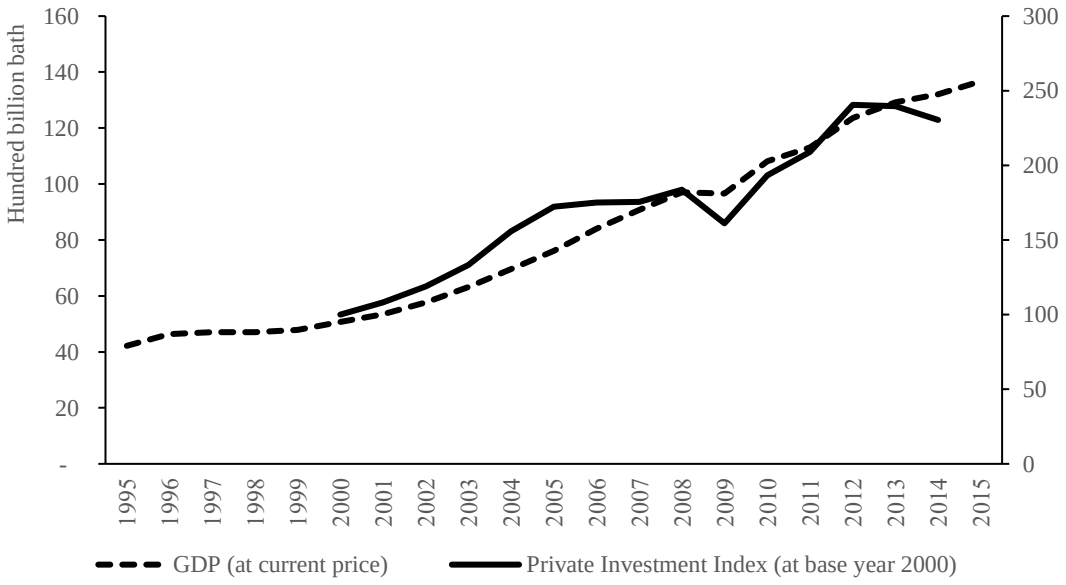

Figure 4.3 Trend Line of GDP and Private Investment Index

Table 4.4 Correlation among CPI Score, Private Investment Index and GDP

		CPI's Score	Private Investment Index	GDP
CPI's Score	Sig. (2-tailed)	1	.704**	.762**
	Pearson Correlation		.003	.000
	N	22	15	21
Private Investment Index	Sig. (2-tailed)		1	.967**
	Pearson Correlation			.000
	N		15	15
GDP	Sig. (2-tailed)			1
	Pearson Correlation			
	N			21

Remark: ** Correlation is significant at the 0.01 level (2-tailed).

Figure 4.4 explains the rationale between transparency and growth. Social capital is trust. Transparency and low transaction costs create rich capital, which means that the growth of the CPI score represents the growth of investment. Capital accumulation depends on the investment ratio growth. Capital costs have been cheaper with low transaction costs. A rising CPI score affects transaction costs and capital costs and causes them to be reduced, and also drives capital stock to be increased according to the investment. Due to the increase in the current return of capital resulting from additional investment, this causes the capital stock and commodity prices to be affected.

Likewise, low transaction costs invite the entrepreneur to invest money to replace the depreciating capital, and to accumulate new additional capital, and this action brings about efficient investment. Moreover, the investment ratio growth per capital is also enhanced.

Additionally, changes in the intermediate input, final demand, and exports cause changes in the economic system. The growth of the output and real GDP is generated by the increase in domestic consumption and exports. In addition, a change in the petroleum sector reflects resources and environmental usage by measuring the carbon dioxide emissions.

The CGE model is used to forecast two economic change trajectories: one is the economic change produced by the assumed rate of the accumulation of capital; the other is economic change produced by the assumed rate of the accumulation of capital plus the accumulation of social capital quantified by the Corruption Perception Index. Scenario 2 for case 2 was applied to the petroleum sector because there were corruption risks in the value chain of this sector, for example regarding survey and exploration, production, and concessionaire selection. Corruption prevention with the Integrity Pact enhances the transparent procurement process which creates rich trust, smooth flow of business transactions, and low costs of doing business. As mentioned above, this is the saving or efficient finance spending.

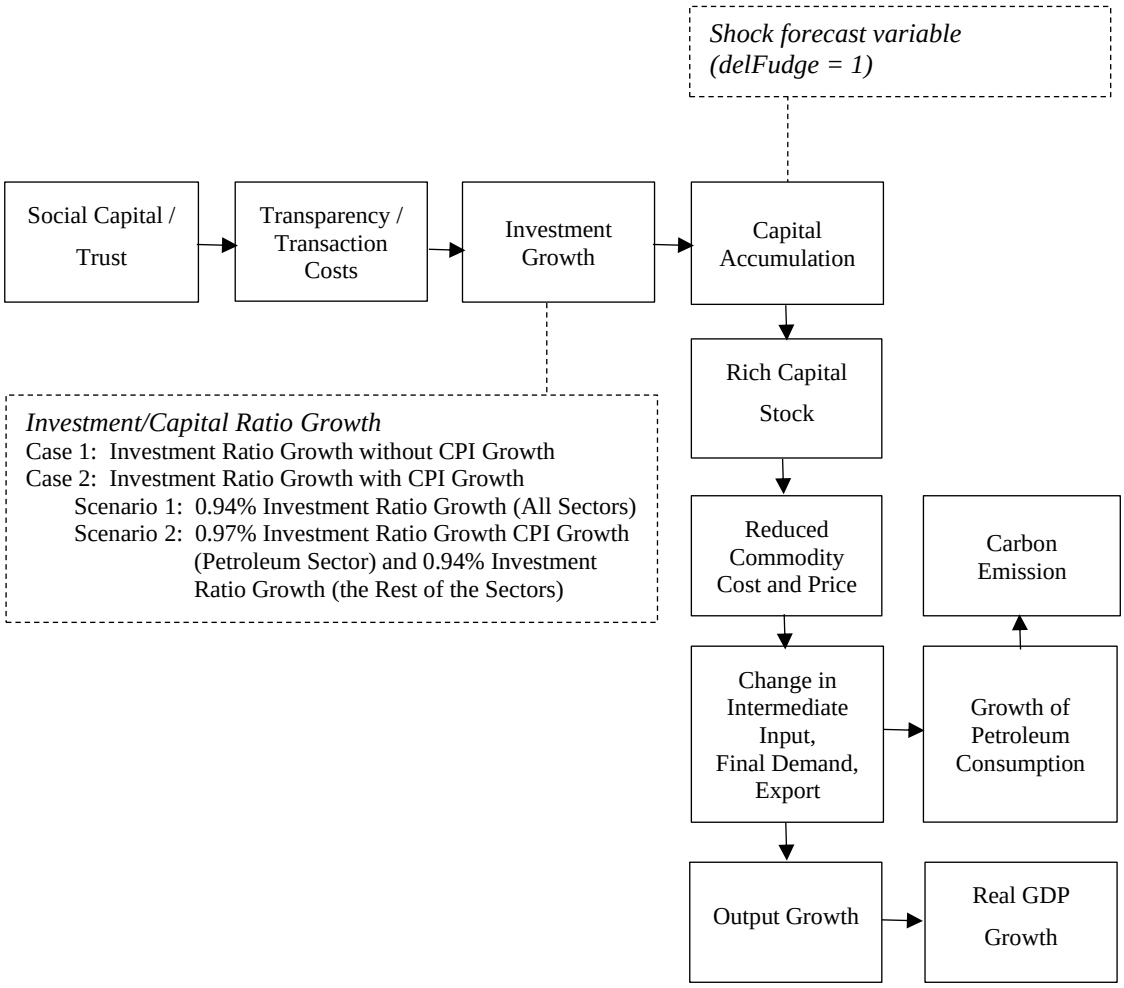

Figure 4.4 Rationale for Transparency and Economic Growth

The projection of economic impacts of changes in Thailand's transparency and associated changes in CO_2 emissions is stimulated by applying the investment ratio growth represented by the growth rate of CPI score in the CGE model. For this study, the projection comprises two cases. Case 1 (base case) does not to apply the growth of CPI score where the investment rate is fixed at 8 percent. Case 2 does apply the investment ratio growth to the growth of the CPI score to compare both test scenarios. In scenario 1 for case 2 the investment rate is specified to be at 8 percent and the investment ratio growth to be at 0.94 percent per year by applying it to all sectors. In scenario 2 for case 2 the investment rate is specified to be at 8 percent and the investment ratio growth to be at 0.97 percent per year by applying it to the petroleum sector, and the investment ratio growth to be at 0.94 percent per year by applying it to the rest of the sectors.

In scenario 1 for case 2, the original growth of the CPI score represents the growth of investment as the increase in transparency and the reduction in transaction costs lead to trust in investment. In scenario 2 for case 2, a rise in the percentage of the efficiency of spending budget by using the Integrity Pact makes the trend of growth of the CPI score change, a representation of the growth of investment. The percentage of the budget saved by the Integrity Pact increases the score of the EIU's data (transparency and audit of spending budget of government issue) where new growth in the CPI score can be computed, as shown in Table 4.5.

The data preparation for Table 4.5 and Figure 4.5 shows the investment ratio growth for simulating the economic impacts with the CGE model, comprising 2 cases. In case 1, the investment ratio is fixed at 8 percent per year. In scenario 1 for case 2, the investment ratio is equivalent to 8.87 percent by the 10^{th} year and 9.65 percent by the 20^{th} year. In scenario 2 for case 2, the investment ratio is equivalent to 8.81 percent by the 10^{th} year and 9.70 percent by the 20^{th} year.

The assumption of the projection specifies the investment rate as of its 1^{st} year to be equivalent to 8 percent, a 5 percent depreciation, and the change in the balance of the trade-GDP ratio, including export demand, to be fixed.

Table 4.5 Investment/Capital Ratio Growth with CPI growth

Year	Case 1	Case 2	
		Scenario 1	Scenario 2
0	0.08	0.0800	0.0800
1	0.08	0.0808	0.0808
2	0.08	0.0815	0.0816
3	0.08	0.0823	0.0823
4	0.08	0.0831	0.0831
5	0.08	0.0838	0.0839
6	0.08	0.0846	0.0848
7	0.08	0.0854	0.0856
8	0.08	0.0862	0.0864
9	0.08	0.0870	0.0872
10	0.08	0.0878	0.0881
11	0.08	0.0887	0.0889
12	0.08	0.0895	0.0898
13	0.08	0.0904	0.0907
14	0.08	0.0912	0.0915
15	0.08	0.0921	0.0924
16	0.08	0.0929	0.0933
17	0.08	0.0938	0.0942
18	0.08	0.0947	0.0951
19	0.08	0.0956	0.0960
20	0.08	0.0965	0.0970
21	0.08	0.0974	0.0979
22	0.08	0.0983	0.0989
23	0.08	0.0992	0.0998
24	0.08	0.1001	0.1008
25	0.08	0.1011	0.1017
26	0.08	0.1020	0.1027
27	0.08	0.1030	0.1037
28	0.08	0.1040	0.1047
29	0.08	0.1049	0.1057
30	0.08	0.1059	0.1068

Source: Calculated.

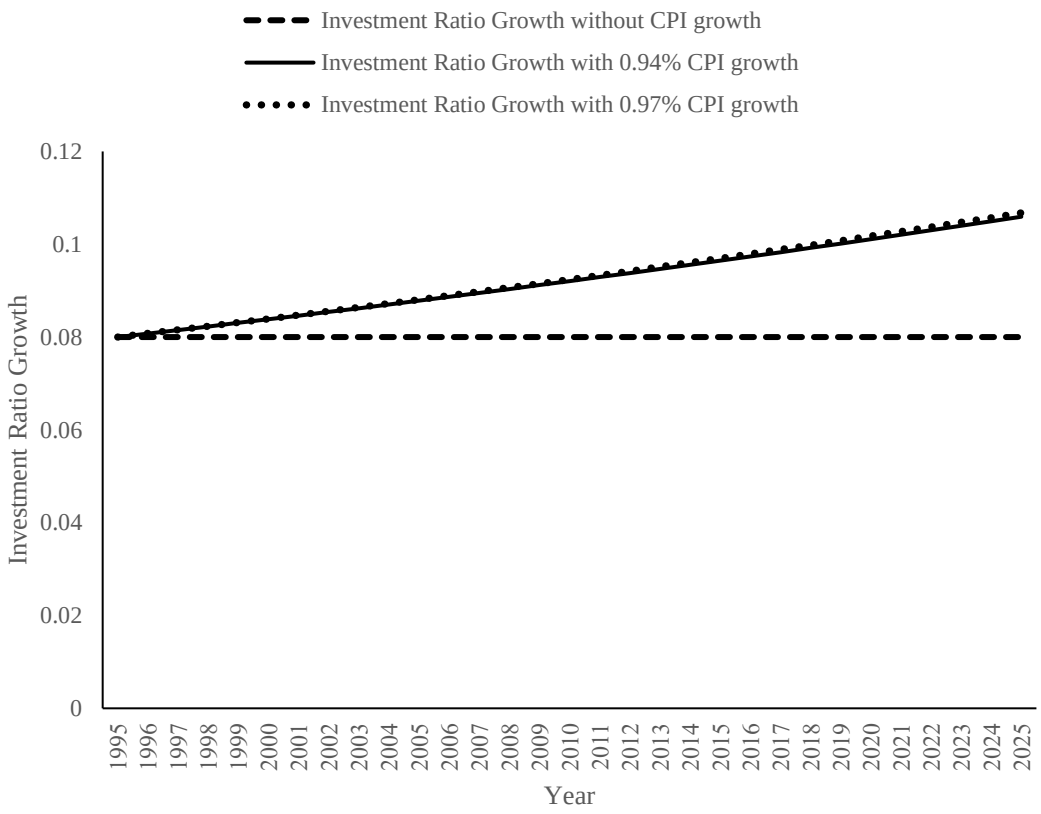

Figure 4.5 Investment Ratio Growth with CPI Growth in 2 Cases

4.2 Macroeconomic Results

The results of the 30-year CGE model projection revealed the factors driving the growth of real GDP in both scenarios. According to Table 4.6, case 1 is the investment ratio growth without CPI growth (base case), where the growth of real GDP has been changed to 33.778 percent by the 30th year. In scenario 1 for case 2 is the investment ratio growth with a 0.94 percent CPI growth, where the growth of real GDP has been changed to 58.628 percent by the 30th year. In scenario 2 for case 2 is the investment ratio growth in the petroleum sector with a 0.97 percent CPI growth, where the growth of real GDP has been changed to 58.636 percent by the 30th year. Therefore, the growth of real GDP is driven by the CPI growth via the investment ratio growth that produces a proficiency in the capital accumulation. Furthermore, from the comparison of the growth of real GDP in both scenarios, case 2 shows that the growth of real GDP in scenario 2 is higher than scenario 1, which results from the transparency test with

anti-corruption mechanism, especially the Integrity Pact Program in the petroleum sector.

According to Table 4.7, in case 1, the investment ratio growth without CPI growth (base case), the implementation by applying an 8 percent investment rate per year makes the growth index of real GDP reach 239.42 percent in 30th year. In scenario 1 for case 2, the investment ratio growth with CPI growth, the implementation by applying a 0.94 percent CPI growth per year makes the growth index of real GDP reach 308.24 percent in 30th year. In scenario 2 for case 2, the investment ratio growth with CPI growth, the implementation by applying a 0.97 percent CPI growth per year in the petroleum sector (s093), makes the growth index of real GDP reach 308.26 percent in 30th year. The result of the projection shows that the economic growth has been changed by the CPI growth. Moreover, in order to use the mechanism for increasing the CPI score such as the Integrity Pact in scenario 2 for case 2 makes the economic growth change more.

Likewise, the growth index of real GDP in case 1 reaches 239.42 percent in the 30th year. In scenario 1 for case 2, the growth index of real GDP reaches 308.24 percent in the 30th year. Due to the consideration of social capital accumulation, its model therefore is specified to apply to the original trend of the CPI score. Similarly, in scenario 2 for case 2, the growth index of real GDP reaches 308.26 percent in the 30th year as its model is specified to apply to the new trend of the CPI score, including the effect on the Integrity Pact Program in the petroleum sector, as shown in Table 4.7 and Figure 4.6.

Table 4.6 Percentage Change of the Macro Variables for 2 Cases

Variable	Description	Case 1 (Base Case)	Case 2					
			Scenario 1: Investment Ratio Growth with 0.94% CPI Growth			Scenario 2: Investment Ratio Growth with 0.97% CPI Growth in Petroleum Sector		
		10^{th}, 20^{th}, 30^{th} Year	10^{th} Year	20^{th} Year	30^{th} Year	10^{th} Year	20^{th} Year	30^{th} Year
c1	Total investment expenditure	42.16991	42.46835	56.67401	74.67429	42.46845	56.68337	74.69123
c1r	Real total investment expenditure	30.16945	30.38991	40.03042	51.93484	30.38995	40.03391	51.94141
c2	Total household expenditure	42.16991	42.46835	56.67401	74.67429	42.46845	56.68337	74.69123
c2r	Real total household expenditure	31.50988	31.73701	41.85706	54.38613	31.73705	41.86113	54.3937
c3	Total government expenditure	42.16991	42.46835	56.67401	74.67429	42.46845	56.68337	74.69123
c3r	Real total government expenditure	32.13607	32.36795	42.71789	55.54798	32.368	42.72209	55.5558
cpi1	Investment price index	9.21911	9.26333	11.88573	14.96676	9.26339	11.88964	14.97295
cpi2	Consumer price index	8.10588	8.14604	10.44503	13.14136	8.14609	10.44845	13.14679
cpi3	Government price index	7.59356	7.63055	9.77886	12.29626	7.63059	9.78218	12.30206
delBT	Trade balance (change)	-294082240	-296260544	-402211552	-540799104	-296261632	-402285696	-540939072
delDT	Debt_GDP Ratio (change)	0	0	0	0	0	0	0
delFudge	Forecast variable (change)	1	1	1	1	1	1	1
e	Total export value	29.19431	29.39133	38.58284	49.85663	29.3914	38.58904	49.86724
gdpdf	GDP deflator	6.27312	6.3018	8.061	10.1153	6.30183	8.06396	10.11999
gdpe	Expenditure side GDP	42.16991	42.46835	56.67401	74.67429	42.46845	56.68337	74.69123
gdpi	Income side GDP	42.16991	42.46836	56.67401	74.67428	42.46847	56.6834	74.69125
gdpr	Real GDP	33.7778	34.02258	44.98655	58.6275	34.02262	44.99118	58.63611
k1	Average capital stock	35.21482	35.47174	46.98174	61.34797	35.47179	46.98615	61.3563
m	Total import value	30.45402	30.66089	40.33919	52.26599	30.66096	40.34568	52.2772
r1	Average rate of return	-4.88114	-4.90622	-6.17368	-7.59951	-4.90623	-6.17459	-7.60094
va1	Total labor value added	42.06753	42.36538	56.52993	74.47407	42.36549	56.53943	74.49126
va2	Total capital value added	42.10355	42.40232	56.58468	74.55442	42.40243	56.59369	74.57073
va3	Total indirect taxes value added	43.09722	43.39568	57.9478	76.41122	43.39582	57.95982	76.43231
xr	Exchange Rate	11.82353	11.88408	15.281	19.28652	11.88414	15.28516	19.29323

Table 4.6 (Continued)

Variable	Description	Case 1 (Base Case)	Case 2					
			Scenario 1: Investment Ratio Growth with 0.94% CPI Growth			Scenario 2: Investment Ratio Growth with 0.97% CPI Growth in Petroleum Sector		
		10^{th}, 20^{th}, 30^{th} Year	10^{th} Year	20^{th} Year	30^{th} Year	10^{th} Year	20^{th} Year	30^{th} Year
oil	Oil consumption (Quantity)	28.68201	28.87886	37.99915	49.25406	28.87913	38.02301	49.292
oil_fd	Oil consumption in Final Demand (Quantity)	21.11362	21.24365	27.67081	35.46893	21.24422	27.72262	35.5491
oil_fd_nx	Oil consumption in Final Demand no export (Quantity)	28.82436	29.03069	38.16904	49.41707	29.03083	38.18237	49.43936
oil_fdv	Oil consumption in Final Demand (Value)	34.18466	34.39893	45.50062	59.36947	34.39949	45.55161	59.45108
oil_fdv_nx	Oil consumption in Final Demand no export (Value)	42.76836	43.07182	57.52014	75.85201	43.0719	57.52708	75.86494
oil_int	Oil consumption in intermediate (Quantity)	33.47111	33.71025	44.53432	57.97607	33.7103	44.5405	57.98724
oil_intv	Oil consumption in intermediate (Value)	47.94401	48.28665	64.81274	85.97405	48.28666	64.81142	85.97366
oil_nx	Oil consumption no export (Quantity)	32.35176	32.583	43.00104	55.91436	32.58308	43.00893	55.92823
oil_v	Oil consumption (Value)	42.61087	42.90374	57.32734	75.66208	42.90397	57.3463	75.69347
oil_v_nx	Oil consumption no export (Value)	46.69718	47.03038	63.05593	83.53559	47.0304	63.0566	83.53843

Table 4.7 Thirty-year Percentage Change of Real GDP Growth for 2 Cases

Year	Case 1	Case 2	
		Scenario 1	Scenario 2
0	100.00	100.00	100.00
1	102.95	102.97	102.97
2	105.99	106.03	106.03
3	109.12	109.18	109.18
4	112.34	112.43	112.43
5	115.66	115.77	115.77
6	119.08	119.21	119.21
7	122.59	122.75	122.75
8	126.21	126.40	126.40
9	129.94	130.15	130.15
10	133.78	134.02	134.02
11	137.73	139.09	139.10
12	141.79	144.36	144.36
13	145.98	149.82	149.82
14	150.29	155.49	155.49
15	154.73	161.38	161.38
16	159.30	167.48	167.49
17	164.00	173.82	173.83
18	168.85	180.40	180.41
19	173.83	187.23	187.23
20	178.96	194.31	194.32
21	184.25	203.49	203.50
22	189.69	213.10	213.11
23	195.29	223.16	223.17
24	201.06	233.70	233.71
25	207.00	244.73	244.75
26	213.11	256.29	256.31
27	219.40	268.39	268.41
28	225.88	281.07	281.09
29	232.55	294.34	294.36
30	239.42	308.24	308.26

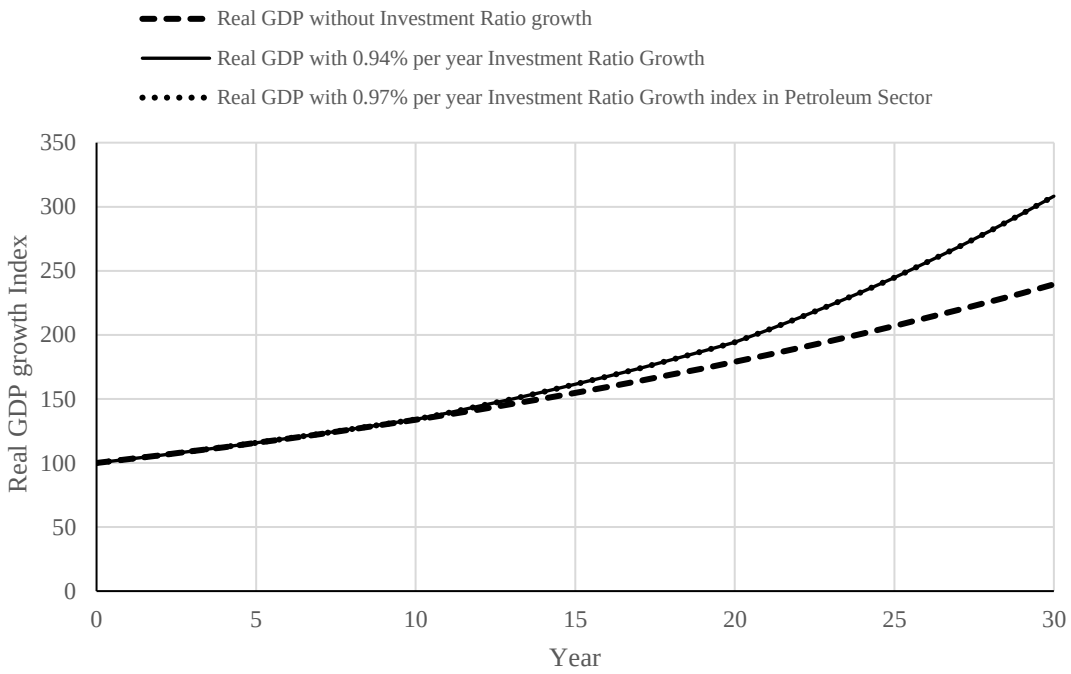

Figure 4.6 Thirty-year Real GDP Growth Index for 2 Cases

Both the investment ratio growth without CPI growth and the investment ratio growth with CPI growth have had apparently different economic growth in the past 15 to 30 years. In case 2, the transparency accumulation increases the social capital and builds confidence that leads to further investment and economic growth. The social capital is a sufficient condition for economic growth, which is a catalyst for capital accumulation.

Additionally, in order to create transparency by implementing mechanisms or measures resulting in the CPI score being increased, such as the Integrity Pact, the said process results in the score of the EIU's data (transparency and audit in government spending issue) to be increased and the trend of the CPI score to be changed. In conclusion, the result of capital accumulation will make the economy grow.

Social capital accumulation is a mechanism where new investment is reduced at the future rate of return of capital according to the capital accumulation function (Dixon et al., 1982, p. 118-122), r1, and there is negative growth, as shown in Table 4.6, as the investment/capital ratio is increased, which this leads to an increase in future capital. Increasing in future capital with a constant current rate of return, that is

enhanced transparency, collective trust, and social capital opposite to corruption, misgovernance and patronage culture.

The low transaction costs or budget savings will increase social capital, which will result in goods and service prices being reduced and which will also stimulate investment consumption, consumers' expenditure, and cause the government's expenditure (final demand) to be increased. The growth of an export results from the depreciation of the Thai Baht currency. The growth of real GDP arises according to the value added growth (output growth).

In addition, the total indirect taxes value added have become higher than total labor value added, and total capital value added. The changes in the 30-year period of total indirect taxes value added in case 1, scenario 1 for case 2, and scenario 2 for case 2 are 43.097 percent, 76.411 percent, and 76.432 percent respectively.

Case 2 is the relationship between transparency and growth applied to the forecasting CGE model via the investment transmission channel. This study found that the positive effect of transparency on the annual growth rate of real GDP is equivalent to 0.8708 percent and 0.8711 percent in scenario 1 and scenario 2 respectively, as shown in Table 4.8.

Table 4.8 Effect of Transparency on Real GDP Growth Rate

Case	**Annual Growth Rate of Real GDP**
Case 1: Investment ratio growth without CPI Growth [1]	2.9529
Case 2:	
Scenario 1: Investment ratio growth with 0.94% CPI Growth [2]	3.8236
Scenario 2: Investment ratio growth with 0.97% CPI Growth in petroleum sector (s093) [3]	3.8239
Effect on Annual Growth Rate of Real GDP for Scenario 1 [4] = [2] – [1]	0.8708
Effect on Annual Growth Rate of Real GDP for Scenario 2 [5] = [3] – [1]	0.8711

4.3 Industry-specific Results

The industry-specific results show which sector receives the most and least benefit. The results revealed that both cases were different according to the growth of investment. From both cases, the top-five sectors receiving the most benefit were tin ore (s33), fluorite (s36), canning and preserving of meat (s43), chemical fertilizers (s37), and other cereals (s3) where there was higher expansion than the growth index of normal GDP, as shown in Table 4.9 to 4.11 and Figure 4.7 to 4.9. The sector receiving most benefit in case 1 was sector s33, tin ore, where the output growth index increased to 345.76 percent in the 30th year. The tin ore sector greatly expanded because it is used in the basic metal sector to manufacture machinery and metal products. Moreover, tin ore is also a component of non-ferrous metal products which are part of the basic metal sector (sector 107), including non-ferrous metal products which are used in manufacturing metal, metal products, and machinery (sector 105-128). Likewise, in terms of sector s36, fluorite, and sector s37, chemical fertilizers, their output growth index increased to 300.47 percent and 285.00 percent in the 30th year respectively, as both sectors are the base of the industrial sector. In terms of the canning and preserving of meat sector s43, its output growth index increased to 290.43 percent by the 30th year due to being exported. For the other cereals, sector s3, their output growth index increased to 273.26 percent by the 30th year, like other cereals, including sorghum, wheat, and barley, which important ingredients of sector 52, flour and other grain milling, sector 62, flour and other grain milling, and sector 63, breweries, which are greatly used in restaurants and beverage shops. According to the content of case 2, the top-five sectors receiving the most benefit were the same as case 1 and case 2, except for the output growth index of case 2, which was higher than case 1.

Table 4.9 Growth Index of the Top-5 Sectors in Case 1: Investment Ratio Growth without CPI Growth

Year	Normal Growth Index	Description (Sector)				
		Tin ore (s33)	Fluorite (s36)	Canning and preserving of meat (s43)	Chemical fertilizers (s37)	Other cereals (s3)
0	100.00	100.00	100.00	100.00	100.00	100.00
1	102.95	104.22	103.74	103.62	103.55	103.41
2	105.99	108.62	107.61	107.37	107.23	106.93
3	109.12	113.21	111.63	111.25	111.04	110.58
4	112.34	117.99	115.80	115.28	114.99	114.34
5	115.66	122.97	120.12	119.45	119.07	118.24
6	119.08	128.16	124.61	123.77	123.30	122.27
7	122.59	133.57	129.27	128.25	127.68	126.43
8	126.21	139.21	134.10	132.89	132.22	130.74
9	129.94	145.09	139.10	137.69	136.92	135.20
10	133.78	151.21	144.30	142.68	141.78	139.81
11	137.73	157.60	149.69	147.84	146.82	144.57
12	141.79	164.25	155.28	153.19	152.03	149.50
13	145.98	171.19	161.08	158.73	157.43	154.59
14	150.29	178.41	167.10	164.47	163.03	159.86
15	154.73	185.95	173.34	170.42	168.82	165.31
16	159.30	193.80	179.81	176.59	174.82	170.94
17	164.00	201.98	186.53	182.98	181.03	176.76
18	168.85	210.51	193.50	189.60	187.46	182.79
19	173.83	219.39	200.73	196.46	194.12	189.01
20	178.96	228.66	208.22	203.56	201.01	195.46
21	184.25	238.31	216.00	210.93	208.16	202.12
22	189.69	248.37	224.07	218.56	215.55	209.00
23	195.29	258.86	232.44	226.47	223.21	216.13
24	201.06	269.79	241.12	234.66	231.14	223.49
25	207.00	281.18	250.13	243.15	239.35	231.11
26	213.11	293.05	259.47	251.95	247.85	238.98
27	219.40	305.42	269.16	261.06	256.66	247.12
28	225.88	318.32	279.22	270.51	265.78	255.55
29	232.55	331.75	289.65	280.29	275.22	264.25
30	239.42	345.76	300.47	290.43	285.00	273.26

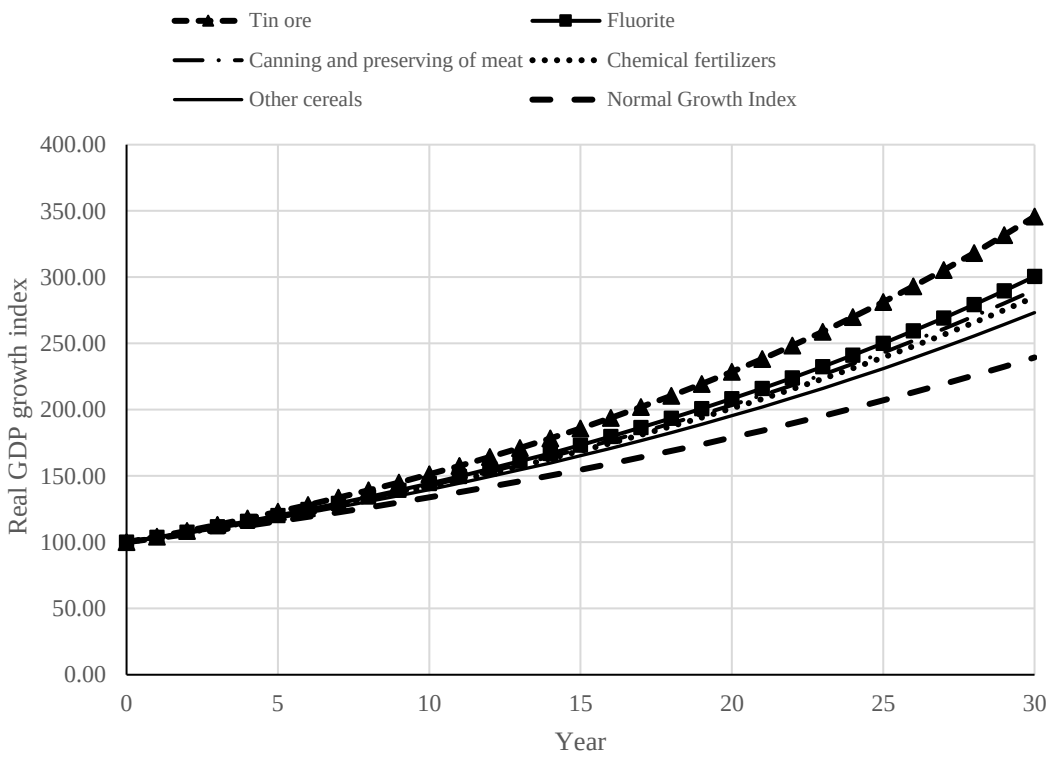

Figure 4.7 Growth Index of the Top-5 Sectors in Case 1: Investment Ratio Growth without CPI Growth

Table 4.10 Growth Index of the Top-5 Sectors in Scenario 1 for Case 2: Investment Ratio Growth with 0.94% CPI Growth

Year	Normal Growth Index	Description (Sector)				
		Tin ore (s33)	Fluorite (s36)	Canning and preserving of meat (s43)	Chemical fertilizers (s37)	Other cereals (s3)
0	100.00	100.00	100.00	100.00	100.00	100.00
1	102.95	104.26	103.78	103.65	103.59	103.44
2	105.99	108.70	107.70	107.43	107.30	106.99
3	109.12	113.33	111.76	111.35	111.15	110.66
4	112.34	118.16	115.99	115.41	115.14	114.46
5	115.66	123.20	120.37	119.62	119.27	118.40
6	119.08	128.45	124.91	123.98	123.54	122.46
7	122.59	133.92	129.63	128.51	127.97	126.67
8	126.21	139.62	134.53	133.19	132.56	131.02
9	129.94	145.57	139.61	138.05	137.32	135.52
10	133.78	151.77	144.88	143.09	142.24	140.18
11	137.73	160.02	152.01	149.77	148.82	146.35
12	141.79	168.72	159.48	156.77	155.71	152.79
13	145.98	177.89	167.32	164.09	162.91	159.51
14	150.29	187.55	175.55	171.75	170.44	166.53
15	154.73	197.74	184.18	179.77	178.33	173.86
16	159.30	208.49	193.24	188.17	186.58	181.51
17	164.00	219.82	202.74	196.96	195.21	189.50
18	168.85	231.77	212.71	206.16	204.23	197.84
19	173.83	244.36	223.17	215.79	213.68	206.55
20	178.96	257.64	234.14	225.87	223.57	215.64
21	184.25	275.10	248.89	239.11	236.65	227.56
22	189.69	293.75	264.56	253.12	250.51	240.14
23	195.29	313.66	281.23	267.95	265.18	253.41
24	201.06	334.92	298.94	283.66	280.70	267.42
25	207.00	357.63	317.76	300.28	297.13	282.20
26	213.11	381.87	337.77	317.88	314.53	297.80
27	219.40	407.75	359.05	336.51	332.94	314.26
28	225.88	435.39	381.66	356.23	352.43	331.63
29	232.55	464.91	405.69	377.11	373.07	349.96
30	239.42	496.42	431.24	399.22	394.91	369.30

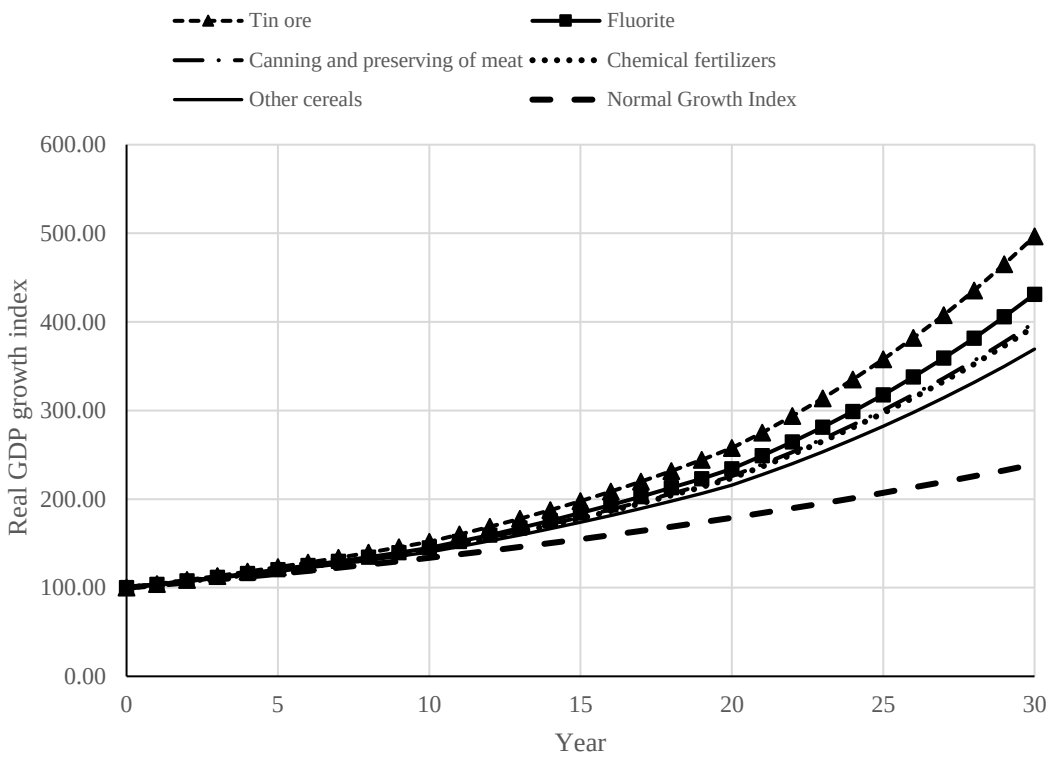

Figure 4.8 Growth Index of the Top-5 Sectors in Scenario 1 for Case 2: Investment Ratio Growth with 0.94% CPI Growth

Table 4.11 Growth Index of the Top-5 Sectors in Scenario 2 for Case 2: Investment Ratio Growth with 0.97% CPI Growth in Petroleum Sector

Year	Normal Growth Index	Description (Sector)				
		Tin ore (s33)	Fluorite (s36)	Canning and preserving of meat (s43)	Chemical fertilizers (s37)	Other cereals (s3)
0	100.00	100.00	100.00	100.00	100.00	100.00
1	102.95	104.26	103.78	103.65	103.59	103.44
2	105.99	108.70	107.70	107.43	107.30	106.99
3	109.12	113.33	111.76	111.35	111.15	110.66
4	112.34	118.16	115.99	115.41	115.14	114.46
5	115.66	123.20	120.37	119.62	119.27	118.40
6	119.08	128.45	124.91	123.98	123.54	122.46
7	122.59	133.92	129.63	128.51	127.97	126.67
8	126.21	139.62	134.53	133.19	132.56	131.02
9	129.94	145.57	139.61	138.05	137.32	135.52
10	133.78	151.77	144.88	143.09	142.24	140.18
11	137.73	160.02	152.01	149.77	148.82	146.35
12	141.79	168.72	159.48	156.77	155.71	152.79
13	145.98	177.89	167.33	164.09	162.91	159.51
14	150.29	187.56	175.55	171.75	170.45	166.54
15	154.73	197.75	184.19	179.78	178.33	173.87
16	159.30	208.50	193.25	188.17	186.58	181.52
17	164.00	219.83	202.75	196.96	195.21	189.51
18	168.85	231.78	212.72	206.16	204.24	197.85
19	173.83	244.38	223.18	215.79	213.69	206.56
20	178.96	257.66	234.16	225.87	223.57	215.65
21	184.25	275.13	248.91	239.11	236.66	227.57
22	189.69	293.78	264.58	253.13	250.52	240.15
23	195.29	313.70	281.25	267.96	265.19	253.42
24	201.06	334.96	298.96	283.67	280.71	267.43
25	207.00	357.67	317.80	300.30	297.15	282.22
26	213.11	381.92	337.81	317.90	314.55	297.82
27	219.40	407.82	359.09	336.53	332.96	314.28
28	225.88	435.46	381.71	356.26	352.46	331.65
29	232.55	464.99	405.75	377.14	373.09	349.98
30	239.42	496.51	431.31	399.25	394.94	369.33

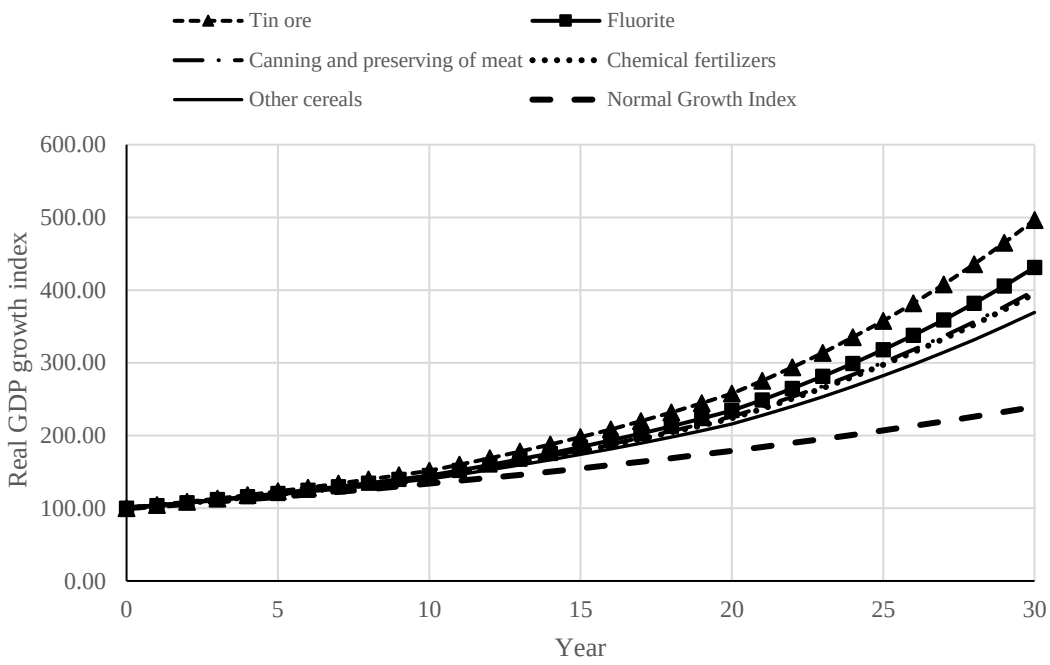

Figure 4.9 Growth Index of the Top-5 Sectors in Scenario 2 for Case 2: Investment Ratio Growth with 0.97% CPI Growth in Petroleum Sector

Looking at both cases, the five sectors receiving the least benefit were the following: radio, television and communication equipment and apparatus (s118), electrical industrial machinery and appliances (s117), petroleum refineries (S93), scientific equipment (s129), and tanneries and leather finishing (s75). Their expansions were lower than the growth index of the normal GDP, as shown in Table 4.12 and Figure 4.10. Furthermore, in scenario 1 and scenario 2 for case 2, where the investment ratio growth increased, the output growth index of s117, electrical industrial machinery and appliances, s93, petroleum refineries, s129, scientific equipment, and s75, tanneries and leather finishing also changed by shifting up over the growth index of the normal GDP, as shown in Tables 4.13 to 4.14 and Figures 4.11 to 4.12. In case 2, when considering the output growth index of s93 between scenario 1 and scenario 2 it was found that they reached 264.08 percent and 264.21 percent in the 30^{th} year respectively and differed by 0.13 percent. Due to the increase in the investment ratio growth in s93, it caused this sector to have further output growth when compared to the remaining sectors.

Therefore, in order to increase in the investment ratio growth by adding transparency and trust will enable the boosting of the growth of the manufacturing sector more than usual.

Table 4.12 Growth Index of the Five Sectors Receiving Least Benefit in Case 1: Investment Ratio Growth without CPI Growth

Year	Normal Growth Index	Description (Sector)				
		Radio, television and communication equipment and apparatus (s118)	Electrical industrial machinery and appliances (s117)	Petroleum refineries (s93)	Scientific equipment (s129)	Tanneries and leather finishing (s75)
0	100.00	100.00	100.00	100.00	100.00	100.00
1	102.95	102.25	102.40	102.54	102.61	102.64
2	105.99	104.55	104.86	105.14	105.28	105.36
3	109.12	106.89	107.38	107.82	108.03	108.14
4	112.34	109.30	109.96	110.55	110.85	111.00
5	115.66	111.75	112.60	113.36	113.74	113.93
6	119.08	114.26	115.30	116.24	116.71	116.94
7	122.59	116.83	118.07	119.20	119.75	120.03
8	126.21	119.46	120.90	122.22	122.88	123.21
9	129.94	122.14	123.80	125.33	126.08	126.46
10	133.78	124.89	126.78	128.51	129.37	129.81
11	137.73	127.69	129.82	131.78	132.74	133.24
12	141.79	130.56	132.94	135.12	136.21	136.76
13	145.98	133.50	136.13	138.56	139.76	140.37
14	150.29	136.50	139.40	142.07	143.40	144.08
15	154.73	139.57	142.75	145.68	147.14	147.89
16	159.30	142.70	146.17	149.38	150.98	151.80
17	164.00	145.91	149.68	153.18	154.92	155.81
18	168.85	149.19	153.28	157.07	158.96	159.93
19	173.83	152.54	156.96	161.06	163.11	164.16
20	178.96	155.97	160.72	165.15	167.36	168.50
21	184.25	159.47	164.58	169.35	171.73	172.95
22	189.69	163.06	168.54	173.65	176.21	177.52
23	195.29	166.72	172.58	178.06	180.80	182.21
24	201.06	170.47	176.73	182.58	185.52	187.03
25	207.00	174.30	180.97	187.22	190.36	191.97
26	213.11	178.22	185.31	191.98	195.32	197.04
27	219.40	182.22	189.76	196.85	200.42	202.25
28	225.88	186.32	194.32	201.85	205.65	207.60
29	232.55	190.50	198.98	206.98	211.01	213.08
30	239.42	194.78	203.76	212.24	216.52	218.72

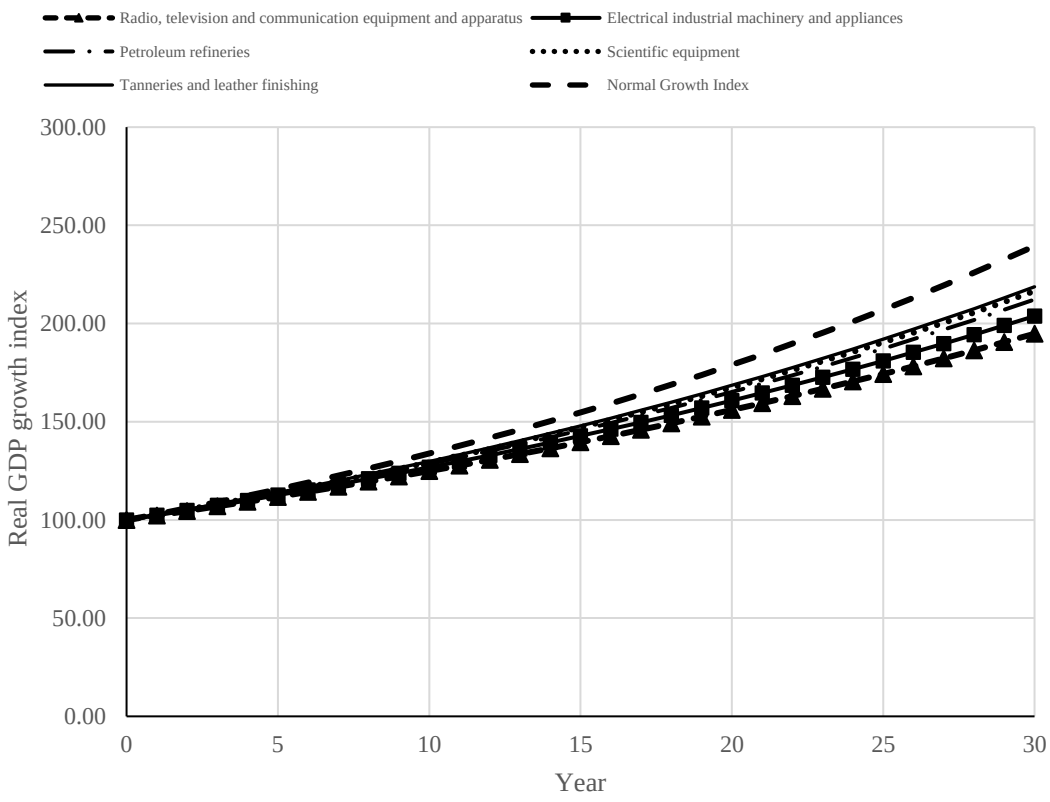

Figure 4.10 Growth Index of the Five Sectors Receiving Least Benefit in Case 1: Investment Ratio Growth without CPI Growth

Table 4.13 Growth Index of the Five Sectors Receiving Least Benefit in Scenario 1 for Case 2: Investment Ratio Growth with 0.94% CPI Growth

Year	Normal Growth Index	Description (Sector)				
		Radio, television and communication equipment and apparatus (s118)	Electrical industrial machinery and appliances (s117)	Petroleum refineries (s93)	Scientific equipment (s129)	Tanneries and leather finishing (s75)
0	100.00	100.00	100.00	100.00	100.00	100.00
1	102.95	102.26	102.41	102.56	102.62	102.66
2	105.99	104.57	104.88	105.18	105.31	105.38
3	109.12	106.93	107.40	107.86	108.07	108.18
4	112.34	109.34	109.99	110.62	110.90	111.06
5	115.66	111.81	112.64	113.45	113.81	114.01
6	119.08	114.33	115.36	116.35	116.79	117.03
7	122.59	116.91	118.14	119.32	119.85	120.14
8	126.21	119.55	120.98	122.37	122.99	123.34
9	129.94	122.25	123.90	125.50	126.22	126.61
10	133.78	125.01	126.89	128.71	129.53	129.97
11	137.73	128.56	130.72	132.90	133.81	134.34
12	141.79	132.22	134.67	137.22	138.24	138.86
13	145.98	135.98	138.74	141.69	142.82	143.52
14	150.29	139.85	142.93	146.30	147.54	148.35
15	154.73	143.82	147.25	151.07	152.42	153.33
16	159.30	147.91	151.70	155.98	157.47	158.48
17	164.00	152.12	156.28	161.06	162.68	163.81
18	168.85	156.45	161.00	166.31	168.06	169.32
19	173.83	160.89	165.87	171.72	173.63	175.01
20	178.96	165.47	170.88	177.31	179.37	180.89
21	184.25	171.27	177.21	184.52	186.71	188.41
22	189.69	177.28	183.77	192.02	194.34	196.25
23	195.29	183.49	190.57	199.82	202.29	204.42
24	201.06	189.93	197.63	207.94	210.56	212.93
25	207.00	196.58	204.95	216.39	219.17	221.79
26	213.11	203.48	212.53	225.18	228.14	231.02
27	219.40	210.61	220.40	234.34	237.47	240.63
28	225.88	218.00	228.56	243.86	247.18	250.64
29	232.55	225.64	237.03	253.77	257.29	261.07
30	239.42	233.55	245.80	264.08	267.81	271.94

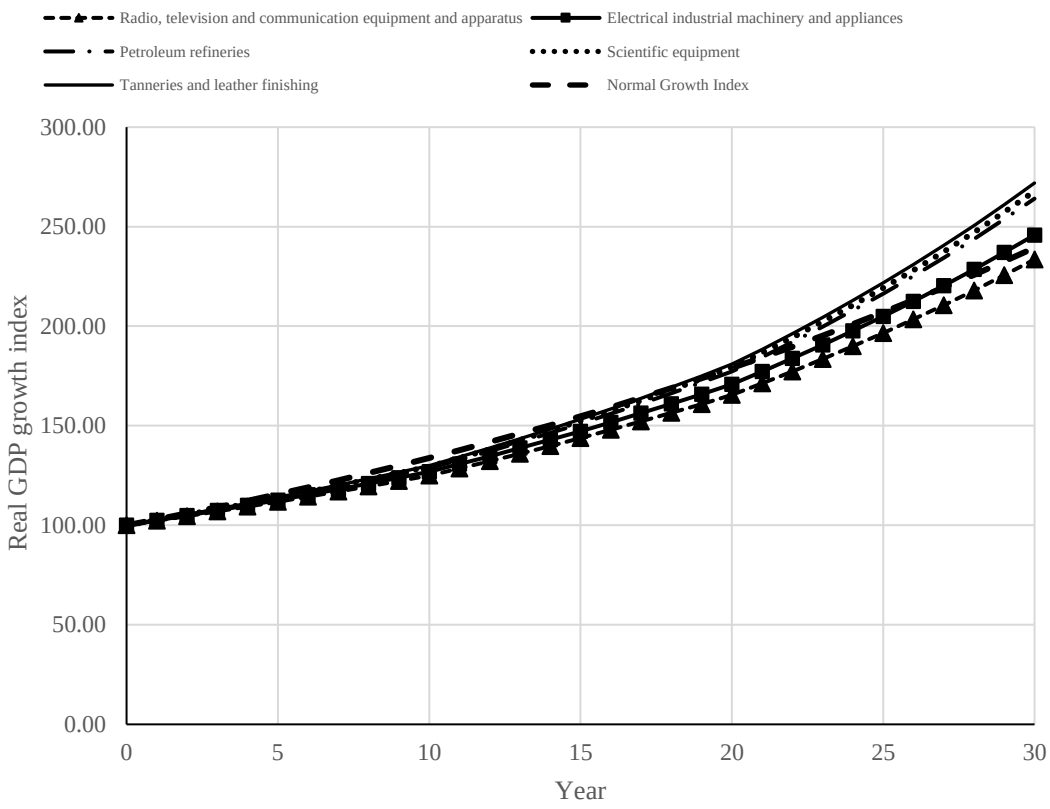

Figure 4.11 Growth Index of the Five Sectors Receiving Least Benefit in Scenario 1 for Case 2: Investment Ratio Growth with 0.94% CPI Growth

Table 4.14 Growth Index of the Five Sectors Receiving Least Benefit in Scenario 2 for Case 2: Investment Ratio Growth with 0.97% CPI Growth in Petroleum Sector

Year	Normal Growth Index	Description (Sector)				
		Radio, television and communication equipment and apparatus (s118)	Electrical industrial machinery and appliances (s117)	Petroleum refineries (s93)	Scientific equipment (s129)	Tanneries and leather finishing (s75)
0	100.00	100.00	100.00	100.00	100.00	100.00
1	102.95	102.26	102.41	102.56	102.62	102.66
2	105.99	104.57	104.88	105.18	105.31	105.38
3	109.12	106.93	107.40	107.86	108.07	108.18
4	112.34	109.34	109.99	110.62	110.90	111.06
5	115.66	111.81	112.64	113.45	113.81	114.01
6	119.08	114.33	115.36	116.35	116.79	117.04
7	122.59	116.91	118.14	119.32	119.85	120.14
8	126.21	119.55	120.98	122.37	122.99	123.34
9	129.94	122.25	123.90	125.50	126.22	126.61
10	133.78	125.01	126.89	128.71	129.53	129.97
11	137.73	128.56	130.72	132.90	133.81	134.34
12	141.79	132.22	134.67	137.23	138.24	138.86
13	145.98	135.98	138.74	141.70	142.82	143.52
14	150.29	139.85	142.93	146.31	147.54	148.35
15	154.73	143.83	147.25	151.08	152.43	153.33
16	159.30	147.92	151.70	156.00	157.47	158.49
17	164.00	152.12	156.28	161.08	162.68	163.81
18	168.85	156.45	161.01	166.33	168.07	169.32
19	173.83	160.90	165.87	171.75	173.63	175.01
20	178.96	165.47	170.88	177.34	179.38	180.89
21	184.25	171.28	177.21	184.56	186.71	188.42
22	189.69	177.28	183.77	192.06	194.35	196.26
23	195.29	183.50	190.58	199.87	202.30	204.43
24	201.06	189.93	197.63	208.00	210.57	212.93
25	207.00	196.59	204.95	216.46	219.18	221.80
26	213.11	203.48	212.54	225.26	228.15	231.03
27	219.40	210.62	220.41	234.43	237.48	240.64
28	225.88	218.00	228.57	243.96	247.19	250.65
29	232.55	225.65	237.03	253.88	257.30	261.09
30	239.42	233.56	245.81	264.21	267.82	271.95

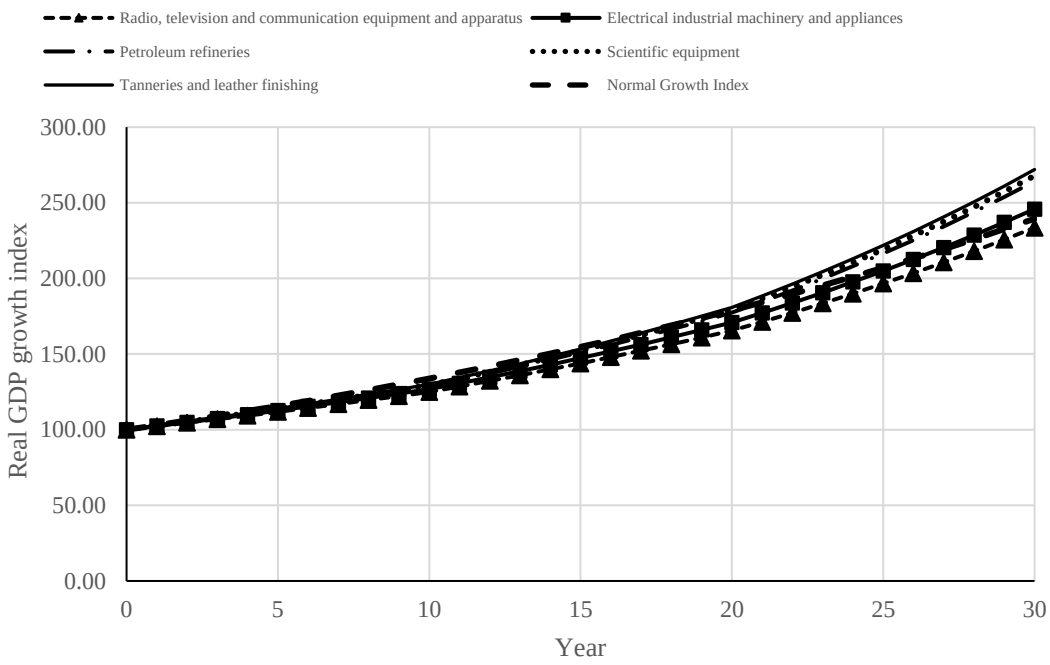

Figure 4.12 Growth Index of the Five Sectors Receiving Least Benefit in Scenario 2 for Case 2: Investment Ratio Growth with 0.97% CPI Growth in Petroleum Sector

4.4 Petroleum Consumption

The results of the 30-year projection showed that the growth index of petroleum consumption increased to 213.085 percent, 265.451 percent, and 265.565 percent in case 1, scenario 1 for case 2, and scenario 2 for case 2 respectively, as shown in Table 4.15.

In scenario 1 for case 2, the reason why the quantity index of total petroleum consumption of 265.451 percent was less than the value index of total petroleum consumption of 394.935 percent was due to the rise in the petroleum prices in the long term. Since the Thai Baht has depreciated by 19.287 percent in the 30th year, it caused the value of imported goods to be more expensive by 52.266 percent, domestic petroleum price (s93) to be more expensive by 17.588 percent, and also to be more expensive than most other goods. When comparing to the GDP deflator, it was found that these increased only by 10.115 percent. However, the cause of the rise in petroleum prices was from importing crude oil, that is the raw material for the entire petroleum

sector, while other sectors chose to use raw materials from some domestic goods. Moreover, the growth index of petroleum consumption in intermediate of 305.300 percent was of a higher value than the quantity index of petroleum consumption in final demand of 209.696 percent as all sectors must use petroleum as inputs.

In scenario 2 for case 2, the quantity index of total petroleum consumption increased to 265.565 percent and was more than scenario 1 of case 2. Since the Thai Baht currency depreciated by 19.293 percent in the 30^{th} year, it caused the value of imported goods to be more expensive by 52.277 percent and domestic petroleum prices (s93) to be more expensive by 17.578 percent. However, the petroleum price in scenario 2 was cheaper than scenario 1, and the value index of petroleum consumption in intermediate of 454.507 percent in scenario 2 was expanded lower than the value index of petroleum consumption of 454.512 percent in scenario 1 as well. On the other hand, the value index of petroleum consumption in final demand of 311.919 percent in scenario 2 was expanded higher than the value index of petroleum consumption in final demand of 311.649 percent in scenario 1 due to the cheap petroleum price. As the Integrity Pact in the petroleum sector causes efficiency in the spending budget, the saved money is increasingly used for investment. The reason according to the mechanism of capital accumulation is that the current return of capital would be lower as the cost of petroleum production (capital costs) decreases more than the reduction in the petroleum prices (capital rent).

Table 4.15 Change of Petroleum Consumption Growth Index

Petroleum Consumption Change	Base Year	10th Year			20th Year			30th Year		
		Case 1	Case 2		Case 1	Case 2		Case 1	Case 2	
			Scenario 1	Scenario 2		Scenario 1	Scenario 2		Scenario 1	Scenario 2
Quantity										
Total Petroleum Consumption	100.000	128.682	128.879	128.879	165.591	177.852	177.883	213.085	265.451	265.565
Petroleum Consumption in Intermediate	100.000	133.471	133.710	133.710	178.145	193.257	193.266	237.773	305.300	305.335
Petroleum Consumption in Final Demand	100.000	121.114	121.244	121.244	146.685	154.793	154.856	177.656	209.696	209.906
Value										
Total Petroleum Consumption	100.000	142.611	142.904	142.904	203.379	224.827	224.854	290.040	394.935	395.054
Petroleum Consumption in Intermediate	100.000	147.944	148.287	148.287	218.874	244.395	244.393	323.811	454.512	454.507
Petroleum Consumption in Final Demand	100.000	134.185	134.399	134.399	180.055	195.551	195.621	241.606	311.649	311.919

The top-ten sectors that most consume petroleum are road freight transport (s151), road passenger transport (s150), air transport (s156), electricity (s135), coastal and inland water transport (s154), petrochemical products (s086), petroleum and natural gas (s031), ocean and coastal fishing (s028), wholesale trade (s145), and business services (s164). According to Table 4.16, case 2, different results are shown between scenario 2 applying the GDP growth and the IP, and scenario 1 applying only the GDP growth. It was found that the most and least affected sectors were road freight transport, petroleum and natural gas, and coastal and inland water transport (these three sectors are not the sectors using the most petroleum).

In addition, it was also found that there has been change in the effect level of each sector for the entire 30 years. In the first 10 years, the third affected sector was road passenger transport. Twenty years later, this was replaced by the coastal and inland water transport sector, and the petrochemical products sector. The aforesaid change occurred from the transport mode shift (modal shift) by switching from road passenger transport (by car or bus) to energy savings, and mass transport by boat or railroad as petroleum prices are more expensive in the long term.

Table 4.16 Percentage Change in the Top-10 Sectors Consuming Petroleum

	Sectors	Scenario 1 for Case 2 [1]			Scenario 2 for Case 2 [2]			Sectors Affected by the changes in petroleum sector [3] = [2] – [1]		
		10th Year	20th Year	30th Year	10th Year	20th Year	30th Year	10th Year	20th Year	30th Year
1.	S151 Road Freight Transport	34.27171	45.26269	58.90176	34.27181	45.27291	58.91976	0.00010	0.01022	0.01800
2.	S150 Road Passenger Transport	31.99666	42.19556	54.82022	31.99673	42.20132	54.83057	0.00007	0.00576	0.01035
3.	S156. Air Transport	32.76538	43.26402	56.29184	32.76543	43.26894	56.3009	0.00005	0.00492	0.00906
4.	S135 Electricity	33.55022	44.31348	57.67463	33.55028	44.31778	57.68266	0.00006	0.00430	0.00803
5.	S154 Coastal and Inland Water Transport	33.61695	44.39379	57.76742	33.61701	44.40113	57.7806	0.00006	0.00734	0.01318
6.	S086 Petrochemical Products	34.44277	45.48972	59.18927	34.44283	45.49628	59.20128	0.00006	0.00656	0.01201
7.	S031 Petroleum and Natural Gas	35.16543	46.57652	60.82075	35.16552	46.58452	60.83496	0.00009	0.00800	0.01421
8.	S028 Ocean and Coastal Fishing	34.65930	45.83316	59.72851	34.65936	45.83802	59.73767	0.00006	0.00486	0.00916
9.	S145 Wholesale Trade	36.60234	48.64989	63.78967	36.60238	48.65367	63.79707	0.00004	0.00378	0.00740
10.	S164 Business services	33.58503	44.36972	57.76464	33.58507	44.37444	57.77337	0.00004	0.00472	0.00873

The efficiency of petroleum usage is based on the petroleum-GDP elasticity, as shown in Table 4.19. In the 30th year, case 1 is projected to grow by 33.78 percent of the real GDP. The aforesaid projection is associated with the growth of total petroleum consumption at 28.68 percent, the growth of petroleum consumption in intermediate at 33.47 percent, and the growth of petroleum consumption in final demand at 21.11 percent. The petroleum-GDP elasticity therefore is computed to be equivalent to 0.8491 percent for the total petroleum consumption, 0.9909 percent for the petroleum consumption in intermediate, and 0.6251 percent for the petroleum consumption in final demand.

In 30 years, scenario 1 for case 2 is projected to grow to 58.63 percent of the real GDP. The aforesaid projection is associated with the growth of total petroleum consumption at 49.25 percent, the growth of petroleum consumption in intermediate at 57.98 percent, and the growth of petroleum consumption in final demand at 35.47 percent. The petroleum-GDP elasticity, therefore, is computed to be equivalent to 0.8401 percent for total petroleum consumption, 0.9889 percent for the petroleum consumption in intermediate, and 0.6050 percent for the petroleum consumption in final demand. Further, the efficiency of petroleum usage also tends to rise due to the reduction in the petroleum-GDP elasticity, which will be equivalent to 0.8488 percent, 0.8447 percent, and 0.8401 percent in 10 years, 20 years, and 30 years respectively. Moreover, the petroleum-GDP elasticity in scenario 1 for case 2 is lower than scenario 1 for case 1, while scenario 1 for case 2 appears in the efficiency of petroleum usage.

In 30 years, scenario 2 for case 2 is projected to grow to 58.64 percent of the real GDP. The aforesaid projection is associated with the growth of total petroleum consumption at 49.29 percent, the growth of petroleum consumption in intermediate at 57.99 percent, and the growth of petroleum consumption in final demand at 35.55 percent. The petroleum-GDP elasticity, therefore, is computed to be equivalent to 0.8406 percent for the total petroleum consumption, 0.9889 percent for the petroleum consumption in intermediate, and 0.6063 percent for the petroleum consumption in final demand. Nevertheless, the petroleum-GDP elasticity in scenario 2 for case 2 is higher than scenario 1 for case 2, which means that the efficiency of petroleum usage in scenario 2 for case 2 is less than scenario 1 for case 2 but is still more than for case 1 because the petroleum price in scenario 2 for case 2 is cheaper than scenario 1 for

case 2. Moreover, scenario 2 for case 2 also emits more carbon dioxide than scenario 1 for case 2 (see details in the next subject section).

Table 4.17 Petroleum Consumption Elasticity

		Case 1	Scenario 1 for case 2			Scenario 2 for case 2		
		10^{th}, 20^{th}, 30^{th} Year	10^{th} Year	20^{th} Year	30^{th} Year	10^{th} Year	20^{th} Year	30^{th} Year
Petroleum Consumption Change	Total Petroleum Consumption [1]	28.68201	28.87886	37.99915	49.25406	28.87913	38.02301	49.29200
	Petroleum Consumption in Intermediate [2]	33.47111	33.71025	44.53432	57.97607	33.71030	44.54050	57.98724
	Petroleum Consumption in Final Demand [3]	21.11362	21.24365	27.67081	35.46893	21.24422	27.72262	35.54910
Real GDP [4]		33.77780	34.02258	44.98655	58.62750	34.02262	44.99118	58.63611
Petroleum-GDP Elasticity	Total Oil consumption [5] = [1]/[4]	0.84914	0.84881	0.84468	0.84012	0.84882	0.84512	0.84064
	Intermediate [6] = [2] / [4]	0.99092	0.99082	0.98995	0.98889	0.99082	0.98998	0.98893
	Final Demand [7] = [3] / [4]	0.62507	0.62440	0.61509	0.60499	0.62441	0.61618	0.60627

4.5 Carbon Emissions

Economic activity has to use petroleum to produce goods and services for growth, but this is accompanied with carbon dioxide emissions. The change in CO_2 emissions is associated with the deterioration of natural capital

Transparency creates the flow of economic transactions, optimizes business investment, and expands the outputs from economic activity that drives economic growth. Meanwhile, petroleum consumption has seen greater expansion and better efficiency of its usage. For this study, CO_2 emissions were computed using the emissions factor method.

CO_2 emissions are computed according to petroleum value change, the petroleum consumption ratio, the petroleum average prices, and the CO_2 emissions factor. The result of the projection is that the CO_2 emissions factor of gasoline per liter reached 0.00232 metric tons, and the CO_2 emissions factor of diesel per liter reached 0.00270 metric tons (EPA, 2015). According to Table 4.18, in 30 years, CO_2 emissions will increase to 30,566,833 tons CO_2 (tCO_2), 52,467,505 tCO_2, and 52,511,246 tCO_2 in case 1 (base case), scenario 1 for case 2, and scenario 2 for case 2 respectively.

In terms of the efficiency of petroleum usage in case 2, the transparency of every economic activity contributes to the growth of the economy, along with the efficient petroleum usage, which was more than the base case.

In scenario 2 for case 2, increasing transparency in the petroleum sector with anti-corruption tools boosts the growth of the economy. However, the petroleum usage in scenario 2 for case 2 was less efficient than scenario 1 for case 2 but still was more than the base case, and emitted more CO_2 than in scenario 1 for case 2 by 43,741 tCO_2, as the petroleum price tends to be reduced.

Nevertheless, it seems that the results of this study are not able to suggest a choice for the best case but might demonstrate a change that will enable us to prepare for prevention and precaution regarding environmental impacts, such as scenario 2 for case 2, where there should be energy saving measures and the promotion of eco-friendly transportation.

Table 4.18 Change of Carbon Dioxide Emissions

		Case 1	Scenario 1 for case 2			Scenario 2 for case 2		
		10^{th}, 20^{th}, 30^{th} Year	10^{th} Year	20^{th} Year	30^{th} Year	10^{th} Year	20^{th} Year	30^{th} Year
Petroleum Value Change (Baht) [1]		367,547,820,907	370,059,580,097	486,829,955,048	630,890,250,680	370,063,189,687	487,161,263,871	631,416,219,552
Petroleum Consumption Ratio (%share)/1	Gasoline [2]	0.29	0.29	0.29	0.29	0.29	0.29	0.29
	Diesel [3]	0.71	0.71	0.71	0.71	0.71	0.71	0.71
Petroleum Average Prices (Baht/liter)/1	Gasoline [4]	41.26	41.26	41.26	41.26	41.26	41.26	41.26
	Diesel [5]	28.69	28.69	28.69	28.69	28.69	28.69	28.69
Petroleum Consumption Change (liter)	Gasoline [6] = {[1]*[2]}/[4]	2,556,582,075	2,574,053,321	3,386,282,453	4,388,334,291	2,574,078,429	3,388,586,964	4,391,992,815
	Diesel [7] = {[1]*[3]}/[5]	9,134,306,187	9,196,728,479	12,098,708,297	15,678,897,799	9,196,818,185	12,106,941,991	15,691,969,188
CO_2 Emissions Factor (tCO2/liter)/2	Gasoline [8]	0.00232	0.00232	0.00232	0.00232	0.00232	0.00232	0.00232
	Diesel [9]	0.00270	0.00270	0.00270	0.00270	0.00270	0.00270	0.00270
Total CO_2 Emissions (tCO_2) [10] = {[6]*[8]}+{[7]*[9]}		30,566,833	30,775,722	40,486,840	52,467,505	30,776,022	40,514,393	52,511,246

Note: 1/ The Energy Policy and Planning Office (EPPO)

2/ Center for Corporate Climate Leadership, United States Environmental Protection Agency (EPA)

CHAPTER 5

CONCLUSION

5.1 Conclusions

This study focuses on the economic impacts of change in Thailand's transparency and associated changes in CO_2 emissions, and it also looks at the structural development associated with changes in Thailand's transparency and economic performance. The methodology applied the growth of the corruption perception index score to the computable general equilibrium model via the investment ratio growth variable. The forecasting CGE model in the ORANI tradition (Dixon et al., 1982) used 180 sector input-output table of Thailand, 2010 Edition, as the database. The system of the CGE model consisted of 135,202 variables and 133,940 equations which offer 1,262 structural exogenous variables.

The forecasting CGE model predicting change in the structural development of Thailand's economies by changing investment variable. The concept influencing this study was the growth theory (Solow, 1956; Swan, 1956), which comprises capital and labor, and the new growth theory (Romer, 1989), which pays attention to human capital. Both theories had been accepted by the economist as well. Moreover, this study also focuses on social capital as a necessary condition for capital accumulation, such as physical capital, human capital, and natural capital, where social capital contributes to the growth of the economy. Therefore, social capital is measured by the cost of business transactions. Most businesses run smoothly and transparently with low transaction costs. Transparency leads to nearly zero-transaction costs and business efficiency.

Social capital is measured through transparency by using Thailand's CPI score. To link social capital with the CGE system via investments, when there is high trust and transparency, the country will have surplus money for investment, which will result in the economy expansion.

In 2016, Thailand had a CPI score of 35 out of 100, a trend that has shown a rise by 0.94 percent per year from the period 1995 to 2016. When examining the surrounding context of Thailand, the country has a lower CPI score than the average score (40-point). Moreover, the countries with a CPI score lower than the average score have tended to also have low investment proportion per GDP and higher costs of doing business.

The Integrity Pact Program with respect to commit all tenders relating to procurement contract may help to make the bidding more transparent. The success of the Integrity Pact makes more transparency in government spending that make the trend of growth of the CPI score rise, a representation of the growth of investment.

The 30-year stimulation is compared in two cases; case 1 (base case) did not to apply the growth of CPI score, and case 2 applied the growth of the CPI score to the investment ratio growth. In case 2, the two test scenarios were comprised of scenario 1 for case 2, the investment ratio growth with a 0.94 percent growth, and scenario 2 for case 2, the investment ratio growth in the petroleum sector with a 0.97 percent growth, and the investment ratio growth in the rest of the sectors with a 0.94 percent growth.

5.1.1 Macroeconomic Results

The result show that applying the growth of the CPI score to the investment ratio growth with a 0.94 percent growth makes the growth index of real GDP be more increased than the base case from 239.42 to 308.24. The growth index of real GDP of two cases has an apparent difference when 20 years have passed. The rise in the CPI score causes the occurrence of investment expansion due to rich social capital or transparency and trust. This trust creates investment to substitute for the depreciation of capital and new investment of capital stock through the investment ratio growth. Consequently, the capital accumulation is a matter requiring time, which is consistent with the idea expressed in His Majesty the Late King Bhumibol Adulyadej's royal guidance given to the graduates from The Royal Police Cadet Academy at Suan Amphorn on 14 August, 1982, as follows:

> Good deeds do difficult and slow in getting the result, however, doing good deeds should to be done because evil that is facile done will enter to replace and will rapidly accumulate without one's awareness, therefore, each people have to pay attention and attempt all the best in enhancing and accumulating good deeds

In addition, applying the investment ratio growth in the petroleum sector with a 0.97 percent growth makes the growth index of real GDP be more increased than the scenario 1 for case 2 from 308.24 to 308.26. Because the Integrity Pact as a tool to increase in the CPI score, created more capital accumulation and cheaper petroleum prices, and caused the growth of the index of real GDP to increase.

5.1.2 Industry-specific Results

The result from CPI growth applied to the CGE model predicts that there will be growth in industry-specific sectors. The strongly affected sectors are tin ore, fluorite, canning and preserving of meat, chemical fertilizer, and other cereals, which are basic industrial sectors. On the other hand, the least affected sectors are radio, television and communication equipment and apparatus, electrical industrial machinery and appliances, petroleum refineries, scientific equipment, and tanneries and leather finishing. Moreover, the effect on the petroleum refineries is projected to be the least, which is good for the economy as petroleum is a basic commodity influencing the cost of producing almost all kinds of products and services. When the oil prices are less affected, the cost of raw materials and transportation costs then will be less than the prices of goods and other services.

With respect to environmental effects, CPI growth applied to the CGE model affected increasing in petroleum usage. The 30-year projection reflects that the strongly affected sector are road freight transport, petroleum and coastal and inland water transport, and natural gas. Furthermore, when comparing scenario 2 and scenario 1 in the 20-year period, it was also found that the road passengers transport sector will decrease, effectively replaced with river and coastal transport. The aforesaid changes will arise from the transport mode shift (modal shift) by switching from road passenger transport by car or bus to energy saving modes, and mass transport by boat or railroad,

as petroleum price costs will be more expensive in long term. Likewise, CO_2 emissions widely vary according to petroleum usage growing exponentially as per economic growth. The efficiency of petroleum usage based on the petroleum-GDP elasticity reflects that case 2 had greater efficiency of petroleum usage than case 1 (base case). Although petroleum will be upward used and carbon dioxide emissions will increase, when trading off with the benefit obtained from economic growth, economic efficiency is still achieved.

In conclusion, transparency economy contributes to economic growth, competitiveness, and investment efficiency.

5.2 Policy Implications

The forecasting CGE model is used to investigate Thailand's transparency affect the economic and environment through anti-corruption tools. The result of this study indicates that the country's transparency and integrity cause efficient investment, which leads to a prosperous economy. Transparency has the significant positive effect on the growth rate of real GDP via investment channel especially the investment ratio growth. Moreover, transparency also affects economic development and competitiveness agendas, such as fair competition, business wide-openness, and environmental concerns, that it provides suggestion to set the policies.

Additionally, transparency as social capital is a necessary condition for all types of capital accumulation that it depend on time, about 20-30 years. The implementation pertaining to the Integrity Pact should be continuously carried out for 20-30 years in order to eliminate bribes, including having to rigorously audit and monitor the government's budget spending. The aforesaid actions will enhance transparency and trust, leading to social capital richness. In particular, getting rid of corruption is an appropriate approach for setting in the 20-year national strategy.

Therefore, anti-corruption agencies should build Thailand to be transparent by destroying the cycle of corruption between the groups in society, i.e. politicians, bureaucrats, and entrepreneurs, especially in terms of grand corruption, by using the voluntary corruption prevention tools to keep anti-corruption mechanisms to curb corruption in public procurement.

Beyond, anti-corruption agencies should prepare resources, law enforcement, and collaboration for corruption prevention as follows:

1) Bureaucrats should create fair competition and reduce monopoly to entrepreneurs in order to eliminate conflicts of interest, which cause trust and smoothness in doing business. On the other hand, people should trust in the accountability of politicians and bureaucrats to get rid of the abuse of power. The benefits received are that the CPI score will rise, investment efficiency will increase, the cost of doing business will decrease, outputs will increase, and the competitive advantage will increase.

2) Anti-corruption agencies should prepare anti-corruption law that should be up-to-date and fair, i.e. corruption cases must have no prescription or limitation.

3) To fight against corruption, such as investigation, prevention, and promotion can be collaborated with partners, for example empowering community participation and enlist collaboration from every sector to fight corruption (Office of the National Anti-Corruption Commission, 2017).

Likewise, with respect to the outcomes and impacts on society and the environment, politicians, public officials and entrepreneurs should doing business with honesty, ethical standards, and corporate governance so that people have trust in them and receive good benefits from paid taxes.

Apart from this, the key factor for creating honesty and ethics is people, consisting of knowledge along with integrity (human capital). Integrity is comprised of four mental qualities or bases for success (the four Iddhipada); aspiration (Chanda), effort (Viriya), thoughtfulness (Citta), and investigation (Vimamsa), including specific qualifications for each work. Moreover, knowledge and integrity also are two conditions of the philosophy of a sufficient economy. To ensure that the public and private sector will operate with honesty and ethics, the sufficient economy basis therefore should be applied as a guideline to create a work-life balance. Sufficiency (the middle path) means moderation (virtue – ordinary), self-immunity (concentration – reduction in risks), and reasonableness (wisdom – clearly understanding) (sufficiency is a great property). Moderation is to spend or to consume to be suitable for one's needs. Self-immunity is security and stability in working and living. Reasonableness is a

roadmap for achieving goals on holistic view. The sufficiency economy is a blueprint for sustainable development, where action does not negatively affect the economy, society, or the environment.

In general, corruption causes tremendous damage to economic and social development. However, a speech that corruption leads to rapid development, that speech is not placed on ethics. For example, a 100 percent budget for road construction can be divided into 70 percent for construction costs and 30 percent for bribery. Its result is non maximum quality of road. If a 30 percent loss is reinvested into the capital accumulation, it will make the economy greatly grow. Therefore, accountability with integrity and transparency should be promoted, such as codes of conduct for the public and private sectors, and actions considering public interests rather than self-interests should be supported. This promotion depends on the cooperation of various concerned organizations, such as the Ministry of Education, which produces good person and talented person.

With respect to environmental effects, consequently, economic growth has resulted in an increase in petroleum usage and CO_2 emissions, therefore the Ministry of Transport should promote energy-efficient transportation. For example, to create transparency in the petroleum sector will result in investment and petroleum utilization being improved because it is expected that there will be a transformation in the transportation mode to a more efficient transportation mode due to better efficiency of energy, reducing environmental impacts. Thus, measures should be taken to support environmentally-friendly transport usage (both water and rail transport), according to studies on the effects of rail transportation investment was found that rail investment induced a modal shift from a road to rail mode of land transport, and make more energy efficiency, which benefits both the economy and the environment (Gritsana Patjakreng & Sompote Kunnoot, 2016, p. 265).

5.3 Suggestions for Future Study

A CGE model is projected economic impacts of change in Thailand's transparency and associated changes in CO_2 emissions, which applied the growth of the CPI score to the CGE model via the investment ratio growth variable. The change of

CPI scores due to procurement with the Integrity Pact which use the percentage of budget savings for calculating improved CPI scores. An interesting topic in the future would be create a linkage between preventive measures or mechanisms and CPI scores by other means to improve Thailand's CPI scores, such as evaluating benefit of good governance.

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APPENDICES

Appendix A

Structure and Classification of Thailand 180 Sectors Input – Output Table

Table A1 Structure and Classification of Thailand 180 Sectors Input – Output Table

Code	Sector	Description
001	Paddy	This sector covers the combined the production of both glutinous and no glutinous paddy. The by-product is straw.
002	Maize	This sector covers the combined the production of fresh, dried and young maize includes by-product.
003	Other cereals	Production in this sector combines sorghum and barley includes by-product.
004	Cassava	The only product included in this sector is fresh cassava roots.
005	Other root crops	The potato, sweet potato, taro root and root-crops not mentioned elsewhere
006	Beans and nuts	This sector covers beans and nuts of all kinds such as mung bean, castor seed, kindney bean, red bean, sesame and ground nut.
007	Vegetable	Vegetable such as chili, ginger, Chinese radish, onion, shallot, garlic, cabbage, tomato and other vegetables not mentioned elsewhere are included in this sector.

Table A1 (Continued)

Code	Sector	Description
008	Fruits	This sector includes the production of oranges, grapes, durians, rambutans, mangoes, pineapples, water melons, bananas, mangosteens, pomeloes, longens, jack fruits, lychees and other fruits not mentioned elsewhere.
009	Sugar cane	The product included in this sector is sugar cane which was consumed by household and put to industrial.
010	Coconut	Fresh coconut is the main product of this sector. Coconut leaf, coconut fiber, copra and coconut shell are the by-product.
011	Oil palm	Production in this sector combines oil palm and palm lily includes by-product.
012	Kenaf and jute	This sector covers the production of kenaf, jute and ramie.
013	Other crops for textile and matting	This sector includes the fiber and seed of kapok and other fiber crops.
014	Tobacco	Fresh tobacco leaf and seed are the two main agricultural products of this sector. Production is classified into Virginia Barley, Turkish and Native varieties.
015	Coffee and tea	This sector covers the production of all fresh coffee bean, tea leaf and cocoa.
016	Rubber	Latex from the rubber tree is the main product of this sector.
017	Other agricultural product	This sector covers flowers and seed of all kinds, including sunflower seed, ornamental plants, horse tamarind, mint and the like.

Table A1 (Continued)

Code	Sector	Description
018	Cattle and buffalo	This sector covers the production of cattle and buffalo for slaughter, export and breeding. Also included in this sector is fresh milk for dairying.
019	Swine	The only product included in this sector is swine.
020	Other livestock	Goat, sheep, horse, rabbit, crocodile, elephant and others are covered under this sector.
021	Poultry	This sector covers the production of chickens, ducks and geese.
022	Poultry products	The product covered by this sector is egg derived from raising fowl.
023	Silk worm	This sector includes the products of silk-worm and silk cocoons.
024	Agricultural services	This sector covers the plough services using both animals and tractors.
025	Logging	This sector includes logs of all kinds such as teak, yang, etc.
026	Charcoal and fire-wood	This sector covers the production of charcoal and firewood.
027	Other forest products	Products of this sector are bamboo, bamboo shoot, rattan and other forest products.
028	Ocean and coastal fishing	Covered in this sector are ocean fishing, coastal fishing and coastal fish-cultivation.
029	Inland fishing	This sector covers the activities of both inland fish catching and cultivation.
030	Coal and lignite	This sector includes establishments primarily engaged in mining coal and lignite.

Table A1 (Continued)

Code	Sector	Description
031	Petroleum and natural gas	This sector covers the exploration activities for crude petroleum and natural gas, the drilling, completing and equipping of wells carried out on an own-account basis, and the operation of oil and natural gas wells.
032	Iron ore	This sector includes activities primarily involving the extraction and extraction and dressing and dressing of iron ore.
033	Tin ore	The coverage of this sector includes activities involving in extracting and dressing of tin ore.
034	Tungsten ore	This sector includes activities involved in extraction and preparing tungsten ore.
035	Other non-ferrous metals	This sector includes activities involved in extraction and dressing non-ferrous ore, such as antimony, chromite, columbite, copper, manganese, monazite, tantalite, zenotize, zinc, zircon and lead ore.
036	Fluorite	This sector covers the activities of exploring for and extraction of fluorite.
037	Chemical fertilizers	Covered in this sector are activities related to the mining or other extraction of mineral such as fluorite, phosphate and nitrate mineral.
038	Salt	Covered in this sector are activities related to extraction of rock salt and the production of salt from sea water.
039	Limestone	This sector primarily covers the activity involved in the extraction of limestone.

Table A1 (Continued)

Code	Sector	Description
040	Stone quarrying	This sector covers the activities of stone quarrying, clay extraction, gravel and sand pit operation, clay pit operation, and marble mining.
041	Other mining and quarrying	Excluding stone quarrying, this sector covers activities of mining and other quarrying of produce such as asbestos, calcite, diatomite, dolomite, feldspar, gypsum, marl quartz, silica sand and jewelry stone.
042	Slaughtering	This sector covers the activity of slaughter-houses and products such as fresh meat, pork, chicken and duck. Also included are hides of cattle and buffalo, feathers of chicken and duck, buffalo horns and other by-products of cattle, buffalo, swine, chicken and duck.
043	Canning and preserving of meat	This sector covers the activity of canning and preserving meat, and the preparation of ham, and sausage.
044	Dairy products	This sector covers pasteurized milk, condensed milk, cream, butter, cheese, margarine and ice cream.
045	Canning and preservation of fruit and vegetables	This sector covers dried and frozen fruits, canned and bottled fruits and vegetables, fruit and vegetable juice, jam, jellies and others.
046	Canning and preservation of fish and other sea foods	This sector covers frozen fish, salted and dried fish and preserved fish.

Table A1 (Continued)

Code	Sector	Description
047	Coconut and palm oil	This sector covers coconut oil. palm oil, coconut cake and palm cake.
048	Animal oil, animal fat, vegetable oil and by-products	The products are lard, animal fat, soy-been oil, cotton-seed oil, kapok-seed oil, sunflower-seed oil, rice-bran oil, other vegetable oil, and their by-products.
049	Rice milling	This sector covers production of husked-cleaned-polished rice, parboiled rice, broken rice, rice bran and rice husk.
050	Tapioca milling	This sector covers milled products of cassava of all kinds such as tapioca flour, tapioca chips and tapioca pellets.
051	Grinding of maize	This sector covers maize milling activities such as the grinding corn, corn cob and other maize products.
052	Flour and other grain milling	This sector covers the activity of flour and other grain milling.
053	Bakery products	This sector covers all bakery products such as bread, cake, pies, crackers.
054	Noodles and similar products	Covers in this sector are noodles of all kinds such as yellow noodles, white noodles made from rice flours, spaghetti, macaroni, etc. Also included in this sector is the production of instant noodles.
055	Sugar	This sector covers and refined sugar made from sugar-cane and coconut tree as well as the by-products of sugar such as syrup, molasses and bagasse.

Table A1 (Continued)

Code	Sector	Description
056	Confectionery	Candies, chocolate, chewing gum and other confectioneries are covered by this sector.
057	Ice	Ice is the sole product of this sector.
058	Monosodium glutamate	Monosodium glutamate is covered in this sector.
059	Coffee and tea	This sector covers the activities involved in the processing of coffee and tea. The productions covered by this sector are coffee and tea powers, instant coffee and tea as well as roasted coffee beans and tea leaves.
060	Other food products	This sector includes soy sauce, bean curd, fish sauce, vinegar, salted and fermented eggs, spices, table salt, other sauces and other prepared food.
061	Animal feed	Covered in this sector is the production of all kinds of animal feed such chicken feed, fish meal.
062	Distilling and spirits blending	This sector covers brandy, liqueurs and wine.
063	Breweries	Malt and beer are included in this sector.
064	Soft drinks and carbonated water	This sector covers soda water, carbonated fruit drinks, distilled water and the other soft drinks.
065	Tobacco processing	This sector covers the activities of tobacco-leaf processing. Only dried tobacco-leaf is included in this sector. There are four kinds of dried tobacco-leaf, i.e., Virginia, Burley, Turkish and Native.
066	Tobacco products	This sector consists of cigar, cigarettes, cut tobacco and chewing tobacco.

Table A1 (Continued)

Code	Sector	Description
067	Spinning	This sector includes cotton, synthetic silk yarn, spun, short and long synthetic staple. Excluded from this sector are yarns from jute and kenaf.
068	Weaving	Covered in this sector are cotton fabrics, mixed-cotton fabrics, synthetic fabrics and silk fabrics. Jute and kenaf fabrics are not included here.
069	Textile bleaching, printing and finishing	This sector covers the activities of printing, bleaching and finishing textile.
070	Made-up textile goods	This sector covers all textile processed products not classified elsewhere. Products included are household textile furnishing materials, textile bags, canvas products, lace and lace products, textile-coated fabrics, felt and felt products and textile wadding material.
071	Knitting	Covered in this sector are knitted fabrics and products from knitted fabrics. Knitting products made directly from yarn such as stocking are also included.
072	Wearing apparel	This sector covers the products of wearing apparel and allied clothing produced in factory, except woven products such as handkerchiefs, neckties, shawls and veils Excluded are all kind of wearing apparel made by tailors.
073	Carpets and rugs	This sector covers only the products of carpets and rugs made from textile materials. Carpets and rugs from straw or material other than textile were not included.

Table A1 (Continued)

Code	Sector	Description
074	Jute mill products	Covered in this sector are products made from kenaf and jute. Other products included are yarn and fabrics of kenaf and jute except for those used in gunny bags. However, fishing nets made from materials of all kinds are included in this sector.
075	Tanneries and leather finishing	The tanning and finishing of animal leather and skin are included in this sector. Excluded are all kinds of artificial leathers.
076	Leather products	Leather and artificial leather products are covered in this sector.
077	Footwear, except of rubber	This sector covers footwear made of leather, fabrics and other materials. It excludes that wholly made of wood or moulded rubber or plastic.
078	Saw mills	This sector covers sawn timber and other wooden construction materials such as plywood and chip board.
079	wood and cork products	Except for furniture and fixtures, this sector covers products made from wood, rattan and bamboo such as wooden boxes and containers. Also included are handicraft utensils, articles and parts of equipment which can be commonly installed in different kinds of equipments.
080	Wooden furniture and fixtures	This sector covers all kinds of furniture and fixtures except those made of metal.
081	Pulp, paper and paperboard	This sector covers pulp, paper and paperboard.

Table A1 (Continued)

Code	Sector	Description
082	Paper and paperboard products	This sector included all kinds of paper and paperboard products such as paper boxes, book covers, writing-pads, envelopes, labels, paper bags and sanitary paper. Publishing house production such as books magazines and newspapers are not included.
083	Printing and publishing	This sector covers printing activities by one or more of the common processes such as the use of the letter-press, lithographing, offset printing and bookbinding. Also included are the publishing of newspapers, periodicals, books and maps.
084	Basic industrial chemicals	This sector covers the manufacture of basic industrial chemicals such as hydrogen, oxygen, nitrogen, chlorine, sulfur and other chemical elements; inorganic acids and other oxygen compounds of metalloids such as hydrochloric acid, sulfuric acid, nitric acid and carbon dioxide; inorganic bases and metallic oxides such as ammonia and caustic soda; salts of inorganic acids such as aluminum sulfate, potassium nitrate, soda ash, sodium silicate and calciumhypochloride; carbides; and organic chemicals such as methylalcohol, polyhydric alcohols, esters of polyhydric alcohols, acetic acid and aldehydes.
085	Fertilizer and pesticides	The products of this are urea, ammonium sulfate, phosphate, chemical fertilizer, organic fertilizer, pesticides and insecticides.

Table A1 (Continued)

Code	Sector	Description
086	Petrochemical products	This sector covers the activities involved in the processing of petrochemical. The productions covered by this sector are upstream production such as Ethylene, Propylene; intermediate production such as Vinyl chloride monomer, Styrene monomer and downstream production such as Polyvinyl chloride, Polyethylene, etc.
087	Paints	This sector covers the manufacture of paints, varnishes, stains and shellac, lacquers, enamels and japans. Also included are the manufacture of allied products such as composite thinners, paint removers, paint brush cleaners, putty and other coating and filling material. Dyes, organic and inorganic pigments are not included.
088	Drugs and medicines	This sector includes the production of drugs and medicines in all forms such as tables, capsules, powder, syrup and liquids for injection. Traditional medicine such as herbs is also included.
089	Soap and cleaning preparations	This products includes in this sector are soap, detergent, shampoo, glycerine and toilet preparation.
090	Cosmetic	This sector includes the production of perfumes, cosmetic, hair cream, toothpaste, talcum powder and deodorant.
091	Matches	This sector covers matches of all kinds.

Table A1 (Continued)

Code	Sector	Description
092	Other chemical products	Included in this sector are the manufacture of chemical products such as furniture and metal polishes, leather polishes, waxes, adhesive and glues, candles, inks, carbon black and essential oil. Also included are tanning and dyeing material such as natural indigo, vegetable dye, tanning agents and inorganic pigments. Wood chemicals such as gums and incense products such as joss sticks are also covered.
093	Petroleum refineries	This sector covers oil-processing refineries. The products if this sectors are gasoline, jet oil, LPG, asphalt, paraffin, sulfur, kerosene, diesel and fuel oil.
094	Other petroleum products	This sector covers refined oil, refined grease and lubricating oil
095	Rubber sheet and block rubber	This sector covers rubber sheets, block rubber, crepe rubber and other processed rubber.
096	Types and tubes	This sector covers all types and tubes such as those for passenger car, truck and bus, tractor, motorcycle and bicycle.
097	Other rubber products	This sector covers the manufacture of rubber products not classified elsewhere such as rubber raincoats, rubber gloves, rubber bags, rubber mats, rubber toys, rubber bands, rubber hose and tubes, rubber bottles and rubber sponges.

Table A1 (Continued)

Code	Sector	Description
098	Plastic ware	This sector covers the moulding, extruding and fabricating of plastic articles such as plastic household articles, plastic containers and cups, plastic mats, laminated sheets. Also included are plastic components for insulation, plastic furniture, and plastic industrial supplies.
099	Ceramic and earthen ware	The sector covers pottery, ceramic and earthenware for industrial and construction use. Sanitary supplies are also included.
100	Glass and glass products	This sector consists of window flat glass, bottles, drinking glasses, lamp chimneys and other.
101	Structural clay products	This sector covers bricks, tiles pipes, refractory bricks and other similarly structural clay products.
102	Cement	This sector consists of portland cement, white cement and lime.
103	Concrete and cement products	This sector covers the manufacture of concrete products such as blocks, posts and piles, precast elements for prefabricates construction materials, other reinforced and pre-stressed concrete products as well as Buddha images and spirit houses.
104	Other non-metallic products	Included in this sector are the manufacture of gypsum plaster products, wood-wool board (cellocrete) and other asbestos product. Cut stone products which were not produced in conjunction with quarrying and all other non-metallic mineral products not classified elsewhere are also included.
105	Iron and steel	The sector covers pig iron, ingot, ferro-silicon, ferro-manganese and (by-product of pig iron).

Table A1 (Continued)

Code	Sector	Description
106	Secondary steel products	The products of this sector are galvanized sheet, tin plate, angle bar and rod wire, tube and pipe. Steel forging, steel casting, polished steel are also included.
107	Non-ferrous metal	This sector covers the activities relating to the manufacture of primary non-ferrous metal products consisting of primary and secondary smelting, alloying, refining, rolling and drawing, founding and casting.
108	Cutlery and hand tools	This sector covers the manufacture of table, kitchen and other cutlery, hand and edge tools such as axes, sickles, shovels, rakes and other agricultural and garden tools, hammers, screw drivers, files and handsaws. Plumbers', masons', mechanics' and machinists' precision hand tools, hinges, locks key sets, builders' hardware and marine luggage and vehicles hardware are also included.
109	Metal furniture and fixtures	This sector covers the manufacture and alteration of furniture and fixtures consisting primary of metal for household, office, public building, transport equipment, professional and restaurant uses.

Table A1 (Continued)

Code	Sector	Description
110	Structure metal products	This sector covers the manufacture of steel or other metal structure components such as bridges, tanks, building structure, doors and screens, window frames and sashes, shutter, staircases, wrought iron gates. Other architectural metalwork such as metal components for ventilating and air-conditioning systems as well as steam and water-tanks are also included.
111	Other fabricated metal products	This sector covers the manufacture of fabricated metal products such as metal cans from tinplate, enameled sheet metal, metal conveyances, metal shipping containers, metal stamping, fabricates wire and wire products from purchased wire rods (excluding insulated wire and cable). Sanitary ware, plumbers' brass good, pipe fittings, enameling, lacquering, galvanizing, electroplating and polishing metal products and a variety of metal products not classified elsewhere are also included. In addition, the sector covers common machinery part such as bearing an spring, except specialized parts for motor vehicles, aircraft and ships which belong to their respective machinery sectors.
112	Engines and turbines	This sector covers the assembling of stream engines, other engines and turbines. Also included are the parts and repair of engines and turbines.

Table A1 (Continued)

Code	Sector	Description
113	Agricultural machinery and equipment	This sector covers the assembling of cultivating machines and equipment, sawing and planting machines, harvesting machines and equipment. parts and repair of agricultural machines and equipment.
114	Wood and metal working machines	This sector covers the activities relating to the assembling of wood and metal working machines such as sawing machines, and the parts and repairing of such machines.
115	Special industrial machinery	This sector covers all kinds of industrial machines except those used for wood and metalworking, agricultural machines as well as electrical machines. Machinery included in the sector is for example, construction and mining machines, food and chemical machines, leather and textile machines, etc. Also included in this sector are pneumatic tools, carrying and loading equipment such as cranes, forklifts and loading trucks, etc. Parts of such machinery and their repair are also included.
116	Office and household machinery and appliances	This sector covers the assembling of office and household machinery and appliances such as air conditioners, refrigerator, freezers, water cooler, sewing machines, typewriters, electric calculators and all parts. Since the repair of them are not covered in this sector.

Table A1 (Continued)

Code	Sector	Description
117	Electrical industrial machinery and appliances	This sector covers the products of electrical industrial machinery and appliances such as generators, transformer, rectifiers, motors, electrical hand tools, electrical motors, electrical welding machines and other electrical machines. Parts for these machines are also are also included.
118	Radio, television and communication equipment and apparatus	This sector covers the assembly of radios, television sets, tape and cassette recorders, stereo components, telephone and other communication equipment. Also included are their parts but repairing is excluded.
119	Household electrical appliances	This sector covers the production of household electrical appliances such as electric stoves, electric iron, electric fans, rice cooker, toasters, food mixers and all their parts.
120	Insulated wire and cable	This sector covers the production of insulates wire and cable.
121	Electric accumulators and batteries	This sector covers the production of batteries and dry cells Parts such as lead plate are also included
122	Other electrical apparatus and supplies	This sector covers electrical apparatus and supplies not classified elsewhere, such as electric bulbs, and related light sources. Other products included are conductors, fuses, connectors, etc.
123	Ship building and repairing	Covered in this sector are the building and repairing of ship, boat and other water transport vessels. Part for these vessels are also included in the sector.

Table A1 (Continued)

Code	Sector	Description
124	Railroad equipment	This sector covers the production of railroad passenger cars and wagons. The parts and repairs of such equipment are also included in the sector.
125	Motor vehicles	This sector covers the production and assembly of motor vehicles. The products included are passenger cars, trucks, vans, pick-up, buses and the classis and parts of such vehicles.
126	Motor vehicles	The products of this sector are motorcycles, tricycles, bicycles, carriages and parts for such products.
127	Repair of motor vehicles	This sector covers automobile and motorcycle repair of all kinds.
128	Aircraft	This sector covers only aircraft repairing
129	Scientific equipment	The sector covers measuring equipment, medical equipment and the parts and repairs of such equipment.
130	Photographic and optical goods	This sector included optical goods, spectacles, telescopes, astronomical, instrument, microscopes, projectors, cameras, photo copying apparatus and parts for these products.
131	Watches and clocks	This sector covers the production and assembly of clocks and watches.

Table A1 (Continued)

Code	Sector	Description
132	Jewelry and related articles	This sector covers activities primary related to the manufacturing of jewelry using precious metals, precious and semi-precious stones and pearls, silverware and plotted ware using silver, gold and other precious metal plating. The cutting and polishing of precious stones and the making of coins and medals from precious metal are also included.
133	Recreational and athletic equipment	The products in this sector include musical instruments, music recording, footballs, golf balls, badminton rackets, boxing gloves and other recreational and athletic equipment.
134	Other manufactured goods	This sector covers the products that have been excluded from the manufacturing sectors by code 042 to 133. The main products of this sector are stationary, toys, umbrella, zippers, buttons, fasteners, etc.
135	Electricity	This sector covers the generation, transmission and distribution of electric for sale to household, industrial, commercial and public users. Electricity generation plants owned by manufacturing enterprises for their own use are also included.
136	Pipe line and gas distribution	This sector covers gas distribution such as LPG, ethane, propane, natural gasoline (NGL).
137	Water work and supply	This sector covers the activities related of the purification and distribution of water to household, industrial, commercial and public users. The operation of irrigation system is not included in this sector.

Table A1 (Continued)

Code	Sector	Description
138	Residential building construction	This sector covers the construction of new building for residential purposes such as homes, sop houses, apartment and dormitories. The activities of extending, repairing, painting and decorating buildings as well as the installation of electricity and air conditioning systems are also included. Excluded from this section is the cost of acquiring land.
139	Non-residential building construction	This sector covers the construction of new non-residential building such as business building, factories, hotels, school, hospitals, and warehouse as well as related activities of extension and repair. Excluded are the constructions of railway station, power station or communication plants.
140	Public works for agriculture and forestry	This sector covers the construction and extension of irrigation works for agriculture and forestry. Only new construction is included.
141	Non-agriculture public works	This sector covers the construction and repair of highway, streets, roads, bridges, airports, water supplies and sewage systems.
142	Construction of electric plants	This sector covers the construction and repair of electricity generating plants and transmission systems.
143	Construction of communication facilities	This sector covers the construction and repair of broadcasting and communication systems such as radio station, town telephone installation and other facilities.

Table A1 (Continued)

Code	Sector	Description
144	Other construction	This sector covers the construction work not classified elsewhere such as the construction of public parks, parking lots, golf courses, tennis courts, swimming pools and athletic fields of all kinds.
145	Wholesale trade	This sector includes establishments for the re-sale of new and used goods to retail, industrial, commercial, institutional and professional outlets, as well as for other wholesale uses. Agents engaged in buying or selling merchandise are also covered in the sector. The principal type of business included are wholesale merchants engaged in own-account buying and selling, industrial distributors, exporters and co-operative buying associations and sales offices maintained by mining or manufacturing enterprises for the purpose of marketing their products. Also included are co-operative associations engaged in the marketing of farm produce, scrap metal and waste dealers, junk yards, wholesalers who sort and grade goods in large lots wholesale packers, bottling companies except those engaged in packing or bottling in airtight containers.

Table A1 (Continued)

Code	Sector	Description
146	Retail trade	This sector included establishments engaged in the sale to the general public of new and used goods for personal or household consumption. Retailing establishments include shops, department stores, stalls, gasoline service stations, retail motor vehicle dealers, peddlers, consumer co-operatives, and auction houses. Included also are own-account retailers who act as agents, buying and selling on consignment or on a commission basis. Establishments engaged in selling displayed merchandise such as typewriters, stationary and petrol to the general public are classified in this group though these goods may not be for personal or household uses.
147	Restaurants and drinking places	The sector includes establishments engaged in selling prepared food or drink for immediate consumption such as nightclubs, restaurants, bard, coffee shops, etc. Also included are canteens and eating facilities in plants and offices. Restaurants operated by hotels and massage parlors for the general public are also included. Peddlers of food and noodle stands are also covered in this sector.

Table A1 (Continued)

Code	Sector	Description
148	Hotels and places of loading	This sector includes establishments engaged in the provision for fee of lodging and camping facilities, whether open to the general public or restricted to members of a particular organization. Related restaurant facilities operated for the purpose of serving the establishment's customers are also included.
149	Railways	This sector covers the service related to the transportation of both passengers and cargo. Also included are dining car services. Since the repair of railway equipment is not covered in this sector.
150	Road passenger transport	This sector covers only the transport of passengers by taxicabs, buses, inter-city buses and other vehicles such as tricycles. Private vehicles for personal transportation are excluded.
151	Road freight transport	This sector cover local and long distance trucking. Also included are such services for one's own business purposes.
152	Land transport support service	This sector includes all land transport support services such as the operation of parking lots, toll roads rental of automobiles and self-driven trucks.
153	Ocean transport	This sector covers the ocean transport of both passengers and freight.
154	Coastal and inland water transport	This sector refers to the operation of freight and passenger vessels along various parts of the coast of Thailand. Those operated on inland waterways, river ferries and tugboats are included.

Table A1 (Continued)

Code	Sector	Description
155	Water transport services	Included in this sector are the provision of supporting services for water transport of all kinds such as the maintenance and operation of harbors, docks, lighthouses and other navigation aids, loading and unloading services, the salvaging of vessels, ship leasing and rental. Included in this sector are the activities of the Port Authority of Thailand.
156	Air transport	The transportation of passengers and freight by air by regular services or by charter are covered in this sector. The operation of airports, landing fields and navigational facilities such as flight control centers, radar stations and the rental of aircraft are also included in the sector.
157	Other services	This sector covers the activity of establishments engaged in providing travel information and arranging tours and transportation for passengers. The activities of establishments engaged in cargo transportation are also covered.
158	Storage and warehousing	This sector covers the operation of storage facilities and warehouse. Silo services for drying maize are also included.
159	Post and telecommunication	This sector covers the services of central and provincial offices of the Telephone Organization of Thailand. Construction and radio-communication activities of the Post and Telegraph Department are not included.

Table A1 (Continued)

Code	Sector	Description
160	Banking services	This sector covers all activities of monetary and financial institutions. Included are the central bank, commercial banks, development banks, saving bank, rural banks, pawnshops, credit cooperatives and foreign exchange dealers.
161	Life insurance services	Life insurance is defined as the activities of life insurance institutions and related services.
162	Other insurance services	This sector covers all insurance other than life such as fire, accident, marine and health insurance.
163	Real estate	This sector covers the activities of real estate agents and brokers
164	Business services	The sector includes service such as accounting, auditing and book-keeping services, data processing and tabulating services, engineering, architectural and technical services, parliament and the judicial authorities.
165	Public administration	The sector covers the central, provincial and local government, as well as the royal household, parliament and the judicial authorities.
166	Sanitary and similar services	This sector covers the activities related to sanitary and similar services such as garbage and sewage disposal, the operation of drainage systems and the purification of water for consumption. Also included are cleaning services

Table A1 (Continued)

Code	Sector	Description
167	Education	This sector covers all public and education institution at all levels such as kindergartens, primary schools, secondary schools, colleges and universities. Also included are vocational schools and others providing specialized education such as language and painting schools. Research institute, hospitals belonging to universities, as well as education provided neither by government nor household are not included.
168	Research	This sector includes institutions primarily engaged in basic and general research in the biological, physical and social sciences. Since information on private research institutes in Thailand are not available, only research accomplished by government offices, universities and public enterprises are included.
169	Hospital	Covered in this sector are medical, surgical, dental and other health services. This includes hospitals, sanitariums, nursing homes and similar institution, maternity and child welfare clinics, consulting offices of physicians, surgeons and other medical practitioners such as dentists, the services of midwives and nurses in private practice ambulance service and medical and dental laboratories that provide testing, diagnostic and other service to the medical and dental professions. Activities primary relating to the manufacture of dental supplies and artificial teeth to order are also included.

Table A1 (Continued)

Code	Sector	Description
170	Business and labor associations	This sector includes private business institution such as the Board of Trade of Thailand, the Thai Chamber of Commerce, The Association of Thai industries and professional organizations such as the Engineering Institute of Thailand, labor unions and labor organization.
171	Other community service	This sector includes institution engaged in providing social welfare services such as the Red Cross Society and other organization for the collection and allocation of charitable contribution such as children and societies, dry nurseries, orphanages, home for destitute adults, homes for handicapped person, home for aged, family welfare society and other charitable organization. This section was classified broadly into three types of organizations, namely, Red Cross Society, other charitable organizations and religious organizations.
172	Movie theatres	This sector covers the activities relating to the production of motion pictures for showing. They also include both still and slide films. Other related services such as film developing, printing, film editing, titling, copying and distributing of both local and foreign films are also included.
173	Movie theatres	All theatres and movie houses are covered in this sector.

Table A1 (Continued)

Code	Sector	Description
174	Radio, television and related services	Included in this sector are radio and television stations primarily engaged in the production and dissemination of audiovisual programs for the public. The activities of television and radio relay stations are also included in this sector.
175	Libraries and museums	This sector covers the operation of libraries, information centers, archeological and others museums, art galleries, botanical and zoological gardens and similar institutions.
176	Amusement and recreation	This sector covers the activities of theatres providing theatrical presentation such as classical drama, dance and concerts, entertainment services such as those provided by bands and orchestras and musical recording. This sector also includes the services related to theatrical presentation such as those provided by booking agencies for plays. Self-employed artists and instructors such as actors, dancers, musicians, singer and other entertainers and producers for radio and television programs, motion picture, play and other presentations, composers and song writers, authors, painters and operators of dance halls, bowling alleys, billiard and pool rooms, race tracks, boxing stadiums, football fields, sports clubs, gymnasiums, tennis courts and golf courses, sport promoters, operators, of amusement parks and renters of pleasure boats, motorcycles, golf carts, saddle horses and similar recreation goods are also included in this sector.

Table A1 (Continued)

Code	Sector	Description
177	Repair not classified elsewhere	This sector included establishments specialized in the repair of household appliances, equipment and furnishing, motor cars and other consumers goods which are not classified elsewhere. Also included in this sector are establishments specialized in the installation of household appliances such as stoves and ranges, refrigerators, air-conditioning apparatus and television sets.
178	Personal service	This sector included establishments primarily engaged in washing, ironing, dry cleaning, pressing and dyeing apparel, house furnishing or household fabrics. The repair of clothing, bedspreads, blanket, curtains and other personal and household textiles are also included in this sector. This sector also included the services of maids, cooks, gardeners, caretakers and other maintenance workers for household, whether provided by individuals who are employed by these households or by business units primarily engaged in furnishing these services. In addition, establishments engaged in rendering personal care and services not classified elsewhere such as barber hairdressing and beauty shop, photographic studios, Turkish baths establishments, massage parlors and crematories are also included.
179	Other service not classified elsewhere	This sector included all service that are not covered by other sectors.

Table A1 (Continued)

Code	Sector	Description
180	Unclassified	This sector includes mainly activities not classified elsewhere.
190	Total intermediate transactions	This is the sum of sectors 001 to 180
201	Wages and salaries	This sector covers compensation by employers to employees both in cash and in kind. Employees are classified as long-term workers, temporary workers, temporary workers, executives and hired laborers in the agricultural sector, but not family workers.
202	Operating surplus	The operating surplus is defined as the total value added including business income tax, minus wages and salaries, depreciation and indirect taxes, less subsidies.
203	Depreciation	Depreciation consists of capital consumption allowances for all fixed assets. The imputation of depreciation of government buildings is describe in the public administration sector and that of self-occupied dwellings is in real estate sector. The depreciation on fixed assets for leasing such as computers is shown in the sector of owner of fixed assets for leasing such as computers is show in the sector of owner of fixed assets.
204	Indirect taxes less subsidies	Indirect taxes cover the domestic commodity sales tax, export duty, licensing frees, service tax of hotels, restaurant and the like, duty stamps and special commodity tax such as those on automobiles, electrical equipment, alcoholic drinks, cigarettes, petroleum products, ect.

Table A1 (Continued)

Code	Sector	Description
209	Total value added	This is sum of all the primary inputs from 201 to 204.
210	Control total	This is sum of total intermediate transactions and value added.
301	Private consumption expenditures	Private consumption expenditures are the current expenditures on goods and service by households and private non-profit organizations. The expenditure also cover the expenditures of Thai nationals abroad as tourists and the expenditures of the family of a foreigner who is working for a private company or a non-profit organization in Thailand.
302	Government consumption expenditure	Government consumption expenditures cover all current expenditures of government for goods and services, including those for the police and military forces. Expenditures of Royal household are also included. However, consumption expenditures of public enterprises which are profit-making are not included.
303	Gross domestic fixed capital formation	Gross domestic fixed capital formation includes fixed assets such as land, buildings, machinery and equipment belonging to households, government and private enterprise except those for military use. Public infrastructure such as roads, dams and power stations are also included. However, installation costs of equipment and machinery are not covered.

Table A1 (Continued)

Code	Sector	Description
304	Increase in stock	Stocks or inventories comprise the followings : finished products stored in producers' factories or warehouses, unused raw materials purchased by producers, semi-processed products and products on processing lines and marketable stocks held by wholesalers and retailers. Stocks kept by households are not included.
305	Export	In the input-output table at purchasers' prices, exports were valued at f.o.b. prices. As for producers' prices, exports were valued by subtracting trade margins and transport costs from f.o.b. process.
306	Special exports	Special exports cover non-merchandised goods and services which are not included in the official export statistics. Item which are included here are freight and insurance related to export, expenditures of foreign tourists in Thailand and related transportation cost, expenditures of foreign government organization, international organizations and families of diplomats, expenditures of foreign military bases, other service charges which are paid by foreigners and estimated smuggling.
309	Total final demand	This is the sum of codes 301 to 306.
310	Total demand	This is the sum of codes 190 and 309

Table A1 (Continued)

Code	Sector	Description
401	Imports	Imports were valued at c.i.f. process plus tariff. However, for valuation at domestic producers' prices, the transport costs and insurance paid by the Thai importers were subtracted in order to avoid double counting. A special treatment was used here. The redundant transport costs and insurance were regarded as special exports and are treated in the special export sector.
402	Import duty	Customs duty on imports is included under this code.
403	Import tax	The Import tax includes both import sales tax and municipal tax on imported.
404	Special imports	As in the case special exports, special imports are non-merchandised goods and services which are not covered in the official trade statistics, e.g. expenditures of Thai nationals abroad, expenditure of Thai government organizations and of the families of Thai diplomats outside Thailand and estimated smuggling into Thailand.
409	Total imports	This is the sum of codes 401 to 404
501	Wholesale trade margin	Wholesale trade margin is margin of goods from factory toward retail trade.
502	Retail trade margin	Retail trade margin is margin of goods from retail toward household consumption.
503	Transport cost	The transport costs is value of transport goods process from factory toward consumer.
509	Total trade margin and transport costs	This is the sum of codes 501 to 503

Table A1 (Continued)

Code	Sector	Description
600	Control total	This is sum of total intermediate transactions and final demands which indicates the output distribution of the table and is equal to codes 190 + 309 + 409 +509.
700	Total supply	The total supply is equal to codes 600 – 409 – 509.

Appendix B

GEMPACK Programming of a CGE Model Using 180 Sectors Input-Output Table of 2010 Edition for the Projection of Economic Impacts of Changes in Thailand Transparency Index and Associated Changes in CO_2 Emissions

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!-------------------------------------------------------------------------------------------!
!   CGE Model 180 sectors for PROJECTION OF ECONOMIC IMPACTS OF    !
!   CHANGES IN THAILAND TRANSPARENCY INDEX AND ASSOCIATED    !
!                          CHANGES IN CO2 EMISSION                                  !
!       Based on The Sufficiency Economy Experimental by Dr.sompote            !
!-------------------------------------------------------------------------------------------!

!-----------------!
!     SET       !
!-----------------!

SET SECT # Sectors # (s1-s180) ;
SET SOURCE # Source # (Domestic,Import) ;

!---------------------!
!   VARIABLE    !
!---------------------!

VARIABLE (all,i,SECT)(all,s,SOURCE) p0(i,s) # Commodity price # ;
VARIABLE (all,j,SECT) p01(j) # Labor Price # ;
VARIABLE (all,j,SECT) p02(j) # Capital Rent # ;
VARIABLE (all,j,SECT) p03(j) # Tax Rate # ;
VARIABLE (all,j,SECT) pz1(j) # Investment cost # ;

VARIABLE cpi1 # Investment Price # ;
VARIABLE cpi2 # Consumer Price # ;
```

```
VARIABLE cpi3 # Government Price # ;

VARIABLE (all,j,SECT) rp01(j) # Real Labor Price # ;
VARIABLE (all,j,SECT) rp02(j) # Real Capital Rent # ;

VARIABLE xr # Exchange Rate # ;

VARIABLE (all,i,SECT) pw1(i) # Export Price # ;
VARIABLE (all,i,SECT) pw2(i) # Import Price # ;
VARIABLE (all,i,SECT) v1(i) # Export tax # ;
VARIABLE (all,i,SECT) v2(i) # Import Tax# ;
VARIABLE (all,i,SECT) fx4(i) # Shift export # ;
VARIABLE (all,i,SECT) (all,j,SECT) (all,s,SOURCE) x0(i,j,s)
# Breakdown produced inputs # ;

VARIABLE (all,j,SECT) x01(j) # Labor input # ;
VARIABLE (all,j,SECT) x02(j) # Capital input # ;
VARIABLE (all,j,SECT) x03(j) # Indirect taxes # ;

VARIABLE (all,j,SECT) z01(j) # Commodity supply and demand # ;
VARIABLE (all,i,SECT) z02(i) # Imports commodity i # ;
VARIABLE (all,j,SECT) z1(j) # Investment by sector # ;
VARIABLE (all,i,SECT) (all,s,SOURCE) cx1(i,s) # Investment by column # ;

VARIABLE gdpi # income side GDP # ;
VARIABLE va1 # Total labor input # ;
VARIABLE va2 # Total Capital input # ;
VARIABLE va3 # Total indirect taxes # ;

VARIABLE gdpe # expenditure side GDP # ;
VARIABLE gdpr # real GDP # ;
VARIABLE gdpdf # GDP deflator # ;

VARIABLE c1 # Total investment consumption # ;
VARIABLE c1r # Real Total investment consumption # ;
VARIABLE c2 # Total household consumption # ;
VARIABLE c2r # Real Total household consumption # ;
VARIABLE c3 # Total government consumption # ;
```

```
VARIABLE c3r # Real Total government consumption # ;

!VARIABLE (all,j,SECT) r0(j) # Current rate of return of capital # ;
VARIABLE r1 # Future rate of return of capital# ;
VARIABLE (all,j,SECT) k1(j) # Future capital stock # ; !
VARIABLE (all,j,SECT) k0(j) # Current capital stock # ;



VARIABLE e # Total exports # ;
VARIABLE m # Total import # ;
VARIABLE (change) delBT # Trade balance # ;
VARIABLE (change) delDT # Debt_GDP Ratio # ;

VARIABLE (all,i,SECT) (all,j,SECT) (all,s,SOURCE) x1(i,j,s)
# Breakdown investment # ;
VARIABLE (all,i,SECT) (all,s,SOURCE) x2(i,s) # Breakdown HH consumption # ;
VARIABLE (all,i,SECT) (all,s,SOURCE) x3(i,s) # Breakdown government # ;
VARIABLE (all,i,SECT) x4(i) # Exports commodity i # ;
VARIABLE (all,i,SECT) (all,s,SOURCE) x5(i,s) # Inventory commodity i # ;
VARIABLE (all,i,SECT) x6(i) # Special exports commodity i # ;

VARIABLE (change) delFudge # Forecast var # ;
VARIABLE (all,j,SECT) f_accum(j) # Cap shift # ;

!-----------------------------------------------!
!                Read Files                     !
!-----------------------------------------------!

FILE data2010 # Data # ;
FILE MDATA180 # Cap_accum # ;

!-----------------------------------------------!
!              COEFFICIENT                      !
!      base data , updates and reads            !
!-----------------------------------------------!

COEFFICIENT (all,i,SECT)(all,j,SECT) VDINPUT(i,j)
# Value domestic intermediate # ;
```

```
UPDATE(all,i,SECT)(all,j,SECT) VDINPUT(i,j)
= p0(i,"Domestic") * x0(i,j,"Domestic") ;
COEFFICIENT (all,i,SECT)(all,j,SECT) VMINPUT(i,j)# value import intermediate # ;
UPDATE(all,i,SECT)(all,j,SECT) VMINPUT(i,j)
= p0(i,"Import") * x0(i,j,"import") ;

COEFFICIENT (all,j,SECT) VX01(j) # value labor inputs # ;
UPDATE (all,j,SECT) VX01(j) = p01(j) * x01(j);

COEFFICIENT (all,j,SECT) VX02(j) # value capital inputs # ;
UPDATE (all,j,SECT) VX02(j) = p02(j) * x02(j) ;

COEFFICIENT (all,j,SECT) VX03(j) # value indirect taxes # ;
UPDATE (all,j,SECT) VX03(j) = x03(j) ;

COEFFICIENT (all,i,SECT)(all,j,SECT) VDX1(i,j) # value domestic investment # ;
UPDATE (all,i,SECT)(all,j,SECT) VDX1(i,j)
= p0(i,"Domestic") * x1(i,j,"Domestic") ;

COEFFICIENT (all,i,SECT)(all,j,SECT) VMX1(i,j) # value Import investment # ;
UPDATE (all,i,SECT)(all,j,SECT) VMX1(i,j) = p0(i,"Import") * x1(i,j,"Import") ;

COEFFICIENT (all,i,SECT) VDX2(i) # value domestic HH consumption # ;
UPDATE (all,i,SECT) VDX2(i) = p0(i,"Domestic") * x2(i,"Domestic") ;

COEFFICIENT (all,i,SECT) VMX2(i) # value Import HH consumption # ;
UPDATE (all,i,SECT) VMX2(i) = p0(i,"Import") * x2(i,"Import") ;

COEFFICIENT (all,i,SECT) VDX3(i) # value domestic government # ;
UPDATE (all,i,SECT) VDX3(i) = p0(i,"Domestic") * x3(i,"Domestic") ;

COEFFICIENT (all,i,SECT) VMX3(i) # value Import government # ;
UPDATE (all,i,SECT) VMX3(i) = p0(i,"Import") * x3(i,"Import") ;

COEFFICIENT (all,i,SECT) VX4(i) # value export # ;
UPDATE (all,i,SECT) VX4(i) = p0(i,"Domestic") * x4(i) ;

COEFFICIENT (all,i,SECT) VDX5(i) # value domestic inventory # ;
```

```
UPDATE (all,i,SECT) VDX5(i) = p0(i,"Domestic") * x5(i,"Domestic") ;

COEFFICIENT (all,i,SECT) VMX5(i) # value Import inventory # ;
UPDATE (all,i,SECT) VMX5(i) = p0(i,"Import") * x5(i,"Import") ;

COEFFICIENT (all,i,SECT) VX6(i) # value special export # ;
UPDATE (all,i,SECT) VX6(i) = p0(i,"Domestic") * x6(i) ;

COEFFICIENT TINY # Small Value # ;
FORMULA TINY = 0.000001 ;

COEFFICIENT TINY2 # Small Value 2 # ;
FORMULA TINY2 = 0.000002 ;

COEFFICIENT TINY4 # Small Value 4 # ;
FORMULA TINY4 = 0.000180 ;

COEFFICIENT (Parameter)(all,i,SECT) GAM(i) # Export elasticity # ;
READ GAM FROM FILE mdata180 HEADER "GAMM" ;

!----------!

READ VDINPUT FROM FILE data2010 HEADER "X0DO" ;
READ VMINPUT FROM FILE data2010 HEADER "X0IM" ;

READ VX01 FROM FILE data2010 HEADER "VA1" ;
READ VX02 FROM FILE data2010 HEADER "VA2" ;
READ VX03 FROM FILE data2010 HEADER "VA3" ;

READ VDX1 FROM FILE data2010 HEADER "DX1" ;
READ VMX1 FROM FILE data2010 HEADER "MX1" ;
READ VDX2 FROM FILE data2010 HEADER "DX2" ;
READ VMX2 FROM FILE data2010 HEADER "MX2" ;
READ VDX3 FROM FILE data2010 HEADER "DX3" ;
READ VMX3 FROM FILE data2010 HEADER "MX3" ;
READ VX4 FROM FILE  data2010 HEADER "EXPD" ;
READ VDX5 FROM FILE data2010 HEADER "DX5" ;
READ VMX5 FROM FILE data2010 HEADER "MX5" ;
```

```
READ VX6 FROM FILE  data2010 HEADER "EXPS" ;

!------ other coefficients and formulas---------!

ZERODIVIDE (NONZERO_BY_ZERO) DEFAULT 0.000001;

COEFFICIENT (all,i,SECT) VZ01(i) # Total domestic demand # ;
FORMULA (all,i,SECT) VZ01(i) = SUM(j,SECT,VDINPUT(i,j))
+ SUM(j,SECT,VDX1(i,j)) + VDX2(i) + VDX3(i) + VX4(i) + VDX5(i)
+ VX6(i) + TINY4 ;

COEFFICIENT (all,i,SECT) VZ02(i) # Total demand import goods # ;
FORMULA (all,i,SECT) VZ02(i) = SUM(j,SECT,VMINPUT(i,j))
+ SUM(j,SECT,VMX1(i,j)) + VMX2(i) + VMX3(i) + VMX5(i) + TINY4  ;

COEFFICIENT (all,j,SECT) VSPLY(j) # Total supply # ;
FORMULA (all,j,SECT) VSPLY(j) = SUM(i,SECT,VDINPUT(i,j))
+ SUM(i,SECT,VMINPUT(i,j)) + VX01(j) + VX02(j) + VX03(j) + TINY4 ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,SOURCE) HX0(i,j,s)
# share X0 Supply # ;
FORMULA (all,i,SECT)(all,j,SECT) HX0(i,j,"Domestic")
= [VDINPUT(i,j) + TINY] / VSPLY(j) ;

FORMULA (all,i,SECT)(all,j,SECT) HX0(i,j,"Import")
= [VMINPUT(i,j) + TINY] / VSPLY(j) ;

COEFFICIENT (all,j,SECT) HX01(j) # Share X01 supply # ;
FORMULA (all,j,SECT) HX01(j) = [VX01(j) + TINY] / VSPLY(j) ;

COEFFICIENT (all,j,SECT) HX02(j) # Share X02 supply # ;
FORMULA (all,j,SECT) HX02(j) = [VX02(j) + TINY] / VSPLY(j) ;

COEFFICIENT (all,j,SECT) HX03(j) # Share X03 supply # ;
FORMULA (all,j,SECT) HX03(j) = [VX03(j) + TINY] / VSPLY(j) ;

COEFFICIENT (all,j,SECT) VFAC(j) # Total primary factor # ;
FORMULA (all,j,SECT) VFAC(j) = [VX01(j) + TINY] + [VX02(j) + TINY] ;
```

```
COEFFICIENT (Parameter) (all,j,SECT) SFAC1(j) # Share X01 Primary # ;
FORMULA (Initial)(all,j,SECT) SFAC1(j) = [VX01(j) +TINY] / VFAC(j) ;

COEFFICIENT (Parameter) (all,j,SECT) SFAC2(j) # Share X02 Primary # ;
FORMULA (Initial)(all,j,SECT) SFAC2(j) = [VX02(j) +TINY] / VFAC(j) ;

COEFFICIENT VA_1 # Total VA1 # ;
FORMULA VA_1 = SUM(j,SECT,[VX01(j)+TINY]) ;

COEFFICIENT VA_2 # Total VA2 # ;
FORMULA VA_2 = SUM(j,SECT,[VX02(j)+TINY]) ;

COEFFICIENT VA_3 # Total VA3 # ;
FORMULA VA_3 = SUM(j,SECT,[VX03(j)+TINY]) ;

COEFFICIENT (all,j,SECT) S01(j) # Share VA1 # ;
FORMULA (all,j,SECT) S01(j) = [VX01(j) + TINY] / VA_1 ;

COEFFICIENT (all,j,SECT) S02(j) # Share VA2 # ;
FORMULA (all,j,SECT) S02(j) = [VX02(j) + TINY] / VA_2 ;

COEFFICIENT (all,j,SECT) S03(j) # Share VA3 # ;
FORMULA (all,j,SECT) S03(j) = [VX03(j) + TINY] / VA_3 ;

COEFFICIENT VGDPI # Income GDP # ;
FORMULA VGDPI = VA_1 + VA_2 + VA_3 ;

COEFFICIENT H01 # Share ZVA1 # ;
FORMULA H01=VA_1 / VGDPI ;

COEFFICIENT H02 # Share ZVA2 # ;
FORMULA H02=VA_2 / VGDPI ;

COEFFICIENT H03 # Share ZVA3 # ;
FORMULA H03=VA_3 / VGDPI ;
```

```
COEFFICIENT (all,i,SECT)(all,j,SECT) VZX0(i,j) # Total sectoral x0 # ;
FORMULA (all,i,SECT)(all,j,SECT) VZX0(i,j)
= [VDINPUT(i,j) + TINY] + [VMINPUT(i,j) + TINY] ;

COEFFICIENT (Parameter)(all,i,SECT)(all,j,SECT)(all,s,SOURCE) SZX0(i,j,s)
 # Share sectoral x0 # ;
FORMULA (Initial)(all,i,SECT)(all,j,SECT) SZX0(i,j,"Domestic")
= [VDINPUT(i,j) + TINY] / VZX0(i,j)  ;
FORMULA (Initial)(all,i,SECT)(all,j,SECT) SZX0(i,j,"Import")
= [VMINPUT(i,j) + TINY] / VZX0(i,j)  ;

!    Capital production parameter SZX1    !

COEFFICIENT (all,i,SECT)(all,j,SECT) VZX1(i,j) # Total sectoral x1 # ;
FORMULA (all,i,SECT)(all,j,SECT) VZX1(i,j)
= VDX1(i,j)  + VMX1(i,j)  ;

COEFFICIENT(Parameter)(all,i,SECT)(all,j,SECT)(all,s,SOURCE) SZX1(i,j,s)
# Sectoral share x1 investment # ;
FORMULA (Initial)(all,i,SECT) (all,j,SECT) SZX1(i,j,"Domestic")
= VDX1(i,j)  / VZX1(i,j)  ;
FORMULA (Initial)(all,i,SECT) (all,j,SECT) SZX1(i,j,"Import")
= VMX1(i,j)  / VZX1(i,j)  ;

! ---------------------------------- !

COEFFICIENT (all,i,SECT)(all,s,SOURCE) COLX1(i,s) # Column x1  # ;
FORMULA (all,i,SECT) COLX1(i,"Domestic") = SUM(j,SECT,VDX1(i,j))  ;
FORMULA (all,i,SECT) COLX1(i,"Import") = SUM(j,SECT,VMX1(i,j))  ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,Source) RCX1(i,j,s)
# Share for column x1  # ;
FORMULA (all,i,SECT)(all,j,SECT) RCX1(i,j,"Domestic")
= VDX1(i,j) /COLX1(i,"Domestic") ;
FORMULA (all,i,SECT)(all,j,SECT) RCX1(i,j,"Import")
= VMX1(i,j) /COLX1(i,"Import") ;
```

```
COEFFICIENT(all,j,SECT) VZ1(j) # Investment by sector # ;
FORMULA (all,j,SECT) VZ1(j) = SUM(i,SECT,VDX1(i,j)) + TINY4
+ SUM(i,SECT,VMX1(i,j)) + TINY4 ;

COEFFICIENT(all,j,SECT) G(j) # Z1 / K1 likes depreciation of capital# ;
FORMULA (all,j,SECT) G(j) = VZ1(j) / [VX02(j) + VZ1(j)] ;

COEFFICIENT VC1 # Total investment  # ;
FORMULA VC1 = SUM(j,SECT,[VZ1(j)+TINY]) ;

COEFFICIENT (all,j,SECT) SZ1(j) # Share total investment  # ;
FORMULA (all,j,SECT) SZ1(j) = [VZ1(j)+TINY]/VC1 ;

!    Add share capital production     !

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,SOURCE) HZ1(i,j,s)
# Share for z1  # ;
FORMULA (all,i,SECT)(all,j,SECT) HZ1(i,j,"Domestic") = VDX1(i,j)/VZ1(j);
FORMULA (all,i,SECT)(all,j,SECT) HZ1(i,j,"Import") = VMX1(i,j)/VZ1(j) ;

COEFFICIENT VC2 # Total HH consumption # ;
FORMULA VC2 = SUM(i,SECT,VDX2(i))+TINY4  + SUM(i,SECT,VMX2(i))+TINY4 ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SX2(i,s) # Share x2 # ;
FORMULA (all,i,SECT) SX2(i,"Domestic") = [VDX2(i)+ TINY]  / VC2  ;
FORMULA (all,i,SECT) SX2(i,"Import") = [VMX2(i) + TINY] / VC2  ;

COEFFICIENT VC3 # Total government # ;
FORMULA VC3 = SUM(i,SECT,VDX3(i)) + TINY4 + SUM(i,SECT,VMX3(i)) + TINY4 ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SX3(i,s) # Share x3 # ;
FORMULA (all,i,SECT) SX3(i,"Domestic") = [VDX3(i) + TINY] / VC3  ;
FORMULA (all,i,SECT) SX3(i,"Import") = [VMX3(i) + TINY] / VC3  ;

COEFFICIENT VC5 # Total inventory # ;
FORMULA VC5 = SUM(i,SECT,VDX5(i)) + TINY4 + SUM(i,SECT,VMX5(i)) + TINY4 ;
```

```
COEFFICIENT VC6 # Total Special Export # ;
FORMULA VC6 = SUM(i,SECT,VX6(i)) + TINY4 ;

COEFFICIENT VE # Total Export # ;
FORMULA VE = SUM(i,SECT,VX4(i)) + TINY4 ;

COEFFICIENT VM # Total Import # ;
FORMULA VM = SUM(i,SECT,VZ02(i)) + TINY4 ;

COEFFICIENT VGDPE # Expenditure GDP # ;
FORMULA VGDPE = VC1 + VC2 + VC3 + VC5 + VC6 + VE - VM ;

COEFFICIENT (all,i,SECT) HX4(i) # Share x4 # ;
FORMULA (all,i,SECT) HX4(i) = [VX4(i) + TINY] / VE  ;

COEFFICIENT (all,i,SECT) HM(i) # Share z02 # ;
FORMULA (all,i,SECT) HM(i) = [VZ02(i) + TINY] / VM  ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,SOURCE) RX0(i,j,s)
# Share X0 in Total demand # ;

FORMULA (all,i,SECT)(all,j,SECT) RX0(i,j,"Domestic")
= [VDINPUT(i,j) + TINY] / VZ01(i) ;
FORMULA (all,i,SECT)(all,j,SECT) RX0(i,j,"Import")
= [VMINPUT(i,j) + TINY] / VZ02(i) ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,SOURCE) RX1(i,j,s)
# Share X1 in total demand # ;
FORMULA (all,i,SECT)(all,j,SECT) RX1(i,j,"Domestic")
= [VDX1(i,j) + TINY] / VZ01(i) ;
FORMULA (all,i,SECT)(all,j,SECT) RX1(i,j,"Import")
= [VMX1(i,j) + TINY] / VZ02(i) ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) RX2(i,s) # Share X2 in total demand # ;
FORMULA (all,i,SECT) RX2(i,"Domestic") = [VDX2(i) + TINY] / VZ01(i) ;
FORMULA (all,i,SECT) RX2(i,"Import") = [VMX2(i) + TINY] / VZ02(i) ;
```

```
COEFFICIENT (all,i,SECT)(all,s,SOURCE) RX3(i,s) # Share X3 in total demand # ;
FORMULA (all,i,SECT) RX3(i,"Domestic") = [VDX3(i) + TINY] / VZ01(i) ;
FORMULA (all,i,SECT) RX3(i,"Import") = [VMX3(i) + TINY] / VZ02(i) ;

COEFFICIENT (all,i,SECT) RX4(i) # Share X4 in total demand # ;
FORMULA (all,i,SECT) RX4(i) = [VX4(i) + TINY] / VZ01(i) ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) RX5(i,s) # Share X5 in total demand # ;
FORMULA (all,i,SECT) RX5(i,"Domestic") = [VDX5(i) + TINY] / VZ01(i) ;
FORMULA (all,i,SECT) RX5(i,"Import") = [VMX5(i) + TINY] / VZ02(i) ;

COEFFICIENT (all,i,SECT) RX6(i) # Share X6 in total demand # ;
FORMULA (all,i,SECT) RX6(i) = [VX6(i) + TINY] / VZ01(i) ;

!----------created share SHZCX1----------!

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SHZCX1(i,s)
# Share x1 by column in GDPE # ;
FORMULA (all,i,SECT) SHZCX1(i,"Domestic")
= [COLX1(i,"Domestic") + TINY] / VGDPE ;
FORMULA (all,i,SECT) SHZCX1(i,"Import")
= [COLX1(i,"Import") + TINY] / VGDPE ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SHX2(i,s) # Share x2 in GDPE # ;
FORMULA (all,i,SECT) SHX2(i,"Domestic") = [VDX2(i) + TINY] / VGDPE ;
FORMULA (all,i,SECT) SHX2(i,"Import") = [VMX2(i) + TINY] / VGDPE ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SHX3(i,s) # Share x3 in GDPE # ;
FORMULA (all,i,SECT) SHX3(i,"Domestic") = [VDX3(i) + TINY] / VGDPE ;
FORMULA (all,i,SECT) SHX3(i,"Import") = [VMX3(i) + TINY] / VGDPE ;

COEFFICIENT (all,i,SECT) SHX4(i) # Share x4 in GDPE # ;
FORMULA (all,i,SECT) SHX4(i) = [VX4(i) + TINY] / VGDPE ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SHX5(i,s) # Share x5 in GDPE # ;
FORMULA (all,i,SECT) SHX5(i,"Domestic") = [VDX5(i) + TINY] / VGDPE ;
```

```
FORMULA (all,i,SECT) SHX5(i,"Import") = [VMX5(i) + TINY] / VGDPE ;

COEFFICIENT (all,i,SECT) SHX6(i) # Share x6 in GDPE # ;
FORMULA (all,i,SECT) SHX6(i) = [VX6(i) + TINY] / VGDPE ;

COEFFICIENT (all,i,SECT) SHZ02(i) # Share z02 in GDPE # ;
FORMULA (all,i,SECT) SHZ02(i) = [VZ02(i) + TINY] / VGDPE ;

! COEFFICIENT (Parameter) (all,i,SECT) GAM(i) # Export elasticity # ;
FORMULA (Initial) (all,i,SECT) GAM(i) = ([VZ01(i) + 0.01] / [VX4(i) + 1]) ; !

!-----------------------------------------!
!              EQUATION                   !
!-----------------------------------------!

!--------------------Final Demand----------!

EQUATION Total_demand #Total domestic demand#
(all,i,SECT) z01(i)
= sum(j,SECT,RX0(i,j,"Domestic") * x0(i,j,"Domestic"))
 + sum(j,SECT,RX1(i,j,"Domestic") *  x1(i,j,"Domestic"))
 + RX2(i,"Domestic") *  x2(i,"Domestic")
 + RX3(i,"Domestic") *  x3(i,"Domestic") + RX4(i) *  x4(i)
 + RX5(i,"Domestic") *  x5(i,"Domestic") + RX6(i) *  x6(i) ;

EQUATION Import_demand #Total import demand#
(all,i,SECT) z02(i) = sum(j,SECT,RX0(i,j,"Import") * x0(i,j,"Import"))
+ sum(j,SECT,RX1(i,j,"Import") *  x1(i,j,"Import"))
+ RX2(i,"Import") *  x2(i,"Import")
+ RX3(i,"Import") *  x3(i,"Import")
+ RX5(i,"Import") *  x5(i,"Import") ;

!-----------------Production Function----------!

EQUATION  Funcion_x0 #Sectoral produced input#
(all,i,SECT)(all,j,SECT)(all,s,SOURCE) x0(i,j,s) = z01(j) - 1 * (p0(i,s)
- SUM(r,SOURCE,SZX0(i,j,r) * p0(i,r))) ;
```

```
EQUATION Labor_demand # Labor demand # (all,j,SECT) x01(j)
= z01(j) - 1 * [p01(j) - ([SFAC1(j) * p01(j)] + [SFAC2(j) * p02(j)])] ;

EQUATION Capital_demand # Capital Demand # (all,j,SECT) x02(j)
= z01(j) - 1 * [p02(j) - ([SFAC1(j) * p01(j)] + [SFAC2(j) * p02(j)])] ;

EQUATION Indirect_taxes # Indirect taxes #
(all,j,SECT) x03(j) = p03(j) + p0(j,"Domestic") + z01(j) ;

!----------Market Clearing (Equilibrium)----------!

EQUATION Total_labor # Total labor demand #
va1 = sum(j,SECT,S01(j) * [p01(j) + x01(j)]) ;

EQUATION Total_Capital # Total Capital #
va2 = sum(j,SECT,S02(j) * [p02(j) + x02(j)]) ;

EQUATION Total_taxes # Total indirect taxes #
va3 = sum(j,SECT,S03(j) * [p03(j) + x03(j)]) ;

EQUATION Income_GDP # Income GDP #
gdpi = (H01 * va1) + (H02 * va2) + (H03 * va3);

! Capital production SZX1 !

EQUATION Subsitution_inv # Substitution of investment #
(all,i,SECT)(all,j,SECT)(all,s,SOURCE) x1(i,j,s)
= z1(j) -1* [p0(i,s) - SUM(r,SOURCE,SZX1(i,j,r) * p0(i,r))] ;

! ---------------------------------- !

EQUATION Subsitution_HH1 #Substitution of Domestic HH#
(all,i,SECT) (all,s,SOURCE) x2(i,s) = c2 - p0(i,s) ;

EQUATION Subsitution_Gov1 #Subsitution of Government#
(all,i,SECT) (all,s,SOURCE) x3(i,s) = c3 - p0(i,s) ;

EQUATION Export_dem # Export demand #
```

```
(all,i,SECT) pw1(i) = -0.01 * x4(i) + fx4(i) ;

EQUATION Inventory_Dem #Inventory Demand#
(all,i,SECT)(all,s,SOURCE) x5(i,s) = c2r ;

EQUATION Special_exp # Special Export #
(all,i,SECT) x6(i) = c2r ;

! Investment/Capital Accumulation !

Coefficient (All,j,SECT) DEP(j) # depreciation factors #;
Read DEP From File MDATA180 Header "DPRC";  ! numbers like 0.95 !

Coefficient (All,j,SECT) R_T(j) # investment/capital ratio #;
Read R_T From File MDATA180 Header "YBYK"; !  numbers like 0.08 !

Coefficient (All,j,SECT) IRG(j) # investment/capital ratio Growth #;
Read IRG From File MDATA180 Header "ICRG"; !  numbers like 0.0097 (s93),
0.0094 (rest sectors) in scenario2 for case 2!

Update (Change) (All,j,SECT)
  R_T(j) = R_T(j) * [ [(1+IRG(j))^T * z1(j)]  - k0(j) ] /100 ;

Coefficient (INTEGER) T # number of years covered by simulation #;
Formula T = 10 ;
! Read T From Terminal;    entered by user at runtime  !

Set YEARS MAXIMUM SIZE 100 SIZE T;

Coefficient (all,y,YEARS) ORD(y) # = y for y = 1 to T #;
Read ORD From File MDATA180 Header "ORDY";
! entered by user at runtime Read ORD From Terminal entered by user at runtime!

Coefficient (All,j,SECT) Z(j) # K(T)/K(0)#;
Formula (Initial) (All,j,SECT) Z(j) = 1;
Update (All,j,SECT) Z(j) = k0(j);

Coefficient (All,j,SECT) R_0(j) # Y(0)/K(0) ratio#;
```

```
Formula (Initial) (All,j,SECT) R_0(j) = R_T(j);

Coefficient (All,j,SECT) DEP_T(j) # DEP to the power of T #;
Formula (Initial) (All,j,SECT) DEP_T(j) = DEP(j)^T;

Coefficient (All,j,SECT) N_term(j) # useful constant #;
Formula (Initial) (All,j,SECT) N_term(j) =
   Sum(y,YEARS, DEP(j)^{T -ORD(y)} );!note y takes values 1 to T!

Coefficient (All,j,SECT) M_term(j) # useful constant #;
Formula (Initial) (All,j,SECT) M_term(j) =
   Sum(y,YEARS,([ORD(y)-1]/T)*DEP(j)^{T -ORD(y)} );

Coefficient (All,j,SECT) K_TERM(j) # delFudge coefficient  #;
Formula (All,j,SECT) K_TERM(j) = 100 *[DEP_T(j) - 1 + R_0(j)*N_term(j)] /Z(j);

Equation k0_f # investment/capital accumulation #
(All,j,SECT)
 k0(j) = K_TERM(j)*delFudge + M_term(j)*R_T(j)*z1(j) + f_accum(j);

EQUATION Utilization_k # Capital utilization #
(all,j,SECT) x02(j) = k0(j) ;

!----------Commodity Price Equation----------!

EQUATION Price_p0 #Commodity price define#
(all,j,SECT) [p0(j,"Domestic")+ z01(j)]
 = SUM(i,SECT,HX0(i,j,"Domestic")*[p0(i,"Domestic") + x0(i,j,"Domestic")])
+ SUM(i,SECT,HX0(i,j,"Import") * [p0(i,"Import") + x0(i,j,"Import")])
+ [HX01(j) * (p01(j) + x01(j))] + [HX02(j) * (p02(j) + x02(j))]
+ [HX03(j) * (p03(j) + p0(j,"Domestic") + z01(j))] ;

EQUATION Export_price # Export price #
(all,i,SECT) p0(i,"Domestic") = pw1(i) + v1(i) + xr ;

EQUATION Import_price # Import price #
(all,i,SECT) p0(i,"Import") = pw2(i) + v2(i) + xr ;
```

```
! Cost of Capital SZX1 !

EQUATION Capital_Cost # Investment by sector #
(all,j,SECT) pz1(j) + z1(j)
= SUM(i,SECT,HZ1(i,j,"Domestic") *[p0(i,"Domestic") + x1(i,j,"Domestic")])
+ SUM(i,SECT,HZ1(i,j,"Import") *[p0(i,"Import") + x1(i,j,"Import")]) ;

EQUATION Capital_out # Capital output #
(all,j,SECT) z1(j) = c1 - pz1(j) + p02(j) ;

! --------------------------------- !

EQUATION Inv_price #Investment price index#
 cpi1 = SUM(j,SECT,SZ1(j) * pz1(j)) ;

EQUATION Cons_price #Consumer price index#
cpi2 = SUM(i,SECT,SX2(i,"Domestic") * p0(i,"Domestic"))
 + SUM(i,SECT,SX2(i,"Import") * p0(i,"import")) ;

EQUATION Gov_price #Government price index#
cpi3 = SUM(i,SECT,SX3(i,"Domestic") * p0(i,"Domestic"))
 + SUM(i,SECT,SX3(i,"Import") * p0(i,"Import")) ;

EQUATION Real_C1 #Real investment#
c1r = c1 - cpi1 ;
EQUATION Real_C2 #Real consumption#
c2r = c2 - cpi2 ;
EQUATION Real_C3 #Real government#
c3r = c3 - cpi3 ;

EQUATION Inv_total #Total investment consumption#
c1 = gdpe ;
 EQUATION HH_total #Total HH consumption#
c2 = gdpe ;
EQUATION Gov_total #Total government consumption#
c3 = gdpe ;
```

```
EQUATION Total_export #Total exports#
e= SUM(i,SECT,HX4(i)*[pw1(i) + x4(i)]) ;

EQUATION Total_import #Total imports#
m= SUM(i,SECT,HM(i)*[pw2(i) + z02(i)]) ;



!----------Numeraire (Reference)----------!

EQUATION Balance_Trade #Odinary Change in the Balance of Trade#
 100*delBT = (VE*e) - (VM*m) ;

EQUATION Debt_GDP #Debt-GDP#
 100*VGDPE*delDT = (VE*e) - (VM*m) - [(VE - VM)*gdpe] ;

EQUATION Real_wage # Real wage #
(all,j,SECT) rp01(j) = p01(j) - cpi2 ;

EQUATION Real_cap # Real capital Rent #
(all,j,SECT) rp02(j) = p02(j) - cpi2 ;

! Column Investment SZX1 !

EQUATION Col_x1 # Column domestic investment #
(all,i,SECT) cx1(i,"Domestic")
= sum(j,SECT,RCX1(i,j,"Domestic") * x1(i,j,"Domestic")) ;

EQUATION Invest_C2 #Column import investment#
(all,i,SECT) cx1(i,"Import")
= sum(j,SECT,RCX1(i,j,"Import") * x1(i,j,"Import")) ;

! ---------- !

EQUATION Identity_GDP # Identity GDP # gdpe =
SUM(i,SECT,SHZCX1(i,"Domestic") * [p0(i,"Domestic") + cx1(i,"Domestic")])
 + SUM(i,SECT,SHZCX1(i,"Import") * [p0(i,"Import") + cx1(i,"Import")])
+ SUM(i,SECT,SHX2(i,"Domestic") * [p0(i,"Domestic") + x2(i,"Domestic")])
 + SUM(i,SECT,SHX2(i,"Import") * [p0(i,"Import") + x2(i,"Import")])
```

```
 + SUM(i,SECT,SHX3(i,"Domestic") * [p0(i,"Domestic") + x3(i,"Domestic")])
 + SUM(i,SECT,SHX3(i,"Import") * [p0(i,"Import") + x3(i,"Import")])
 + SUM(i,SECT,SHX4(i) * [p0(i,"Domestic") + x4(i)])
 + SUM(i,SECT,SHX5(i,"Domestic") * [p0(i,"Domestic") + x5(i,"Domestic")])
 + SUM(i,SECT,SHX5(i,"Import") * [p0(i,"Import") + x5(i,"Import")])
 + SUM(i,SECT,SHX6(i) * [p0(i,"Domestic") + x6(i)])
 - SUM(i,SECT,SHZ02(i) * [p0(i,"Import") + z02(i)]) ;

EQUATION GDP_Def # GDP Deflator #
gdpdf = SUM(i,SECT,SHZCX1(i,"Domestic") * p0(i,"Domestic"))
 + SUM(i,SECT,SHZCX1(i,"Import") * p0(i,"Import"))
 + SUM(i,SECT,SHX2(i,"Domestic") * p0(i,"Domestic"))
 + SUM(i,SECT,SHX2(i,"Import") * p0(i,"Import"))
 + SUM(i,SECT,SHX3(i,"Domestic") * p0(i,"Domestic"))
 + SUM(i,SECT,SHX3(i,"Import") * p0(i,"Import"))
 + SUM(i,SECT,SHX4(i) * p0(i,"Domestic"))
 + SUM(i,SECT,SHX5(i,"Domestic") * p0(i,"Domestic"))
 + SUM(i,SECT,SHX5(i,"Import") * p0(i,"Import"))
 + SUM(i,SECT,SHX6(i) * p0(i,"Domestic"))
 -  SUM(i,SECT,SHZ02(i) * p0(i,"Import")) ;

EQUATION Real_GDP #Real GDP# gdpr = gdpe - gdpdf ;

!------------------------------------------------------------!
!---   Environmental Equations (Linearized)   ----!
!------------------------------------------------------------!

!--- Petroleum refinery (oil consumption) -----!
VARIABLE oil # Oil consumption (Quantity) # ;
VARIABLE oil_v # Oil consumption (Value) # ;

COEFFICIENT (all,i,SECT) VCOM(i) # Total commodity demand # ;
FORMULA (all,i,SECT) VCOM(i) = VZ01(i) + VZ02(i) ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,SOURCE) SCX0(i,j,s)
# Share X0 in total demand # ;
FORMULA (all,i,SECT)(all,j,SECT) SCX0(i,j,"Domestic")
= [VDINPUT(i,j)+TINY]/VCOM(i) ;
```

```
FORMULA (all,i,SECT)(all,j,SECT) SCX0(i,j,"Import")
= [VMINPUT(i,j)+TINY]/VCOM(i) ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,SOURCE) SCX1(i,j,s)
# Share X1 in total demand # ;
FORMULA (all,i,SECT)(all,j,SECT) SCX1(i,j,"Domestic")
= [VDX1(i,j)+TINY]/VCOM(i) ;
FORMULA (all,i,SECT)(all,j,SECT) SCX1(i,j,"Import")
= [VMX1(i,j)+TINY]/VCOM(i) ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SCX2(i,s)
# Share X2 in total demand # ;
FORMULA (all,i,SECT) SCX2(i,"Domestic")
= [VDX2(i)+TINY]/VCOM(i) ;
FORMULA (all,i,SECT) SCX2(i,"Import")
= [VMX2(i)+TINY]/VCOM(i) ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SCX3(i,s)
# Share X3 in total demand # ;
FORMULA (all,i,SECT) SCX3(i,"Domestic")
= [VDX3(i)+TINY]/VCOM(i) ;
FORMULA (all,i,SECT) SCX3(i,"Import")
= [VMX3(i)+TINY]/VCOM(i) ;

COEFFICIENT (all,i,SECT) SCX4(i)
# Share X4 in total demand # ;
FORMULA (all,i,SECT) SCX4(i) = [VX4(i)+TINY]/VCOM(i) ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SCX5(i,s)
# Share X5 in total demand # ;
FORMULA (all,i,SECT) SCX5(i,"Domestic")
= [VDX5(i)+TINY]/VCOM(i) ;
FORMULA (all,i,SECT) SCX5(i,"Import")
= [VMX5(i)+TINY]/VCOM(i) ;

COEFFICIENT (all,i,SECT) SCX6(i)
# Share X6 in total demand # ;
FORMULA (all,i,SECT) SCX6(i) = [VX6(i)+TINY]/VCOM(i) ;
```

```
EQUATION refinary # Oil consumption (Quantity) #
oil = sum(j,SECT,SCX0("s93",j,"Domestic")*x0("s93",j,"Domestic"))
+ sum(j,SECT,SCX0("s93",j,"Import")*x0("s93",j,"Import"))
+ sum(j,SECT,SCX1("s93",j,"Domestic")*x1("s93",j,"Domestic"))
+ sum(j,SECT,SCX1("s93",j,"Import")*x1("s93",j,"Import"))
+ SCX2("s93","Domestic")*x2("s93","Domestic")
+ SCX2("s93","Import")*x2("s93","Import")
+ SCX3("s93","Domestic")*x3("s93","Domestic")
+ SCX3("s93","Import")*x3("s93","Import")
+ SCX4("s93")*x4("s93")
+ SCX5("s93","Domestic")*x5("s93","Domestic")
+ SCX5("s93","Import")*x5("s93","Import")
+ SCX6("s93")*x6("s93") ;

EQUATION refiery_v # Oil consumption (Value) #
oil_v =
sum(j,SECT,SCX0("s93",j,"Domestic")*[p0("s93","Domestic")+x0("s93",j,"Domestic")])
+ sum(j,SECT,SCX0("s93",j,"Import")*[p0("s93","Import")+x0("s93",j,"Import")])
+ sum(j,SECT,SCX1("s93",j,"Domestic")*[p0("s93","Domestic")+x1("s93",j,"Domestic")])
+ sum(j,SECT,SCX1("s93",j,"Import")*[p0("s93","Import")+x1("s93",j,"Import")])
+ SCX2("s93","Domestic")*[p0("s93","Domestic")+x2("s93","Domestic")]
+ SCX2("s93","Import")*[p0("s93","Import")+x2("s93","Import")]
+ SCX3("s93","Domestic")*[p0("s93","Domestic")+x3("s93","Domestic")]
+ SCX3("s93","Import")*[p0("s93","Import")+x3("s93","Import")]
+ SCX4("s93")*[p0("s93","Domestic")+ x4("s93")]
+ SCX5("s93","Domestic")*[p0("s93","Domestic")+x5("s93","Domestic")]
+ SCX5("s93","Import")*[p0("s93","Import")+x5("s93","Import")]
+ SCX6("s93")*[p0("s93","Domestic")+x6("s93")] ;

!--- Oil consumption in Final Demand -----!

VARIABLE oil_fd # Oil consumption in Final Demand (Quantity) # ;
VARIABLE oil_fdv # Oil consumption in Final Demand (Value) # ;

COEFFICIENT (all,i,SECT) VFDD(i) # Final Demand Domestic # ;
FORMULA (all,i,SECT) VFDD(i) = sum(j,SECT,VDX1(i,j)) + VDX2(i) + VDX3(i)
```

```
+ VX4(i) + VDX5(i) + VX6(i) ;

COEFFICIENT (all,i,SECT) VFDM(i) # Final Demand Import # ;
FORMULA (all,i,SECT) VFDM(i) = sum(j,SECT,VMX1(i,j)) + VMX2(i) + VMX3(i)
+ VMX5(i) ;

COEFFICIENT (all,i,SECT) VFDT(i) # Total Oil Final Demand # ;
FORMULA (all,i,SECT) VFDT(i) = VFDD(i) + VFDM(i) ;



COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,source) SFDX1(i,j,s)
# Share X1 in Final Demand # ;
FORMULA (all,i,SECT)(all,j,SECT) SFDX1(i,j,"Domestic")
= [VDX1(i,j) + TINY]/VFDT(i) ;
FORMULA (all,i,SECT)(all,j,SECT) SFDX1(i,j,"Import")
= [VMX1(i,j) + TINY]/VFDT(i) ;

COEFFICIENT (all,i,SECT)(all,s,source) SFDX2(i,s)
# Share X2 in Final Demand # ;
FORMULA (all,i,SECT) SFDX2(i,"Domestic")
= [VDX2(i) + TINY]/VFDT(i) ;
FORMULA (all,i,SECT) SFDX2(i,"Import")
= [VMX2(i) + TINY]/VFDT(i) ;

COEFFICIENT (all,i,SECT)(all,s,source) SFDX3(i,s)
# Share X3 in Final Demand # ;
FORMULA (all,i,SECT) SFDX3(i,"Domestic")
= [VDX3(i) + TINY]/VFDT(i) ;
FORMULA (all,i,SECT) SFDX3(i,"Import")
= [VMX3(i) + TINY]/VFDT(i) ;

COEFFICIENT (all,i,SECT) SFDX4(i)
# Share X4 in Final Demand # ;
FORMULA (all,i,SECT) SFDX4(i)
= [VX4(i) + TINY]/VFDT(i) ;

COEFFICIENT (all,i,SECT)(all,s,source) SFDX5(i,s)
# Share X5 in Final Demand # ;
```

```
FORMULA (all,i,SECT) SFDX5(i,"Domestic")
= [VDX5(i) + TINY]/VFDT(i) ;
FORMULA (all,i,SECT) SFDX5(i,"Import")
= [VMX5(i) + TINY]/VFDT(i) ;

COEFFICIENT (all,i,SECT) SFDX6(i)
# Share X6 in Final Demand # ;
FORMULA (all,i,SECT) SFDX6(i)
= [VX6(i) + TINY]/VFDT(i) ;

EQUATION refiery_fd # Oil consumption in final demand (Quantity) #
oil_fd = sum(j,SECT,SFDX1("s93",j,"Domestic")*x1("s93",j,"Domestic"))
+ sum(j,SECT,SFDX1("s93",j,"Import")*x1("s93",j,"Import"))
+ SFDX2("s93","Domestic")*x2("s93","Domestic")
+ SFDX2("s93","Import")*x2("s93","Import")
+ SFDX3("s93","Domestic")*x3("s93","Domestic")
+ SFDX3("s93","Import")*x3("s93","Import")
+ SFDX4("s93")*x4("s93")
+ SFDX5("s93","Domestic")*x5("s93","Domestic")
+ SFDX5("s93","Import")*x5("s93","Import")
+ SFDX6("s93")*x6("s93") ;

EQUATION refiery_fdv # Oil consumption in final demand (Value) #
oil_fdv =
sum(j,SECT,SFDX1("s93",j,"Domestic")*[p0("s93","Domestic")+x1("s93",j,"Domestic")])
+ sum(j,SECT,SFDX1("s93",j,"Import")*[p0("s93","Import")+x1("s93",j,"Import")])
+ SFDX2("s93","Domestic")*[p0("s93","Domestic")+x2("s93","Domestic")]
+ SFDX2("s93","Import")*[p0("s93","Import")+x2("s93","Import")]
+ SFDX3("s93","Domestic")*[p0("s93","Domestic")+x3("s93","Domestic")]
+ SFDX3("s93","Import")*[p0("s93","Import")+x3("s93","Import")]
+ SFDX4("s93")*[p0("s93","Domestic")+ x4("s93")]
+ SFDX5("s93","Domestic")*[p0("s93","Domestic")+x5("s93","Domestic")]
+ SFDX5("s93","Import")*[p0("s93","Import")+x5("s93","Import")]
+ SFDX6("s93")*[p0("s93","Domestic")+x6("s93")] ;

!--- Oil consumption in intermediate -----!

VARIABLE oil_int # Oil consumption in intermediate (Quantity) # ;
```

```
VARIABLE oil_intv # Oil consumption in intermediate (Value) # ;

COEFFICIENT (all,i,SECT) VIND(i) # Domestic intermediate demand # ;
FORMULA (all,i,SECT) VIND(i) = VZ01(i) -VFDD(i) ;
COEFFICIENT (all,i,SECT) VINM(i) # Import intermediate demand # ;
FORMULA (all,i,SECT) VINM(i) = VZ02(i) -VFDM(i) ;

COEFFICIENT (all,i,SECT) VINT(i) # Total intermediate demand # ;
FORMULA (all,i,SECT) VINT(i) = VIND(i) + VINM(i) ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,SOURCE) SINX0(i,j,s)
# Share X0 in total intermediate demand # ;
FORMULA (all,i,SECT)(all,j,SECT) SINX0(i,j,"Domestic")
= [VDINPUT(i,j)+TINY]/VINT(i) ;
FORMULA (all,i,SECT)(all,j,SECT) SINX0(i,j,"Import")
= [VMINPUT(i,j)+TINY]/VINT(i) ;

EQUATION refinary_int # Oil consumption in intermediate (Quantity) #
oil_int = sum(j,SECT,SINX0("s93",j,"Domestic")*x0("s93",j,"Domestic"))
+ sum(j,SECT,SINX0("s93",j,"Import")*x0("s93",j,"Import")) ;

EQUATION refiery_intv # Oil consumption in intermediate (Value) #
oil_intv =
sum(j,SECT,SINX0("s93",j,"Domestic")*[p0("s93","Domestic")+x0("s93",j,"Domestic")])
+ sum(j,SECT,SINX0("s93",j,"Import")*[p0("s93","Import")+x0("s93",j,"Import")]) ;

!---   Oil excluding export and special export   ----!

!--- Petroleum refinery (oil consumption) -----!
VARIABLE oil_nx # Oil consumption no export (Quantity) # ;
VARIABLE oil_v_nx # Oil consumption no export (Value) # ;

COEFFICIENT (all,i,SECT) VCOM_nx(i) # Total commodity demand # ;
FORMULA (all,i,SECT) VCOM_nx(i) = VZ01(i) + VZ02(i) - VX4(i) - VX6(i) ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,SOURCE) SCX0_nx(i,j,s)
# Share X0 in total demand # ;
FORMULA (all,i,SECT)(all,j,SECT) SCX0_nx(i,j,"Domestic")
```

```
= [VDINPUT(i,j)+TINY]/VCOM_nx(i) ;

FORMULA (all,i,SECT)(all,j,SECT) SCX0_nx(i,j,"Import")
= [VMINPUT(i,j)+TINY]/VCOM_nx(i) ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,SOURCE) SCX1_nx(i,j,s)
# Share X1 in total demand # ;
FORMULA (all,i,SECT)(all,j,SECT) SCX1_nx(i,j,"Domestic")
= [VDX1(i,j)+TINY]/VCOM_nx(i) ;
FORMULA (all,i,SECT)(all,j,SECT) SCX1_nx(i,j,"Import")
= [VMX1(i,j)+TINY]/VCOM_nx(i) ;
COEFFICIENT (all,i,SECT)(all,s,SOURCE) SCX2_nx(i,s)
# Share X2 in total demand # ;
FORMULA (all,i,SECT) SCX2_nx(i,"Domestic")
= [VDX2(i)+TINY]/VCOM_nx(i) ;
FORMULA (all,i,SECT) SCX2_nx(i,"Import")
= [VMX2(i)+TINY]/VCOM_nx(i) ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SCX3_nx(i,s)
# Share X3 in total demand # ;
FORMULA (all,i,SECT) SCX3_nx(i,"Domestic")
= [VDX3(i)+TINY]/VCOM_nx(i) ;
FORMULA (all,i,SECT) SCX3_nx(i,"Import")
= [VMX3(i)+TINY]/VCOM_nx(i) ;

COEFFICIENT (all,i,SECT)(all,s,SOURCE) SCX5_nx(i,s)
# Share X5 in total demand # ;
FORMULA (all,i,SECT) SCX5_nx(i,"Domestic")
= [VDX5(i)+TINY]/VCOM_nx(i) ;
FORMULA (all,i,SECT) SCX5_nx(i,"Import")
= [VMX5(i)+TINY]/VCOM_nx(i) ;

EQUATION refinary_nx # Oil consumption no export (Quantity) #
oil_nx = sum(j,SECT,SCX0_nx("s93",j,"Domestic")*x0("s93",j,"Domestic"))
+ sum(j,SECT,SCX0_nx("s93",j,"Import")*x0("s93",j,"Import"))
+ sum(j,SECT,SCX1_nx("s93",j,"Domestic")*x1("s93",j,"Domestic"))
+ sum(j,SECT,SCX1_nx("s93",j,"Import")*x1("s93",j,"Import"))
+ SCX2_nx("s93","Domestic")*x2("s93","Domestic")
```

```
+ SCX2_nx("s93","Import")*x2("s93","Import")
+ SCX3_nx("s93","Domestic")*x3("s93","Domestic")
+ SCX3_nx("s93","Import")*x3("s93","Import")
+ SCX5_nx("s93","Domestic")*x5("s93","Domestic")
+ SCX5_nx("s93","Import")*x5("s93","Import") ;

EQUATION refiery_v_nx # Oil consumption no export (Value) #
oil_v_nx =
sum(j,SECT,SCX0_nx("s93",j,"Domestic")*[p0("s93","Domestic")+x0("s93",j,"Domestic")])
+ sum(j,SECT,SCX0_nx("s93",j,"Import")*[p0("s93","Import")+x0("s93",j,"Import")])
+ sum(j,SECT,SCX1_nx("s93",j,"Domestic")*[p0("s93","Domestic")+x1("s93",j,"Domestic")])
+ sum(j,SECT,SCX1_nx("s93",j,"Import")*[p0("s93","Import")+x1("s93",j,"Import")])
+ SCX2_nx("s93","Domestic")*[p0("s93","Domestic")+x2("s93","Domestic")]
+ SCX2_nx("s93","Import")*[p0("s93","Import")+x2("s93","Import")]
+ SCX3_nx("s93","Domestic")*[p0("s93","Domestic")+x3("s93","Domestic")]
+ SCX3_nx("s93","Import")*[p0("s93","Import")+x3("s93","Import")]
+ SCX5_nx("s93","Domestic")*[p0("s93","Domestic")+x5("s93","Domestic")]
+ SCX5_nx("s93","Import")*[p0("s93","Import")+x5("s93","Import")] ;

!--- Oil consumption in Final Demand no export -----!
VARIABLE oil_fd_nx # Oil consumption in Final Demand no export (Quantity) # ;
VARIABLE oil_fdv_nx # Oil consumption in Final Demand no export (Value) # ;

COEFFICIENT (all,i,SECT) VFDD_nx(i) # Final Demand Domestic # ;
FORMULA (all,i,SECT) VFDD_nx(i) = sum(j,SECT,VDX1(i,j)) + VDX2(i) + VDX3(i)
+ VDX5(i) ;
COEFFICIENT (all,i,SECT) VFDM_nx(i) # Final Demand Import # ;
FORMULA (all,i,SECT) VFDM_nx(i) = sum(j,SECT,VMX1(i,j)) + VMX2(i) + VMX3(i)
+ VMX5(i) ;

COEFFICIENT (all,i,SECT) VFDT_nx(i) # Total Oil Final Demand # ;
FORMULA (all,i,SECT) VFDT_nx(i) = VFDD_nx(i) + VFDM_nx(i) ;

COEFFICIENT (all,i,SECT)(all,j,SECT)(all,s,source) SFDX1_nx(i,j,s)
# Share X1 in Final Demand # ;
FORMULA (all,i,SECT)(all,j,SECT) SFDX1_nx(i,j,"Domestic")
= [VDX1(i,j) + TINY]/VFDT_nx(i) ;
FORMULA (all,i,SECT)(all,j,SECT) SFDX1_nx(i,j,"Import")
```

```
= [VMX1(i,j) + TINY]/VFDT_nx(i) ;

COEFFICIENT (all,i,SECT)(all,s,source) SFDX2_nx(i,s)
# Share X2 in Final Demand # ;
FORMULA (all,i,SECT) SFDX2_nx(i,"Domestic")
= [VDX2(i) + TINY]/VFDT_nx(i) ;
FORMULA (all,i,SECT) SFDX2_nx(i,"Import")
= [VMX2(i) + TINY]/VFDT_nx(i) ;

COEFFICIENT (all,i,SECT)(all,s,source) SFDX3_nx(i,s)
# Share X3 in Final Demand # ;
FORMULA (all,i,SECT) SFDX3_nx(i,"Domestic")
= [VDX3(i) + TINY]/VFDT_nx(i) ;
FORMULA (all,i,SECT) SFDX3_nx(i,"Import")
= [VMX3(i) + TINY]/VFDT_nx(i) ;

COEFFICIENT (all,i,SECT)(all,s,source) SFDX5_nx(i,s)
# Share X5 in Final Demand # ;
FORMULA (all,i,SECT) SFDX5_nx(i,"Domestic")
= [VDX5(i) + TINY]/VFDT_nx(i) ;
FORMULA (all,i,SECT) SFDX5_nx(i,"Import")
= [VMX5(i) + TINY]/VFDT_nx(i) ;

EQUATION refiery_fd_nx # Oil consumption in final demand no export (Quantity) #
oil_fd_nx = sum(j,SECT,SFDX1_nx("s93",j,"Domestic")*x1("s93",j,"Domestic"))
+ sum(j,SECT,SFDX1_nx("s93",j,"Import")*x1("s93",j,"Import"))
+ SFDX2_nx("s93","Domestic")*x2("s93","Domestic")
+ SFDX2_nx("s93","Import")*x2("s93","Import")
+ SFDX3_nx("s93","Domestic")*x3("s93","Domestic")
+ SFDX3_nx("s93","Import")*x3("s93","Import")
+ SFDX5_nx("s93","Domestic")*x5("s93","Domestic")
+ SFDX5_nx("s93","Import")*x5("s93","Import") ;

EQUATION refiery_fdv_nx # Oil consumption in final demand no export (Value) #
oil_fdv_nx =
sum(j,SECT,SFDX1_nx("s93",j,"Domestic")*[p0("s93","Domestic")+x1("s93",j,"Domestic")])
+ sum(j,SECT,SFDX1_nx("s93",j,"Import")*[p0("s93","Import")+x1("s93",j,"Import")])
+ SFDX2_nx("s93","Domestic")*[p0("s93","Domestic")+x2("s93","Domestic")]
```

```
+ SFDX2_nx("s93","Import")*[p0("s93","Import")+x2("s93","Import")]
+ SFDX3_nx("s93","Domestic")*[p0("s93","Domestic")+x3("s93","Domestic")]
+ SFDX3_nx("s93","Import")*[p0("s93","Import")+x3("s93","Import")]
+ SFDX5_nx("s93","Domestic")*[p0("s93","Domestic")+x5("s93","Domestic")]
+ SFDX5_nx("s93","Import")*[p0("s93","Import")+x5("s93","Import")] ;

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Appendix C

Thai Poem for Summary of Dissertation: Transparency Economy

BIOGRAPHY

NAME	Mr. Rapee Pholpanich
ACADEMIC BACKGROUND	Bechelor's Degree with major in Agricultural Economic, Kasetsart University, Bangkok, Thailand in 1997 Master's Degree in Environmental Management, The Graduate School of Social and Environmental Development, National Institute of Development Administration (NIDA) in 2007
PRESENT POSITION	2015-Present: Independent Researcher 2004-2011: Senior Researcher at Thailand Development Research Institute (TDRI) 1999-2001: Researcher, and Planning and Policy Analyst at Kasetsart University (Sri Racha Campus)